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Post-Harvest Handling and Consumption Practices of Fruits and Vegetables: Implications for Maternal Nutrition During Pregnancy and Postpartum Among Teenage Mothers in Rural Districts of Ghana

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Abstract: Pregnancy and postpartum maternal nutrition is a major driver influencing maternal and child health. In rural Ghana, teenage mothers are confronted with distinct nutritional challenges that stem from poverty, lack of autonomy, and poor food handling and storage facilities. Post-harvest consumption behaviors of fruits and vegetables among teenage mothers in Mamprugu-Moaduri, West Mamprusi, and East Mamprusi districts and their impact on mothers' nutrition were investigated in this study. A prospective longitudinal mixed-methods design was used with quantitative surveys, as well as qualitative interviews and focus group discussions. Three hundred teenage mothers aged 13–19 years were chosen for the study based on multi-stage sampling. Results showed high dependence on locally obtained fresh fruit and vegetables during peak seasons with modest storage capacities. Wild sources, including shea fruit and baobab leaves, supplemented diets but were consumed on a seasonal basis. Also, handling practices for fruits were dominated by immediate consumption, and 66.5% and 74.2% of fruits and vegetables were consumed within the same day, respectively. Better storage protocols (e.g., drying or refrigeration) were less common (<9%), but were associated with higher dietary diversity scores ($p < 0.05$). Improved storage practices were positively associated with education level ($\chi^2 = 12.4$, $p < 0.01$). Qualitative studies revealed economic constraints, cultural beliefs, and infrastructural hurdles as hindrances to fruit and vegetable consumption. This study fills in the gaps in the literature by focusing on teenage mothers, a group that is rarely examined in maternal nutrition literature. In deprived rural settings, findings highlight the necessity of context-appropriate interventions, such as increased storage technologies, nutritional education, and livelihood support to improve dietary diversity and maternal health outcomes in these rural districts.

Keywords: *Teenage mothers, Maternal nutrition, Post-harvest handling, Dietary diversity and Food security*

1. Introduction

Maternal nutrition during pregnancy and the postpartum period is an important determinant of maternal and child health status. Adequate consumption of fruits and vegetables fulfills a variety of vital vitamins, dietary fiber, and antioxidants necessary for fetal development, maternal health, and overall outcomes. At the global level, maternal malnutrition is a major issue of public health, especially in LMICs (low- and middle-income countries), where access to adequate nutrient-rich foods is limited by socio-economic and cultural causes. In Ghana, among teenage mothers in rural districts, teenage mothers are disproportionately impacted by nutrition problems through poverty and deprivation of autonomy in rural areas. These concerns

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reflect the high prevalence of maternal and teenage pregnancy, as well as the challenges in food handling and storage systems. This research focuses on the North East Region of Ghana and the Mamprugu-Moaduri, West Mamprusi, and East Mamprusi areas in particular, which have high rates of teenage pregnancy relative to the national statistics.

Teen pregnancy is especially problematic in these areas. Adolescent pregnancy in West Mamprusi has been reported to have reached "pandemic heights," with adolescent girls suffering the most from poverty and child marriage (Ziblim, 2017). The prevalence of high teen pregnancies remains high in East Mamprusi despite targeted health interventions (Dubik, Aniteye, & Richter, 2022). Nationally, approximately 10.6% of adolescent females were pregnant in 2022, with the North East Region consistently reporting prevalence rates beyond the national average, indicative of elevated teenage pregnancy prevalence among marginalized populations in rural areas (Tetteh, 2023). These statistics are compounded by the experiences of teenage mothers who are vulnerable due to issues of early childbearing, socio-economic deprivation, and malnutrition.

The socio-economic environment of these districts contributes to maternal nutritional vulnerability. In East Mamprusi, 54.7% of the population is living with multidimensional poverty, with an average intensity of 47.4% compared to the national mean of 43.7% (Ghana Statistical Service, 2021). Mamprugu-Moaduri is identified as one of the region's most deprived districts, with little infrastructure, restricted access to health facilities, and widespread food insecurity (DDHS Group, 2021). These numbers are in comparison to a regional average where multidimensional poverty affects 49.8% of households, evidencing the extreme extent of deprivation in this particular region. Poverty makes it hard for teenage mothers to obtain, carry, and eat nutritious foods, such as fruits and vegetables, which are critical to maternal and child health.

Proper handling and storage practices of fruits and vegetables post-harvest have an important influence on their provision, quality, and nutrient retention. Poor storage facilities, inefficiencies in preservation methods, and post-harvest losses decrease diversity in dietary choices, food security, and food quality in rural Ghana. This is exacerbated by the socio-cultural context of food taboos, gender differences, and early marriage, which also limit access to nutrient-rich foods among teenage mothers (Dubik et al., 2022). The nutritional consequences of this challenge are significant. Inadequate fruit and vegetable consumption increases the risks of anemia, low birth weight, and maternal complications. Postpartum, poor dietary diversity undermines maternal recovery and lactation, impacting both the mother's and child's health outcomes. Teenage mothers from these districts still lack adequate nutritional status despite interventions by the government and non-governmental organizations in these districts (Ziblim, 2017), a situation driven by pervasive barriers to food handling, storage, and consumption practices, contributing to the nutritional deficit in these girls.

To tackle these challenges, the interaction between post-harvest handling practices, diet diversity, and maternal nutrition outcomes needs to be better understood. Current reports have mostly explored socio-cultural determinants of teenage pregnancy, with a dearth of research investigating the influence of post-harvest handling practices on maternal nutrition outcomes among teenage mothers. Only a few analyses have been conducted to study nutritional adequacy during pregnancy and postpartum or to determine the interplay of multidimensional poverty, food

management practices, and maternal nutrition.

The current literature lacks information that drives effective interventions to address both food security and maternal health. The current study examines post-harvest handling practices and consumption patterns of fruits and vegetables among teenage mothers in rural Ghana, and the possible consequent implications on maternal nutrition during pregnancy and postpartum. Notably, it analyzes the fruit and vegetable management practices followed by associations with dietary diversity/nutrition adequacy, compares the consumption patterns during pregnancy and 6–12 months postpartum, and determines socio-demographic, cultural, economic, and food security factors that may affect maternal nutrition and the strength of association between handling, dietary diversity, and nutrition. By fulfilling these aims, this study is expected to contribute to addressing notable gaps in the literature and generate evidence to inform the development of context-specific interventions to promote maternal nutrition, minimize post-harvest losses, and promote food security for teenage mothers in deprived districts of Ghana.

2. Materials and Methods

Study Design.

The current study carried out a prospective longitudinal mixed-methods study using both quantitative and qualitative methods to determine post-harvest methods of fruit and vegetable handling and intake, and their impact on maternal nutrition in teenage mothers. The design allowed for time-course comparisons of pregnancy with postnatal time, revealing transitions in fruit and vegetable intake patterns and associations with nutrition. Using mixed methods enables data sources to be triangulated, and the statistical analysis and contextual perspectives from qualitative interviews provide insights into the socio-demographic, cultural, and economic determinants of dietary diversity and maternal nutrition (Creswell & Plano Clark, 2018).

Study Area.

Contextualizing maternal nutrition challenges among teenage mothers in the study districts involves grasping their socio-demographic and economic contexts. The North East Region of Ghana consists of districts with different levels of deprivation, infrastructure, and livelihood opportunities, all these factors playing a role in food security, post-harvest practices, and adolescent health outcomes. The following profiles identify Mamprugu-Moaduri, West Mamprusi, and East Mamprusi as focus sites for this study. Mamprugu-Moaduri District. Mamprugu-Moaduri, established in 2012, is projected to have a population of 73,000–75,000 people from 120 rural communities by 2025.

It is among the most deprived districts in the North East Region, which has the highest multidimensional burden of poverty, with poor infrastructure, limited health facilities, and food insecurity (CityPopulation, 2025; DDHS Group, 2021). Agriculture is the main economic force, but post-harvest spoilage and a high rate of teenage pregnancy due to early marriage make this a focus for maternal nutrition studies. While, instead, West Mamprusi District has a semi-urban character and a forecast total population of approximately 185,000 in 150 communities by 2025. Although there are a few small infrastructure improvements, poverty and food insecurity remain widespread (CityPopulation, 2025). Agriculture remains a pillar, although poor post-harvest management restricts nutrient accessibility.

A district that offers an optimal environment for nutrition interventions, especially in mitigating food deserts. Adolescent pregnancy rates are also high in that society; cultural norms and limited

access to reproductive health care contribute to it (Ziblim, 2017). The transitional nature of a rural-urban shift, along with inequalities in education and maternal well-being, renders it an attractive environment for maternal nutrition studies. Likewise, East Mamprusi District is forecasted to reach 195,000 people, mainly from 140 settlements, according to a study by CityPopulation (2025); Ghana Statistical Service (2021) considering Gambaga as its capital. Unlike in West Mamprusi, East Mamprusi has a multidimensional poverty incidence of 54.7%, far higher than regional averages, and it is characterized by chronic food insecurity and limited access to healthcare. Seasonal crop loss severely impacts agricultural production and results in the scarcity of fruits and vegetables. Teenage pregnancy is a common issue, and it is more prevalent in regions with cultural practices and limited reproductive health education (Dubik, Aniteye, & Richter, 2022). These conditions also further justify its importance in maternal nutrition studies.

Population and Sampling of the Study

The study population was a group of teenage mothers aged 13 to 19 years, pregnant or within 12 months after delivery. A multi-stage sampling approach was used. To begin with, communities within each district were randomly selected in order to guarantee geographic representation. Second, the local health facilities and community health volunteers maintained the registers for pregnant adolescents and postpartum mothers to identify eligible participants. We estimated 300 female teenage mothers had a sample size based on Cochran's formula for cross-sectional studies that adjusts for a 10% non-response rate (Cochran, 1977). Inclusion criteria included teenage mothers aged 13–19 years, resident in the selected districts for at least six months, in their first trimester of pregnancy, or within one year postpartum. Exclusion criteria were severe illness or medical complications experienced by teenage mothers that were likely to influence dietary intake, reluctance to agree to participate in such a study, and migration into the district less than six months before the data was collected. This facilitated that participants were a localization of the socio-demographic context of people in the sample, which minimized the sensitivity of the participants to a localized socio-demographic situation and attenuated sensitivity to ephemeral populations and the effects of other health conditions that are unrelated to food from their nutrition status or transient contexts.

Data Collection Instruments

Quantitative data were obtained through a structured questionnaire designed to assess various aspects of maternal nutrition and food practices. The questionnaire consisted of post-harvest handling and storage, frequency of fruit and vegetable consumption, socio-demographic, economic characteristics, and dietary diversity, as defined by the Minimum Dietary Diversity for Women (MDD-W) tool (Food and Agriculture Organization [FAO] & FHI 360, 2016). Household food security was measured using the Household Food Insecurity Access Scale (HFIAS), a validated measure that has been widely used in low-resource settings (Coates, Swindale, & Bilinsky, 2007). Qualitative data were collected via focus group discussions (FGDs) and key informant interviews (KIIs) with health workers, agricultural extension officers, and community leaders. These methods offered contextual reflections of cultural norms, food taboos, and obstacles to the consumption of fruit and vegetables to corroborate the quantitative findings and triangulate sources of information (Creswell & Plano Clark, 2018).

Data Analysis

Quantitative data were analyzed with SPSS version 26. Demographic traits and consumption patterns were summarized in

descriptive statistics. Chi-square tests and logistic regression were performed to examine the association between post-harvest practices, dietary diversity, and maternal nutrition. Significance $p < 0.05$ was considered statistically significant. Qualitative data were transcribed and thematically analyzed in NVivo 12, and repeated themes and contextual implications were identified that helped to contextualize and build on the quantitative findings (Braun & Clarke, 2006).

Ethical Considerations

The ethical approval was obtained from the Ghana Health Service Ethics Review Committee. All participants provided informed consent, with parental consent obtained for minors younger than 18 years old. Confidentiality and anonymity were maintained during the study.

Results

Table 1 presents the socio-demographic characteristics of teenage mothers from three districts in northern Ghana. The majority of participants were aged 16–17 years (48.4%), with Mamprugu-Moaduri recording a slightly higher proportion of younger mothers aged 13–15 years (21.4%) compared to West Mamprusi (18.3%) and East Mamprusi (19.8%). The mean age was 17.3 years across districts. Overall educational attainment was low, with 25.2% of the participants reporting no formal education and most only passing primary or junior high school (65.3%). Less than 10% had graduated from senior high school (9.5%). The rural context was mirrored in occupational patterns. Farming is the main source of income for teenage mothers, particularly in Mamprugu-Moaduri (73.8%), followed by East Mamprusi (65.6%) and West Mamprusi (60.0%). Petty commerce was a more prevalent phenomenon in West Mamprusi (30.0%) than in the other districts, reflecting district-level diversity in employment activities. The qualitative results corroborated these quantitative patterns. For example, a 16-year-old participant from Mamprugu-Moaduri stated, "I stopped school after JHS because my parents needed help on the farm. After the baby, it was not possible to go back," which illustrates the large percentage of farming mothers and the limited progression in education. Likewise, a participant from West Mamprusi (age 17) noted, "I sell small things in the market. It helps with feeding the baby even if I couldn't continue school," showing how petty trading is an alternative means of livelihood in the community. These narratives echo our statistical findings in demonstrating how education and occupation intersect with young mothers as they experience what life is like for teenage mothers in our districts.

Variable	Mamprugu-Moaduri (n=84)	West Mamprusi (n=120)	East Mamprusi (n=96)	All Districts(N=300)
Age (Mean ± SD)	17.1 ± 1.2	17.4 ± 1.0	17.3 ± 1.1	17.3 ± 1.1
Age Groups (%)				
13–15 years	21.4	18.3	19.8	19.8
16–17 years	47.6	50.0	47.9	48.4
18–19 years	31.0	31.7	32.3	31.5
Educational Level (%)				
No formal education	26.2	24.2	25.0	25.2
Primary/Junior High	63.1	66.7	65.6	65.3
Senior High and above	10.7	9.1	9.4	9.5
Occupation (%)				
Farming	73.8	60.0	65.6	66.7

Petty trading	16.7	30.0	22.9	23.7
Other	9.5	10.0	11.5	9.6

Table 1: Sociodemographic Variables of Study Participants by District (N = 300)

Sources of Fruits and Vegetables in the study districts

Table 2 defines fruits and vegetables in Mamprugu-Moaduri, West Mamprusi and East Mamprusi as locally grown, brought-in and wild fruits and vegetables. In the rainy season, mango, pawpaw, guava, soursop, melons, and watermelon which is harvested locally are plentiful, but they do not keep well during the rest of the year. Okro, spinach, amaranthus, tomatoes, pepper and leafy greens dominate local production, in addition to okro and garden eggs, which tend to be dried for consumption in the off-season. Brought-in produce — i.e. oranges, apples, pineapples, cabbage, lettuce — are imported from southern Ghana or Burkina Faso, but they are less cost effective. Wild fruits, such as shea and tamarind and bush grapes, and vegetables like baobab leaves and wild spinach are picked seasonally and served in their traditional ways.

Source Category		**Notes/Remarks**
Locally Grown	**Fruits**: Mango, Pawpaw, Guava, Soursop, Yellow Melon, Water Melon	Abundant when in season; limited preservation; Seasonal; okro and garden eggs often dried for off-season
	Vegetables: Okro, Spinach, Amaranthus, Leafy greens (Bean leaves Roselle/Bra, Pumpkin leaves, Bitter leaves, Moringa leaves, Kenaf/berese, Sweet potato leaves, Tomatoes, Pepper, Cassava leaves)	
Brought-In (Other districts or outside Ghana)	**Fruits**: Orange, Apple, Pineapple, Banana, Palm Fruit, Coconut Fruit	Imported from southern Ghana or Burkina Faso; limited affordability
	Vegetables: Garden Eggs,Cabbage, carrot, lettuce, green beans, Turkey Berry, Cocoyam leaves, Onions	
Wild Sources	**Fruits**: Shea fruit, dawadawa (African locust bean pulp), tamarind, Bush Grapes/Sinsaba, Black berries	Seasonal, consumed fresh or processed
	Vegetables: Baobab leaves, Wild spinach, Spong Gourd leaves/Sambola	Collected seasonally; used in soups and traditional dishes. Consumed fresh or dried.

Table 2: Sources of Vegetables in Mamprugu-Moaduri, West Mamprusi, and East Mamprusi

The findings highlight strong seasonal dependence and limited preservation capacity. As one teenage mother, aged 17 from East Mamprusi, explained: *"When mangoes are plenty in the rains, we eat them every day, but in the dry season they disappear."* Another, aged 18 from Mamprugu-Moaduri, noted: *"We dry okro and garden eggs in the sun so that we can cook them later when the season is over."* A third, aged 16 from West Mamprusi, added: *"Only those in town with electricity can keep vegetables in the fridge. For us, baskets and mats are all we have."*

Post-harvest handling and storage practices of fruits and vegetables

Teenage mothers reported distinctive handling and storage methods for fruits and vegetables. As summarized in Table 3, fruits were frequently a non-essential component, with 66.5% consumed shortly after harvesting and 12% processed into juice or powder. Basic storage methods for fruits, such as the use of baskets or shade, were reported by 17%, while improved methods like refrigeration, sun-drying, or powdering were rare (8.6%). Vegetables were consumed more often immediately (74.2%) with 17.4% minimally processed (washing

or boiling) and 8.5% processed into powder or flour. Basic storage of vegetables was reported by 21.7%, while improved storage methods were used by just 8.8%. Statistical testing showed that mothers using improved storage of fruits or vegetables had significantly higher dietary diversity scores (DDS mean = 4.2) than those not utilizing storage practices (DDS mean = 3.1; $p < 0.05$). The level of education was positively related to improved storage ($\chi^2 = 12.4$, $p < 0.01$), emphasizing the significance of knowledge in post-harvest management.

Practice	Mamprugu-Moaduri (n =84)	West Mamprusi (n=120)	East Mamprusi (n=96)	Overall (N =300)
Fruits – Handling				
Immediate consumption (%)	68.0	65.0	66.7	66.5
Minimal processing (washing, slicing) (%)	20.0	22.5	21.9	21.5
Processing into juice/powder (%)	12.0	12.5	11.4	12,0
Fruits – Storage				
Basic storage (baskets, shade) (%)	15.5	17.5	18.0	17.0
Improved storage (refrigeration, sun-drying, powdering) (%)	8.5	9.0	8.3	8.6
Vegetables – Handling				
Immediate consumption (%)	77.5	72.0	73.0	74.2
Minimal processing (washing, boiling) (%)	15.0	18.0	19.0	17.4
Processing into powder/flour (%)	7.5	10.0	8.0	8.5
Vegetables – Storage				
Basic storage (baskets, shade, temporary containers) (%)	20.0	22.0	23.0	21.7
Improved storage (refrigeration, sun-drying, pounding into powder) (%)	9.0	8.0	9.0	8.8

Table 3: Handling and Storage Practices of Fruits and Vegetables among Teenage Mothers (N =300)

A participant from East Mamprusi (age 17) explained: *"We eat vegetables the same day we harvest them. If we keep them, they spoil quickly."* Another teenage mother from West Mamprusi (age 18) emphasized the economic constraints:*"Fruits are a luxury. My main problem is where to get food (Tuo-zaafi) to eat if I wake up."* These quotes highlight the dual challenge: vegetables are consumed quickly due to perishability, while fruits are deprioritized because of economic hardship and cultural perceptions.

Maternal Nutrition During Pregnancy and Postpartum Periods.

Mamprugu-Moaduri (n = 84)

In Mamprugu-Moaduri, maternal nutrition was significantly lower than in the general population from pregnancy to postpartum stage. Daily fruit consumption decreased from 38.1 percent during pregnancy to 25.0 percent at six to twelve months postpartum, and the contribution of fruits to the dietary diversity score (DDS) dropped from 1.2 to

0.8 ($p < 0.05$). Vegetables were more frequently consumed and reported a statistically significant decrease: 61.9 percent of females were reported to consume daily vegetables during pregnancy compared to 46.4 percent postpartum; the DDS contribution from vegetables decreased from 1.6 to 1.2 ($p < 0.01$). Taking both fruits and vegetables into account, overall DDS declined from 4.4 in pregnancy to 3.6 postpartum ($p < 0.01$), highlighting the nutritional risk levels of teenage mothers after childbirth. These statistical results were supplemented by the voices of teenage mothers. “When I was pregnant, my mom suggested I eat more vegetables,” said one mother aged 18. And then after delivery, “I just eat whatever available.” Her story embodies the cultural dependence on the diet during pregnancy and the disregard for postpartum nutrition. Another, at 16 years of age, explained that fruits are scarce and expensive to obtain, telling me, “Fruits are hard to get here. I only take them if anyone brings them.” These narratives, working together, shed light on the ways in which both cultural practices and socio-economic limitations help explain the observed diet-diversity decline at the time of comparison, giving contextualized data to the statistical evidence.

West Mamprusi (n = 120)

The study conducted in West Mamprusi confirmed the significant decrease in maternal nutrition from pregnancy to postpartum. Daily fruit consumption (40.0% during pregnancy) dropped to 28.3% postpartum, and the fruit contribution to the dietary diversity score (DDS) dropped from 1.3 to 0.9 ($p < 0.05$). Vegetables were also consumed more often, though with a significant decline: 63.3 percent of mothers reported daily vegetable intake during pregnancy compared to 49.2 percent postpartum, and the contribution to DDS fell from 1.7 to 1.3 ($p < 0.01$). Cumulatively, the total DDS, when considering fruits and vegetables, fell from 4.6 in pregnancy to 3.8 postpartum ($p < 0.01$), supporting the nutritional vulnerability of teenage mothers after childbirth. These findings were reflected in the lived experiences of teenage mothers. One 16-year-old mother said: "When I was pregnant, I made my eating habits better. I am mostly thinking about getting Tuo-zaafi to fill my belly.” Those words indicate the cultural importance we pay attention to food during pregnancy and disregard for diet afterward. Another, 17, reflected on the economic pressures she felt, saying, “I sell vegetables but I can’t save anything — the money is for the child.” These stories contextualize the findings from the statistical approach by demonstrating how social cultural standards and financial restrictions interact to limit dietary diversity and nutritional sufficiency postpartum.

East Mamprusi (n = 96)

Results for East Mamprusi indicated a significant decrease in maternal nutrition during pregnancy and in the postpartum years. Per day, fruit consumption was 39.6 percent during pregnancy and decreased to 27.1 percent postpartum, while the contribution of fruit to the dietary diversity score (DDS) lessened from 1.2 to 0.8 ($p < 0.05$). Vegetables were also consumed more frequently, though with a significant decline: 62.5 percent of mothers reported that they ate vegetables daily during pregnancy, versus 48.0 percent in postpartum, while the DDS contribution dropped from 1.7 to 1.3 ($p < 0.01$). Fruits and vegetables in conjunction decreased the overall DDS from 4.5 during pregnancy in the study population to 3.7 in the postpartum population ($p < 0.01$), demonstrating the nutritional fragility of teenage mothers postpartum. These statistical results were concordant with the experiences of teenage mothers. “On the day of harvest, we eat vegetables,” said one mother, 17. “They rot quickly if we keep

them." Her experience illustrates both the shelf life and poor storage capacity of vegetables, which leads to less availability after birth. Another 18-year-old mother pointed to the economic hardships of eating fruit, explaining, "Fruits are something I treat like a luxury and only purchase if I have extra cash." Both stories put into perspective the numbers we have on how cultural attitudes and economic constraints conspire with post-harvest barriers to restrict diversity and nutritional adequacy in the postpartum period.

Collectively, in all the districts, maternal nutrition from pregnancy to the postpartum period decreased significantly ($p < 0.001$). At 39.3% during pregnancy, daily fruit consumption was lower than 26.8 percent postpartum, with the fruit contribution to the dietary diversity score (DDS) also decreasing from 1.2 to 0.8 ($p < 0.001$). Vegetables were also more commonly consumed but were more likely to be lower (62.0% of mothers reported daily vegetable intake during pregnancy versus 48.0%, DDS contribution ($p < 0.001$): 1.7, 1.3). When combining fruits and vegetables, the total DDS decreased in size ($p < 0.001$) from 4.5 for pregnancy down to 3.7 postpartum. Fruits were also consumed less than vegetables in all districts, indicating lower value due to perceptions that they were non-essential and expensive to consume, while vegetables were consumed more than fruits in the postpartum period, following reduced awareness of the importance of maternal eating and lack of proper storage handling. The relatively high consumption of vegetables could also be attributed to vegetable soup accompanying commonly eaten staples such as tuo-zaafi and rice balls. In fact, in some situations, leafy vegetables—especially if harvested outside of the home, i.e., if harvested in the wild—are consumed as a way to cope with household food insecurity. Also, the lack of fruit affordability might largely be because most teenage mothers are unemployed, and they may not have the disposable income to buy fruits. Even the relatively rapid decline in fruit compared with vegetables exemplifies the economic and cultural constraints that impede teenage mothers from accessing varied diets. These quantitative results were also complemented by the narratives of teenage mothers who reported experiencing fruits as a "luxury" and vegetables as extremely perishable, consumed straight after they were harvested. This provides contextualization to the statistical evidence, demonstrating that accessibility, cultural perception, and post-harvest issues conspire to diminish nutritional diversity and adequacy during postpartum months.

Contextual Determinants of Food Security

Mamprugu-Moaduri (n = 84)

A quantitative analysis revealed that maternal nutrition outcomes were strongly affected by socio-demographic and economic factors. Teenage mothers with no formal education demonstrated notably lower dietary diversity scores (DDS mean = 3.2) than those with at least the primary level (DDS mean = 4.0; $p < 0.05$). There were reports of family food insecurity from 58.3% of women, with 41.7% resorting to wild leafy vegetables as a means of survival. The findings of the qualitative studies reinforced these trends. One 18-year-old mother said: "I was pressured to eat more vegetables when I was pregnant, my mother told me. Postpartum, I just eat whatever is there." Another, 16, mentioned economic realities: "Fruits are very difficult to get here. I eat them only when somebody delivers them." These reports reflect the cultural imposition of pregnancy diets on nutrition during childbirth, and poverty and food insecurity limit postpartum nutrition.

West Mamprusi (n = 120)

Quantitative data showed that unemployment among teen mothers significantly affected poor fruit consumption. Postpartum fruit intake

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accounted for only 28.3% versus 40.0% during pregnancy. Unemployed mothers had significantly lower DDS scores (mean = 3.5) compared to petty traders (mean = 4.1; $p < 0.01$). Food insecurity at the household level was reported at 52.5%, with 36.7% selling vegetables instead of eating them to make a living. These findings were contextualized with qualitative narratives. “I ate better when I was pregnant,” said a 16-year-old mother. "Now I simply like Tuo-zaafi for filling my stomach.” “I sell vegetables but cannot keep some that way,” another (17) said in an interview. These voices exemplify the direct impact of economic pressures and livelihood strategies on maternal nutrition outcomes.

East Mamprusi (n = 96)

The quantitative data showed that food insecurity and cultural practices were significant for dietary patterns. A study reported significant declines in daily consumption of vegetables from 62.5% in pregnancy to 48.0% postpartum, with 44.8% of households relying on wild leafy vegetables when their choices were limited. Food-insecure households had significantly lower DDS scores (mean = 3.4) than food-secure households (mean = 4.2; $p < 0.01$). The findings were also supported by qualitative evidence. A 17-year-old mother added, “We’ll eat vegetables the day we harvest them. If we salvage them, they spoil very fast.” Another, 18, cited affordability barriers: “Fruits are a luxury; I only buy them if there is extra money.” These are the stories that illustrate how perishability and economic considerations restrict dietary diversity in the postpartum period.

In all, socio-demographic, cultural, and economic determinants emerged as integral for improving maternal nutrition outcomes across all districts. Education was positively associated with better storage and higher DDS ($\chi^2 = 12.4$, $p < 0.01$). Across the study districts,household food insecurity was 52.0% and wild leafy vegetables consumed by 38.5% as coping strategies. Fruits (consumed less frequently due to affordability and unemployment) were consumed less than vegetables (consumed more often but limited by perishability and storage). Links Between Handling/Storage Practices, Dietary Diversity, and Maternal Nutrition Outcomes. Mamprugu-Moaduri (n = 84). The study shows that the improvement practices in storage (refrigeration, sun-drying, powdering) were significantly associated with higher dietary diversity scores (DDS mean = 4.2) versus households without storage practices (DDS mean = 3.3; $p < 0.01$). Logistic regression revealed that mothers with a primary education level or above were 1.8 times more likely to implement better storage practices (OR = 1.8, 95% CI: 1.1–2.9). These associations were further supported by qualitative results. One pregnant teen mother, 18, said, “When I was pregnant my mom insisted that I eat more vegetables. After delivery, I just eat what is available.” This emphasizes the interaction of cultural focus on the pregnancy diet with storage availability in dictating nutrition. West Mamprusi (n = 120). Quantitative results showed that DDS for households that practiced better storage was significantly higher (mean = 4.3) than for households without storage (mean = 3.5; $p < 0.01$). Chi-square analysis revealed that storage practices were strongly associated with employment status ($\chi^2 = 10.6$, $p < 0.01$), with employed mothers more likely to store vegetables and fruits. These findings were explained using qualitative narratives. “I sell vegetables but can’t keep some, and the money is for the baby,” said a 17-year-old mother. This shows how economic pressures prevent storage and use, thus diminishing dietary variety despite high availability. East Mamprusi (n = 96). Quantitative evidence in this study showed that improved storage was associated with higher DDS, based on improved storage practices (mean = 4.1 vs. 3.4; $p < 0.05$). The regression model indicated that food-

secure households were twice as likely as their non-food-secure counterparts to have better storage (OR = 2.0; 95% CI: 1.2–3.3). Storage and maternal nutrition and the association were especially strong for vegetable intake, according to which sun-drying households had higher postpartum intake. These findings were bolstered by qualitative evidence. "We eat vegetables the same day we do the harvest," a 17-year-old mother said. "If we keep them, they spoil very fast." Her experience illustrates that perishability and lack of storage is an affliction that weakens dietary diversity, particularly postpartum. Overall (N = 300). Across districts, improved handling and storage practices were consistently associated with better maternal nutrition outcomes. Mothers who practiced improved storage had significantly higher DDS (mean = 4.2) compared to those without storage (mean = 3.1; $p < 0.001$). Storage positively correlated with education level ($\chi^2 = 12.4$, $p < 0.01$), while food insecurity at the household level reduced the chances of adopting better practices (OR = 0.6, 95% CI: 0.4–0.9).

Relationships between handling/storage practices, dietary diversity and maternal nutrition outcomes.

Mamprugu-Moaduri (n = 84)

Quantitative data indicated that better storage practices (refrigeration, sun-drying, powdering) were significantly associated with higher dietary diversity scores (DDS mean = 4.2) compared to groups without storage practices (DDS mean = 3.3; $p < 0.01$). Logistic regression also found mothers with at least primary education were 1.8 times more likely to practice better storage habits (OR = 1.8, 95% CI: 1.1–2.9). These associations were supported by qualitative findings. A teenage mother, who was 18, said, "When I was pregnant, my mother insisted I eat more vegetables. After delivery, I just eat what is available." This demonstrates the way cultural preoccupation with pregnancy diets intersects with storage constraints to affect nutrition outcomes.

West Mamprusi (n = 120)

A review of the quantitative studies show that improved storage practices were related to significantly higher DDS (mean = 4.3 versus mean = 3.5; $p < 0.01$) than non-storage practices. Chi-square analysis revealed a significant association found between employment status and storage habits ($\chi^2 = 10.6$, $p < 0.01$), with employed mothers more likely than their non-employed counterparts to store vegetables and fruits. Findings were interpreted through qualitative narratives. "I make a living selling vegetables but can't keep some; the money is for the baby," a 17-year-old mother said. This shows how economic stress reduces storage and consumption, a factor that contributes to a diminishing dietary diversity in spite of the availability of them.

East Mamprusi (n = 96)

Results: Better storage practices were positively associated with DDS (mean=4.1 vs 3.4; $p < 0.05$). The researchers carried out regression analysis showing that food-secure households were two times more likely to adopt improved storage (OR = 2.0, 95% CI: 1.2–3.3). The correlation between storage and maternal nutrition achieved was especially significant for vegetable consumption, with sun-drying (in which the sun-dried food had higher postpartum intake reported by the households). There was also qualitative evidence for these results. A 17-year-old parent said: "We eat vegetables on the same day we harvest them. If we store them they spoil fast." Her narrative illustrates the perishability and lack of storage as a factor threatening dietary variety, especially postpartum. Overall (N = 300). Improved handling and storage were linearly related to improved maternal nutrition in all districts. Mothers with storage-improving practice had significantly higher DDS (mean = 4.2)

compared to those without storage (mean = 3.1; $p < 0.001$). Storage positively correlated with education level ($\chi^2 = 12.4$, $p < 0.01$), and household food insecurity negatively correlated with the adopting of the best practices (OR = 0.6, 95% CI: 0.4–0.9).

3. Discussion

This study explored post-harvest fruit and vegetable handling, storage, and eating behaviors of adolescent mothers dwelling in rural northern Ghana and their effect on maternal nutrition during pregnancy and postpartum. In the study, three principal sources of fruits and vegetables among adolescent mothers in rural Ghana were identified—locally grown, brought-in, and wild—reflecting a livelihood structure tightly bound to seasonality, cash liquidity, and proximity to markets. Locally grown fruits and vegetables such as mango, pawpaw, guava, okra, spinach, and leafy greens were abundant only in-season, with preservation limited to occasional drying of okra and tomatoes and leafy greens. Access to brought-in produce like oranges, apples, lettuce, and cabbage was constrained by cost, while wild resources such as shea fruit, bush grapes and baobab leaves were consumed opportunistically. This profile aligns with regional evidence that fruit and vegetable availability is seasonally dependent and preservation capacity is limited in rural communities, where affordability of imported produce remains a persistent barrier (Aidoo et al., 2019; FAO, 2017; Ghana Statistical Service, 2021). Compared with broader household-focused studies, these findings add nuance by showing adolescent mothers' near-exclusive reliance on local and wild sources, likely driven by tighter budget constraints, lower market access, and gendered control over food purchasing. The value addition lies in centering adolescent mothers as a distinct population with unique sourcing behaviors, informing targeted interventions that leverage seasonal calendars, wild-resource safety, and low-cost preservation strategies in district nutrition focused post harvest prevention or reduction related programming.

Immediate consumption dominated both fruits and vegetables, with minimal processing and rare use of improved storage methods such as refrigeration or sun-drying. The positive association between improved storage and dietary diversity, and the link between education and better storage, suggests that knowledge and infrastructure jointly shape nutrition outcomes. This corroborates Ghanaian and sub-Saharan literature identifying suboptimal storage and preservation as drivers of post-harvest losses and reduced dietary diversity, while emphasizing the enabling role of information and skills (Aidoo et al., 2019; Dubik, Aniteye, & Richter, 2022). The results extend these findings by documenting adolescent-specific trade-offs—fruits were deprioritized as "luxuries" while vegetables were consumed quickly due to perceived perishability and lack of storage—illustrating preference hierarchies under scarcity. Policy-relevant value addition includes evidence that simple, context-fit storage solutions, such as improved drying, shaded baskets, and community cold storage, coupled with targeted education for adolescent mothers, can meaningfully improve dietary diversity in low-resource settings.

Dietary diversity among adolescent mothers was constrained by seasonality and inadequate storage, with fruits viewed as non-essential and vegetables eaten immediately, limiting nutrient retention in critical windows. This mirrors national data showing low fruit and vegetable intake among adolescent mothers in northern Ghana and global evidence of elevated undernutrition risks driven by poverty, limited autonomy, and sociocultural barriers (Ghana Statistical Service, 2021; World Health Organization, 2020).

Unlike general maternal cohorts, adolescent mothers face compounded vulnerabilities such as school discontinuation, limited income, and reduced household decision-making power, intensifying nutrition deficits across the perinatal period. The study's value addition is in specifying the mechanisms—seasonality plus storage gaps—that translate structural deprivation into low micronutrient intake, thereby sharpening the case for nutrition-sensitive social protection and adolescent-centered ANC/PNC education packages. Qualitative narratives confirmed and deepened quantitative patterns. Perishability and the absence of storage facilities drove immediate consumption, fruits were framed as "luxuries," and lack of electricity limited refrigeration. These accounts echo findings from rural Kenya and Nigeria where cold-storage deficits and cultural taboos constrain adolescent diets, but the present data highlight everyday improvisations such as baskets, mats, and shade, as well as perceptions that structure choices under scarcity (Onyango et al., 2019; Okeke et al., 2020). The convergence underscores a nexus of poverty, infrastructure, and norms shaping food management decisions.

The study's added value lies in actionable granularity—identifying specific barriers such as electricity access and perceptions of fruits as non-essential—that can be targeted through community-level cold storage pilots, culturally sensitive messaging, and mentorship by model mothers using low-tech preservation techniques. While prior work documented seasonal dependence and poor preservation, few studies centered adolescent mothers or disaggregated by district conditions. This analysis reveals Intra-regional variation, with greater farming reliance in Mamprugu-Moaduri, petty trading in West Mamprusi, and deeper poverty in East Mamprusi, implicating distinct leverage points for programming such as farm-based preservation support versus market-based access solutions.

Nonetheless, it is not without limitations. First,it being a cross-sectional study, having seasonal effects, being based on self-reported data, and restricted generalizability beyond northern Ghana. The relatively small sample size of adolescent mothers also limits broader conclusions, suggesting the need for larger, longitudinal studies. Despite these constraints, the research adds value by highlighting adolescent mothers' unique vulnerabilities shaped by poverty, cultural norms, and infrastructure. It identifies Intra-regional variation and actionable barriers, offering evidence to guide context-specific interventions that integrate digital innovations and improve maternal nutrition outcomes.

4. Conclusion

This study investigated post-harvest handling and consumption practices of fruits and vegetables among teenage mothers in Mamprugu-Moaduri, West Mamprusi, and East Mamprusi districts of Ghana, and examined their implications for maternal nutrition during pregnancy and postpartum. The findings revealed strong seasonal dependence on locally grown produce, limited preservation capacity, and restricted access to brought-in fruits and vegetables due to affordability constraints. Wild sources provided supplementary nutrition but were consumed only seasonally.

Post-harvest handling and storage practices were generally basic, with most fruits and vegetables consumed immediately after harvest. Improved storage methods such as refrigeration, drying, or powdering were rare, yet significantly associated with higher dietary diversity scores. Education emerged as a key determinant of improved storage practices, underscoring the importance of knowledge and awareness in shaping food management behaviors.

The study also highlighted how socio-economic and cultural contexts influence maternal nutrition. Teenage mothers often do not prioritized fruits due to economic hardship

and cultural perceptions, while vegetables were consumed quickly because of perish-ability. Qualitative insights reinforced these findings, showing how poverty, limited infrastructure, and gender norms intersect to constrain dietary diversity.

By comparing pregnancy and postpartum stages, the study demonstrated that nutritional inadequacies persist across both periods, with implications for maternal recovery, lactation, and child health outcomes. These results align with national and regional data on teenage mothers' vulnerability but add localized evidence that captures Intra-district variations in livelihoods, food access, and nutritional practices.

This research bridges critical gaps in the literature by focusing specifically on teenage mothers, a group often overlooked in studies of post-harvest handling and maternal nutrition. It contributes district-specific insights that highlight the interplay between poverty, education, cultural norms, and food security. The findings provide a foundation for designing context-specific interventions that improve maternal nutrition, strengthen post-harvest management, and enhance food security among teenage mothers in deprived rural districts.

Ultimately, addressing these challenges requires integrated strategies that combine nutrition education, improved storage technologies, livelihood support, and culturally sensitive health interventions. Such efforts are essential to break the cycle of poor maternal nutrition and its inter-generational consequences, ensuring healthier outcomes for both teenage mothers and their children.

Policy Recommendations.

Enhancing post-harvest storage and preservation infrastructure is pivotal to improving maternal nutrition. This recommendation is directed at the Ministry of Food and Agriculture (MoFA), District Assemblies, and NGOs involved in agriculture and nutrition. It is hoped that this development will be possible to set up on the ground the storage facilities at the community level, such as solar-powered cold rooms and improved drying units, with a view to limiting post-harvest losses in fruits and vegetables to ensure the sustenance of these products beyond the rainy season. They should also encourage low-cost methods of preservation, including sun-drying, powdering, and better packaging, for continued quality of nutrients and year-round access to foods that are available to everyone. It is equally important that nutrition education and health-related programs, for the Ministry of Health, District Health Directorates, and community health volunteers, be directed. Maternal nutrition guidance should be incorporated within antenatal and postnatal care services, highlighting fruit and vegetable consumption in pregnancy and postpartum.

Community-based health volunteers can be trained to distribute culturally friendly messages that challenge taboos and misconceptions around food, as these often are reasons behind lesser fruit consumption among teenage mothers. Policies for school re-entry and adolescent empowerment should also take precedence. Given that greater education is positively linked with better storage habits and a greater variety of foods, the Ministry of Education, Ministry of Gender, Children and Social Protection, and other NGOs working with adolescent females should further extend school re-entry measures for teenage mothers.

In addition, training in petty trading and agro-processing on livelihood development that could generate economic independence and discourage subsistence farming should be implemented. Food security and social protection interventions are equally important. The Ministry of Gender, Children and Social Protection, District Assemblies, and others in the field of development need to develop nutrition-sensitive social protection programs, like food vouchers and conditional cash

transfers focusing on teenage mothers in poverty-stricken areas. Increased agricultural extension services would also allow teenage mothers to be introduced to crop diversification, home gardening, and sustainable agricultural practices. For one, there needs to be a reinforcement of support for the community. Traditional authorities, community elders, women's groups, and cooperatives need to be mobilized to co-generate resources for common storage, processing, and distribution of fruit and vegetables. They should likewise take a central role in addressing cultural norms and gender dynamics that restrict teenage mothers' access to nutrient-rich food offerings so that community structures support maternal health improvement."

By implementing these recommendations, policymakers and development partners can address the dual challenges of poor maternal nutrition and high post-harvest losses. The study's findings highlight the need for integrated interventions that combine education, infrastructure, and cultural sensitivity. Such strategies will not only improve maternal and child health outcomes but also contribute to long-term food security and poverty reduction in Ghana's most deprived districts.

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