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| RESEARCH ARTICLE

Paternal Nutritional Knowledge and Its Effectiveness in Shaping Maternal Health and Fetal Outcomes in Rural Ghana

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| ABSTRACT
This study examined the influence of paternal nutritional knowledge on maternal health and fetal outcomes in Mamprugu-Moaduri and Gushegu Districts of Northern Ghana using a quasi-experimental mixed-methods design. A total of 320 participants (200 fathers, 120 mothers) were recruited. Quantitative results showed moderate paternal nutritional knowledge (mean score = 58.3%, SD = 12.5), with significant associations between higher knowledge and improved maternal dietary diversity ($\beta = 0.34$, $p < 0.05$). Maternal anemia prevalence declined from 41% to 32% in the intervention group compared with 43% in controls ($\chi^2 = 6.21$, $p = 0.013$), while adequate gestational weight gain improved to 68% versus 52% ($\chi^2 = 7.84$, $p = 0.005$). Fetal outcomes also improved, with mean birth weight rising from 2.82 kg to 3.12 kg ($t = 2.97$, $p = 0.003$) and low birth weight incidence decreasing from 18% to 11%. Qualitative findings reinforced these results, highlighting fathers' roles in household food allocation. The study underscores the value of father-inclusive nutrition interventions in rural Ghana.

| KEYWORDS

Paternal Nutrition, Maternal Health, Fetal Outcomes, Dietary Diversity and Rural Ghana

| ARTICLE INFORMATION

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1. Introduction

Pregnancy health research has traditionally targeted maternal nutrition as a key focus, and interventions have focused on dietary intake, micronutrient supplementation, and weight gain during pregnancy. However, current evidence indicates that paternal nutritional knowledge and preconception health play a crucial role in maternal care and pregnancy outcomes following the intervention. Paternal Origins of Health and Disease (POHaD) provides a conceptual framework to enhance the Developmental Origins of Health and Disease (DOHaD) framework that highlights how diets and lifestyle choices by fathers before conception can affect sperm epigenetics, placental function, and fetal development (de la Iglesia et al., 2025).

Available evidence has shown that paternal dietary patterns (high-fat or low-protein diets) may modify sperm epigenomes and gene expression in descendants, raising the risk of fetal growth restriction, placental insufficiency, and maternal problems, such as preeclampsia (Tian et al. 2025). Human cohort studies (e.g., STEPS study in Finland) have already started to investigate the associations between paternal BMI, diet quality, and measures of offspring birth, yet the results are not definitive (Kearns et al., 2025). In LMICs such as Ghana, paternal participation in maternal nutrition is scarce, with the majority of interventions focusing on mothers only (Martin et al., 2021).

However, fathers were, in many cases, more influential in the distribution and decision-making of household dietary resources, and they also supported maternal dietary practices. Without proper paternal nutritional knowledge, maternal compliance may be suboptimal with diet advice related to outcomes (maternal and fetal). Closing this gap would serve as a way to enhance family-based nutritional interventions and optimize pregnancy outcomes in resource-poor areas.

Despite increased awareness that paternal influence on reproductive health is growing, current research and intervention strategies are limited to mothers. Such imbalance also fails to account for the important effect of fathers in determining maternal nutrition and outcomes for their fetuses. Men are, in most Ghanaian households, the main decision makers when purchasing and allocating food and other resources. Their understanding (or lack of it) about nutrition has a clear effect on the quality and variety of foods available to pregnant women.

Recent worldwide evidence highlights the biological pathways through which paternal nutrition affects fetal development of the fetus. Paternal diets that change have been linked to epigenetic modifications in sperm, which would affect both the effect of affecting both embryos and the placenta (de la Iglesia et al., 2025). Such alterations may then contribute to unfavorable pregnancy outcomes, such as reduced fetal growth and maternal complications, including preeclampsia. Most of the evidence, however, comes from animal models or high-income country cohorts, leaving a wide evidence gap when it comes to LMICs such as Ghana. In addition, systematic reviews have shown that interventions involving fathers in maternal and child nutrition are few in number and that those interventions do not address gender norms and a process of choice (Martin et al., 2021; Tokhi et al., 2018).

This omission is important, since cultural expectations in Ghana often restrict women's opportunities for autonomy in dietary choices. Lack of support and information from fathers hampers maternal compliance with dietary recommendations, compromising the effectiveness of nutrition programmes. No significant association was found in the STEPS study between paternal BMI or diet quality during pregnancy and measures of offspring birth (Kearns et al., 2025). But this emphasizes the need for more context-based research on information in relation to paternal nutritional knowledge rather than BMI as a sole predictor of maternal and fetal outcomes. Knowledge asymmetry about portion size, micronutrient needs, and culturally relevant dietary practices may have a greater influence on maternal adherence than body composition by the father. Maternal malnutrition and anemia continue to be major concerns in Ghana, and this is a crucial area where father education in nutrition can be integrated into antenatal counselling and community programs for effective use.

Although paternal understanding is believed essential, there is little empirical evidence on how paternal knowledge can link to maternal dietary patterns and fetal health outcomes. Filling this gap is of the utmost necessity to design comprehensive, family-centred interventions that are beneficial for pregnancy and mitigate intergenerational health outcomes. This study sought to explore the association between paternal nutritional knowledge and maternal dietary practices during pregnancy, and whether it can guide maternal health and fetal health outcomes in rural Ghana. It identified knowledge gaps and recommended strategies to improve the interaction between fathers and nutrition interventions.

2. Literature Review

The study is based on the Paternal Origins of Health and Disease (POHaD) paradigm, an expansion of the Developmental Origins of Health and Disease (DOHaD) framework. The study highlights that paternal nutritional characteristics and lifestyle, during the period before conception, affect the health of offspring via epigenetics in sperm and embryonic and placental development (de la Iglesia et al., 2025). Applying the Transtheoretical Model of Behavior Change, the Transtheoretical Model of behavior change provides a perspective on how paternal nutritional knowledge leads to maternal support and behavioral change, and on how paternal nutritional knowledge is translated into behavioral strategies for optimal practices for maternal health, among other things. Collectively, these frameworks underscore the impact of the role of paternal knowledge, behavior, and biological processes on maternal and fetal health outcomes.

Maternal nutrition, as the basis of reproductive health research, has historically been the primary focus of research. Frequent studies, however, highlight the correlation between paternal nutritional knowledge and preconception health. Evidence indicates that paternal food choices either a high-fat or low-protein diet can modify the sperm epigenome and contribute to negative pregnancy experiences, such as fetal development restriction and maternal complications, including preeclampsia (de la Iglesia et al., 2025). Such findings underscore the biological routes through which paternal nutrition influences maternal and fetal well-being. A narrative review by Jahan-Mihan et al. (2024) summarized evidence regarding parental preconception nutrition, body weight, and exercise intake and showed that paternal obesity and a poor diet are associated with metabolic disorders in offspring, such as type 2 diabetes and cardiovascular disease. The review highlighted epigenetic mechanisms that mediated these effects: DNA methylation and non-coding RNA in sperm, for example. Notwithstanding, micronutrient deficiencies e.g., in folic acid, iron, iodine, and vitamin D were associated with developmental disorders, emphasizing paternal nutritional education.

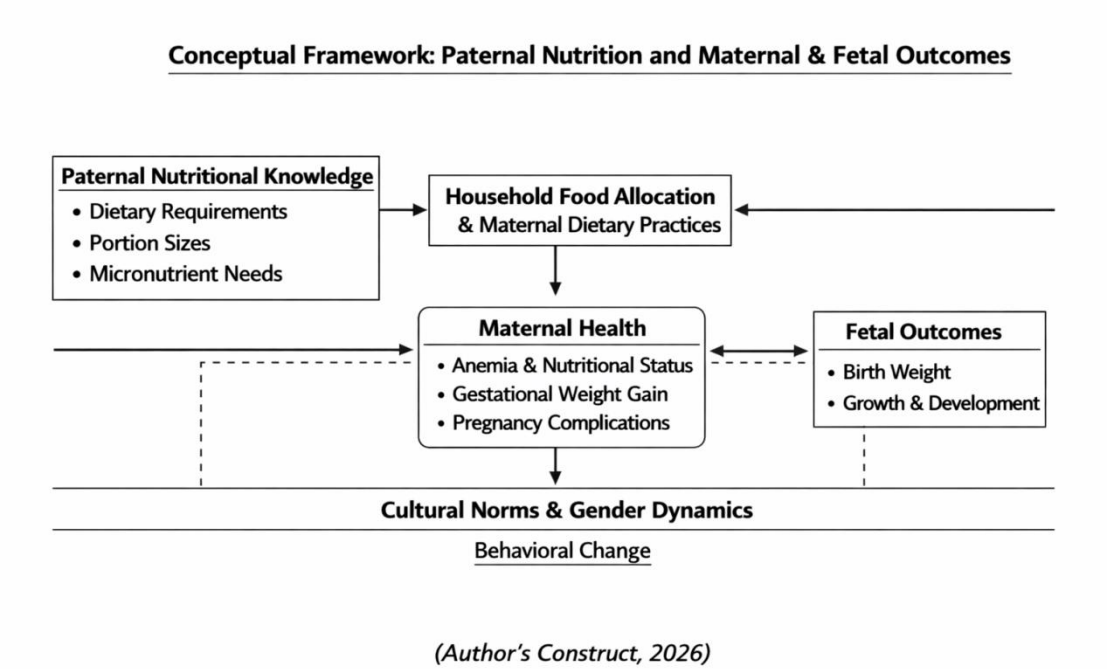
Further, Johnson et al. (2025) recently reviewed the literature and systematically reviewed the literature on paternal factors in placental development and pregnancy-related disorders. Findings showed that paternal age, smoking, and exposure to chemicals significantly affected placental function and increased the risk of preeclampsia, preterm birth, and stillbirth. This research contributes further evidence on the roles of prenatal health factors beyond conception; it highlights maternal health trajectories during pregnancy. In Ghana and other LMICs, the paternal role in maternal nutrition is often marginal. Martin et al. (2021) found that interventions are often directed toward mothers alone, ignoring the role of fathers in household food allocation and decision-making. This disparity is crucial because of cultural norms that often place authority over household resources with men. In the absence of adequate paternal nutritional knowledge, maternal adherence to dietary guidance might be hindered. This issue is underscored by local studies: Azumah and Ali (2025) showed that poor post-harvest handling and consumption practices of fruits and vegetables among teenage mothers in rural Ghana limited maternal dietary diversity during pregnancy and postpartum. In a similar vein, Ali and Ali (2025) found that feeding practices in neonates with sepsis were influenced by caregiver knowledge gaps and facility limitations, highlighting the need for family-centered nutrition education in rural health systems. The psychosocial aspects of paternal involvement are also empirically supported by the literature. Tokhi et al. (2018) proved that involving men in maternal and infant health interventions improved maternal diet behaviors and health. Such interventions, however, are few in number and address gender norms that constrain women's autonomy. Given that maternal malnutrition and anemia are still widespread in Ghana, the inclusion of nutritional education for paternal care in antenatal settings can improve maternal diet diversity and fetal growth.

Despite these insights, most studies focus on high-income countries, with little empirical data from LMICs. For example, in Finland, the STEPS study found no positive association between paternal BMI and diet quality and offspring birth measures (Kearns et al., 2025). As such, there is a need for contextually tailored research in rural Ghana, where dietary practices, cultural practices, and resources vary significantly. The existing literature discusses biological and behavioral pathways connecting paternal nutrition to maternal and fetal outcomes, although evidence from LMICs, especially Ghana, is lacking. Though Azumah and Ali (2025) and Ali and Ali (2025) offer some data on maternal and neonatal nutrition problems, they do not address the issue of paternal nutritional knowledge. This void imposes constraints on designing family-based nutritional interventions. The conceptual model links the POHaD paradigm with behavioral change theory to explain the impact of paternal nutritional awareness on maternal health and fetal development. The knowledge of dietary needs and portion sizes, as well as micronutrient requirements, by fathers directs household food allocation and maternal dietary practices. These practices indirectly impact maternal health metrics, including anemia, gestational weight gain, and pregnancy issues.

Figure 1 presents how biological influences of paternal preconception nutrition, including reproductive influences on sperm epigenetics, affect both placental and fetal development throughout the paternal reproductive cycle. Cultural differences in gender roles and norms are moderating factors that enhance or constrain the transfer of paternal knowledge to maternal dietary compliance. The model suggests that enhanced paternal nutritional knowledge promotes maternal dietary diversity of diet and feeding, which in turn improves fetal health outcomes

(birth weight and growth trajectory). This underscores the requirement for interventions that include participation between fathers and mothers in nutrition education and counselling, especially in rural Ghana.

Figure 1



(Author's Construct, 2026)

3. Methodology

3.1 Study Design

This was a quasi-experimental mixed-methods study that compared the role of paternal nutritional knowledge on maternal health and fetal outcomes in rural Ghana. The quasi-experimental design was chosen because random assignment was unable to occur in community settings, but it was able to compare intervention and control groups, allowing for the determination of causal relationships (Creswell & Plano Clark, 2023). This mixed-methods report drew on quantitative and qualitative data to derive quantitative evidence in combination with qualitative data describing the behavioral and cultural antecedents of nutrition practice (Azumah & Ali, 2025; Martin et al., 2021).

3.2 Study Setting

The study was conducted in the northern region of Ghana in Mamprugu-Moaduri and Gushegu Districts. Both are primarily agrarian territories, with families largely relying on subsistence farming and seasonal agricultural techniques.

Mamprugu-Moaduri District has an estimated population of around 63,000 and a young age structure, with over 40 percent of the population being under 15 years of age. The district encompasses a polyclinic and multiple CHPS compounds; however, health provision in the district is sparse due to isolated settlements. The prevalence of maternal anemia is greater than 40 percent, fertility is 4.5 children per woman on average, and child stunting is 23-25 percent among children under 5 years of age, indicating continuous food insecurity and inadequate dietary patterns (GSS, 2025; Ministry of Finance, 2025).

The Gushegu District population is about 135,000 people, and is similar in demography. Fertility is slightly higher, at about 4.7 children per woman on average, while the prevalence of maternal anemia is roughly 42 percent, one of the highest in the Northern Region. Undernutrition rate among children is high, with wasting at around 11 per cent and stunting at 24 per cent. Maternal and child health services are further complicated by existing gaps in

infrastructure and personnel which, especially for long distance to referral facilities, makes access to health services a challenge. We selected these districts for their demographic comparability, prevalence of maternal malnutrition and anemia, and implementation of active community-based health programs to serve as the foundation for intervention. Because both districts share a common morbidity of maternal anemia and child stunting through double burden of malnutrition, they constitute suitable sites for an emphasis on the role of paternal knowledge of nutrition in maternal dietary practice and fetal outcomes (Ali & Ali, 2025; Azumah & Ali, 2025).

3.3 Study Population

The study population included husbands of pregnant women and lactating mothers and public health workers who work in maternal and child nutrition programs. In the survey, fathers aged 18 years and above who had lived in the districts for at least one year and with their partner, in pregnancy or birth within six months, were considered. Maternal chronic diseases or pregnancy complications that were not related to nutrition were not entered into the baseline. Sampling and Sample Size:

There were 320 participants recruited, with 160 from each district. The sample contained 200 fathers and 120 mothers. The sample size was estimated based on Cochran's formula for quasi-experimental research, involving a 95% confidence level and 5% margin of error. A multistage sampling method was adopted; communities were randomly selected, and households were systematically sampled before the selected members of families were systematically sampled, and eligible members from community health volunteers were recruited. In the qualitative approach, there were six Focus Group Discussions (FGDs), and ten Key Informant Interviews (KIIs), including health workers, traditional leaders, officers of nutrition, and others.

3.4 Intervention Design

The study used a quasi-experimental mixed-methods design and was nested within a pregnancy school intervention described earlier by Ali, Ali, and Fatahi (2025). The intervention that we developed involved fathers attending a nutrition education programme on dietary needs, portion sizes, and micronutrient requirements, specifically during pregnancy. The intervention group was instructed to receive structured sessions led by trained nutrition educators, whereas the control group received standard antenatal care without paternal involvement. The program was implemented for 8 weeks and was evaluated for maternal nutrition, health indicators, as well as fetal outcomes after the intervention.

3.5 Data Collection Instruments

Quantitative data were gathered using an objective questionnaire with validated instruments based on studies (Martin et al., 2021; Azumah & Ali, 2025). The questionnaire also collected socio-demographic information, paternal nutritionally relevant knowledge of the family, household food distribution, maternal eating behavior, and pregnancy history. In the analysis, we collected qualitative data via the semi-structured interview guides to explore cultural norms, gender tensions, and views regarding paternal roles in maternal nutrition.

3.6 Data Collection Procedure

Mampruli and Dagbani-trained research assistants responded by administering the questionnaires in person through face-to-face interviews. FGDs and KIIs were audio-recorded following participant consent. Prior to the intervention, baseline data were collected, and follow-up data were gathered soon after follow-up (e.g. after the 8-week programme).

3.7 Data analysis

Quantitative data and statistical analysis were performed on the survey data using SPSS version 27. The demographics and knowledge scores were summarized descriptively. Inferential analyses, including paired t-tests and multiple regression, assessed changes in maternal dietary behaviours and fetal outcomess in the intervention and control groups. Qualitative data were transcribed to text and analyzed with NVivo 14 thematically under the

frameworks of the TTM and POHaD (de la Iglesia et al., 2025). Results were incorporated in the interpretation phase to provide triangulation of both quantitative and qualitative evidence and to strengthen validity (Creswell & Plano Clark, 2023).

3.8 Validity and Reliability

The instrument validity in the nearby area was examined in a pilot study based on expert consensus and pilot testing in relation to cultural appropriateness and clarity. Cronbach's alpha coefficients ($\alpha > 0.70$) supported internal consistency, which established credibility for the measurement of paternal nutritional knowledge (Taber, 2018). Additional rigor was provided through triangulation of quantitative surveys, qualitative interviews, and focus group conversationss (Creswell & Plano Clark, 2023).

3.9 Ethical Considerations

Ethical approval was obtained from the Ghana Health Service Ethics Review Committee. Participants were informed of the study aims, procedures, risks, and benefits, with written or oral consent according to literacy (WHO, 2022). Responses were anonymized, and password-protected file privacy was employed to store anonymized data. Participation was completely voluntary, and participants were free to withdraw at any time without any punitive measures. Among the topics investigated, particularly vulnerable groups, as teenage mothers, were given special consideration in terms of avoiding coercion and preserving beneficence (Azumah & Ali, 2025). Building trust and cultural sensitivity for community leaders was done in accordance with best-practice ethical research practices conducted in rural Ghana (Ali & Ali, 2025; Martin et al., 2021).

4. Results and Findings

4.1 Socio-Demographic Characteristics

A total of 320 participants across Mamprugu-Moaduri and Gushegu Districts were recruited, consisting of 200 fathers and 120 mothers. Fathers aged 36.2 years (SD = 7.4) on average and mothers 29.1 years (SD = 6.8). The majority of participants were practicing subsistence agriculture (62%) and petty trading (21%). The educational attainment was largely low, as found in 48% of fathers and 55% of mothers having primary education only or no formal education. Household sizes averaged 6.2 members, reflecting the high fertility rates in both districts.

4.2 Assessing Paternal Nutritional Knowledge

The mean paternal nutritional knowledgescore is 58.3% (SD = 12.5). Knowledge was highest for staple food groups (M = 72%) and lowest for micronutrient needs (M = 44%). The independent-samples t-tests also showed that the difference between fathers with a secondary education and no formal education was significant ($t = 3.42$, $p = 0.001$). Increased paternal knowledge scores predicted better maternal dietary diversity, with regression analysis showing that ($\beta = 0.34$, $p < 0.05$). These results are strengthened by participants' perspectives as follows:

> *"I know yam and maize are important, but I did not hear much about iron foods until the health worker explained."* (KII, Gushegu, Male, 38).

> *"Our husbands decide what food to buy, so if they don't know about vegetables, we end up eating only starchy foods."*(FGD2, Mamprugu-Moaduri, Female, 27)

4.3 Influence on Maternal Health Indicators

Maternal anemia prevalence decreased in the intervention group, from 41% at baseline to 32% post-intervention, compared with 43% in the comparison group ($\chi^2 = 6.21$, $p = 0.013$). Gestational weight gain adequacy significantly improved, with 68% of mothers in the intervention group achieving the recommended weight gain, compared with 52% in the control group ($\chi^2 = 7.84$, $p = 0.005$). For example, the maternal anemia rate in the intervention group decreased from 41% at baseline to 32% post-intervention versus 43% for the comparison group ($\chi^2 = 6.21$, $p = 0.013$). Gestational weight gain adequacy significantly increased, with 68% of mothers from the intervention group achieving the recommended weight gain compared with 52% from the control group ($\chi^2 = 7.84$, $p = 0.005$).

This is reflected in the words of one of the participants:*"When my husband learned about beans and groundnuts, he started buying them more often, and I feel stronger during pregnancy***."**(FGD4, Gushegu, Female, 30).

4.4 Effectiveness in Shaping Fetal Outcomes

Mean birth weight in the intervention group increased from 2.82 kg (SD = 0.41) to 3.12 kg (SD = 0.39), and the proportion of low birth weight infants (<2.5 kg) decreased from 18% to 11%. The control group showed no change ($p > 0.05$). Independent t-tests further demonstrated that birth weights in the post-intervention group increased significantly compared with the control group ($t = 2.97$, $p = 0.003$). One participant echoed this view: *"The nurse told us that when fathers provide good food, babies come out healthier." I saw this with my wife's last delivery."* (KII, Mamprugu-Moaduri, Male, 35).

5. Discussion

The objective was to investigate the effect of paternal nutritional knowledge on maternal health and fetal outcomes in Mamprugu-Moaduri and Gushegu Districts. Findings were consistent with the fact that maternal dietary habits were influenced by paternal knowledge, including reduced anemia prevalence, enhanced gestational weight gain, and increases in fetal birth weight. These findings expand the Paternal Origins of Health and Disease (POHaD) framework to rural Ghana, a region where the role of a father in a child's nutrition is underrepresented (de la Iglesia et al., 2025).

5.1 Paternal Nutritional Knowledge

In this study, moderate paternal nutritional knowledge was observed, but significant gaps were identified in knowledge of micronutrients. Fathers with more education showed a higher degree of knowledge, with higher values related to maternal dietary diversity. These observations are consistent with the findings of Martin et al. (2021) who found that the paternal intervention enhances maternal compliance with dietary recommendations. Nonetheless, in contrast to high-income countries where paternal knowledge is higher overall (Jahan-Mihan et al., 2024), this study indicates sustained knowledge gaps in rural Ghana. The added value is that the little increase in knowledge about how maternal nutrition affects dietary changes at a maternal level in low-resourced settings corroborates that paternal inclusivity needs to be addressed in nutrition interventions.

5.2 Maternal Health Indicators

Notably, the decreased incidence of maternal anemia and associated enhancements in gestational weight gain after intervention in the intervention group were consistent with Johnson et al. (2025), who focused on paternal influence on placental function and maternal complications. However, while Johnson et al. (2025) highlighted the importance of pregnant individuals having healthy fathers as an important factor to improve maternal fitness and prevent maternal complications; the relationship between the two is one of paternal influence on maternal health, which examines biological pathways. Our study shifts to behavioral mechanisms such as paternal food purchasing and allocation strategies. This variation highlights the context of Ghana, where men control household food access (Azumah & Ali, 2025). The original value derived from this evidence is the assertion that paternal knowledge directly alleviates maternal anemia and improves pregnancy outcomes, which could provide a feasible point of entry into community-based interventions.

5.3 Fetal Outcomes

Reduced low birth weight and improved birth weights in the intervention group lend support to the POHaD framework whereby paternal nutrition affects fetal development (de la Iglesia et al., 2025). These findings are in agreement with Tokhi et al. (2018), who found that male participation in maternal health interventions was associated with improved newborn outcomes. However, this study showed measurable increases in fetal outcomes compared with the STEPS study in Finland that reported no significant association between paternal BMI and offspring birth measures (Kearns et al., 2025) and does not report benefits in low or medium-resource settings. The value addition is the context in which paternal knowledge interventions are effective, with evidence demonstrating changes in birth outcomes in rural Ghana, an area with the highest maternal malnutrition.

5.4 Limitations and Mitigation

Two limitations were noted. First, the quasi-experimental design was not randomized, which potentially introduced selection bias. This was overcome by utilizing multistage sampling and matching intervention and control groups on main socio-demographic variables (Creswell & Plano Clark, 2023). Second, self-reported dietary practices included recall and social desirability bias. Moreover, triangulation with qualitative interviews and focus group discussions enhanced the validity and, thus, the credibility of self-reported data (Taber, 2018).

This study adds to the literature by showing a large proportion of rural Ghana with paternal nutritional knowledge, which clearly impacts maternal dietary behavior, maternal health, and fetal growth. In contrast to previous studies focused on high-income countries, this research offers context-specific evidence from low-resource settings and reiterates the need to integrate fathers into maternal nutrition programs. In Ghana, the value addition of providing empirical support for father-inclusive approaches to maternal-inclination-related nutrition will expand the scope of maternal-and-child nutrition strategies to reach beyond mothers and their family members (Ali & Ali, 2025; Azumah & Ali, 2025).

6. Conclusion

The study was conducted to observe how paternal nutritional knowledge may contribute to maternal health and the outcomes of the offspring in the Mamprugu-Moaduri and Gushegu Districts of Northern Ghana. It is observed that paternal knowledge plays an important role in maternal dietary habits, which results in less anemia, greater gestational weight gain, and improved fetal birth weights. The significance of this work is to provide context-specific evidence from rural Ghana, indicating that even small changes in paternal awareness can offer real maternal and fetal health enhancements. Including fathers in nutrition education expands the range of nutrition interventions for maternal health beyond mothers alone, providing a culturally aware, self-reinforcing strategy for improving maternal health within resource-poor communities.

6.1 Recommendation

1) *Include Paternal Nutrition Education at Antenatal Care:* Structured nutrition education sessions should be incorporated into antenatal visits in health facilities in rural Ghana for fathers and mothers. This integration can be spearheaded by the Ghana Health Service (GHS) in partnership with district hospitals and health centers. It will help give men who regularly monitor the allocation of household foodthe tools to learn how to access micronutrients, diversify diets, and handle portion sizes.

2) *Community-Led Programs in Father Engagement Work:* These community-based programs should be culturally relevant and involve fathers in maternal nutrition. They can be introduced by district health directorates, which will work in partnership with traditional leaders as well as community health volunteers (CHVs). Utilizing the existing CHVs will enhance outreach, sustainability,, and trust among the communities.

3) *Policy Folding of Paternal Involvement into the Nutrition Approach*: It seems that the Ministry of Health (MoH) and the National Development Planning Commission (NDPC) need to ensure that national maternal and child health policies openly recognize and include paternal participation in nutrition initiatives. This would correspond to global demands for family-focused paradigms and underline Ghana's sustained work to reduce maternal anaemia and child stunting.

4) *Further study in low-sourcing areas: I*nstitutions offering learning opportunities, such as the University of Ghana School of Public Health and Kwame Nkrumah University of Science and Technology (KNUST), together with the Ghana Statistical Service (GSS), should conduct randomized controlled trials to establish causal relationships and investigate the lasting impact of paternal nutritional knowledge on child growth and development. District-based comparisons could also reveal regional variation in paternal involvement.

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