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IMPACT OF HOUSEHOLD FOOD SECURITY AND ANAEMIA ON PREGNANCY OUTCOMES AMONG RURAL WOMEN IN EASTERN UGANDA

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SUMMARY

KALINAKI HANIFAR. Impact of Household Food Security and Anaemia on Pregnancy Outcomes Among Rural Women in Eastern Uganda. Supervised by DRAJAT MARTIANTO, ALI KHOMSAN, ENY PALUPI, HADI RIYADI.

Food security in Uganda is influenced by a combination of factors, including agricultural practices, climate conditions, economic stability, and social dynamics. According to the 1996 World Food Summit, food security exists "when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996; Summit 2007).

Anaemia is a medical condition characterized by a deficiency or a reduced amount of protein hemoglobin in the blood (Parbey *et al.* 2019; Nkurunziza *et al.* 2022). Globally, Iron deficiency anaemia (IDA) is one of the most prevalent types of anaemia, affecting a significant proportion of women, particularly during pregnancy, as well as young children and individuals in low-income settings. (Finkelstein *et al.* 2020; Udho *et al.* 2022). It occurs when the body lacks enough iron to produce adequate hemoglobin. Anaemia in pregnancy has been linked to adverse pregnancy outcomes for both the mother and the infant. Infant adverse outcomes may include preterm birth, low birth weight, Inter Uterine Growth Restriction (IUGR), still birth and low birth length.

The study aimed at determining the impact of household food security and anaemia on pregnancy outcomes among rural women in Eastern Uganda and specifically to (1) determine the prevalence and severity of anaemia among pregnant women (2) assess the level of household food security among pregnant women (3) examine the associations between household food security and maternal anaemia with adverse pregnancy outcomes, including low birth weight, preterm birth, and birth length (4) identify the factors influencing household food security, including socioeconomic, dietary, and health factors, in the study population as well as (5) to determine effect of postpartum maternal iron supplementation and food security on infant weight, length and maternal anaemia and provide evidence-based recommendations for culturally tailored interventions aimed at improving food security, preventing anaemia, and enhancing pregnancy outcomes among rural women in Eastern Uganda.

This study was conducted in three stages, the first stage and second stage were carried out in health facilities and the third stage (intervention) was done in the community. The first stage had a total of 263 participants who were recruited from the healthcare facilities using the simple random sampling method. The inclusion criteria included, (1) pregnant mothers in the third trimester and those booked to deliver from that health facility. (2) those who had delivered and had not been discharged yet within 72 hours. (3) mothers with complete medical records reflected in the hospital data. (4) mothers with a singleton or infant. (5) without other medical complications and chronic illnesses like Tuberculosis (TB) and HIV. (6) Mothers who consented to be part of the study.

Mothers who were excluded from the study were those who had medical complications such as hypertension, diabetes, and sickle cell anaemia, TB, HIV. (2) mothers with multiple pregnancies or twins (3) mothers who didn't live within

the eastern Uganda. (4) mother without complete medical records. (5) those who didn't consent to participate in the study.

The second stage (case-control) included 50 mothers who had delivered from the above healthcare facilities. They were recruited using consecutive sampling method. This stage used a case- control method. Participants were allocated into two groups. (I) The case group included 25 mothers with infants who had Low birth weight, participated in the first stage of the study, lived within eastern Uganda, consented to be part of the second stage of the study (II) The control group included 25 mothers, who had infants with normal birth weight, participated in the first stage of the study living in eastern Uganda, those who consented to be part of the second stage of the study.

The third stage was an interventional stage which included mothers with infants having adverse pregnant outcomes, participated in stage I and stage II, lived in eastern Uganda, consented to be part of the third stage and agreed to be visited in their homes.

The third stage (intervention), included home visits which were carried out after every two weeks for a period of 2 months making a total of four visits for the intervention. The intervention group was offered (1) nutrition education and counselling about breast feeding, food security, hygiene and sanitation and backyard farming, (2) Iron and Folic Acid Supplementation (200mg Ferrous and 400mcg Folic acid), (3) supply of a food basket having 15 raw eggs, 1 kg iron rich beans, 2kg orange sweet potato, 2 bulbs of spinach and nutrition assessment of the baby on every visit. The home visits lasted for a maximum of one hour.

The findings of the study showed that majority of the respondents, 42.6% were aged between 18-28 years. 52.9% of the respondents attained primary level of education and most of them were farmers which accounted for 61.6%. Majority of the households, 46.8% had more than five children. Many of the households had more than 7 members (53.6%). 62.7% of the mothers had limited land access. 68.0% of the respondents owned livestock. The majority of the mothers 82.0% had low income.

Food insecurity was high with only 11% of the respondents being food secure and 89% being food insecure. Several socio-demographic factors, including maternal age, education level, occupation, number of children, land availability, and household income, were significantly associated with food security status. The study revealed that 4.8% of the respondents were severely food insecure. Risk factors that were significant with prevalence of food insecurity included food safety, access to safe water, waste management and involvement of households in sugarcane growing.

The findings of this study indicated that 49.1% of the households had moderate household dietary diversity meaning that they consumed at least 6-7 food groups while 62.9% of the respondents had adequate individual minimum dietary diversity. (5 food groups). Cereals and tubers were highly consumed, 73% and 61% respectively. Animal protein including meat, fish, poultry were among the food groups least consumed.

The study showed an association between food insecurity and higher rates of anaemia. 38.8% of the respondents were anaemic with 2% severely anaemic though majority 27.3% were mildly anaemic. Factors such as low dietary diversity ($\leq$ 5 food groups), inadequate access to and compliance with iron and folic acid (IFA) supplements, and experiencing side effects from these supplements were significant contributors to anaemia.

Conversely, anaemia was associated with adverse pregnancy outcomes. Anaemic mothers had higher odds of preterm birth at 2.95, low birth weight 2.74. and infants with anaemia indicating that food security and anaemia status profoundly affect pregnancy outcomes. Factors including time of 1st ANC visit, interpregnancy interval and gestation age were significant risk factors to low birth weight.

The findings of the study intervention indicated that maternal anthropometric measurements improved except for height which doesn't usually change in adults. Body weight, BMI and MUAC increased by 4.17kg, 2.29kg/m2, 3.72cm respectively. The Hb level showed the highest increment from 10.44g/dL to 12.48 g/dL with an increase of 2.05g/dL. The average infant weight also increased from 1.88 kg to 2.94 kg and the average length increased from 40.94 cm to 48.33 cm.

There was increased knowledge and compliance for iron and folic acid supplementation. The side effects of the Supplements reduced. Nutrition education increased maternal awareness about breast feeding, food availability, backyard farming and hygiene and sanitation. Eggs were most consumed at 88%, orange sweet potato most shared at 28.8% and iron rich beans were most lost at 20.2%.

Key words: Eastern Uganda, household food security, iron deficiency anaemia, pregnancy outcomes, pregnant women

RINGKASAN

KALINAKI HANIFAR. Dampak Ketahanan Pangan Rumah Tangga dan Anemia Defisiensi Zat Besi terhadap Hasil Kehamilan di Kalangan Perempuan Pedesaan di Uganda Timur. Dibimbing oleh DRAJAT MARTIANTO, ALI KHOMSAN, ENY PALUPI, HADI RIYADI.

Ketahanan pangan di Uganda dipengaruhi oleh kombinasi berbagai faktor, termasuk praktik pertanian, kondisi iklim, stabilitas ekonomi, dan dinamika sosial. Menurut KTT Pangan Dunia 1996, ketahanan pangan terwujud "ketika semua orang setiap saat memiliki akses fisik dan ekonomi terhadap pangan yang cukup, aman, dan bergizi untuk memenuhi kebutuhan gizi dan preferensi pangan mereka demi kehidupan yang aktif dan sehat" (FAO, 1996; KTT 2007

Anemia adalah kondisi medis yang ditandai dengan kekurangan atau berkurangnya jumlah protein hemoglobin dalam darah (Parbey et al. 2019; Nkurunziza et al. 2022). Secara global, anemia defisiensi besi (ADB) merupakan salah satu jenis anemia yang paling umum, yang memengaruhi sebagian besar wanita, terutama selama kehamilan, serta anak kecil dan individu di lingkungan berpenghasilan rendah. (Finkelstein et al. 2020; Udho et al. 2022). Anemia terjadi ketika tubuh kekurangan zat besi untuk memproduksi hemoglobin yang cukup. Anemia selama kehamilan telah dikaitkan dengan hasil kehamilan yang buruk bagi ibu dan bayi. Hasil buruk pada bayi dapat mencakup kelahiran prematur, berat badan lahir rendah, Inter Uterine Growth Restriction (IUGR), lahir mati, dan panjang badan lahir rendah.

Ketahanan pangan rumah tangga dan prevalensi anemia saling terkait erat karena ketersediaan, aksesibilitas, dan kualitas pangan di tingkat rumah tangga berperan penting dalam menentukan risiko dan prevalensi anemia. Untuk mengatasi masalah ini diperlukan pendekatan holistik yang menggabungkan inisiatif ketahanan pangan dengan program kesehatan dan gizi. Penelitian ini bertujuan untuk menentukan dampak ketahanan pangan rumah tangga dan anemia terhadap hasil kehamilan di kalangan perempuan pedesaan di Uganda Timur dan khususnya untuk (1) menentukan prevalensi dan tingkat keparahan anemia di kalangan perempuan hamil (2) menilai tingkat ketahanan pangan rumah tangga di kalangan perempuan hamil (3) memeriksa hubungan antara ketahanan pangan rumah tangga dan anemia ibu dengan hasil kehamilan yang merugikan, termasuk berat badan lahir rendah, kelahiran prematur, dan panjang lahir (4) mengidentifikasi faktor-faktor yang memengaruhi ketahanan pangan rumah tangga, termasuk faktor sosial ekonomi, pola makan, dan kesehatan, dalam populasi penelitian serta (5) untuk menentukan efek suplementasi zat besi ibu pascapersalinan dan ketahanan pangan terhadap berat badan, panjang bayi, dan anemia ibu serta memberikan rekomendasi berbasis bukti untuk intervensi yang disesuaikan dengan budaya yang bertujuan untuk meningkatkan ketahanan pangan, mencegah anemia, dan meningkatkan hasil kehamilan di kalangan perempuan pedesaan di Uganda Timur.

Penelitian ini dilakukan dalam tiga tahap, tahap pertama dan tahap kedua dilakukan di fasilitas kesehatan dan tahap ketiga (intervensi) dilakukan di masyarakat.

Tahap pertama melibatkan total 263 peserta yang direkrut dari fasilitas kesehatan menggunakan metode pengambilan sampel acak sederhana. Penelitian ini menggunakan desain metode campuran dengan menggunakan data primer dari responden dan data sekunder dari laporan medis dan riwayat dari fasilitas kesehatan. Kriteria inklusi meliputi, (1) ibu hamil pada trimester ketiga dan mereka yang dijadwalkan melahirkan di fasilitas kesehatan tersebut. (2) mereka yang telah melahirkan dan belum dipulangkan dalam waktu 72 jam. (3) ibu dengan catatan medis lengkap yang tercermin dalam data rumah sakit. (4) ibu dengan anak tunggal atau bayi. (5) tanpa komplikasi medis lain dan penyakit kronis seperti Tuberkulosis (TB) dan HIV. (6) Ibu yang setuju untuk menjadi bagian dari penelitian.

Ibu yang dikecualikan dari penelitian adalah mereka yang memiliki komplikasi medis seperti hipertensi, diabetes, dan anemia sel sabit, TB, HIV. (2) ibu dengan kehamilan ganda atau anak kembar (3) ibu yang tidak tinggal di Uganda timur. (4) ibu tanpa catatan medis lengkap. (5) mereka yang tidak setuju untuk berpartisipasi dalam penelitian.

Tahap kedua (kasus-kontrol) mencakup 50 ibu yang telah melahirkan di fasilitas kesehatan di atas. Mereka direkrut menggunakan metode pengambilan sampel konsekutif. Tahap ini menggunakan metode kasus-kontrol. Peserta dialokasikan ke dalam dua kelompok. (I) Kelompok kasus mencakup 25 ibu dengan bayi yang memiliki berat badan lahir rendah, berpartisipasi dalam tahap pertama penelitian, tinggal di Uganda timur, dan setuju untuk menjadi bagian dari tahap kedua penelitian. (II) Kelompok kontrol mencakup 25 ibu yang memiliki bayi dengan berat badan lahir normal, berpartisipasi dalam tahap pertama penelitian yang tinggal di Uganda timur, mereka yang setuju untuk menjadi bagian dari tahap kedua penelitian.

Tahap ketiga adalah tahap intervensi yang mencakup ibu dengan bayi yang memiliki hasil kehamilan yang buruk, berpartisipasi dalam tahap I dan tahap II, tinggal di Uganda timur, setuju untuk menjadi bagian dari tahap ketiga dan setuju untuk dikunjungi di rumah mereka.

Tahap ketiga (intervensi), termasuk kunjungan rumah yang dilakukan setelah setiap dua minggu selama periode 2 bulan sehingga total empat kunjungan untuk intervensi. Kelompok intervensi ditawarkan (1) pendidikan gizi dan konseling tentang pemberian ASI, keamanan pangan, kebersihan dan sanitasi dan pertanian pekarangan, (2) Suplementasi Zat Besi dan Asam Folat (200mg Ferrous dan400mcg asam folat), (3) penyediaan keranjang makanan yang berisi 15 butir telur mentah, 1 kg kacang kaya zat besi, 2 kg ubi jalar oranye, 2 umbi bayam dan penilaian gizi bayi pada setiap kunjungan. Kunjungan rumah berlangsung maksimal satu jam.

Hasil penelitian menunjukkan bahwa mayoritas responden, 42,6% berusia antara 18-28 tahun. 52,9% responden mencapai tingkat pendidikan dasar dan sebagian besar dari mereka adalah petani yang mencakup 61,6%. Mayoritas rumah tangga, 46,8% memiliki lebih dari lima anak. Banyak rumah tangga memiliki lebih dari 7 anggota (53,6%). 62,7% ibu memiliki akses lahan terbatas. 68,0% responden memiliki ternak. Mayoritas ibu 82,0% berpenghasilan rendah.

Ketahanan pangan tinggi dengan hanya 11% responden yang memiliki ketahanan pangan dan 89% tidak memiliki ketahanan pangan. Beberapa faktor sosio-demografis, termasuk usia ibu, tingkat pendidikan, pekerjaan, jumlah anak, ketersediaan lahan, dan pendapatan rumah tangga, secara signifikan terkait dengan

status ketahanan pangan. Studi ini mengungkapkan bahwa 4,8% responden sangat rawan pangan. Faktor risiko yang signifikan dengan prevalensi kerawanan pangan termasuk keamanan pangan, akses ke air bersih, pengelolaan limbah dan keterlibatan rumah tangga dalam penanaman tebu.

Temuan penelitian ini menunjukkan bahwa 49,1% rumah tangga memiliki keragaman makanan rumah tangga sedang yang berarti bahwa mereka mengonsumsi setidaknya 6-7 kelompok makanan sementara 62,9% responden memiliki keragaman makanan minimum individu yang memadai. (5 kelompok makanan). Serealia dan umbi-umbian sangat dikonsumsi, masing-masing 73% dan 61%. Protein hewani termasuk daging, ikan, unggas termasuk di antara kelompok makanan yang paling sedikit dikonsumsi.

Studi ini menunjukkan hubungan antara kerawanan pangan dan tingkat anemia yang lebih tinggi. 38,8% responden mengalami anemia dengan 2% anemia berat meskipun mayoritas 27,3% mengalami anemia ringan. Faktor-faktor seperti rendahnya keragaman makanan (≤ 5 kelompok makanan), akses yang tidak memadai dan kepatuhan terhadap suplemen zat besi dan asam folat (IFA), dan mengalami efek samping dari suplemen ini merupakan faktor-faktor yang berkontribusi signifikan terhadap anemia. Sebaliknya, anemia dikaitkan dengan hasil kehamilan yang buruk. Ibu yang anemia memiliki kemungkinan kelahiran prematur yang lebih tinggi yaitu 2,95, berat badan lahir rendah 2,74, dan bayi dengan anemia yang menunjukkan bahwa ketahanan pangan dan status anemia sangat memengaruhi hasil kehamilan. Faktor-faktor termasuk waktu kunjungan ANC pertama, interval antar kehamilan, dan usia kehamilan merupakan faktor risiko signifikan terhadap berat badan lahir rendah. Temuan intervensi studi menunjukkan bahwa pengukuran antropometri ibu membaik kecuali tinggi badan yang biasanya tidak berubah pada orang dewasa. Berat badan, BMI, dan MUAC masing-masing meningkat sebesar 4,17 kg, 2,29 kg/m2, 3,72 cm. Kadar Hb menunjukkan peningkatan tertinggi dari 10,44 g/dL menjadi 12,48 g/dL dengan peningkatan sebesar 2,05 g/dL. Berat badan bayi rata-rata juga meningkat dari 1,88 kg menjadi 2,94 kg dan panjang rata-rata meningkat dari 40,94 cm menjadi 48,33 cm.

Terdapat peningkatan pengetahuan dan kepatuhan terkait suplementasi zat besi dan asam folat. Efek samping dari suplemen sangat berkurang. Pendidikan gizi meningkatkan kesadaran ibu terkait pemberian ASI, ketersediaan pangan, pertanian pekarangan, serta kebersihan dan sanitasi.

Telur sangat banyak dikonsumsi sebesar 88%, ubi jalar oranye sangat banyak dikonsumsi sebesar 28,8%, dan kacang-kacangan kaya zat besi sangat banyak dikonsumsi sebesar 20,2%.

Kata kunci: anemia defisiensi besi, hasil kehamilan, ibu hamil, keamanan pangan rumah tangga, Uganda Timur

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I I INTRODUCTION

1.1 Background

Food security has been defined in various ways over the decades. According to the 1996 World Food Summit, food security exists “when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 1996; Summit 2007). This definition emphasizes not only the availability of food but also its quality, safety, and the ability of people to access it consistently. More recent scholarship have expanded the understanding of food security to include additional dimensions, reflecting the evolving nature of food systems and the challenges they face. These dimensions include availability, accessibility, utilization, stability, sustainability, and agency (Clapp *et al.* 2022; Schleifer & Sun 2020).

Food security can be understood as a causal pathway that links food production to consumption, with multiple factors influencing each stage along the way (Grote *et al.* 2021; Nicholson *et al.* 2021; Subramaniam *et al.* 2022). This pathway is shaped by global trade, local economies, environmental conditions, and social policies.

Many Ugandan households face food insecurity limiting access to nutritious foods such as animal proteins. These nutritional deficiencies are compounded by cultural and economic factors leading to anaemia and poor pregnancy outcomes. Evidence shows that untreated anaemia during pregnancy leads to complications like postpartum hemorrhage, maternal exhaustion and reduced fetal iron stores. These issues can have long -term health implications for both mother and the child.

Anemia is a medical condition characterized by a deficiency or a reduced amount of protein hemoglobin in the blood (Parbey *et al.* 2019; Nkurunziza *et al.* 2022). Hemoglobin is a protein within red blood cells that is responsible for carrying oxygen from the lungs to the body's tissues and organs. Anemia can result from various underlying causes, and it often leads to a reduced capacity of the blood to transport oxygen (Finkelstein *et al.* 2020; Udho *et al.* 2022). This condition can have significant health implications for both the mother and the developing fetus (Leonard *et al.* 2019; Molla *et al.* 2020).

Anemia is a global public health concern, with particularly severe implications for pregnant women and their offspring (Tusa *et al.* 2021; Zhang *et al.* 2021). In sub-Saharan Africa, including Uganda, the prevalence of anemia is alarmingly high, and its impact on maternal and child health is significant (Robert 2019; Udho *et al.* 2022; Egesa *et al.* 2023). The region faces multiple challenges, such as poverty, limited healthcare infrastructure, and inadequate access to nutritious food, which exacerbate the issue (Dowhaniuk 2021; Ssennono *et al.* 2021; Atamanov *et al.* 2022). Eastern Uganda, in particular, is characterized by a predominantly rural population, with a high proportion of women of reproductive age facing socio-economic and dietary challenges that impact their nutritional status (Ssendagire 2019; Molla *et al.* 2020). The region's reliance on subsistence agriculture and limited access to diverse and nutrient-rich foods makes it susceptible to food insecurity, leading to nutritional deficiencies (Musoke 2019;

Amuge 2022; Benard dan Ainomugisha). Anemia during pregnancy is associated with an increased risk of adverse pregnancy outcomes, such as preterm birth, low birth weight, and maternal morbidity (Mukaire *et al.* 2019; Clinton *et al.* 2022; Onyango *et al.* 2023). Understanding the correlation between household food security and anemia is crucial for developing effective interventions to improve pregnancy outcomes among rural women in Eastern Uganda (Dhabangi *et al.* 2019; Ikendi 2019; Sivahikyako *et al.* 2021).

1.2 Problem Statement

Eastern Uganda faces a multifaceted public health challenge, with a high prevalence of anaemia among pregnant women estimated at 22%. Anemia is known to have adverse consequences on maternal and fetal health (Namazzi *et al.* 2022; Egesa *et al.* 2023). In this region, food security remains a critical concern, as many households face challenges in accessing an adequate and diverse diet especially in the rural areas. The situation has been exacerbated by the region's economic focus on cash crop farming, particularly sugar cane. The expansion of sugar cane cultivation, driven by the demand for land leased to sugar cane factories, has led to the displacement of traditional food crops, limiting the availability of nutritious foods such as grains, legumes, vegetables, and fruits (Mpuuga *et al.* 2021; Guloba *et al.* 2023)..

Compounding these challenges, is the region's high fertility rate, averaging six births per woman, a figure significantly high (UDHS, 2022). This high fertility rate not only places substantial physiological demands on women but also exacerbates the strain on household resources, further limiting access to adequate nutrition during pregnancy. Teenage pregnancies, particularly among girls aged 15-19, remain alarmingly high in rural areas, with a prevalence of 27%. Early pregnancies often result in poor pregnancy outcomes due to the physiological immaturity of young mothers, inadequate prenatal care, and poor nutritional status (Brigham *et al.* 2021; Kansiime *et al.* 2021; Squarcina 2023).

Furthermore, the consumption of nutrient dense foods is still very low in this region. Heme iron from animal-based sources like meat, fish and poultry is low due to the economic constraints and cultural dietary practices. Non- heme iron primarily found in foods like beans, cereals and vegetables constitute a significant part of the diet in eastern Uganda.

1.3 Research Objectives

The study aims to achieve the following objectives.

1.3.1 Primary Objectives

To determine the impact of household food security and anemia on pregnancy outcomes among rural women in Eastern Uganda

1.3.2 Specific Objectives

a) To determine the prevalence and severity of anemia among pregnant women in rural communities of Eastern Uganda.

b) To assess the level of household food security among pregnant women in the rural communities in Eastern Uganda.
c) To examine the associations between household food security and maternal anemia with adverse pregnancy outcomes, including low birth weight, preterm birth, and birth length.
d) To identify the factors influencing household food security, including socioeconomic, dietary, and health factors, in the study population.
e) To determine effect of postpartum maternal iron supplementation and food security on infant weight, length and maternal anemia and provide evidence-based recommendations for culturally tailored interventions and policies aimed at improving food security, preventing iron-deficiency anemia, and enhancing pregnancy outcomes among rural women in Eastern Uganda.

1.4 Benefits of the Study

For the general population, the study findings can raise public awareness about the importance of nutrition, food security, and anemia prevention during pregnancy. The insights from the study can guide communities and improve their knowledge and develop effective strategies and mechanisms to improve on household food security, reducing anemia prevalence, achieving desired pregnancy outcomes and decrease the risks of complications during pregnancy. For the government and supporting organization the study's findings can inform evidence-based interventions, policies and strategies tailored to the specific needs of rural women in Eastern Uganda. This can include nutritional programs, educational campaigns, targeted support and resource allocation to enhance food security and address anemia. For academic purposes, the study shall also contribute to scientific knowledge in the fields of maternal and child health, nutrition, and epidemiology. For Sustainable development and global relevance, this study aligns with efforts to achieve sustainable development goals through eradicating hunger, promoting health and well-being. The study outcomes shall have long-term health and economic benefits by addressing anemia and improving maternal health, healthier mothers and infants are more likely to thrive and contribute positively to their communities, potentially reducing the burden on the healthcare system.

1.5 Scope

The study was conducted in rural communities across Eastern Uganda. Specific areas and villages within the region were selected for data collection ensuring a representative sample of the rural population capturing a variety of socio-economic backgrounds, agricultural practices, and healthcare access patterns. The primary study participants were pregnant women residing in the selected rural communities in Eastern Uganda.

In addition to pregnant women, the study also involved their households and families, as food security at household-level is influenced by a variety of factors such as household income, agricultural production, access to markets, and intra-household food distribution. Household heads, spouses, and other family members responsible for food provision were included to explore their perspectives on food security, dietary diversity, and how these factors influenced maternal nutrition.

The study also investigated the broader socio-economic and environmental factors affecting food security in these rural communities. This included exploring the impact of agricultural practices, such as the widespread cultivation of sugar cane, on local food production and the availability of diverse, nutritious to gain insights into how local food systems and healthcare access interact to influence maternal health outcomes.

1.6 Novelty

a. Integrated care-model of home-based approach

The study pioneered an innovative, community-integrated continuum of care that transcends traditional healthcare settings by embedding nutrition and anemia prevention strategies directly within households. By using regular, personalized home visits, this approach fosters a community-centered model that directly addresses household food security and nutrition, emphasizing preventive care rather than reactive treatment.

b. Culturally tailored intervention with community resources

This study advanced beyond observation by designing, implementing, and rigorously testing targeted interventions that leverage locally available, nutrient-rich foods to improve dietary diversity and reduce anemia through IFA supplementation. The interventions were community-biased to ensure cultural sensitivity, practicality, and sustainability.

1.7 Research Hypothesis

a. An integrated care model employing a home-based approach significantly improves household food security, reduces prevalence of anemia and enhances pregnancy outcomes compared to conventional facility- based care in food insecure communities.
b. A culturally tailored intervention leveraging community resources significantly improves household food security and reduces the prevalence of anemia among pregnant women in rural communities compared to standard nutrition programs.

II METHOD

2.1 Location, Time and Research Design

This study was conducted in three stages, the first and second stages were carried out in health facilities and the third stage (intervention) was done in the community. The first stage of the study involved a descriptive cross-sectional design and the second stage was a case-control study design that were carried out in three healthcare facilities at different admission levels namely Jinja Regional Referral Hospital (JRRH) at the regional level, Buwenge General Hospital (BGH) at the district level, and Bugembe Health Centre IV (BHC) at sub-district level.

The third stage was a community-based intervention carried out using an intervention group under a home visit approach in the communities served by the hospitals where the first and second stages were carried out. This intervention was done in the homes of the respondents who lived in the catchment area of these health facilities and stayed in Eastern Uganda. The home intervention was carried out after discharge from the health facility in the months of February to March of 2024.

2.2 Tools and Materials

The following tools were used in the study Hemoglobinometer (HemoCue), Micro cuvettes (for measuring anemia status), Weighing Scale (for taking maternal body weight), Stadiometer (for maternal height), Mid-Upper Arm Circumference (MUAC) tapes (for measuring Mid Upper Arm Circumference for the mothers), Infant weighing scale (for infant body weight), and length board (for infant length). The materials that were used in the study included maternal blood samples, Maternal medical history, facility data reports, study questionnaires, Immunization cards, Nutrition Counselling cards. The intervention used micro-nutrient supplements including Iron and Folic Acid (IFAS) as well as food items including eggs, Iron-rich beans, Orange sweet potato, and Spinach seeds.

2.3Sample Size Determination

Using the hospital bed capacity where JRRH has approximately 600 beds, BGH with 200 beds, and BHC with 50 beds, the percentage contribution of participants from these facilities was calculated. JRRH contributed 70% of the participants, BGH contributed 23% and BHC 7% (Table 7) for the first stage of the study. The sample size was obtained from sample size calculation using Lwanga and Lemeshow method. The estimated anemia prevalence among pregnant women is 22% as per 2 studies carried out in Hoima and Gulu Hospitals. Using a margin of error of 5% and Z- statistics at 95% confidence interval.

$$n = \frac{Z^{\alpha/2} \times P\,(1-P)}{E^2}$$

$$n = \frac{(1.96)^2 \times 0.22\,(1-0.22)}{(0.05)^2}$$

$$n = 263 \text{ participants}$$

where

- n : required minimum sample size needed
- p : the estimated prevalence (percentage of total pregnant women affected by anaemia)
- Zα : Z- score corresponding to the degree of confidence (value of α =5% which is 1.96)
- α : level of significance
- E : desired precision (5%)

2.4 Study Subjects, Sampling Methods, Inclusion and Exclusion Criteria

The study subjects in stage one involved pregnant women attending antenatal care services and those who had just delivered in the three health facilities (Jinja regional referral hospital, Buwenge general hospital and Bugembe health centre IV). Participants were recruited from the healthcare facilities using the simple random sampling method. The pregnant mothers were recruited as they were available and were willing to participate in the study. The study employed a mixed method design using both primary data from the respondents and secondary data from the medical reports and history from the health facilities. The inclusion criteria included, (1) pregnant mothers in the third trimester and those booked to deliver from that health facility. (2) Mothers who had delivered from those health facilities and had not been discharged yet within 72 hours. (3) The mothers who had complete medical records that were reflected in the hospital data. (4) Mothers with a singleton or infant. (5) Mothers without other medical complications and chronic illnesses like Tuberculosis (TB) and HIV. (6) Mothers who consented to be part of the study.

Mothers who were excluded from the study were those who had medical complications such as hypertension, diabetes, and sickle cell anaemia, TB, HIV. (2) Mothers with multiple pregnancies or twins were not considered for the study. (3) Mothers who didn't live within the eastern Uganda. (4) Mother without complete medical records. (5) Mothers who didn't consent to participate in the study.

The second stage included mothers who had delivered from the above healthcare facilities. The participants were recruited while still at the hospital using consecutive sampling method. This stage used a case- control study design. Participants were allocated into two groups. (I) The case group included mothers with infants who had Low birth weight. (II) Mothers who had participated in the first stage of the study (III) Mothers who lived within eastern Uganda. (IV) Mothers who consented to be part of the second stage of the study.

The control group included mothers, (I) who had infants with normal birth weight (II) Mothers who participated in the first stage of the study. (III) Mothers who reside within eastern Uganda. (IV) Mothers who consented to be part of the second stage of the study.

The third stage was a community-based intervention which included mothers with adverse pregnant outcomes. The intervention had a total of 25 mothers with their infants.

2.5 Study Stage I and II (Health Facility Study)

The study had Household Food Security as the independent variables, anaemia as the mediator variable and pregnancy outcomes as the dependent variable. After obtaining signed consent from the mothers, a questionnaire was used to obtain information from the mother and their medical records from the facility.

2.6 Data Collection Procedures

Maternal characteristics such as age, income, parity, educational level, occupation, marital status, gestational age, interpregnancy interval, history of abortion, time of 1st ANC visit, smoking and alcohol usage, and the number of antenatal visits in the current pregnancy were collected by the study questionnaire. Gestation age was estimated using the last date of the normal menstrual period. Nutritional status, namely body weight, height, and MUAC were taken. Weight was measured with minimal clothing and without shoes using a digital bathroom scale and height was measured using a stadiometer. The mothers, Body Mass Index (BMI)) was calculated by dividing weight in kilograms and squared height in meters. The pregnancy outcomes of the birth were measured which included the life of the baby (live birth). This was observed if the infant was breathing with vital signs like heartbeat and movements. Gestation age was used to determine if the infant was full-term or pre-term. Infants below 37 weeks of gestation were regarded as preterm infants. Birth weight was considered and those infants born with a weight below 2.5 kg were regarded as having low birth weight. Birth length was determined as those infants with less than 48cm being too short and having a low birth length. Infant pallor was assessed in the infant conjunctiva of the eyes, palms, and tongue. The infants who were pale were regarded as being anaemic.

Household Food Security

Household food security was measured using the Food Insecurity Experience Scale (FIES), (FAO, 2014). This survey module comprised of eight questions regarding the respondents' access to food within a period of 12 months as shown below. The respondents would answer (1) No, (2) Yes, (3), don’t know (4) refused.

Table 1 Questions of FIES used in the study

Item[a]	**Description** (if the respondents experienced the following situation because of lack of money or other resources)	Label[b]	**Assumed level of food insecurity**
1	Worried about not having enough food	WORRIED	Mild
2	Could not eat healthy and nutritious food	HEALTHY	Mild
3	Ate only a few kinds of foods	FEWFOOD	Mild
4	Had to skip a meal	SKIPPED	Moderate
5	Ate less than you thought you should	ATELESS	Moderate
6	Household ran out of food	RUNOUT	Moderate
7	Were hungry but did not eat	HUNGRY	Severe
8	Went without eating for a whole day	WHLDAY	severe

a- The term item refers to the FIES questions in the study
b- Standard level according to the FIES methodology

Affirmative responses were assigned 1 and 0 to negative responses. Don't know and refused were classified as missing. Since FIES consisted of 8 questions, the raw score ranged from 0 to 8. The questions expressed varying difficulty with 1 as mild and 8 as severe as shown above in Figure 8. However, all forms of food insecurity were aggregated to determine the prevalence of food insecurity.

Dietary Diversity

a) Household dietary diversity

The household dietary diversity was measured using the Household Dietary Diversity Score (HDDS). The HDDS measured the variety of foods groups consumed the previous day (24 hr recall) as proxy for household food access. The following in Table 11 is a set of 12 food group were used to calculate HDDS.

Table 2 Set of food groups in HDDS

a. Cereal	g. Fish and sea foods
b. White roots and tubers	h. Nuts, seeds and legumes
c. Vegetables	i. Milk and milk products
d. Fruits	j. Fats and oils
e. Meat	k. Sweets and sugar
f. Eggs	l. Condiments

The food groups consumed were coded as 1 and those not consumed as 0. The 12 food groups were then summed to calculate the HDDS, yielding a total HDDS score ranging from 0-12. Household were regarded to have low diet diversity if they consumed ≤ 5 food groups, Medium 6-7 food groups and high if they consumed more than 7 food groups.

b) Individual dietary diversity

The minimum dietary diversity for women of reproductive age (MDD-W) was used to measure the individual pregnant woman's dietary diversity.The MDD-W focused on 10 food groups. The foods groups which were consumed were scored 1 and 0 for those that were not consumed. Consumption of at least 5 of the groups in a day was considered to have met the minimum dietary diversity. The food groups that were considered included;

Food Frequency

The Food frequency questionnaire (FFQ) was used to assess the food frequency. The food items were compiled in 11 broad groups with sub groups and 34 food items as shown in Table 13. The frequency was documented as daily, weekly, monthly, rarely and never. This was estimated over a period of 12 months.

2.7 Study Stage III (Community Intervention)

This phase was carried out in the community using the home visit approach. In this phase an intervention was made which included participants selected using a consecutive sampling method among those who had participated in the health facility study. This intervention group had 25 mothers with babies who had adverse undesirable pregnancy outcomes. Upon consent, participants were followed to their homes after discharge from the health facilities. Home visits were carried out after every two weeks for a period of 2 months making a total of four visits for the intervention. Maternal and infant anthropometric measures and maternal anaemia status was done before and after the intervention to measure the effectiveness of the intervention and also compared with the global standards.

Table 3 Activities done during the intervention

	Intervention
All activities were done on every visit	1. Iron and folic acid supplements 14 tablets (Ferrous and folic acid, 200 mg & 400 mcg); 2. Nutrition education & counselling (exclusive breast feeding, food security, hygiene & sanitation and backyard farming); 3. Food basket (15 raw eggs, 1 kg iron-rich beans, 2 kg of orange sweet potato, and 2 bulbs of spinach); 4. Infant anthropometric assessment (weight, length); and 5. Check for up-to-date immunisation, all this was done on every visit after every 2 weeks for 8 weeks making 4 visits of the intervention.

Nutrition education and counselling topics included exclusive breastfeeding on visit one, food security on visit 2, hygiene and sanitation on visit 3, and home gardening or back yard farming on visit 4. Nutrition education sessions were conducted verbally with use of visual aids including flip charts and posters. Questions were asked and for each correct response it was scored 1 and 0 for the negative responses.

IFAS was made on every visit and mothers were encouraged to take it once a day for at least 4 months to treat anaemia. The supplement contained 200mg of

Ferrous and 400mcg of Folic acid. Maternal knowledge regarding IFAS, Compliance to the supplements as well as the side effects was assessed. Knowledge regarding IFAS included questions about benefits, dosage, duration and consequences of not taking IFAS. Mothers were regarded to be compliant if they took 4 tablets or more of IFA within a week. Mothers were asked about side effects of IFAS and their management. Supply of a food basket was done on every visit and this included 15 raw eggs, 1kg of uncooked Iron-rich beans, 2 kg of Orange sweet potato, and 2 bulbs of spinach. Assessment was done to estimated what was consumed, shared and lost. Methods regarding food preparation, safety and preservation were discussed.

The infant's weight and length were taken on every visit and checked immunisation schedule. On the last visit, the mothers' anaemia status was measured and an anthropometric assessment of weight, height, MUAC and Body Mass Index was done. The infant anthropometric measurements were also done on the last visit.

2.8 Data Quality Control

To control data quality, the data collection was done using questionnaires which was been translated to the local language commonly spoken in Eastern Uganda which is Lusoga. Other efforts to maintain quality included,training enumerators, questionnaire tryout, data collection supervision. The questionnaires were double checked by the researcher and the enumerators to ensure completeness of the data.

2.9 Data Analysis

Data was analyzed using excel and IBM SPSS software version 24. Categorical data was expressed in the form of frequencies and percentages. Parametric data was summarized as mean and standard deviations (mean ± SD) and non-parametric data as proportions. Chi-square tests were used to assess for associations between anemia and categorical variables. Logistic regression was used to assess for association between food security, anemia and categorical variables. Binary logistic regression was done for the significant variables, and a crude odds ratio with 95% confidence intervals was obtained. Multivariable logistic regression model was used to assess for independent risk factors of low birth weight. P – value of less than 0.05 was considered significant. Data were presented descriptively in tables, graphs and pictures.

2.10 Ethical Clearance and Informed Consent

This study obtained ethical approval from division of public health and nutrition under the Health Research and Innovation Board- Central and Eastern Uganda with reference number 522/ HRIB/EC/09/24 (attached). The procedures and benefits of the study were elaborated before approval.

The participants were informed with clear explanation of the study and those who were willing to participate in the study were asked to sign a consent form (attached).

III RESULTS AND DISCUSSIONS

3.1 Social Demographic Characteristics of the Study Population

A total of 263 respondents participated in the first stage of the study. The socio-demographic factors associated with food security among the respondents were recorded. The factors analysed include maternal age, education level, occupation, number of children in the household, household size, land availability, livestock ownership, and household income as shown in Table 16. Majority of the mothers, 42.6% were aged between 18-28 years. 52.9% of the respondents attained primary level of education and most of them were farmers which accounted for 61.6%. Majority of the households, 46.8% had more than five children. May of the households had more than 7 members (53.6%). 62.7% of the mothers had limited land access. 68.0% of the respondents owned livestock. Majority of the mothers 82.0% had low income.

3.2 Socio-Demographic Factors and Household Food Security

As shown in the table below the findings of the current study indicate that 29 (11 %) of the respondents were food secure and 234 (89%) were food insecure. Maternal age, education level, occupation, number of children, land availability, and household income were all significantly associated with food security status.

Table 4 Socio-demographic characteristics and household food security

Variable	Frequency (n=263)	Percent (%)	% Food secure	% Food insecure	P-Value
Maternal age					
18-28	112	42.6	1.0	99.0	0.019*
29-39	93	35.3	8.6	91.4	
40-50	58	22.1	12.9	87.1	
Education level					
No education	67	25.5	1.8	98.2	
Primary	139	52.9	2.3	97.7	
Secondary	43	16.3	4.8	95.2	0.033*
Tertiary	14	5.3	18.7	81.3	
Occupation					
Farmer	162	61.6	22.3	77.7	
Business	51	19.4	9.4	90.6	0.028*
Civil servant	8	3.0	5.1	94.9	
Daily wager	42	16.0	0.8	99.2	
Children in HH					
0-1	41	15.6	12.3	87.7	
2-4	99	37.6	3.9	96.1	0.003*
>5	123	46.8	0.4	99.6	
HH size					
0-3	37	14.0	23.1	76.9	
4-6	85	32.4	17.9	82.1	0.947

>7	141	53.6	9.4	90.6	
Land availability					
Yes	98	37.3	10.4	89.6	0.041*
No	165	62.7	3.2	96.8	
Livestock					
Yes	178	68.0	23.7	76.3	0.736
No	85	32.0	14.0	86.0	
HH income					
Subsistence level	215	82.0	0.4	99.6	0.013*
Above Subsistence	48	18.0	32.8	67.2	

n= number of subjects, Bivariate analysis using chi-square test, * significant if p< 0.05

This study indicated that 99% of the mothers aged between 18-28 were food insecure. The difference in maternal age had a statistical significance of 0.019. This is attributed to younger mothers potentially having less financial stability, fewer job opportunities and lower levels of education compared to older mothers (Tacoli 2020). They may also have less experience in managing household resources effectively (Essilfie *et al.* 2021). Education level was significant with p = 0.033, the study shows that mothers without education are overwhelmingly food insecure (98.2%). Education often correlates with better employment opportunities and higher income, which can reduce food insecurity (Akbar *et al.* 2020; Essilfie *et al.* 2021). Lack of education can also impact a mother's ability to access information on nutrition, healthcare, and social services. This is line with the study made in developing countries (Smith. 2000, Nankinga *et al.* 2019).

The high percentage of food insecurity among daily wage workers (99.2%) with a significance of p=0.028 is linked to the instability and low wages associated with such jobs (Rahman dan Mishra 2020; Haini *et al.* 2023). Daily wage earners often lack job security, benefits, and sufficient income to consistently afford food as discussed in a study in the United States (Gundersen 2015, Muggaga *et al.* 2022). Households with more than five children being 99.6% food insecure (p=0.03). This suggests that larger families face greater challenges in providing sufficient food for all members (Akello dan Mwesigwa 2023)Getaneh *et al.* 2022,). More children mean higher expenses and increased demand for resources, which can strain a family's finances (Bahiru *et al.* 2023). Many children demand for attention through caring practices which can reduce the productivity of the caregivers yet the children have many expenses. Household size was not significant (p=0.947) which indicates that other factors such as income and number of dependents that more critically affect food security. This is in agreement with a study made in USA (Nord 2010; Akello dan Mwesigwa 2023). Some household members can be adults contributing to the pool of household income which can improve on food security.

The study showed that 96.8% without land access were food insecure. The significant association (p=0.041) between lack of land access and food insecurity can be explained by the role of land in providing food through subsistence farming or as a source of income (Cheteni *et al.* 2020; Kehinde *et al.* 2021) Without land, families may struggle to grow their own food or generate income through agricultural activities. This is line with a United Nations report of the

special rapporteur on right to food (De Schutter, 2010). Livestock ownership was not statistically significant with P=0.736. The non-significance of livestock ownership suggests that owning livestock alone may not be sufficient to ensure food security as discussed in a study made in Ethiopia (Headey, 2016,). Many of the households keep livestock to be used in situations when there is a big financial issue or in times of difficulties but not for food consumption.

Mothers with subsistence income were 99.6% food insecure with a significance of p= 0.013 which underscores the direct link between income and food security (Junaidi *et al.* 2022). Low subsistence income limits the ability to purchase sufficient and nutritious food, pay for essential services, and cope with financial shocks. This has been supported by studies made in United States department of agriculture (Coleman 2013, (Ogwal *et al.* 2022)).

3.3 Severity of Household Food Security

Approximately 89% of the households experienced some form of food insecurity, with 21.6% being mildly food insecure, 62.4% moderately food insecure and 4.8% severely food insecure as shown in Figure 9.

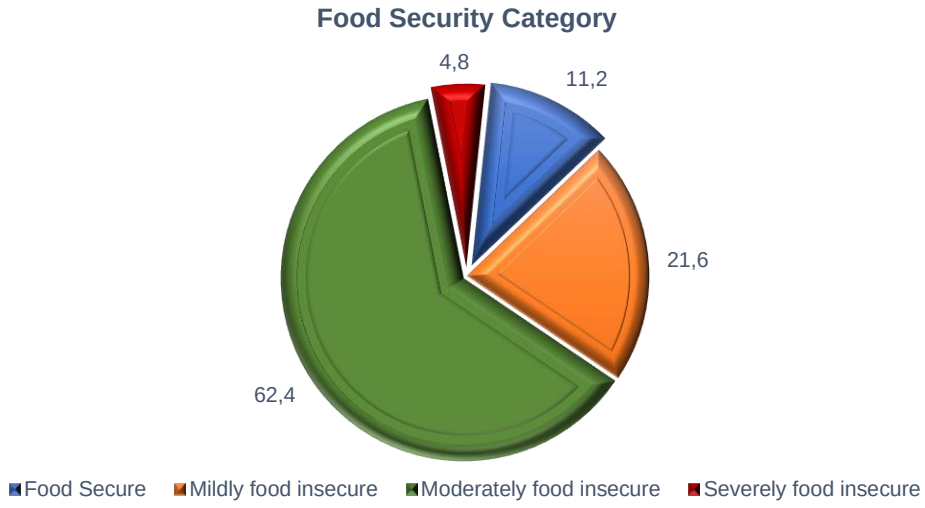

Figure 1 Severity of food security status

The findings indicated that severe food insecurity was below the global level of 11.3% according to the Food Security and Nutrition in the World 2023(FAO, WFP, WHO 2023) and that of Karamoja region in Uganda which is 45% according to Integrated Food Security Phase Classification (IPC, 2023).

3.4 Risk Factors Related to Household Food Security

The study analysed some of the risk factors that contribute to household food security among the participants. Among these factors were the source of the food, food safety, post-harvest handling techniques, access to safe water, waste management procedures, and participation in sugarcane growing in this area.

Table 5 Risk factors to household food insecurity

Variable	Food secure		Food insecure		Total		P-value	OR	95% CI
	n	(%)	n	(%)	n	(%)			
Food source									
Own production	3	1.2	32	12.2	35	13.4			
Own + Market purchase	12	4.6	59	22.4	71	27.0	0.084	4.14	1.634-7.448
Market purchase only	6	2.2	151	57.4	157	59.6			
Food safety									
Adequate	14	5.3	73	27.7	87	33.0	0.044*	4.03	1.637-8.743
Inadequate	8	3.1	168	63.9	176	67.0			
Post-harvest handling									
Traditional methods	10	3.8	208	79.0	218	82.8	0.731		
Modern technology	6	2.3	39	14.9	45	17.2		3.20	1.207-4.836
Safe water									
Adequate	18	6.9	74	28.1	92	35.0	0.029*	6.69	1.989-10.196
Inadequate	6	2.0	165	63.0	171	65.0			
Waste management									
Proper	7	2.7	60	22.8	67	25.5	0.050*	7.51	1.669-12.364
Improper	3	1.2	193	73.3	196	74.5			
Sugarcane growing									
Yes	4	1.5	224	85.2	228	86.7	0.034*		1.384-1.736
No	14	5.3	21	8.0	35	13.3		0.03	

n= number of subjects, % - Percent, OR-Odds ratio, Bivariate analysis using chi-square test, *Significant if $P < 0.05$.

Findings of the current study indicate that households relying on both their own production and market purchases are over four times (OR= 4.14) more likely to be food secure compared to those relying solely on other sources. Diversification of food sources can improve food security because households can better manage the risks associated with food shortages (Nii *et al.* 2022) If one source fails, they have another to fall back on.

Adequate food safety practices make households approximately four times (OR=4.0) likely to be food secure compared to those with inadequate food safety. Proper food safety practices prevent foodborne illnesses and ensure that food is safe to consume (Mutua *et al.* 2021). Healthy household members are better able to work and contribute to food production and income generation, thereby enhancing food security (Roy *et al.* 2023; Oba 2024). Adequate food safety practices reduce food spoilage and waste, ensuring that more food is available for consumption. This finding is line with a study made in low- and middle-income countries (Grace, 2015; Kennard 2020).

Households using modern post-harvest technology are over three times (OR= 3.2) more likely to be food secure. Modern post-harvest technologies, such as improved storage facilities and pest control methods help in preserving the quantity and quality of harvested crops reducing food loss (Raut *et al.* 2024; Sharps *et al.* 2024). This leads to greater availability of food throughout the year.. This study finding is supported by a study made in developing countries (Kumar, 2017 (Mutungi *et al.* 2023; Sugri *et al.* 2024)

Access to adequate safe water significantly increases the likelihood of food security, making households nearly seven times (OR=6.69) more likely to be food secure compared to those with inadequate safe water. Access to safe water reduces the incidence of waterborne diseases, which can sap household resources and reduce productivity (Asaki *et al.* 2024). Safe water is crucial for food preparation such as cooking, cleaning, and maintaining hygiene, which are essential components of food safety and nutrition. Just as discussed in a study made in Nigeria (Onabolu, 2018)

Proper waste management practices are strongly associated with food security, making households over seven times (OR= 7.5) more likely to be food secure compared to those with improper waste management. Proper waste management reduces environmental contamination and health hazards, contributing to overall household health and productivity (Skawińska dan Zalewski 2022). Efficient waste management can also involve recycling organic waste into compost, enhancing soil fertility and agricultural productivity. This discussion is supported by the similar study made in |Indonesia (Zurbrugg, 2012, Hengsdijk *et al.* 2020)

Households engaged in sugarcane growing are less likely to be food secure compared to those not involved in sugarcane growing, indicating a potential negative impact on food security (OR= 0.03). Sugarcane growing is associated with monocropping, which can reduce biodiversity and soil fertility, making households more vulnerable to food insecurity if the sugarcane crop fails (Sileshi *et al.* 2019; Kaahwa *et al.* 2023). Sugarcane is a perennial cash crop which takes a long time to be harvested and may not directly contribute to household food supplies. The discussions are in line with previous studies made in Addis Ababa (Minten, 2016).

3.5 Dietary Diversity

Dietary diversity was measured at both household level and individual level. Household food security was measured using the Household Diet Diversity Score (HDDS) and the individual dietary diversity for pregnant women was measured using the Minimum Dietary Diversity for Women (MDD-W).

Household Dietary Diversity Score (HDDS)

The study used the 12 food categories. The foods that were consumed by the different households were analysed to measure the capacity of households to secure a variety of nutrient -rich foods as well as food consumption patterns.

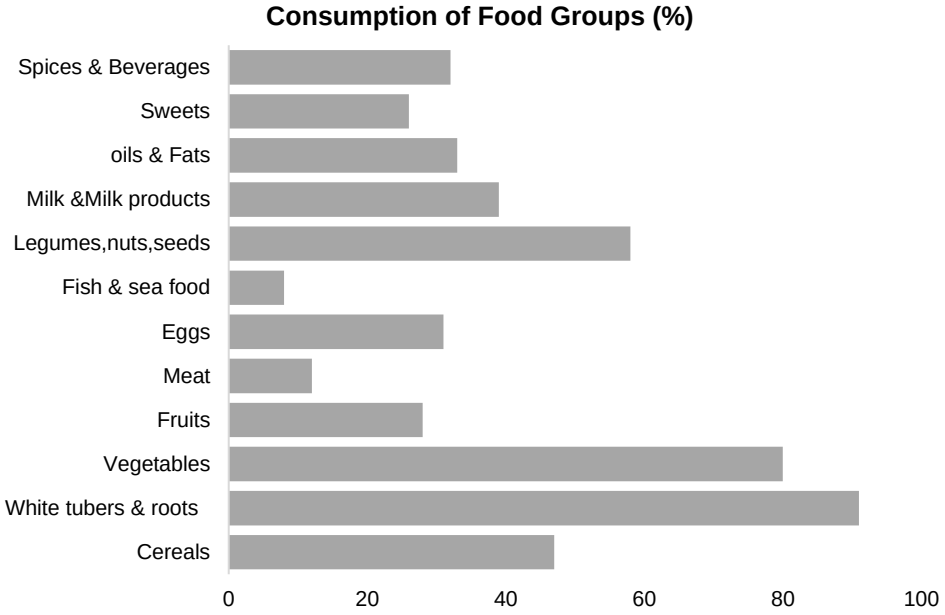

Figure 2 Household dietary diversity score

The study relieved that there was high consumption of white tubers and roots (91%) such as potatoes, yams, cassava. This trend is attributed to the understanding that these foods are regarded as food staple foods in many diets in this region (Grant *et al.* 2019; Girard *et al.* 2021). Due to their affordability, availability, and role as a primary source of energy, these foods are culturally preferred and regarded as traditional meals (Jordan *et al.* 2022). High consumption of cereals (47%) is associated with the fact that in many cultures in this region, cereals such as maize, rice, wheat, and millet are alternative to staple tubers providing necessary carbohydrates (Tarus 2019).

Vegetable consumption (80%) was high due to the nutrient needs essential for providing vitamins, minerals, and fibre, which are critical for a balanced diet. Vegetables are often readily available due to shorter maturity time and can be grown locally, making them a regular part of meals (Derose *et al.* 2021). The study also found that there is moderate consumption of legumes, nuts, and seeds (58%). These are important sources of plant-based proteins and essential fatty acids, which can be particularly important in vegetarian or low-meat diets (Kimere *et al.* 2022).

The study also discovered moderate consumption of milk & milk products (39%). These findings are attributed to belief that milk and milk products are mainly food for infants only and the commercialisation of the milk and its products to industries influencing their consumption rates (Bain *et al.* 2020).

There was low consumption of meat (12%) and Fish & Seafood (8%). Meat and seafood are often more expensive compared to plant-based foods, limiting their consumption, especially in low-income households (Ntakyo dan Berg 2019). The cultural practices and food taboos also influence the consumption of these foods. There was low consumption of fruits (28%) attributed to seasonality. Fruits can be seasonal, affecting their availability

throughout the year. The cost of the fruits can be relatively high, impacting their regular consumption in some households.

There was moderate consumption of eggs (31%) associated with many households having local birds which do not require intense resources. However, eggs bought from markets are relatively expensive. There was low consumption of oils & fats (33%) which can be associated with health awareness. Increasing awareness of the health impacts of excessive oil and fat consumption may lead to moderation in their use.

There was low consumption of sweets (26%) and spices & beverages (32%). These findings can be associated with health concerns regarding high sugar intake might lead to lower consumption of sweets.

The study also identified that almost half of the participants, 49.1% had moderate diet diversity (6-7 food groups). 32.8 % of the participants had low food diversity (≤ 5 food groups) while 18.1% consumed more than 7 food groups (Figure 11).

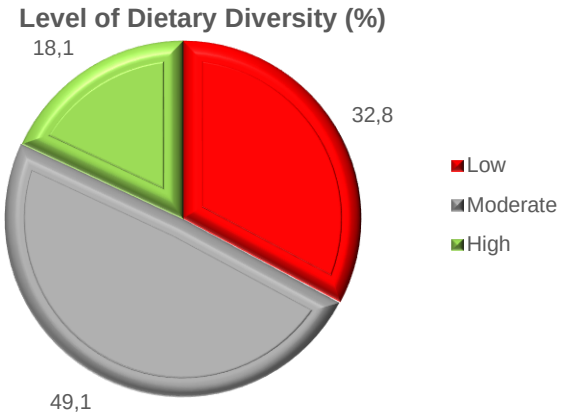

Figure 3 Level of household dietary diversity

Minimum Dietary Diversity for Women (MDD-W)

Pregnant women require increased amounts of nutrients which directly impact on pregnancy outcomes (Marshall *et al.* 2022). The study further assessed MDD-W to measure individual food intake. This gave more insight about intra-household food distribution that may affect nutrient intake in the particular mothers. The cultural practices, taboos and food cravings of the mothers affect their food intake.

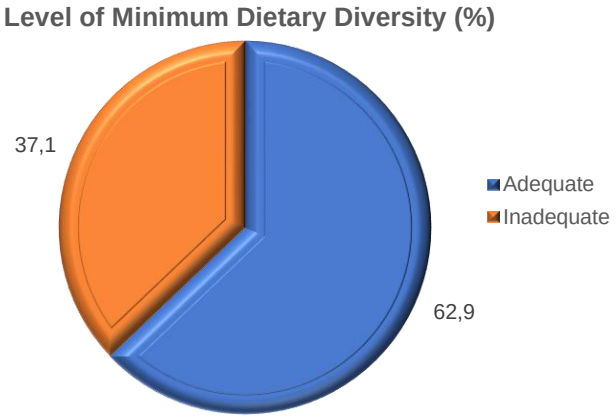

Figure 4 Level of minimum dietary diversity

The study showed that 62.9% of the respondents had adequate minimum dietary diversity (more than 5 food groups) and 37.1% had inadequate minimum dietary diversity. Even with these findings, there was still prevalence of anaemia and this can be attributed to intake of foods with less nutrients such as low bioavailability of iron where the non-heme iron found in plants may not easily be absorbed (Piskin *et al.* 2022) Certain food, even within a diverse diet can inhibit iron absorption such as phytates found in grains and legumes, polyphenols found in tea and coffee (Warkentin *et al.* 2020; Rahman dan Shaheen 2022). Parasitic infections such as hook worm may contribute to loss of blood and other infections like malaria can lead to inflammation reducing the body's ability to use the iron (Dixit *et al.* 2021).

3.6 Food Frequency

The Food Frequency Questionnaire (FFQ) was used to determine the frequency of intake of different food items which were categorised into 11 categories. The responses were categorised as daily, weekly, monthly, and rarely Figure 13.

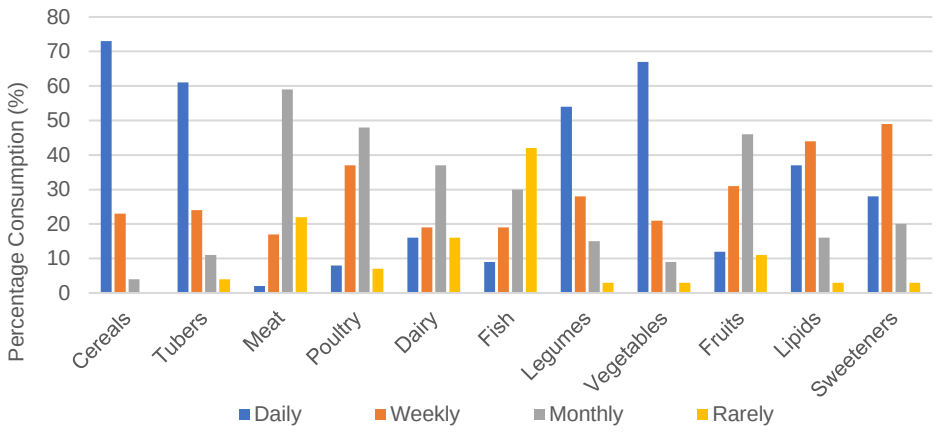

Figure 5 Frequency of food intake

The cereals and tubers were consumed daily and this is attributed to economic factors where these foods are affordable and readily available making them accessible to low-income households. These are also staples in the traditional diets passed down through generations (Tugume *et al.* 2023). The meat, poultry and fish tend to be more expensive and this accounts for their weekly and monthly consumption (Palupi *et al.* 2024). Fish is less available in rural inland areas where fishing resources are limited. Vegetables and legumes were consumed daily as they can grow with relative ease such as dodo, timpa (Akpo *et al.* 2020). The fruits were less frequently consumed and this is due to seasonality. When out of season, the prices tend to increase limiting consumption. Dairy products are less consumed and this is due to the selloff of milk and the dairy products are highly perishable without proper refrigeration. Lipids and sweeteners were consumed in moderation and this is due to health considerations and the regard of these foods as being luxurious.

3.7 Anaemia

The study assessed the prevalence and the severity of anaemia among the respondents. The findings indicated that 38.8% of the respondents were anaemic with 2% severely anaemic, 9.5 % moderately anaemic and 27.3 mildly anaemic (Figure 14). Despite the moderate food intake, some of the respondents faced anemia.

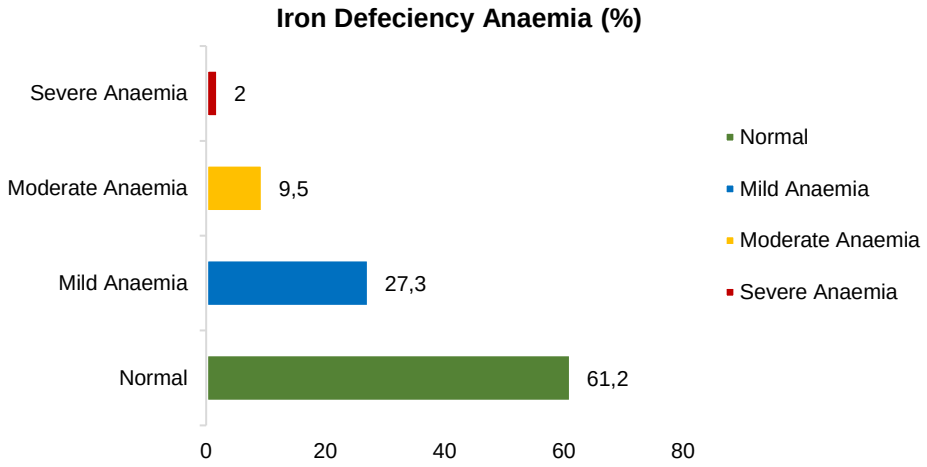

Figure 6 Prevalence and severity of anaemia

The findings of the study indicated a high prevalence of mild anemia (27.3%). This is influenced by dietary factors where many people may have diets low in iron-rich foods such as meat, leafy greens, and iron-fortified products (Adokorach *et al.* 2024; Werner *et al.* 2024). Economic hardships may make it challenging for families to afford iron-rich foods or supplements.

Moderate anemia (9.5%) and severe anemia (2%) was observed among the participants and this can be due to chronic infections and disease burden. In rural areas, the burden of diseases like malaria, parasitic infections (e.g., hookworm), and chronic inflammation can lead to moderate or severe anemia. These infections

often interfere with the body's ability to absorb or use nutrients efficiently (Abioye *et al.* 2024).

The small percentage of severe anemia could be attributed to untreated cases where women might not have access to antenatal care or supplements. Poor access to healthcare in rural regions contributes to cases of moderate and severe anemia (AlQurashi *et al.* 2024). When they are unnoticed or untreated until they become critical, which could explain the lower percentage of those in the severe anemia category (Bathla dan Arora 2022).

3.8 Household Food Security and Anaemia

The study revealed a direct association between household food insecurity and anaemia. As the level of household food insecurity increased the chances of becoming anaemic also increased.

Table 6 Household food security anaemia

Food security	Frequency	Percent (%)	Anaemic (%)	Not anaemic (%)	OR	95% CI Lower-upper
Food secure	29	11.2	2.0	98	0.074	1.324-1.964
Mildly food insecure	57	21.6	38.2	61.8	0.618	1.553-1.957
Moderately food insecure	164	62.4	51.6	48.4	1.066	1.295-1.758
Severely food insecure	13	4.8	98.5	1.5	65.667	1.997-13.582

These odds ratios indicate that compared to food-secure households (OR=0.074), the odds of being anaemic increase dramatically with the level of food insecurity. The severely food insecure group has an especially high odds ratio (OR=65.7), highlighting a very strong association between severe food insecurity and anaemia.

Severe food insecurity often leads to a lack of access to nutrient-rich foods such as meat, fish, poultry, and leafy green vegetables leading to anemia. Food-insecure households may lack access to essential micro nutrients like vitamin B12, folate, and vitamin C, which are crucial for red blood cell production and overall health (Awoniyi *et al.* 2024; Ramachandran *et al.* 2024). In severe cases, individuals may skip meals or have prolonged periods of fasting, exacerbating nutrient deficiencies. Food insecurity is often associated with poor living conditions characterized by inadequate access to safe and clean water contributing to poor sanitation which can increase susceptibility to gastrointestinal infections and parasitic diseases such as hookworm, further contributing to anaemia. Limited financial resources can also restrict access to healthcare services, making it difficult to diagnose and treat conditions like anemia early enough.

Some of the risk factors to anaemia that were assessed included dietary diversity, knowledge about IFAS, availability of the iron supplements, compliance to IFAS, side effects of IFAs, and access to medical care.

Table 7 Risk factors to the prevalence of anaemia

Variable	Anaemic		Not anaemic		Total		P-value	OR	95% CI
	n	(%)	n	(%)	n	(%)			
Dietary diversity									
Low (≤ 5 food groups)	60	22.9	135	51.3	195	74.2		0.68	
Medium (6-7 food groups)	10	12.5	10	3.80	43	16.3	0.015*		1.482-1.963
High (> 7 food groups)	7	2.7	18	6.8	25	9.5			
Knowledge IFAS									
Poor (<60)	37	14.1	52	19.8	89	33.8			1.295-1.874
Moderate (60-80)	32	12.2	75	28.5	107	40.7	0.072		
Good (> 80)	8	3.1	59	22.4	67	25.5		0.60	
IFA supplements									
Available	9	3.5	68	25.8	77	29.3		0.50	1.196-1.655
Out of stock	39	14.8	147	55.9	186	70.7	0.038*		
Compliance to IFAS									
Adequate (≥ 4 tablets per week)	5	1.9	53	20.1	58	22.0		0.36	1.128-1.457
Inadequate (< 4 tablets per week)	43	16.4	162	61.6	205	78.0	0.020*		
Side effects of IFAS									
Yes	13	4.9	170	64.7	183	69.6		1.25	1.468-1.994
No	7	2.7	73	27.7	80	30.4	0.049*		
Access to medical care									
Easy	11	4.2	111	42.2	122	46.4			1.381-1.953
Hard	48	18.2	93	35.4	141	53.6	0.952	0.19	

*Significant if P < 0.05, OR-Odds ratio, analysed using binary logistic regression.

Low dietary diversity is significantly associated with a higher prevalence of anemia (P = 0.015). Previous studies show that low dietary diversity often leads to insufficient intake of essential nutrients such as iron, folate, and vitamin B12, which are critical for the production of healthy red blood cells (Basrowi and Dilantika 2021). This is in line with previous studies in Africa (Seid *et al.* 2023), Poland (Skolmowska *et al.* 2022), Kenya (Adan *et al.* 2023), Ethiopia (Fite *et al.* 2023), Uganda (Adokorach *et al.* 2024). Improved dietary diversity is linked to lower odds of anemia, suggesting that food-secure households with diverse diets can better meet the nutritional needs of pregnant women, leading to better pregnancy outcomes (Heesemann *et al.* 2021; Zhou *et al.* 2024),

Though the odds ratio of 0.60 indicates a trend towards lower anemia with better knowledge of IFAS, there is no statistical significant association between knowledge of IFAS and anemia status (P= 0.072). This can be associated to the awareness and practice gap**.** While knowledge of IFAS is crucial, it may not translate directly into practice. (Jardí *et al.* 2021). Knowledge alone might not be enough if cultural or behavioral barriers prevent proper usage of IFAS.

The availability of IFA supplements is significantly associated with anemia status (P= 0.038). The odds ratio of 0.50 suggests that the availability of IFA supplements is associated with lower anaemia prevalence. The availability of iron and folic acid supplements directly impacts the ability of individuals to use them.

Compliance with IFAS is significantly associated with anemia status (P = 0.020). The odds ratio of 0.36 indicates that adequate compliance with IFAS is associated with substantially lower odds of anemia. Compliance with IFAS means that individuals are taking the supplements as recommended, which is essential for them to be effective (Ali dan Abdo 2022; Bahati 2022). Regular intake of iron and folic acid helps replenish iron stores and supports red blood cell production. Education and follow-up support can enhance adherence to IFAS regimens (Palikhey *et al.* 2022).

The presence of side effects from IFAS is significantly associated with anemia status (P = 0.049). Side effects such as gastrointestinal discomfort can discourage mothers from continuing with the supplements. This can lead to lower compliance and effectiveness, resulting in higher odds of anemia (Haile *et al.* 2024). Providing education on how to manage side effects and alternative formulations of supplements can help mitigate this issue and improve compliance.

Access to medical care does not show a significant association with anemia status (P = 0.952). Anemia is influenced by various factors including diet, supplement use, and overall health status (Berarti *et al.* 2023). Access to medical care is important, but it might not show a direct significant impact in this context due to the interplay of these other factors.

3.9 Anemia and Pregnancy Outcomes

The study assessed the infant pregnancy outcomes including infant being alive at birth, attainment of full-term delivery, birth weight and birth length. The parameters were determined at birth.

Table 8 Anaemia and pregnancy outcomes

	Anemic mothers (n=102)	**Non-anemic mothers (n=**161)	**P-value**	**OR**	**95% CI**
Alive	95 (93.1)	155 (96.9)	0.064	0.525	1.783-1.917
Preterm	39 (38.2)	28 (17.4)	0.022*	2.95	1.835-4.592
Low birth weight	51 (50.0)	43 (26.7)	0.018*	2.74	1.664-2.849
Low birth length	9(8.8)	8 (4.9)	0.142	1.85	1.238-2.044

* Significant if $p < 0.05$

Both anaemic and non-anemic mothers had high percentage of live births, with non-anemic mothers having a slightly higher rate (96.9% vs. 93.1%). Although the difference in the percentage of live births between anemic and non-anemic mothers is not statistically significant, there is a trend suggesting that anemia is associated with a slightly higher risk of adverse outcomes for the new-born. Anemia can lead to reduced oxygen supply to the foetus, potentially affecting its development and survival (Ghani 2022; Helfrich *et al.* 2022).

Anemic mothers had approximately 2.95 times higher odds of having a preterm birth compared to non-anemic mothers (p=0.022) indicating this difference is statistically significant. Anemia can cause increased fatigue and stress on the body, which can lead to developmental delays complications including intrauterine growth restriction (IUGR) that may result in preterm labour (Akmal *et al.* 2024).

Anemic mothers had 2.74 times higher odds of having a baby with low birth weight compared to their counterparts (p=0.018) showing a statistically significant difference. Anemic mothers are almost three times more likely to have babies with low birth weight. This was attributed to the insufficient supply of essential nutrients and oxygen to the developing foetus due to anemia. Adequate maternal iron levels are crucial for foetal growth and development, and a deficiency can hinder this process, leading to low birth weight (Latunde-Dada 2024).

Anemic mothers have 1.85 times higher odds of having a baby with low birth length compared to non-anemic mothers. However, the P-value of 0.142 suggests this difference is not statistically significant. Low birth length could be influenced by factors such as overall maternal health, nutrition, and genetics, in addition to anemia prevalence (Babah *et al.* 2024).

3.10 Risk Factors to Low Birth Weight

The study findings in stage I indicated that low birth weight was the most significant adverse pregnancy outcome. The risk factors low birth weight were analysed and these included parity, number of ANC visits, time of 1st ANC visit, interpregnancy interval and gestational age.

A bivariate and multivariate logistic regression was done adjusting for cofounders including maternal age, socio economic factors, education level and income.

Table 9 Bivariate and multivariate logistic regression

Variable	P Value	OR	CI (95%)	AOR	CI (95%)
Parity					
1		1.94	1.76-2.36	0.88	1.45-1.63
3 and more	0.076	2.67	1.87-2.75	2.02	1.26-1.97
2		Ref		Ref	
No of ANC visits					
1	0.392	3.85	1.89-2.58	2.87	1.52-2.21
2		2.12	1.47-1.96	1.22	1.16-1.79
3 and more		Ref		Ref	
Time of 1st ANC visit					
2nd trimester		3.14	2.79-3.81	1.26	2.06-3.17
3rd trimester	0.038	5.97	1.85-2.36	3.81	1.27-1.61
1st trimester		Ref		Ref	
Interpregnancy interval					
<12 months	0.046	4.95	2.62-2.94	3.14	1.64-1.85
12-24 months		3.05	1.95-2.54	1.83	1.48-1.73
>24 months		Ref		Ref	
Gestational age					
<37 weeks	0.025	7.86	2.29-5.63	5.97	1.86-4.76
>37 weeks		Ref		Ref	

Adjusted for age, socio demographic factors, education, income

Parity (number of prior pregnancies) indicated that women with 3 or more pregnancies have high odds of having low birth infants though it was not statically significant (p=0.076). High parity (≥3) is associated with maternal depletion syndrome due to cumulative nutritional deficiencies and strain on maternal health systems over multiple pregnancies, leading to adverse outcomes.

Number of ANC visits showed that women with only 1 ANC visit were 2.87 times at risk of having a low-birth-weight infant compared to those with more ANC visits though this was not significant (p=0.392). Insufficient ANC visits increase risks due to delayed or missed opportunities for early detection and management of pregnancy complications. Missing ANC visits may delay the diagnosis and management of conditions like anemia, infections, or malnutrition that directly affect birth weight.

Timing of first ANC visit indicated that women initiating ANC in the 3rd trimester were 5.97 times at risk of having an infant with low birth weight compared to those who have their first ANC visit in the 1st trimester. This finding was statistically significant with p=0.038. Delayed ANC leads to missed chances for improving maternal and foetal health, increasing the likelihood of LBW.

Interpregnancy Interval (IPI) indicated that women with IPI < 12 months had higher risks of LBW infants AOR 3.14 which was significant at p=0.046. Short IPIs (<12 months) contribute to maternal nutrient depletion, delay physical recovery resulting into increased risks of low birth weight, and other adverse outcomes. A longer interval (>24 months) allows for maternal recovery and replenishment of nutritional reserves, optimizing maternal and foetal health.

Gestational age <37 weeks was associated with LBW. Mothers with infants below 37 weeks of gestation had high odds of LBW OR 7.86 (95% CI: 2.29–5.63), AOR 5.97 (95% CI: 1.86–4.76), statistically significant at p=0.025 The shorter gestational period directly limits foetal growth and development, making preterm birth a primary driver of LBW. Preterm delivery often results from underlying physiological stress or complications (e.g., hypertensive disorders or infections).

3.11 Community Intervention

Maternal Measurements

The maternal anthropometric measurements at the time of delivery while in the health facilities were considered as the baseline before the intervention and the assessment done after the intervention was the end line assessment.

Table 10 Maternal measurements

Variables	**Maternal measurements (Mean ± SD)**	
	Baseline	**After intervention**
Weight (Kg)	66.25±11.32	70.42±10.88
Height (cm)	151.58±8.94	151.58±9.13
Body mass index (Kg/m^2)	21.68±3.79	23.97±6.87
MUAC (cm)	23.5±5.47	27.22±6.33
Hb (g/dL)	10.44±23.82	12.48±18.26

The average weight increased from 66.25 kg to 70.42 kg, indicating a mean weight gain of 4.17 kg. This can be attributed to the improved nutritional support through nutrition education improving on the dietary choices and better eating habits (Nelson-Peterman *et al.* 2023). There was no significant change in maternal height. Height remained constant because it is a static measurement in adults.

The BMI increased from 21.68 to 23.97, indicating an average BMI increase of 2.29kg/m². This is a direct result of weight gain observed. The average MUAC increased from 23.5 cm to 27.22 cm, indicating a mean increase of 3.72 cm and 0.86 rise in SD. The increase suggests improved nutritional intake and better muscle mass or overall body composition.

The average Hb level increased significantly from 10.44 g/dL to 12.48 g/dL, indicating an average rise of 2.05 g/dL which suggests an improvement in anaemia. The iron supplementation or dietary changes increased iron intake, leading to improved haemoglobin levels. This is crucial for preventing and treating anemia (Kakkar dan Aundhakar 2022)

Comparison of Maternal Measurements with Standards

Table 11 Comparison with standards

Variable	Baseline (Mean ± SD)	Standards
Weight (Kg)	66.25±11.32	74 kg (estimated for 20-29 years)
Height (cm)	151.58±8.94	172 (for weight of 74kg)
BMI (Kg/m2)	21.68±3.79	18.5 – 24.9
MUAC (cm)	23.5±5.47	23.0
Hb (g/dL)	10.44±23.82	11.0

The mean weight of 66.25 kg falls within the normal range for many women, depending on their height and BMI though it below the estimated weight (74kg) for pregnant women aged 20-29 years. For a height of 151.58 cm, this weight corresponds to a BMI of 21.68, which is in the normal range. The average height of 151.58 cm is on the shorter side compared to global averages which should be averagely 172 cm for women of 74 kg but still aligns with regional norms in many low- and middle-income countries. Height is fixed and primarily used to calculate BMI, with no direct health implications postpartum. The mean BMI of 21.68 kg/m² is within the normal range, indicating adequate nutritional status postpartum.

The mean MUAC of 23.5 cm meets the threshold for adequate nutrition, though the standard deviation (±5.47 cm) suggests a subset of women may have MUAC <23 cm, indicating undernutrition. While the mean value is within the normal range, the wide variability suggests the need for targeted interventions for women at the lower end. The mean Hb of 10.44 g/dL indicates mild anemia in the postpartum mothers. The large standard deviation (±23.82 g/L) suggests some women may fall into the moderate or severe anemia categories.

Infant Measurements

These infants were expected to be exclusively breastfed as the mothers were given nutrition education regarding the benefits of breast feeding. The findings of the study are shown in Figure 15 and 16.

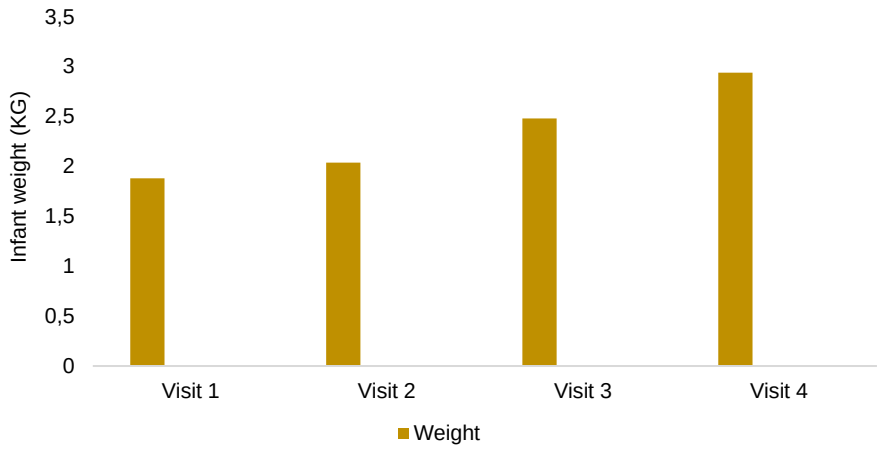

Figure 7 Average Infant weight at different weeks

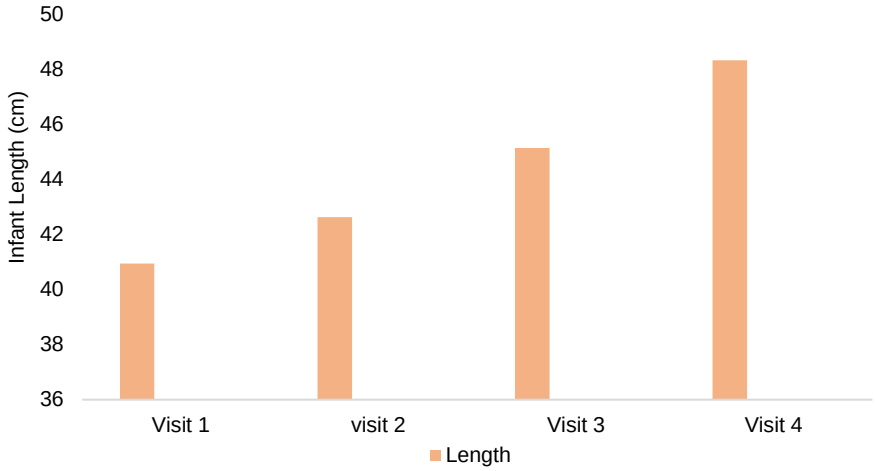

Figure 8 Average infant length at different weeks

The findings showed a steady growth pattern with the infants' weight and length increasing on every visit. This can be associated with normal physical development which could be attributed to exclusive breastfeeding practices. Breastfeeding can improve growth and development of infants.

Table 12 Infant measurements

Variables	**Infant measurements (Mean ± SD)**	
	Baseline	**After intervention**
Weight (Kg)	1.88 ± 0.32	2.94±1.17
Length (cm)	40.94 ± 3.48	48.33± 2.12

There was substantial increase in the mean weight of the infants after the intervention by 1.06 kg suggesting significant growth. The (SD) increased from

0.32 to 1.17, indicating that the weights of the infants were more spread out and less consistent after the intervention which could be due to different rates of growth among the infants (Kiguli *et al.* 2019). The significant increase in infant weight can be attributed to improved maternal nutrition and postnatal care, and possibly the direct nutritional support provided to infants through exclusive breastfeeding and better hygiene practices (Ebadi-Vanestanagh *et al.* 2023).

The mean length of the infants increased from 40.94 cm to 48.33 cm, indicating significant growth in length by 7.39 cm. The considerable improvement in infant length indicates overall better foetal growth and development, which can result from enhanced maternal nutrition, effective postnatal care, and reduced maternal stress and infections (Eicher-Miller *et al.* 2020).

Comparison of infant measurements with standards

The infant weight at birth was compared with standard. Normal birth weight is considered to be 2.5kg. The Z-scores at birth to 6 months were used to compare the growth curves of the infants. Weight for age in girls was used because most of the infants (72%) were female.

The mean weight of 1.88 kg indicates low birth weight (LBW). The WHO standard Z- scores showed that the mean weight was below -3SD. The standard deviation (±0.32 kg) suggested that some infants may had weights close to very low birth weight (VLBW) thresholds. The group exhibits low birth weight, which is commonly associated with preterm delivery, IUGR, or maternal factors such as poor nutrition or anemia. However, after the intervention for 2 months the average weight increased to 2.99. The Z-scores show that weight after the intervention was above -2SD which emphasises the effectiveness of the intervention. Even with this increment the infants were still below the normal body weight expected for the infants of their age.

Using the Length for age Z-Scores, the average length of the infants was analysed and the average birth length of 40.9 cm increased to 48.33 cm after the intervention. Normal length at birth (term infants) is 48–53 cm

The mean length of 40.94 cm is significantly lower than the normal range for term neonates. The standard deviation (±3.48 cm) suggests a range of 37.46–44.42 cm, with some infants possibly exhibiting severely restricted length. Even with the increase in length, the infants' length is still below -2SD in the Z-Score growth chart which shows that the infants still need to catch up with growth.

Iron and Folic Acid Supplementation

The study intervention included iron and folic acid supplementation. Maternal knowledge, compliance to IFAS and side effects were measured**.**

Table 13 Iron and Folic Acid Supplementation

Variables	**Iron and folic acid supplementation (Mean ± SD)**

	Baseline	By the end of intervention
Knowledge IFAS	23.45 ± 19.89	39.28 ± 20.11
Compliance	21.87 ± 18.45	40.05 ± 16.94
Side effects	33.71 ± 12.85	27.99 ± 9.56

There was a notable increase in the mean knowledge score by 15.83 from 23.24 to 39.28, indicating that there was an improvement in participants' understanding of IFAS. This means that while overall knowledge improved, the range of knowledge levels among participants remained consistent. The nutrition education intervention increased the awareness and knowledge regarding IFAS (Jani *et al.* 2022).Guntari *et al.* 2022).

The findings show a significant increase in compliance by 18.18, indicating that mothers adhered to the IFAS by the end of the intervention. As knowledge about the importance and benefits of IFAS increases, compliance improved (Tsegaye 2024). This aligns with a study in Ethiopia (Bekele *et al.* 2022; Tsegaye 2024), and another study in Iran (Zamanlu *et al.* 2024). The intervention improved the availability and accessibility of iron and folic acid supplements. Regular supply and easy access to supplements can significantly improve compliance rates in addition to the presence of support systems, such as follow-up visits (Xu *et al.* 2022).

The mean side effects score decreased by 5.72 from 33.71 to 27.99, indicating that participants experienced fewer side effects by the end of the intervention. This attributed to the strategies to manage or mitigate side effects more effectively such as taking supplements with meals to reduce gastrointestinal discomfort thus leading to a more uniform and improved experience for the mothers (Alhaija *et al.* 2024).

Nutrition Education

Knowledge regarding breastfeeding increased from 22.8% to 49.5%. Breastfeeding education included the benefits and techniques of breastfeeding. When mothers are informed about the importance of breastfeeding for both the infant's and mother's health, they are more likely to adopt and continue the practice (Girma *et al.* 2019).

The average knowledge regarding food availability increased from 40.4% to 63.7%. The intervention aimed at improving food security through delivering nutrition knowledge. Agricultural support through education on backyard farming or kitchen gardening contributed to better understanding of agricultural practices for better food production and availability (Alaimo *et al.* 2020).

Maternal knowledge regarding hygiene and sanitation increased from 38.2% to 51.7%. Education on hygiene practices and proper sanitation practices contributed to behavioural changes in the households.

Nutrition education about backyard farming had a noticeable increase from 49.6% to 77.6%. Households were encouraged to start or improve their backyard farms. Nutritional knowledge about the nutritional benefits of growing their own food can motivate households to engage in backyard farming (Suri 2020).

Food Items Consumption

The study intervention supplied a food basket which had the orange sweet potato as the source of carbohydrate, the eggs as the animal source protein and the iron rich beans for the plant protein. Spinach was also supplied as the vegetable . The respondents were encouraged to consume a variety of food groups alongside those supplied.

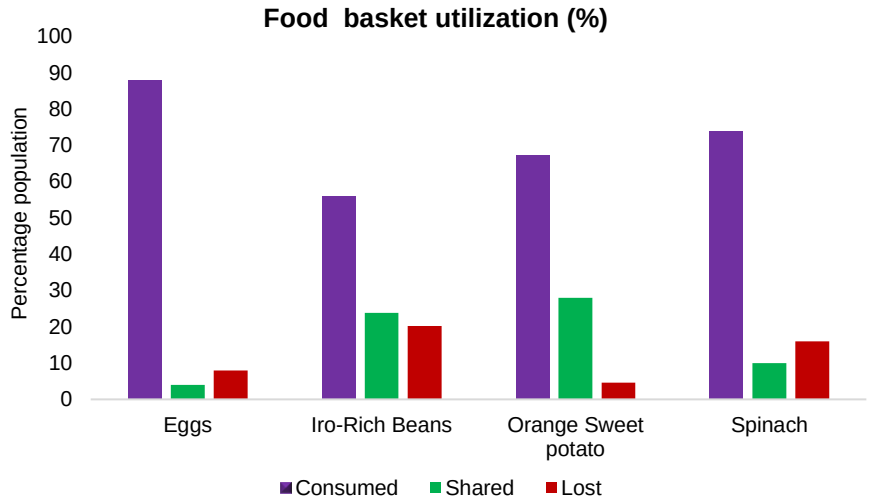

Figure 9 Household food basket utilization

Eggs, orange sweet potatoes, and spinach were highly consumed, with 88%, 67.4%, and 74% consumption rates, respectively. Eggs (88% Consumed, 4% Shared, 8% Lost). Being a rich source of protein and essential nutrients, makes them a preferred food item for many households (Nuwahereza 2019). However, the 8% loss could be attributed to improper storage conditions or mishandling. The sharing rate of 4% might be influenced by cultural practices of sharing food with neighbours or extended family, although it remains relatively low compared to consumption.

Iron-rich beans were consumed by a moderate portion of the population (56%). Iron-rich beans and orange sweet potatoes had higher sharing percentages (23.8% and 28%, respectively) compared to eggs and spinach. Iron-Rich Beans (56% Consumed, 23.8% Shared, 20.2% Lost). The moderate consumption rate suggests that while households recognize the nutritional benefits of iron-rich beans, they might not be as preferred as other food items like eggs. This trend is also associated with the belief that these beans need a longer preparation time which needs more fuel. Beans can be prone to pest infestation and spoilage if not stored properly, which explains the relatively high loss rate (20.2%) (Abigaba dan Aheisibwe 2023).

The orange sweet potato (67.4% Consumed, 28% Shared, 4.6% Lost). The consumption of the orange sweet potatoes was high given that potatoes are regarded as a staple food in this particular region and its culturally acceptable. Its colour and sweet taste improved its acceptability (Girard *et al.* 2021).

Spinach (74% Consumed, 10% Shared, 16% Lost). Its easily prepared contributing to its high consumption rate and highly acceptable in eastern Uganda. Spinach is highly perishable and can spoil quickly if not consumed or

stored properly, explaining the relatively high loss rate (16%). The sharing rate of 10% suggests that while spinach was shared within the community, its perishability limited the extent to which it was shared compared to more durable foods like beans (Liu *et al.* 2021).

IV CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion of the Study

The socio-economic factors of the respondents indicated that majority of the respondents, 42.6% were aged between 18-28 years. 52.9% of the respondents attained primary level of education and most of them were farmers which accounted for 61.6%. Majority of the households, 46.8% had more than five children. Many of the households had more than 7 members (53.6%). 62.7% of the mothers had limited land access. 68.0% of the respondents owned livestock. The majority of the mothers 82.0% had subsitence income.

Food insecurity was high with only 11% of the respondents being food secure and 89% being food insecure. Several socio-demographic factors, including maternal age, education level, occupation, number of children, land availability, and household income, were significantly associated with food security status. The study revealed that 4.8% of the respondents were severely food insecure. Risk factors that were significant with prevalence of food insecurity included food safety, access to safe water, waste management and involvement of households in sugarcane growing.

Findings of the study revealed that 49.1% of the households had moderate household dietary diversity meaning that they consumed at least 6-7 food groups while 62.9% of the respondents had adequate individual minimum dietary diversity. (5 food groups). Cereals and tubers were highly consumed, 73% and 61% respectively. Animal protein including meat, fish, poultry were among the food groups least consumed.

The study showed an association between food insecurity and higher rates of anaemia. 38.8% of the respondents were anaemic with 2% severely anaemic though majority were 27.3% were mildly anaemic. Factors such as low dietary diversity (≤5 food groups), inadequate access to and compliance with iron and folic acid (IFA) supplements, and experiencing side effects from these supplements were significant contributors to anaemia.

Conversely, anaemia was associated with adverse pregnancy outcomes. Anaemic mothers had higher odds of preterm birth at 2.95, low birth weight 2.74 and infants with anaemia indicating that food security and anaemia status profoundly affect pregnancy outcomes. Risk factors including time of 1st ANC visit, interpregnancy interval and gestation age were highly associated with low birth weight.

The findings of the study intervention indicated that maternal anthropometric measurements improved except for height which doesn't usually change in adults. Body weight, BMI and MUAC increased by 4.17kg, 2.29kg/m^2, 3.72cm respectively. The Hb level showed the highest increment from 10.44 g/dL to 12.48g/dL with an increase of 2.5g/dL. The average infant weight also increased from 1.88 kg to 2.94 kg and the average length increased from 40.94 cm to 48.33 cm. This highlights the impact of the intervention. However, even with the increment in the infant measurements, they were still below the normal growth curve as per the WHO Z-Scores.

There was increased knowledge and compliance regarding iron and folic acid supplementation. The side effects of the Supplements greatly reduced.

Nutrition education increased maternal awareness regarding breast feeding, food availability, backyard farming and hygiene and sanitation.

Eggs were highly consumed at 88%, the orange sweet potato highly shared at 28.8% and the iron rich beans were highly lost at 20.2%.

4.2 Recommendations

Based on the findings of the current study conducted, the following recommendations can be made to address food insecurity, maternal nutritional status, and pregnancy outcomes:

a) The government should improve access to health care services especially to community level. This can be implemented by increasing the number and capacity building of the health and community health workers to facilitate community interventions. Through fully enrolling and paying the community volunteer health workers, linkage of health services to community members can improve. These community workers can encourage early and timely health seeking behaviour such as time of 1St ANC visit, IFAS compliance. Timely management of anaemia and pregnancy monitoring can reduce adverse pregnancy outcomes.

b) Relevant authorities including ministry of agriculture, planning, education, health should encourage households to engage in diversified agricultural practices including growing a variety of nutrient-rich food crops through backyard farming initiatives rather than concentrating a lot on sugarcane production. Strict by-laws for sugarcane growing should be enforced.

c) There should also be an improvement and expansion in maternal nutrition education. Continued nutrition education programs to improve knowledge about Iron and Folic Acid Supplementation (IFAS), dietary diversity among others. Opinion leaders such as cultural, religious and local leaders should be involved to tailor these programs to be relevant and accepted. Community engagement to strengthen community health systems can be improved through advocacy for region-based policies. Innovative nutrition education can be made through mobile apps, SMS, or videos through culturally tailored content in local language about food habits, and practices. The community can be engaged through cooking demonstrations, storytelling, or peer support groups.

d) The government to establish and implement enabling policies that support women involvement such as offering adult education, vocational studies which can improve the skills of the mothers and earn better income. Maternal higher education should be underscored through economic empowerment to increase household income. Women should also be offered leadership roles to be part of decision-making teams. Policies that improve land access, property ownership and inheritance should be implemented especially for women, people with disabilities, teenage mothers and vulnerable people.

e) Systems need to be enforced for continuous monitoring and evaluation. Establish ongoing monitoring and evaluation frameworks to track the impact of interventions and use this data to make informed adjustments to programs alongside creating mechanisms for regular feedback from community members to ensure that interventions are meeting their needs and to identify areas for improvement.

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