Effect of Integrated Nutrition Intervention Package on Maternal Nutritional Status and Birth Weight in Rwanda.

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A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD), in the School of Public health; College of Medicine and Health Sciences; University of Rwanda.

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DECLARATION

I, Michael Habtu, declare that this thesis is entirely my own creation and hasn't been submitted to another university or organization for a degree or other award.

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Signature:

DEDICATION

I dedicate this work to the All-Mighty God and to my parents, who have never stopped encouraging supporting me.

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I am most grateful to the Almighty God for providing the ability, knowledge, and wisdom to come this far and write this thesis.

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ABSTRACT

In Rwanda, low birth weight (LBW), which is caused by maternal undernutrition, is a public health concern. Five Districts have adopted the *Gikuriro* Program, which consists of an integrated 'nutrition-sensitive' and 'nutrition-specific' intervention. However, there is no information on the effect of such intervention on maternal nutritional status and birth weight. Therefore, the study had three main objectives: 'to determine the effect of integrated nutrition-specific and nutrition-sensitive intervention package on maternal undernutrition among pregnant women'; 'to assess the effectiveness of an integrated maternal nutrition intervention package on birth weight'; and 'to explore the effect and challenges of an integrated nutrition intervention package utilization among pregnant women and lactating mothers'.

A quasi-experimental design was employed for the first and second objectives. A total of 552 and 545 pregnant women for intervention and control group were recruited respectively. The highest percentage were aged 25-29years (27.3%), married (46.1%) and attended primary school (62.6%). More than half (56.1%) of babies were females and the average birth weight was 3,106.84grams. When compared to the control group, maternal undernutrition was significantly lower in the intervention group (4.7% vs 18.2%; $p<0.001$). After adjusting for relevant confounders, the intervention group's risk of maternal undernutrition was 77.0% lower [AOR = 0.23; 95%CI = 0.15 – 0.36]. For the second objective, the intervention has increased the average birth weight by 219grams ($p<0.001$) and decreased LBW by 66.99% ($p<0.001$). The intervention group showed a decreased risk of LBW (AOR = 0.23; 95%CI = 0.12 - 0.43). For the third objective, qualitative research was conducted among 25 community health officers and 27 nutritionists for key informant interviews (KIIs), as well as 40 pregnant women and 40 lactating mothers in 10 focus group discussion (FGDs). Among implementers and beneficiaries, the view of the intervention was improved nutrition knowledge and skills, enhanced attitude toward a balanced diet, perceived improved nutrition, and financial independence. However, some of the main challenges identified were lack of awareness of the *Gikuriro* Program, undesirable attitude towards nutrition, economic constraints, lack of husband support, and time constraints.

Thus, to establish causation and provide information for the possible national scale-up of this intervention, more research using randomization approach is recommended. Besides, other upcoming nutrition intervention projects should consider the challenges highlighted in this study for optimal nutrition intervention implementation and utilization.

Keywords

Integrated Intervention Package, Low Birth Weight, Maternal Undernutrition, 'Nutrition-sensitive', 'Nutrition-specific'.

LIST OF PAPERS

This thesis is comprised of the following three sub-studies:

Paper 1: Habtu, M., Agena, A. G., Umugwaneza, M., Monchama, M., & Munyanshongore, C. (2022). Effect of integrated nutrition-sensitive and nutrition-specific intervention package on maternal malnutrition among pregnant women in Rwanda. Published in Maternal & Child Nutrition, 18(3), e13367. PMID: 35538044; PMCID: PMC9218321.

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Paper 3: Habtu M, Agena AG, Umugwaneza M, Mochama M, Munyanshongore C. (2022). Effect and Challenges of an Integrated Nutrition-Intervention Package Utilization among Pregnant Women and Lactating Mothers in Rwanda: An Exploratory Qualitative Study. Published in Journal of Current Developments in Nutrition. 7(1):100018. PMID: 37181118; PMCID: PMC10100936.

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ABBREVIATIONS AND ACRONYMS

AOR	Adjusted Odds Ratio
BIATs	Bio Intensive Agriculture Techniques
BMI	Body Mass Index
CHWs	Community Health Workers
CI	Confidence Interval
CMHS	College of Medicine and Health Sciences
COR	Crude Odds Ratio
CRS	Catholic Relief Services
DDS	Women Dietary Diversity Score
FAO	Food and Agriculture Organization
FFLS	Farmer Field Learning School
FFQ	Food Frequency Questionnaires
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
Hb	Hemoglobin
HIV	Human Immunodeficiency Virus
IRB	Internal Review Board
KIIs	Key Informant Interviews
LBW	Low Birth Weight
LMICs	Low and Middle Income Countries
MUAC	Mid Upper Arm Circumference
NEC	Nutrition Education and Counseling
RDHS	Rwanda Demographic and Health Survey
SILC	Saving and Internal Lending Communities
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

CHAPTER ONE: GENERAL INTRODUCTION

1.1 Operational definition of key terms

Nutrition-specific : Refers to measures taken to address the immediate causes of undernutrition.

Nutrition-sensitive : Nutrition interventions that focus on the root causes of undernutrition**.**

Pregnant women's nutritional status : In this study it was assessed using Body Mass Index (BMI) in the first trimester and Mid Upper Arm Circumference (MUAC) during delivery and pregnant women were categorized as malnourished if they had either low MUAC (<23cm) or low BMI (< 18.5kg/m^2) or both.

Intervention group : This refers to Rwandan districts where combined/integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package was implemented for pregnant women and young children.

Control group : Refers to Districts in Rwanda where pregnant women did not receive the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package.

1.2 General overview

Maternal undernutrition continued to be a global [1, 2] and local [3, 4] public health concern, due to the unfavorable effect it has on both pregnant women and their babies [1]. Despite significant recent worldwide economic growth, Low and Middle Income Countries (LMIC) are disproportionately affected by the extent and burden of maternal undernutrition [5, 6]. According to reports, more than 20% of pregnant women in several South Asian and Sub-Saharan African (SSA) countries are undernourished [7]. Additionally, maternal undernutrition is the primary cause of 3.5 million maternal deaths in LMICs [1, 8] and a number of unfavorable pregnancy outcomes [9 –12].

Nutritional status among pregnant women is measured using anthropometric measures (MUAC and BMI) as well as biological components (hemoglobin level/concentration). Maternal undernutrition measured by MUAC is the most used in most countries of SSA [13, 6]. For instance, a study done in Ethiopia among pregnant women revealed that 40.6% of them were undernourished (MUAC <23cm) [14], while a recent study in Rwanda, reported 19.8% (MUAC <23cm) [15]. However, assessing nutritional status among pregnant women using BMI during second and third trimesters is not reliable due to the effect of pregnancy related weight [16]. In several SSA countries, underweight in reproductive women (BMI < 18.5kg/m^2) is reported more than 20% [17] and 17% to 28% of women gain gestational weight below recommendations [18–20]. Maternal anemia, on the other hand, affects about 32 million or 38% of pregnant women globally [21]. It affects almost two-thirds of pregnant women in developing countries [22]. The rate is highest in Central and West Africa where it is estimated at 56% [21]. Among Rwandan pregnant women, anemia is estimated about 23% according to World Bank estimate in 2016 [23] and 24.4% according to Rwanda Demographic Health Survey in 2020 [3].

Maternal undernutrition is linked to higher risk of perinatal mortality and morbidity [24–27]**.** Inadequate nutrition at the time of pregnancy is also thought to be the chief factor contributing to LBW [12, 22]. Globally, LBW is estimated 15% to 20% [30, 31], which is greater than 22 million per year [32]. More than 95% of LBW neonates are born in LMICs and SSA alone has 15% [33] and in Rwanda it is estimated at 7% [3]. Globally, LBW is still the main cause of newborn

morbidity and mortality [34, 35]. Therefore, enhancing a maternal nutritional status during pregnancy can lower the incidence of LBW [1, 36].

Maternal and child undernutrition are caused by a variety of complicated, frequently linked factors and mechanisms [37, 42]. According to different studies, the key contributing factors are poverty or low socioeconomic status, income inequality; gender inequality or lack of women empowerment; lack of women education; gross food insecurity; gender discriminatory food allocation; lack of improved sanitation, safe drinking water and hand washing; recurrent infections and lack of accessibility to high-quality nutrition and health services [37–41]. They are primarily divided into three categories: basic determinants, underlying determinants and immediate determinants [42]. The basic determinants involve interactions between social, demographic, and societal factors and have their roots in poverty. The underlying factors, however, include household food insecurity, unsafe environment, and a lack of proper access to or availability of health care, whereas the immediate determinants are insufficient food/nutrients and diseases [42].

Given the above highlighted burden, effects and determinants of maternal undernutrition, there is high demand on how to reduce maternal and child undernutrition. The '*Lancet* Maternal and Child Nutrition series' in 2013 revealed cost-efficient strategies, such as a bundle of 'nutrition-specific' as well as 'nutrition-sensitive' programs, to enhance child and maternal nutritional status [43, 44]. The immediate determinants of undernutrition are addressed by the 'nutrition-specific' intervention package while the primary objective of the 'nutrition-sensitive' intervention is to target the underlying and basic determinants of undernutrition/malnutrition [43]. Among the common 'nutrition-specific' intervention package during pregnancy are maternal dietary supplementation, micronutrient supplementation, dietary diversification, nutrition education and counseling, disease prevention and management and maternal deworming [44]. The main components of maternal 'nutrition-sensitive' intervention package are agriculture and food security; economic strengthening; women's empowerment and water, sanitation, and hygiene [44]. The *Lancet* Nutrition Series also indicated that if adopted on a large scale, 'nutrition-specific' intervention alone would only reduce undernutrition by 20%, whereas 'nutrition-sensitive' intervention package would address the remaining 80% [43].

Previous studies and reviews on the effectiveness of such an intervention to alleviate maternal undernutrition mostly focused on single intervention and produced mixed results. Nutrition education and counseling (NEC) intervention has been rated among the most effective programs in improving maternal and child nutrition [45]. A recent study using a guided NEC showed effective nutrition outcomes among pregnant women [46]. A NEC intervention delivered one-to-one or in groups showed increased energy and protein intake with improved knowledge of the nutritional value of different foods [47]. On the other hand, a systematic review on NEC intervention during prenatal period found that it only modestly improved gestational weight gain and birth weight, though it positively impacted knowledge of nutrition and quality of diet [48]. Another systematic review also noted that the evidence on the effectiveness of nutrition education alone by lay healthcare workers on nutritional status was insufficient [49]. However, there is evidence that delivering NEC with other 'nutrition-sensitive' programs like nutrition safety nets or economic growth will increase its impact [50].

Economic strengthening (social safety nets) and WASH scored as having a 'modest' strength of evidence, while almost all interventions related to agricultural productivity, including homestead food production, livestock, and bio-fortification scored as having a 'limited' strength of evidence. Different systematic reviews have revealed that agricultural intervention has a low effect on overall undernutrition but leads to improved dietary patterns and specific micronutrient intakes [50–52]. Moreover, in various country settings analyzed in a series studies demonstrated direct correlation between household agricultural production and dietary quality and nutritional status, although effectiveness vary widely [53]. Regarding to WASH, a meta-analysis showed a small, although significant effect on undernutrition reductions [54]. Whilst there is greater evidence of the effect of economic strengthening (social safety net) intervention on household dietary diversity through improving household income and protecting household assets [55], there is mixed and inconclusive evidence in improving nutrition [44, 56].

Similarly, some systematic reviews demonstrated that 'nutrition-sensitive' intervention is associated with decreased risk of LBW [31]. This might be as a result of the direct impact of these intervention on enhancing nutrition throughout pregnancy, which might lead in an increase in birth weight. The primary factor causing LBW is believed to be maternal malnutrition during pregnancy [12, 22]. Therefore, in order to improve the birth weight, appropriate nutrition intervention

measures throughout pregnancy are essential [86]. In addition, in 2013, the '*Lancet* Maternal and Child Nutrition series' advocated for the aforementioned 'nutrition-sensitive' and 'nutrition-specific' interventions to enhance fetal optimal growth [60, 107].

The main reasons and explanations for the limited evidence of the nutritional effect of different intervention may be due to differences in program design [57] as well as weaknesses in design, implementation and evaluation [58, 59]. For instance, agricultural interventions may be more effective in reducing acute malnutrition than chronic undernutrition, or research assessments were conducted soon after interventions, so they did not adequately account for long-term nutrition effects [51]. Additionally, the majority of research on interventions were based on a small number of people/participants or trials [31].

A combined or integrated nutrition intervention has been proposed to have a greater effect on reducing undernutrition [60]. For example, a single sector agriculture program will probably change diets, but it might not significantly reduce undernutrition unless it is integrated with an intervention that addresses the other underlying causes [61]. There is also some evidence that combining economic growth with other nutrition-focused initiatives increases effectiveness [57]. The majority of studies have suggested conducting high-quality research and more research on the impact of integrated nutrition interventions [31, 62, 63].

The Government of Rwanda and its development partners are engaged on delivering evidence-based nutrition interventions to lower maternal and child undernutrition in accordance with the *Lancet* series. For instance, between 2015 and 2020 in eight selected districts, the United States Agency for International Development in Rwanda (USAID/Rwanda) funded the *Gikuriro* Program, an evidence-based integrated nutrition intervention. The districts that were targeted for the *Gikuriro* Program's integrated nutrition intervention were Kayonza and Ngoma in the Eastern Province, Nyabihu in the Western Province, as well as Kicukiro and Nyarugenge in Kigali City. However, districts including Rwamagana from Eastern Province and Nyanza and Ruhango from Southern Province had implemented only WASH activities. Therefore, this study has focused on the five districts implementing an integrated 'nutrition-specific' as well as 'nutrition-sensitive' intervention package. These districts were selected because of their high proportion of undernutrition among children and women. The program's intervention package comprised

improved WASH practices, greater agricultural output, economic strengthening, as 'nutrition-sensitive' intervention and for 'nutrition-specific' intervention was nutrition education and counseling.

It is worth to note that certain community-based organizations are carrying out national-level programs and policies to promote and increase the welfare of community members. These among others include home grown solutions (local actors taking control of development agenda and process), "*ibimina*" or "*amatsinda*" (focuses mainly on micro saving and credit schemes), "*girinka"* (giving a cow to the poorest family) and kitchen garden. Community-based organizations may have less chances for citizen participation and for local governments to completely implement their own policies and solutions than other components of civil society, such as NGOs. However, *Gikuriro* has trained, coached, supervised, and equipped personnel at district level and volunteers driven to perform community activities, community-based programs were enhanced and fully executed at district, sector, and community levels. *Gikuriro*'s main goal was to enhance the nutritional status of women of reproductive age and young children by scaling up both in volume and quality of services.

Despite increased interest in nutrition, the research has received little to no attention about whether combining 'nutrition-specific' and 'nutrition-sensitive' intervention packages can reduce maternal and child undernutrition [64]. Moreover, there is limited scientific study examining the effect of an integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on nutritional status of pregnant women and birth weight.

Problem statement

Maternal undernutrition and low birth weight remain among the most challenging health problems in developing countries [65]. Guidelines and interventions have been well recognized to enhance nutrition during pregnancy and improve fetal growth. However, evidence on the effect of these interventions intended to improve nutritional status among pregnant women is limited [66]. Furthermore, the majority of the studies that are currently available focus solely on the effectiveness of nutrition interventions on children's nutritional status [67, 68], despite evidence that poor maternal nutritional status is the key contributing factor to child undernutrition [69, 70, 31, 12]. Effective nutrition intervention during pregnancy can improve maternal nutrition as well as promote fetal growth and in turn both are critical for preventing LBW [71]. However, scientific evidence on nutritional intervention during pregnancy for improving outcomes for mothers and their newborn babies is scarce.

Constructing on the '*Lancet* Maternal and Child Nutrition Series' proposed in 2013 [43], community based intervention focusing on 'nutrition-specific' and 'nutrition-sensitive' intervention package can avert maternal undernutrition and low birth weight. The fundamental causes of malnutrition are assumed to be addressed by the 'nutrition-sensitive' intervention, which reduces undernutrition by 80%, whereas the 'nutrition-specific' intervention only prevents 20% of the problem even when the coverage is scaled up to 90% [72]. Moreover, 'nutrition-sensitive' intervention packages show significant potential for extending the reach and efficacy of 'nutrition-specific' interventions thus improving nutritional outcomes [44]. It is in this regard therefore, that the Government of Rwanda and its development partners have put in place an ambitious plan to reduce maternal and child malnutrition/ undernutrition by implementing 'nutrition-specific' and 'nutrition-sensitive' intervention package in five districts of the country.

All previous research on individual intervention have varied levels of evidence, ranging from weak to moderate. Additionally, some nutritional programs (but not all) have demonstrated success in reducing undernutrition [44]. The results of a combined intervention may produce more positive outcome than those of a single intervention. However, there is limited information /evidence on this integrated approach with rigorous evaluation and design. Further, specific efforts are required to determine the effect of such integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal nutritional status and birth weight in the local context.

Therefore, the research questions of this study were as follows:

1. What was the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal nutritional status?
2. What was the effectiveness of an integrated maternal nutritional intervention package on the birth weight?
3. What were the effect and challenges of an integrated nutrition intervention package utilization among pregnant women as well as lactating mothers?

1.3 Study objectives

1.3.1 General Objective

To determine the effect of an integrated nutrition intervention package on the maternal nutritional status and birth weight in Rwanda.

1.3.2 Specific objectives

1. To determine the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal nutritional status.
2. To establish the effectiveness of an integrated maternal nutritional intervention package on the birth weight.
3. To explore the effect and challenges of an integrated nutrition intervention package utilization among pregnant women as well as lactating mothers?

Thus, based on the above specific objectives, three sub-studies were conducted as stated below.

Sub-study one

Title: Effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on nutritional status of pregnant women.

Specific objectives

1. To assess the maternal nutritional status among the intervention group and control group.
2. To determine the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal undernutrition.

Sub-study two

Title: Effectiveness of an integrated maternal nutritional intervention package on the birth weight in Rwanda.

Specific objectives

1. To determine the proportion of LBW and average birth weight in the intervention group and control group.
2. To establish risk factors of LBW among the intervention group and control group.
3. To determine the effect of nutritional status of pregnant women benefiting from integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on birth weight.

Sub-study three

Title: Effect and challenges of an 'integrated nutrition intervention package' utilization among pregnant women and lactating mothers.

Specific objectives

1. To explore the effect/benefits of an 'integrated nutrition intervention package' utilization among pregnant women and lactating mothers.
2. To identify the challenges of an 'integrated nutrition intervention package' utilization among pregnant women and lactating mothers.

1.4 Conceptual framework

Figure 1.1 shows the graphical representations of the interactions among the independent (predictors/intervention) variables and dependent (outcome) variables. The study is informed by the *Lancet* series on the intervention to reduce maternal and child undernutrition. Similarly, the study considers the determinants of maternal and child undernutrition according to the model proposed by UNICEF (1990). After considering the two conceptual framework (UNICEF and *Lancet*), the study proposed a conceptual framework as indicated in Figure 1.1.

The independent variables include the nutrition intervention as well as determinants of undernutrition. The intervention included intervention package during pregnancy which is believed to reduce maternal undernutrition and low birthweight (dependent variables) through addressing the determinants. This intervention includes nutrition education and counseling which addresses immediate determinants of undernutrition as well as promotion of increased agricultural productivity; economic strengthening; and WASH activities targeting the underlying and basic determinants of undernutrition. The main determinants of maternal and child undernutrition are immediate, underlying and basic. These include inadequate dietary diversity intake and index women health status and pregnancy (disease), household food insecurity and production, inadequate care/support and feeding practices, inadequate health services uptake, unhealthy environment, socio-demographic factors, socio-cultural, and socio-economic and house hold asset ownership. In addition, birth weight is affected by the nutritional status of the pregnant women which depends on the integrated nutrition intervention package.

The *Gikuriro* program informed by the *Lancet* framework was guided by the theoretical approaches of health belief model and theory of change to achieve optimum maternal, fetal and child nutrition. In order to address the bottlenecks of malnutrition at the community level, these theories are utilized to link nutrition with health education/counseling, promotion of agricultural productivity, enhancement of access to WASH facilities, and promoting financial literacy/economic resilience. These approaches enable the construction and usage of indicators at the process, output, outcome, and effect levels, allowing for the iterative improvement of programming while tracking development. The initiative is based on the research, lessons discovered, and evaluations of various ‘nutrition-specific’, ‘nutrition-sensitive’, and government-supported program components.

Health belief model was specifically used for ‘nutrition-specific’ interventions such as nutrition education and counseling to boost the impact of educational programs that seemed to be successful in changing the behavior about nutrition [132]. It is one of the effective theoretical models in the health education. The main application of theories of change was for ‘nutrition-sensitive’ intervention, which are frequently utilized in developing, planning, managing, assessing, and scaling complex programs [133]. *Gikuriro*'s theory of change was closely aligned with its goals, which rely on enhancing the capability and involvement of local key players, such as Government of Rwanda, pertinent sub-partners, community members, and target beneficiaries, to take charge of and steer the process of addressing the causes and effects of malnutrition in a sustainable way.

Conceptual framework

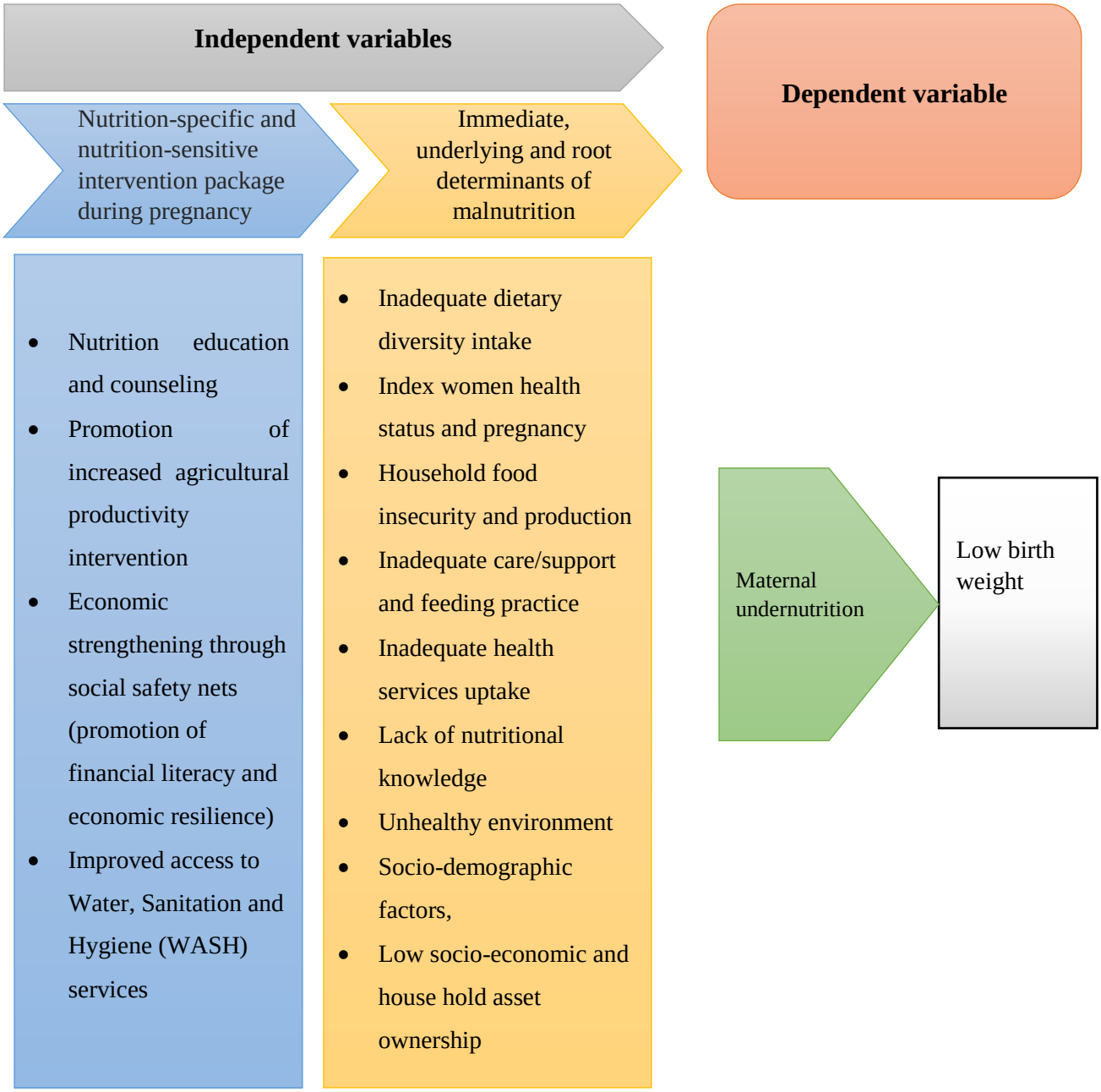

Figure 1.1: Conceptual framework.

1.5 Methods and Materials

1.5.1 Study area and description of the intervention

Rwanda is a landlocked nation located in central Africa near the equator between latitudes 1°4' and 2°51'S and longitudes 28°63' and 30°54'E. It covers a total of 26,338 square kilometers surface area and has five provinces with 30 districts. It shares borders with Burundi to the south, Tanzania to the east, the Democratic Republic of the Congo to the west, and Uganda to the north. There were 13,246,394 people living in Rwanda as per the most recent housing and population census in 2022. It is the most populous nation in Africa, and 27.9% of people reside in urban areas.

The main economic activities of the population depend on investment and agriculture. It has made remarkable socioeconomic progress in the past decade with gross domestic product (GDP) growth of 8.2% annually. Regarding Rwandan healthcare system, it was historically poor quality, but in recent decades it has seen great improvement. It operates a universal health care system with 508 health centers, 680 health posts and 42 district hospitals. The life expectancy at birth in 2022 was at 69.9 years. Despite these achievements, there are several health challenges including malnutrition/ undernutrition and communicable diseases accounting for 90% of complaints at health facilities.

The study was carried out in two districts that were receiving an integrated ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention package, as well as in two districts that weren't receiving it. In early 2015, the Government of Rwanda in collaboration with USAID initiated ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention package called *Gikuriro* project in five districts. These include Kayonza, Ngoma, Nyabihu, Kicukiro and Nyarugenge. In sub-studies 1 and 2, the intervention group consisted of the urban Kicukiro District and the rural Kayonza District, two of the five areas where the Gikuriro program carried out a ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention. For sub-study 3, all five Gikuriro districts were chosen.

The two intervention districts (Kicukiro and Kayonza) were selected based on high percentage of food insecurity according to Comprehensive Food Security and Vulnerability Analysis (CFSVA) [73] and settlement structure (rural vs urban). Similarly, Food insecurity [73], the absence of a ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention package, and location (whether urban or rural) were used as criteria to select control districts. Based on these criteria, the selected districts

for control group were Gisagara (rural area) and Gasabo (urban area). Figure 2.1 displays the selected districts in Rwanda.

Description of the intervention: The term 'integrated nutrition intervention package' refers to three 'nutrition-sensitive' components (promotion of agricultural productivity, improvement of access to WASH services, and promotion of financial literacy/economic resilience) as well as one 'nutrition-specific' intervention component, which is nutrition education and counseling. All these interventions were accompanied by a strong focus on behavior change communication using booklets, posters and messages to address nutrition and WASH related behavior gaps. In collaboration with the Rwandan government, Catholic Relief Services (CRS) carried out the intervention. Detailed description of the integrated nutrition intervention is given in Table 1.1.

Table 1. 1: Description of the integrated nutrition intervention package

Intervention Group	**Control Group**
'Nutrition-specific' component	
Nutrition education and counseling : Community health workers (CHWs) and nutritionists provided additional nutrition education and counseling to the pregnant women in the intervention group. The program implementers first gave the nutritionists and CHWs a five-day training on the counseling guide module. The CHW in charge then provided to new CHWs with training in the villages. During routine antenatal care appointments, which lasted between 30 and 45 minutes each, the qualified nutritionists gave the pregnant women advice about nutrition. The CHWs also provided counseling and instruction at household level. Additionally, those nutritionists and CHWs in charge often received monthly in-service training. Performance-based incentives were put into place to keep CHWs engaged and providing high-quality services, including follow-up, symbolic prizes, and CHWs cooperatives. The in-charge of CHWs and nutritionist regularly underwent refresher training every 6 months to one year and were supervised and evaluated on a monthly basis using a competency checklist. This evaluation criteria was based on the counseling guide provision, preparedness and accuracy of the whole content and ability to properly respond to questions. . Moreover, through cooking demonstrations and the Village Nutrition School, nutritionists educated the women about a balanced diet. Participants were required to come along with food items for the demonstration. The instructional and counseling manual's principal sections included (1) to consume an additional little meal or "snack" (more food between	In the control group, pregnant women only received counseling about healthy eating as well as daily oral iron and folic acid supplementation. These are the standard nutrition care practices adopted from WHO ANC model (WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience: Summary. Geneva, Switzerland: WHO; 2018. Licence: CC BY-NC-SA 3.0 IGO.) This care was delivered by nurses at the health facilities to those pregnant women attending ANC.

meals) each day to support the mother and her developing child with energy and nutrition; (2) to consume the highest-quality, most nutrient-dense foods that are readily available, such as milk, fresh fruit and vegetables, meat (particularly organ meat like liver, heart, and kidney), fish, eggs, cereals, groundnuts, peas, and beans; (3) to drink plenty of liquids; (4) recommendation to avoid drinking tea or coffee with meals because they can affect how well the body absorbs the food; (5) to reduce the amount of coffee consumed when pregnant; (6) must take folic acid and iron supplements to avoid anemia when pregnant; (7) to use iodized salt (8)) to attend antenatal care at least 4 times during pregnancy, beginning during the first 3 months; (9) to take de-worming tablets to help prevent anemia and (10) to prevent malaria by sleeping under an insecticide-treated mosquito net every night.	
'Nutrition-sensitive' components	
1. **Promotion of increased agricultural productivity :** This involved promotion of agricultural productivity through implementation of Bio Intensive Agriculture Techniques (BIATs), Farmer field learning school (FFLS), promotion of bio fortified crops and small livestock in all Villages from the five districts. The main activities included training on crop disease/pest control and improving the soil fertility, supplying and promoting indigenous vegetables, fruit trees and bio-fortified crops (Orange Fleshed Sweet Potato, Iron Rich beans, Quality Protein Maize, orange maize, Passion fruit, Tree tomato and Papaya), promoting agriculture activities in urban areas using bags in case of no land, provision of agricultural tools, provision of small livestock (chicken, rabbit, goats and pigs) and sensitization on consumption of home garden produced through meetings and monitoring field visits. These were done in close collaboration with Government agricultural extension agents (sector agronomists) and Community volunteers (Farmer Promoters) who supported the program to promote the adoption of BIATs at household level by beneficiaries and community members.	The control group did not receive any of these interventions, with the exception of the policies and programs that are implemented on a national level such as '*girinka'* (giving a cow to the poorest family), Kitchen Garden (growing of fruits and vegetables at the backyard) and offering small livestock like chicken to the poorest families.
2. **Promotion of financial literacy and economic resilience :** In order to address household financial issues that prevent people from achieving improved nutrition outcomes, the *Gikuriro* initiative developed and promoted Saving and Internal Lending Communities (SILC) Groups. This was a holistic community-based, user-owned and self-managed savings method that offers a conducive environment for poor households to save and borrow to increase their income. Moreover, the main purpose was to teach them the basic financial management skills to better manage their existing resources. SILC was a savings group approach developed by Catholic Relief Services	The control group did not receive any of these interventions, with the exception of the policies and programs that are implemented on a national level such as home grown solutions (local actors taking control of development agenda and process) and

(CRS) that promoted accessible, transparent and flexible social protection mechanisms. The main activities of SILC under *Gikuriro* were as follows: The first step was to train trainers for the district staff cooperatives and sub-partners of *Gikuriro* (those in charge of project coordination and economic strengthening). The sector cooperative officers were then instructed by the trained personnel on how to recognize local volunteers known as field agents. They were identified within the community using a checklist, after which they were interviewed by CRS. They were trained to form and manage SILC groups which will ensure that all beneficiaries were embraced in the SILC groups and receive high quality financial services. The people were then made aware of SILC by the field agents, who also organized groups. Members select each other based on characteristics of trustworthiness, honesty, reliability, and punctuality. One field agent supervises 10 groups of which one group consists of 25 to 30 members. Then after a group is formed, they decide how often to meet, the minimum contribution amount and how long to function and discuss about internal rules and select management committee. The group also selects Chairperson, Secretary, Treasurer and a Money Counter from its members. The frequency of meetings and contributions was on weekly basis. The maximum contribution does not exceed five times the minimum contribution. The cycle of savings and lending is 12 months. Pooled contributions create a loan fund for members to be repaid with interest and a social fund to help members with emergency situations. By the end of the cycle, all loans were repaid. Accumulated savings and interest earnings were paid out in proportion to members' contributions relative to the amount that has been invested by each member throughout the cycle. After pay-out, the group may disband or decide to continue for another cycle and may invite new members to join. During the year, more focus is put on monitoring of established SILC groups to ensure savings were bringing a change in the nutritional outcomes at targeted households. The result is that the poor can accumulate valuable lump sums without accruing excessive debt or interest.	"*ibimina*" or "*amatsinda*" (focuses mainly on micro saving and credit schemes). However, like other community based programs, this faces the challenge of lacking a regulatory framework.
3. **Water, Sanitation and Hygiene (WASH) services :** This intervention improved WASH behavior in the community to prevent nutrition problems brought on by poor WASH habits by using a 'Community Based Environmental Health Promotion Program (CBEHPP)' technique through 'Community Health Clubs (CHC)' at the village level. With the help of the CBEHPP, communities were reached and empowered to determine their own personal and household hygiene needs and environmental health-related problems (including access to safe drinking water for instance having boreholes, water kiosks, extending water pipelines to each Village and improved	None of these interventions were given to the control group apart from the nationally implemented programs and policies like '*IMIHIGO'* for WASH which still faces ownership

sanitation) and to solve them. Every Village has been established with a CHC and a demonstration site. They conduct 20 weekly community health club sessions using high-quality instructional materials. In addition to the CHW facilitator, who visits each household to assess environmental and household sanitation, it is the responsibility of the CHCs to ensure that hygiene levels were monitored. These observations, known as a 'household inventory' were conducted on a regular basis. Besides a Chairperson and Secretary were elected, who keep a register of attendance of the members.	problems amongst concerned parties.

1.5.2 Study design

The study employed two different designs to achieve the objectives and research questions.

In sub-study 1 and 2, a quasi-experimental study design was utilized in two control districts, Gasabo and Gisagara, and two intervention districts, Kicukiro and Kayonza. In sub-study 1, this design was utilized to compare the levels of maternal undernutrition in both the control and intervention groups. Similarly, it was used to compare birth weight status among the intervention group and control group. Thus, this study design suits well to determine the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on both maternal undernutrition and low birth weight.

In sub-study 3, an exploratory qualitative study design was used. This qualitative approach was conducted to explore the effect, challenges and limitations of the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package utilization among pregnant women and lactating mothers. The study was conducted in five districts where an integrated nutrition intervention package was implemented by *Gikuriro* program. The districts that included were Kayonza, Ngoma, Nyabihu, Kicukiro and Nyarugenge Districts.

Sub-study 1

Effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on nutritional status of pregnant women.

Specific objectives achievement

1. **To determine the maternal nutrition status among the intervention group and control group.**

Anthropometric measurements, such as MUAC prior to delivery and the body mass index (BMI) during the first trimester, were used to assess the nutritional status of the women. In light of numerous studies conducted in Africa and the requirement for global comparison, MUAC <23 cm was considered as undernutrition. A flexible, non-elastic tape was used to measure the MUAC in the less functioning arm that was hanging freely in the middle between the tip of the shoulder and the tip of the elbow. Furthermore, in order to determine the BMI, weight and height during the first trimester were also retrieved from antenatal care records. Using the equipment available in the health facilities, the weight and height were measured in accordance with the Rwandan Ministry of Health's guidelines.

Maternal undernutrition was then defined as a woman who had a low BMI (18.5 kg/m^2) in the first trimester, or a low MUAC (23 cm) during pregnancy, or both. Then the proportion of the maternal malnutrition in both intervention and control group was computed and compared.

In-addition, according to guidelines from the Rwandan Ministry of Health, trained midwives assessed hemoglobin (Hb) concentration using a finger prick of capillary blood with the help of a portable HEMOCUE B-Hb photometer. Then based on WHO categorization (1989), Hb readings 11 g/dL or below were considered anemic, while those above 11 g/dL were considered normal.

2. **To assess the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on reduction of maternal undernutrition.**

First, the balance of the explanatory factors for the control group and intervention group was assessed. To ascertain how the integrated nutrition intervention package affects maternal undernourishment, a multiple logistic regression model was used to account for all potential confounders during the comparison between the intervention and control groups.

Study variables

The outcome variable was maternal undernutrition among pregnant women. Integrated nutrition intervention package, socio-demographic (age, marital status, religion, level of education, number of household members), socio-economic (occupation, house ownership, cooking fuel, source of lighting, household items and owning agricultural land), obstetric (ANC visit, ANC frequency and HIV status) and lifestyle (alcohol use, smoking, passive smoke) factors were considered as independent variables.

Analysis plan

Univariate analysis: The data were entered into the Statistical Package for Social Sciences (SPSS) Version 25.0 IBM New York. To describe the basic characteristics of the respondents in the intervention group and control group, descriptive statistics using frequency, percentages, mean, and standard deviation were generated.

Bivariate analysis: The distribution of the explanatory factors between the intervention group and control group was assessed using the chi-square test (to compare proportion). The results were statistically significant at a p-value of 0.05 using two-sided statistical tests.

Multivariate analysis: To determine the relationship between the integrated nutrition intervention package and maternal undernutrition, a multivariate logistic regression model was applied. In a multiple logistic regression, all potential confounders in the comparison of the intervention and control groups were taken into account. Using the Adjusted Odds Ratio (AOR) and 95% Confidence Interval (CI), the strength and direction of the association was determined.

Study population

The study participants were pregnant women coming for delivery to the health facilities in the selected Rwandan districts.

Sample size calculation

A two population proportion sample size formula was used to determine the sample size [74] which is;

$$n = \frac{\{Z_{1-\alpha/2}\sqrt{[2P(1-P)]} + Z_{1-\beta}\sqrt{[P_1(1-P_1)+P_2(1-P_2)]}\}^2}{(P_1-P_2)^2}$$ Where;

- $Z_{1-\alpha/2}$ refers to 95% confidence which is 1.96 (α = type I error).
- $Z_{1-\beta}$ refers to 90% power which is 1.64 (β = type II error).
- P_1 refers prevalence of maternal undernutrition in pregnant women in Rwanda with no nutrition intervention which was 19.8% [15].
- P_2 refers prevalence of maternal undernutrition among pregnant women with nutrition intervention and was assumed to be 9.8% (assumed reduction by 10%).
- P stands for the mean of P_1 and P_2.
- Besides the effect size of 10 and design effect of 1.2 were used.

After taking into account these presumptions, the 'n' for one group was 520. The sample size was increased to 572 when a 10% non-response rate was considered. Therefore, there were 572 participants in each group (572 in the intervention group and 572 in the control group). Figure 2.2 displays a flow chart outlining the procedure for enrolling participants in the intervention and control groups.

Sampling techniques

The pregnant women who were coming for delivery were enrolled consecutively using the following criteria: 1) permanent resident of the study area who were between the ages (15 and 49years); 2) being enrolled in the selected nutrition intervention program for the intervention group for at least a year before conception; 3) falling under social groups 1 and 2; and 4) not having any known obstetric or medical conditions. All public health facilities (District Hospital and Health

Centers) in the selected districts were included in the study. Probability proportional to population size was used in each selected health facilities and the distribution is presented in Table 1.2. The average deliveries to estimate the proportional distribution was obtained from Maternal and Child Health Unit of Ministry of Health for the year 2019.

Table 1. 2: Sample distribution

Intervention group				**Control group**			
District	**Health facility**	**Average monthly delivery**	**Sample size**	**District**	**Health facility**	**Average monthly delivery**	**Sample size**
Kayonza (Rural area)	Rwinkwavu DH	187	65	Gisagara (Rural area)	Kibilizi DH	180	66
	Gahini DH	178	62		Gakoma DH	130	47
	Mukarange HC	68	24		Mugombwa HC	78	28
	Rukara HC	65	23		Gakoma HC	59	21
	Rwinkwavu HC	43	15		Gikonko HC	54	20
	Ryamanyoni HC	41	14		Gisagara HC	42	15
	Kabarondo HC	40	14		Kigembe HC	39	14
	Nyamirama HC	40	14		Gishubi HC	36	13
	Nyakabungo HC	39	14		Musha HC	33	12
	Cyarubare HC	37	13		Save HC	32	12
	Gahini HC	33	11		Kibilizi HC	32	12
	Ndego HC	31	11		Gikore HC	26	9
	Ruramira HC	23	8		Kansi HC	25	9
	Sub-Total	**824**	**286**		Agahabwa HC	21	8
					Sub-Total	**787**	**286**
Kicukiro (Urban area)	Masaka DH	422	147	Gasabo (Urban area)	Kibagabaga DH	562	161
	Kabuga HC	113	39		Kagugu HC	121	35
	Gahanga HC	52	18		Remera HC	71	21
	Gikondo HC	52	18		Kinyinya HC	69	20
	Kicukiro HC	46	16		Nyacyonga HC	64	17
	Masaka HC	42	15		Kabuye HC	54	16
	Bethsaida HC	39	14		Rubungo HC	53	16
	Busanza HC	35	12		**Sub-Total**	**994**	**286**
	Nyarugunga HC	22	8	**Grand Total**		**2485**	**572**
	Sub-Total	**823**	**286**				
Grand Total		**1,647**	**572**				
DH: District Hospital; HC: Health Center							

Data collection procedures and tools

All the eligible pregnant women were informed about the study and consent was obtained before the actual data collection. Then, participants were interviewed face-to-face by trained data collectors. The objectives of the study, its relevance, data confidentiality, respondent rights, informed consent, and the procedures for conducting in-person interviews and anthropometric measurements were covered during the training of data collectors. To protect the participants' confidentiality and privacy, the interviews were held in a private setting. At the conclusion of each day of data gathering, the data were validated and verified.

To collect the data, a structured questionnaire that was modified from past similar studies was employed [75], which was validated by USAID – ENGINE ('Empowering the New Generation to Improve Nutrition and Economic opportunities'). Nevertheless, it was modified to fit the Rwandan context after being pre-tested at Biryogo Health Center in Nyarugenge District. The main component of the questionnaire included maternal socio-demographic attributes, socio-economic factors, lifestyle factors, obstetric factors as well as anthropometric and biological measurements. The data collection tool was translated into Kinyarwanda.

Sub-study 2

Effectiveness of an integrated maternal nutrition intervention package on birth weight in Rwanda.

Specific objectives achievement

1. **To determine the average birth weight and proportion of LBW in the intervention group and control group.**

Birth weight was measured naked or in minimal clothing using a digital scale to the nearest 100g following standard guidelines of Rwandan Ministry of Health. This was done right after delivery within 24 hours by trained midwives. Then the average of birth weight was calculated by adding all weights and then dividing by the total sample in the intervention group and control group using SPSS Version 25.

Low birth weight was determined according to WHO as weight less than 2500 gram within 24 hours of birth. During analysis, the total number of new born babies with low birth weight were divided by the total sample then multiplied by one hundred to assess proportion of LBW in the intervention group as well as in the control group separately.

2. **To establish risk factors of LBW among the intervention group and control group.**

Bivariate analysis was performed to examine the factors associated with LBW. The strength and direction of association during bivariate analysis were described using Crude Odds Ratio (COR) and 95% Confidence Interval (CI). The risk factors were assessed by considering all variables with p value less than 0.2 during bivariate analysis in the multivariable analysis using multiple logistic regression model. Adjusted Odds Ratio (AOR) and 95% CI were used to determine the strength and direction of the risk factors.

3. **To determine the effectiveness of nutritional status of pregnant women benefiting from integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on birth weight**

Bivariate and multivariable analysis were conducted to measure the effectiveness of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package during pregnancy on birth weight. First comparisons between intervention and control group were computed. All variables having a p value of less than 0.2 in the bivariate analysis were taken into account for the multiple

logistic regression. Step-wise multiple linear regression model was also used for all significant covariates during comparison. Considering that fetal growth depends on the maternal nutritional status, an investigation of the pathway and mediation was done to determine the direct and indirect impact of the intervention package during pregnancy on birth weight.

Study variables

The primary outcome of this study was birth weight of the newborn babies regardless of the gestational age. The independent variables included maternal basic demographic characteristics, lifestyle and obstetric factors, maternal dietary diversity, maternal nutritional status as well as integrated maternal nutrition intervention package.

Data analysis plan

The analysis was performed using IBM New York's Statistical Package for the Social Sciences (SPSS) Version 25.0. Counts, percentages, mean, and standard deviation were computed to summarize the basic characteristics in the intervention and control group. To assess the balance of the explanatory variables between the intervention and control group, Chi-square test (to compare proportion) and independent *t* test (to compare means) were performed.

By taking into account all variables having a p value of 0.2 in the bivariate analysis, multiple logistic regression analysis was carried out to evaluate the effectiveness of the intervention. Adjusted odds ratios with corresponding 95% confidence intervals were used to present the degree of relationship between the LBW and the intervention. Some factors linked to birth weight as a continuous variable were also subjected to linear regression analysis. In order to evaluate the direct and indirect effect of the intervention on birth weight, a pathway and mediation analysis was carried out using Hayes' PROCESS macro Version 4.0 for SPSS [76].

Population, sample size and sampling technique

The mother-baby pairs that resulted from the delivery of live singleton babies in sub-study 1 were the target population. As a result, the sampling and sample size were identical to those in sub-study one and those who matched the criteria for inclusion were included in the study. This gives a total sample size of 1144 (572 for the intervention group and 572 for control group). Besides to the

criteria used in sub-study 1, all live singleton babies with normal spontaneous delivery were included. Figure 3.1 displays the flowchart for recruitment.

Data collection procedures

Before data collection, ethical clearance from Institutional Review Board, approval from Ministry of Health and permission from district hospitals were obtained. Then, mothers delivered at the selected health facilities were consented. They were interviewed face-to-face in a private room of the health facilities before discharge. Anthropometric measurements were taken by trained midwives or nurses. Birth weight was taken within 24 hours of delivery. It was measured to the nearest 100gram on a digital scale and was checked before each weighing against standard weights. A standard operating procedure was created for each measure in order to ensure consistency in data gathering techniques.

Data collection tools

A pre-tested structured quantitative questionnaire was used to gather the data by trained midwives and nurses. It was composed of demographic characteristics, maternal dietary diversity, anthropometric and biological measures as well as lifestyle and obstetric factors. The detailed description of the tool is presented in Chapter 3 (paper 2) under data collection and measurement. The tool was translated into the indigenous language which is Kinyarwanda.

Sub-study three

Effect and challenges of an integrated nutrition intervention package utilization among pregnant women and lactating mothers.

Specific objectives achievement

1. **To assess the effect of an integrated nutrition intervention package utilization among pregnant women and lactating mothers.**

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) guide were developed to collect data about the perceived effect or benefits of the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package among pregnant women and lactating mothers. Reliable and valid tool was used to collect qualitative data with the help of audio recorders. Participants' responses were translated into English after being verbatim recorded without any grammatical corrections in order to preserve the meaning. ATLAS.ti-Version 9.15 was used for coding and analysis using a thematic content approach. At the end of the FGDs and KIIs, the keynotes were shared/reviewed for validation purpose.

2. **To explore challenges of an integrated nutrition intervention package utilization among pregnant women and lactating mothers.**

FGDs and KII guides were used focusing on the barriers that could prevent pregnant women and lactating mothers from utilizing 'nutrition-specific' and 'nutrition-sensitive' intervention package. After collecting the qualitative data using trained research assistants, ATLAS.ti-Version 9.15 was used for analysis. Furthermore, the same procedure stated above in specific objective one were followed.

Data analysis plan

The qualitative data collection was conducted in Kinyarwanda and transcribed verbatim first then translated to English. The data were imported to ATLAS.ti-Version 9.15 for coding and analysis. Four main stages including the "decontextualisation, recontextualisation, categorisation, and compilation" [80] were followed. To maintain the quality and trustworthiness of the analysis, each stage was performed several times. All transcripts were read through several times in a slow and

very thorough manner to familiarize with the data and identify emerging and recurrent themes. There were two coders and agreement were reached between the two coders through continuous discussion. Responses with similar were re-grouped under unifying themes or sub-themes. A matrix was created and individual matrices were reviewed until an agreement was reached. Finally, the categories were interpreted and descriptive quotes representing key themes were included in the final report.

Study population

The target population were pregnant women and lactating mothers who were beneficiaries of the *Gikuriro* program from the five districts (Kayonza, Ngoma, Nyabihu, Kicukiro and Nyarugenge). In addition, community health officers and nutritionists implementing the program for at least one year of experience were included.

Sample size and sampling method

The pregnant women and lactating mothers participated in ten FGDs, two from each district. The group discussions included a total of 80 participants, including 40 pregnant women and 40 lactating mothers. Each FGD was consisted of 8 participants (4 pregnant women and 4 lactating mothers). They were selected with the help of Community Health Officers (CHOs) who had the records of the participants which assisted the researchers to select participants. The women were selected based on their educational background and involvement in the *Gikuriro* program. Women who had participated in the program for the entire time were included. Additionally, in each district, one FGD was composed of women with post-primary education, and the other FGD was comprised women with education below the level of a secondary school. The discussions took place in the health facilities, and transportation costs for each participant's round trip were reimbursed.

Additionally, KIIs were carried out among nutritionists (n=27) and community health officers (n=25) who were actively involved in the project's implementation. From each health facility in the five districts, one community health officer and one nutritionist were selected. Nevertheless, newly appointed employees and those with less than a year of *Gikuriro* program experience were excluded.

Data collection procedures

After obtaining consent, the participants were interviewed using FGD and KII guides. The discussion and interview were conducted by trained and experienced research assistants. Kinyarwanda was used to collect the data. The FGDs were recorded where there was optimal privacy and low noise in the respective selected health centers. In order to allow for face-to-face interaction, discussions were held in a circular manner. A note-taker and a moderator were assigned to each FGD but for KIIs only one was assigned for note taking and interviewing. Data were audio recorded and were saved in a personal computer for security and confidentiality.

Data collection tools

Semi-structured FGDs and KIIs were used to collect qualitative data as attached in Appendix V and Appendix VI respectively. In this case the demand and supply theory [81] was applied to identify the effect and bottlenecks for 'nutrition-specific' and 'nutrition-sensitive' intervention package utilization. The discussions and interviews were conducted by two females (one with Master's degree in public health and the other with a Master's in nursing). Both were highly experienced as they had previously conducted several qualitative data collections. They were however trained by the principal investigator regarding the objectives of the study, the guide questions, approach, recording, and confidentiality.

Data collection was done face-to-face in Kinyarwanda and numbers from 1 to 8 were assigned to participants to allow anon transcription. At the end of the FGDs and KIIs, the keynotes were shared/reviewed to validate what they had said. On average the focus group discussion lasted about 1 hour and the interview around 45 minutes.

Table 1.3 below summarizes the three sub-studies.

Table 1. 3: Summary of the three sub-studies.

Data collection period	Design	Setting	Number of participants	Data collection method	Data analysis	Objective	Outcome
January to June 2020	Quasi-experimental design	In all public health facilities of intervention districts namely: Kayonza and Kicukiro and for control group including Gasagara and Gasabo districts.	A total of 572 pregnant women for intervention group and 572 for control group were considered.	Structured questionnaire was adopted from other similar studies. Anthropometric measurements (MUAC, Weight, height) were used for assessing nutritional status. Biological measurement was also used to measure the hemoglobin concentration among pregnant women coming for delivery.	The data were analysed using SPSS Version 25.0. Descriptive statistics (counts, proportions and averages) were computed to summarize the basic characteristics of the study participants. To evaluate the distribution of the explanatory factors between the intervention group and control group, chi-square test (to compare proportion) and independent *t* test (to compare means) were used. To determine the intervention's impact on undernutrition among pregnant women, mulitivariable logistic regression analysis was performed. Using the adjusted odds ratio (AOR) and 95% confidence interval (CI), the strength and direction of the association were computed after taking into account the potential confounders.	To determine the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal undernutrition among pregnant women in Rwanda.	Paper 1
January to June 2020	Quasi-experimental design	Conducted in all public health facilities of intervention districts (Kicukiro and	A sample of 572 mother-baby pairs for intervention group and 572 mother-baby pairs for control	A semi-structured quantitative questionnaire was used to collect basic attributes of the mothers and their babies. A food frequency questionnaire validated by the	The analysis was performed using SPSS Version 25.0. To summarize continuous and categorical data, mean and percentages were used. Bivariate analysis was done to look at the explanatory variables between the	To assess Effectiveness of integrated maternal nutrition intervention package on birth	Paper 2

		Kayonza) and control districts (Gasabo and Gisagara)	group were considered.	Food and Agriculture Organization was also used to obtain dietary information for mothers. Anthropometric measurements were taken of the babies and their mothers. The anthropometric measurements for the mothers were the same with sub-study 1. Bith weight was measured with 24 hours.	intervention and control groups using an independent sample *t*-test for means or a Chi-square test for proportions. Multiple logistic regression and linear regression were conducted by considering all potential confounding variables during bivariate analysis to assess the impact of the intervention on birth weight.	weight in Rwanda.	
March to June 2021	Exploratory qualitative study design	Five districts where the *Gikuriro* program was implemented including Kicukiro, Nyarugenge, Kayonza, Ngoma and Nyabihu.	A total of 80 pregnant women and lactating mothers. In addition, 25 community health officers and 27 nutritionists actively involved in the implementation of the *Gikuriro* program were included.	Semi-structured FGDs guide for pregnant women and lactating mothers as well as KIIs guide of community health officers and nutritionists were used to collect qualitative data.	The data were analyzed using ATLAS.ti-Version 9.15. Four main stages including decontextualization, recontextualization, categorization, and compilation were followed. After following all these steps, the categories were interpreted and descriptive quotes representing key themes were compiled for the final report.	To explore the effect and challenges of an integrated nutrition intervention package utilization among pregnant women and lactating mothers.	Paper 3

CHAPTER 2 PAPER 1

Effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal malnutrition among pregnant women in Rwanda

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ABSTRACT

Despite tremendous improvements and development, maternal undernutrition is still a significant public health issue in Rwanda. In order to promote maternal and child nutrition, a combination of 'nutrition-sensitive' and 'nutrition-specific' interventions was put into place in five districts of Rwanda. The package comprised education and counseling on nutrition, agricultural production promotion, increasing financial literacy/economic resilience as well as providing improved water, hygiene, and sanitation. There is, however, little information on how effective these interventions are at lowering maternal undernutrition. A postintervention quasi-experimental study was carried out, to ascertain the impact of the integrated intervention on pregnant women's nutritional status. 545 women were recruited for the control arm, whereas 552 were recruited for the intervention arm. The effect of the combined interventions was evaluated using a multivariable logistic regression model. When compared to the control group, the intervention group's prevalence of maternal undernutrition was significantly reduced (4.7% vs. 18.2%; $p<0.001$). After accounting for pertinent confounding, the probability of maternal undernutrition was 77.0% lower in the intervention group than in the control group ['adjusted odds ratio= 0.23; 95% confidence range = 0.15-0.36; $p<0.001$']. Therefore, more prospective randomization research should be done in order to determine the cause-effect relationship and to guide national scaling up of these initiatives in Rwanda.

Keywords: 'integrated intervention package, maternal undernutrition, nutrition-sensitive, nutrition-specific, pregnant women, quasi-experimental'

1. INTRODUCTION

Pregnant women's maternal undernutrition is still a global public health problem '(Black et al. 2013; Salunkhe 2018)' and locally '(Williams et al. 2019)', due to the unfavorable effect it has on both pregnant women as well as their babies '(Black et al. 2013)'. Despite significant recent worldwide economic growth, in Low and Middle Income Countries (LMIC), the scope and burden of maternal undernutrition are extremely high '(Tang et al. 2016; Nana and Zema 2018)'. According to reports, more than 20% of pregnant women in many South Asian and Sub-Saharan African nations are undernourished '(Ravaoarisoa et al. 2018)'. In Rwanda, 19.8% of pregnant women with MUAC measurements of less than 23 cm are undernourished '(Nsereko et al. 2020)' and 24.5% are anemic (RDHS 2020). Maternal undernutrition is the primary underlying factor for

3.5 million maternal deaths that occur in LMICs ‘(Black et al. 2013; Loudyi et al. 2016)’ and a number of unfavorable pregnancy consequences ‘(Victora et al. 2016; Acharya, Bhatta, and Timilsina 2017; Hasan et al. 2017; Mosha et al. 2018)’.

Maternal undernutrition is caused by a variety of complicated, frequently linked variables and mechanisms ‘(Stevens et al. 2012; Gebre and Mulugeta 2015; Obai, Odongo, and Wanyama 2016; Dattijo, Daru, and Umar 2016; Ismail et al. 2017)’. They are primarily divided into three categories: immediate determinants (poor nutrition and disease), underlying determinants (poor access to and availability of health care, unsafe environments, and household food insecurity), and fundamental determinants (rooted in poverty and involving interactions between social, demographic, and societal conditions) ‘(Black et al. 2013; UNICEF 1990)’.

Given the burden, impacts, and drivers of maternal undernutrition that have been previously mentioned, there is high demand on how to reduce maternal and child undernutrition. The ‘*Lancet* Maternal and Child Nutrition series’ identified cost-effective strategies in 2013 and 2021 to enhance maternal and child nutritional status, such as a bundle of ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention ‘(Bhutta et al. 2013; Keats et al. 2021; Ruel et al. 2013)’. According to Bhutta et al. (2013), the *Lancet* Nutrition Series also found that a large-scale implementation of ‘nutrition-specific’ intervention alone would only reduce undernutrition by 20%, while ‘nutrition-sensitive’ intervention would address the remaining 80%. Evidently, several studies and evaluations on the effectiveness of such an intervention to address maternal undernutrition have primarily focused on a single intervention and demonstrated varied results, where the evidence for such interventions was found to be effective ranging from moderate to high ‘(Carletto et al. 2015; Dangour et al. 2013; Demilew, Alene, and Belachew 2020; Gilligan et al. 2014; Gilmore and McAuliffe 2013; Girard and Olude 2012; Hambidge and Krebs 2018; Headey 2012; Masset et al. 2012; Nielsen et al. 2006; Reinhardt and Fanzo 2014; WHO Reproductive Health Library 2016)’.

It has been suggested that a combined intervention package may have a stronger impact on the reduction of undernutrition (Ruel, Quisumbing, and Balagamwala 2018). For instance, a program focused on one sector of agriculture would reasonably affect diets, but it might not have a meaningful impact on undernutrition until it is mainstreamed with an intervention aimed at the

other underlying causes (Bonde 2016). Some evidence suggests that adding additional 'nutrition-sensitive' interventions to economic strengthening increases its effectiveness (Fenn and Yakowenko 2015). The impact of nutrition education and counseling would be increased if administered along with other 'nutrition-sensitive' interventions like providing nutrition safety nets or encouraging economic growth (Girard and Olude 2012). The majority of studies have advised conducting high-quality and additional research on the results of these integrated nutrition interventions '(da Silva Lopes et al. 2017; Soltani et al. 2015; Zerfu, Umeta, and Baye 2016)'.

In line with the *Lancet* series, the Rwandan government and its development partners are putting a priority on providing evidence-based interventions to lower maternal and child undernutrition. For instance, from 2016 to 2020, the United States Agency for International Development in Rwanda (USAID/Rwanda) developed a program called *Gikuriro* (good growth as opposed to stunting) in five targeted districts to implement evidence-based nutrition interventions. Kayonza and Ngoma in the Eastern Province, Nyabihu in the Western Province, Kicukiro, and Nyarugenge in Kigali City are the districts that are being targeted. The Integrated Nutrition and WASH Activities (INWA) program was being implemented in these districts. In close cooperation with the local governments structures in these five districts, Catholic Relief Service (CRS) and its implementing partners developed the *Gikuriro* initiative. The program's package of interventions also promotes increased agricultural productivity, financial literacy/economic resilience, and improved WASH services as important 'nutrition-sensitive' interventions in addition to nutrition education and counseling as a 'nutrition-specific' intervention.

Despite the growing interest in nutrition, little or no effort has been made to produce evidence that combining 'nutrition-specific' as well as 'nutrition-sensitive' intervention can result in significant reductions in maternal undernutrition (Khalid, Gill, and Fox 2019). Even though *Gikuriro*'s evaluations indicated some tendencies in this direction, there are few comparative scientific research examining the impact of an integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on maternal undernutrition. The current study sought to determine the effect of integrated 'nutrition-sensitive' and 'nutrition-specific' interventions on maternal nutritional status.

2. METHODS AND MATERIALS

2.1 Study design, setting and population

From November 2020 to June 2021, we carried out a post-program quasi-experimental study. The comparison of maternal undernutrition between the intervention and control groups was done using this design. The intervention group was selected from the rural Kayonza District and the urban Kicukiro District, two of the five districts where the Gikuriro program's "nutrition-specific" and "nutrition-sensitive" intervention package was implemented. According to the Comprehensive Food Security and Vulnerability Analysis (CFSVA), they were chosen due to the high percentage of food insecurity ('World Food Programme, 2018') and locality (rural vs urban). Similarly, three criteria were used to choose the control districts. These include the lack of a 'nutrition-specific' and 'nutrition-sensitive' intervention package, food insecurity and setting (rural versus urban). Gisagara District, a rural setting, and Gasabo District, an urban area, were chosen after taking all the criteria into account. Figure 2.1 displays the selected districts.

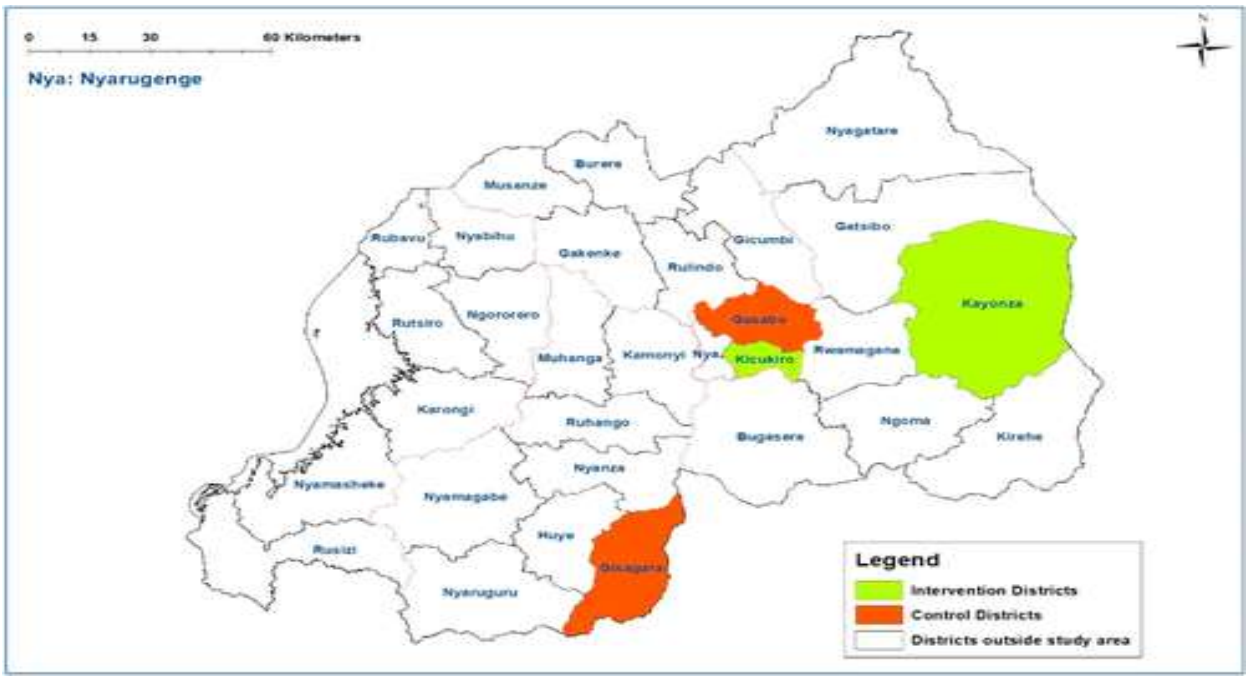

Figure 2. 1: Map of study area

Pregnant women who lived in the selected districts of Rwanda and were scheduled to give birth participated in this study. The following criteria were used to recruit them consecutively as they

come for delivery: between the ages of 15 and 49 years, having a permanent address in the study region; having participated in the chosen nutrition intervention program for at least a year prior to conception (for the intervention group); those who don't have any known medical, surgical, or obstetric concerns and those who fall into wealth categories of 1 and 2. Each public health facilities within the chosen districts was included, and the distribution of participants was dependent on the population size within each facility within the chosen district.

A two population proportion sample size formula was used to determine the sample size (Casagrande, Pike, and Smith 1978) which is;

$$n = \frac{\{Z_{1-\alpha/2}\sqrt{[2P(1-P)]} + Z_{1-\beta}\sqrt{[P_1(1-P_1) + P_2(1-P_2)]}\}^2}{(P_1 - P_2)^2}$$

Where;

- $Z_{1-\alpha/2}$ refers to 95% confidence which is 1.96 (α = type I error).
- $Z_{1-\beta}$ refers to 90% power which is 1.64 (β = type II error).
- P_1 refers prevalence of maternal undernutrition in pregnant women in Rwanda with no nutrition intervention which was 19.8% according to a recent study [15].
- P_2 refers prevalence of maternal undernutrition among pregnant women with nutrition intervention and was assumed to be 9.8% (assumed reduction by 10%).
- P stands for the average of P_1 and P_2.
- Besides the effect size of 10 and design effect of 1.2 were used.

After taking into account all the presumptions, the sample size for one group was 520. The sample size was increased to 572 when a 10% non-response rate was taken into account. Therefore, there were 572 participants in each group, for a total sample size of 1144 (572 in the intervention group and 572 in the control group). Figure 2.2 shows a flow chart showing how participants were recruited for the intervention and control arms.

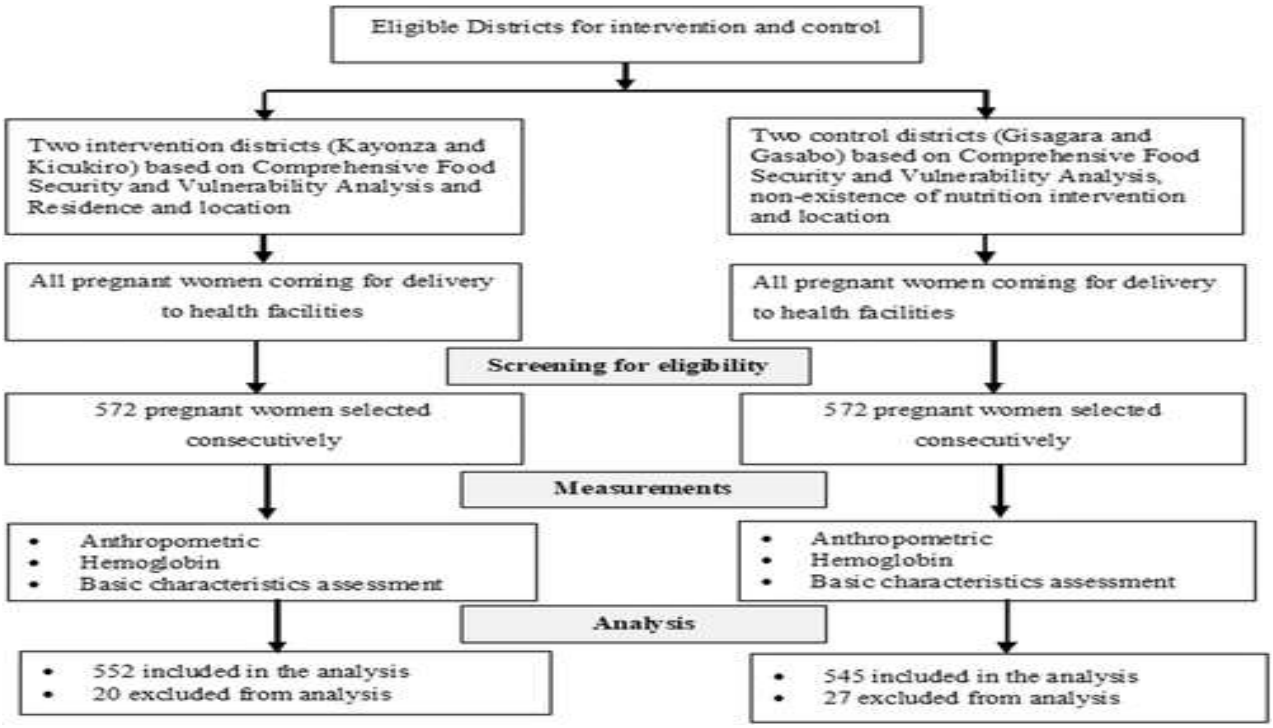

Figure 2. 2: Recruitment flow chart for pregnant women

2.2 Description of the intervention

The term "integrated nutrition intervention package" refers to three 'nutrition-sensitive' components—promotion of financial literacy/economic resilience, improvement of access to WASH services, and promotion of agricultural productivity—as well as one 'nutrition-specific' intervention component, which is nutrition counseling and education. Between September 2016 and July 2020, the intervention was conducted. In collaboration with the Rwandan government, Catholic Relief Services a non-profit organization carried out the intervention. Table 1.1 provides an in-depth description of these interventions.

2.2 Data collection and measures

Data collectors received training on the goals of the study, its applicability, data confidentiality, respondent rights, informed permission, and the proper methods for conducting in-person interviews and anthropometric measurements. To protect the participants' privacy and anonymity, the interviews were held in a private room. At the conclusion of each day of data collection, the data were validated and verified.

A structured questionnaire that was adapted from other studies of a similar nature was used to gather the data (Ghosh et al. 2019). However, after pretesting it in a district outside the research area, it was improved to fit the Rwandan setting. Maternal sociodemographic traits, socioeconomic attributes, lifestyle factors, and obstetric factors made up the questionnaire.

Body mass index (BMI) during the first trimester and the MUAC just prior to birth were used as the two anthropometric measurements to assess the nutritional status. To measure the MUAC, a flexible, non-elastic tape was utilized on a less functioning arm hanging freely by the woman's side between the tip of the shoulder and the tip of the elbow. Additionally, the weight and height during the first trimester were retrieved from antenatal care records to calculate the body mass index (BMI). Using the equipment available in the health facilities, the weight and height were measured in accordance with the Rwandan Ministry of Health's recommendations. Maternal undernutrition was defined as a woman who had a low MUAC (23 cm) at delivery, a low BMI (18.5 kg/m^2) in the first trimester, or both. Furthermore, one drop of capillary blood taken via a finger prick by trained midwives was used to determine hemoglobin (Hb) concentration to test for anemia in accordance with Rwandan Ministry of Health guidelines. According to WHO categorization (1989), Hb result of less than 11 g/dL was anemic and greater than 11 g/dL was considered normal.

2.4 Data analysis

The distribution of the attributes was evaluated using descriptive analysis, which included counts, proportions, and averages. The balance of the explanatory factors and nutritional status between the intervention and control groups were assessed using the chi-square test (comparison of proportions) and independent t test (comparison of means). Using a multivariate logistic regression model, the relationship between the integrated nutrition intervention and maternal undernutrition was examined. In a multiple logistic regression utilizing a "backward conditional" selection approach, all potential confounders with a p value of less than 0.1 during the comparison of the intervention and control groups were taken into account. The Hosmer-Lemeshow goodness of fit test was used to determine the suitability of the model, and the results were satisfactory ($p = 0.127$). At a p value of 0.05, the results were statistically significant. Statistical Package for Social Sciences (SPSS) Version 25.0 IBM New York was used to analyze the data.

2.5 Ethical considerations

The University of Rwanda, College of Medicine and Health Sciences' Institutional Review Board (IRB) was consulted in order to acquire approval to carry out the study. The Rwandan Ministry of Health also gave permission to go into the field. Each participant was asked for and given written informed consent.

3. RESULTS

3.1 Socio-demographic attributes of the women

A total of 1097 pregnant women were included in the analysis, yielding response rates of 95.3% for the control group (545 out of 572) and 96.5% (552 out of 572) for the intervention group. The demographic features of the women in the intervention and control groups are presented in Table 2.1. Between the intervention group and control group, there was no significant difference.

Table 2.1: Socio-demographic characteristics of the women

Variables	Total, %(n)	Intervention, %(n)	Control, %(n)	χ^2 value	p value
Age (years)					
15-19	6.3(69)	6.9(38)	5.7(31)	4.66	0.459
20-24	26.2(287)	25.9(143)	26.4(144)		
25-29	27.3(302)	28.6(158)	26.4(144)		
30-34	21.3(234)	22.1(122)	20.6(112)		
35-39	14.2(156)	12.9(71)	15.6(85)		
40^{+}	4.5(49)	3.6(20)	5.3(29)		
Marital status					
Married	46.1(506)	48.8(267)	43.9(239)	3.8	0.283
Cohabitating	42.4(465)	41.7(230)	43.1(235)		
Single	10.4(114)	8.9(49)	11.9(65)		
Divorced or separated	1.1(12)	1.1(6)	1.1(6)		
Religion					
Christian	95.4(1046)	94.7(523)	96.0(523)	1.15	0.563
Muslim	3.7(41)	4.3(24)	3.1(17)		
Others	0.9(10)	0.9(5)	0.9(5)		
Level of education					
None	11.8(129)	11.4(63)	12.1(66)	4.25	0.374
Primary	62.6(687)	62.9(347)	62.4(340)		
Secondary	22.6(248)	23.2(128)	22.0(120)		
Vocational	1.2(13)	1.4(8)	0.9(5)		
Higher education	1.8(20)	1.1(6)	2.6(14)		
Spouse's/Partner's completed level of education[a]					
None	9.5(92)	8.9(44)	10.1(48)	2.5	0.777
Primary	56.1(545)	56.1(279)	56.1(266)		
Secondary	25.1(245)	26.0(129)	24.5(116)		
Vocational	3.7(36)	3.2(16)	4.2(20)		
Higher education	2.8(27)	2.6(13)	3.0(14)		
Don't know	2.7(26)	3.2(16)	2.1(10)		
Number of household members [Mean, SD]	4.8[1.76]	4.45[1.83]	4.52[1.68]	-0.68	0.499[b]

' [a]Total response was 971'

' [b]Independent t test was used to the compare the total number of household members'

3.2 Socio-economic factors of the women

Table 2.2 provides a summary of the socio-economic characteristics. There was no apparent difference in the proportions between the control and intervention groups. Even though the intervention group had larger proportions of participants with electricity and home goods, these

differences were not statistically significant. Similarly, though the percentage of control group participants who owned animals was larger, this difference was not found to be statistically significant.

Table 2 2: Socio-economic factors of the women

Variables	Total, %(n)	Intervention, %(n)	Control, %(n)	χ^2 value	p value
Occupation					
Farming/agriculture	41.8(459)	39.5(218)	44.2(241)	4.59	0.469
House wife/unemployed	19.0(208)	19.7(109)	18.2(99)		
Salaried employee	3.4(37)	3.6(20)	3.1(17)		
Self-employed	10.8(118)	12.3(68)	9.2(50)		
Casual wage	23.4(257)	23.2(128)	23.7(129)		
Student	1.6(18)	1.6(9)	1.7(9)		
Spouse's/partner's employment status[a]					
Farming/agriculture	40.6(394)	38.8(193)	42.4(201)	9.25	0.100
Salaried employee	8.5(83)	8.9(44)	8.2(39)		
Self-employed	16.8(163)	19.7(98)	13.7(65)		
Casual wage	29.6(287)	28.6(142)	30.6(145)		
Unemployed	3.8(37)	3.0(15)	4.6(22)		
Student	0.7(7)	1.0(5)	0.4(2)		
Ownership of a house					
Self	46.9(514)	45.5(251)	48.3(263)	4.00	0.165
Rental	49.1(539)	49.5(273)	48.8(266)		
Others	4.0(44)	5.1(28)	2.9(16)		
Most common cooking fuel					
Wood or charcoal	96.4(1057)	95.3(526)	97.4(531)	3.94	0.140
Gas or biogas	2.4(26)	2.9(16)	1.8(10)		
Electricity	1.3(14)	1.8(10)	0.7(4)		
Main source of fuel or energy for lighting					
Electricity	65.2(715)	68.3(377)	62.0(338)	7.42	0.060
Solar	9.4(103)	9.1(50)	9.7(53)		
Gas	1.3(14)	1.6(9)	0.9(5)		
Others (Torch)	24.2(265)	21.0(116)	27.3(149)		
Having household items[b]					
Yes	83.3(914)	85.3(471)	81.3(443)	3.22	0.073
No	16.7(183)	14.7(81)	18.7(102)		
Owning agricultural land					
Yes	41.7(457)	43.3(239)	40.0(218)	1.23	0.268
No	58.3(640)	56.7(313)	60.0(327)		

' [a]Total response = 971'

' [b]Household items include Radio, TV, Telephone – fixed line, Mobile phone, Car, Motorcycle'

3.3 Lifestyle and obstetric factors

According to Table 2.3, 14.7%, 2.6%, and 11.7% of the women smoked, drank alcohol, and were exposed to secondhand smoke, respectively. The percentages of these lifestyle characteristics were higher in the control group than in the intervention group, indicating a significant difference between the two groups. In terms of obstetric factors, 94.4% of women visited antenatal care facilities, however there was no statistically significant difference between the two groups. The intervention group's prevalence of HIV infection was significantly greater than that of the control group (5.8% vs 3.1%; p=0.032).

Table 2 3: Lifestyle and obstetric factors

Variables	Total, %(n)	Intervention, %(n)	Control, %(n)	χ^2 value	p value
Taking alcohol during pregnancy					
Yes	14.7(161)	12.1(67)	17.2(94)	5.719	**0.017**
No	85.3(936)	87.9(485)	82.8(451)		
Smoking during pregnancy					
Yes	2.6(29)	1.1(6)	4.2(23)	10.461	**0.001**
No	97.4(1068)	98.9(546)	522(95.8)		
Partner smoking					
Yes	11.7(128)	7.6(42)	15.8(86)	17.765	**<0.001**
No	88.3(969)	92.4(510)	84.2(459)		
Antenatal care (ANC) visit					
Yes	94.4(1036)	94.4(521)	94.5(515)	0.006	0.936
No	5.6(61)	5.6(31)	5.5(30)		
ANC frequency					
1	20.0(207)	22.6(118)	17.3(89)	4.866	0.182
2	16.9(175)	15.9(83)	17.9(92)		
3	29.2(303)	28.8(150)	29.7(153)		
4+	33.9(351)	32.6(170)	35.1(181)		
HIV status					
Negative	95.5(1048)	94.2(520)	96.9(528)	4.608	**0.032**
Positive	4.5(49)	5.8(32)	3.1(17)		

3.4 Nutritional status of the women

Anemia among the total population was 17.0%, with a significant difference ($p<0.001$) between the intervention group and the control group (10.5% vs. 23.7%). The mean hemoglobin level was 12.38g/dL for both groups, with the intervention group (12.65g/dL) being significantly higher ($p< 0.001$) than the control group (12.1g/dL). An evaluation of anemia severity revealed that there was a large proportion of moderate anemia in the control group and a higher prevalence of mild anemia in the intervention group ($p=0.014$).

The average MUAC was also considerably higher in the intervention group (26.06 cm) than in the control group (24.87 cm) ($p<0.001$). The proportion of MAUC less than 23cm was also considerably greater in the control group (14.5%) compared to the intervention group (3.4%) ($p<0.001$). Additionally, compared to women in the control group (5.5%), women in the intervention group (1.8%) had a significantly reduced percentage of BMI less than 18.5 kg/m^2 in the first trimester ($p=0.010$). The participants in the intervention group also had significantly greater average weights in the first and third trimesters ($p<0.001$). After accounting for MUAC and BMI, the prevalence of maternal undernutrition was found to be 11.4% overall, and among controls it was significantly higher ($p<0.001$) compared to the intervention group (13.6%) (Table 2.4).

Table 2.4: Nutritional status of the women

Variables	Total, %(n)	Intervention, %(n)	Control, %(n)	χ^2 values	p value
Anemia status					
Anemic (Hb <11g/dL)	17.0(187)	10.5(58)	23.7(129)	33.6	**<0.001**
Normal (Hb ≥11g/dL)	83.0(910)	89.5(494)	76.3(416)		
Hb concentration, (Mean, SD)	12.38[1.39]	12.65[1.24]	12.10[1.48]	6.71	**<0.001**[a]
Severity of anemia (n=187)					
Mild (Hb = 9 to 10.9 g/dL)	90.4(169)	98.3(57)	86.8(112)	6.03	**0.014**
Moderate (Hb = 7 to 8.9 g/dL)	9.6(18)	1.7(1)	13.2(17)		
Acute wasting status					
Wasting (MUAC <23cm)	8.9(98)	3.4(19)	14.5(79)	41.18	**<0.001**
Normal (MUAC ≥23cm)	91.1(999)	96.6(533)	85.5(466)		
MUAC [Mean, SD]	25.47[2.52]	26.06[2.46]	24.87[2.45]	8.05	**<0.001**[a]
Underweight status in first trimester[b]					
Underweight (BMI < 18.5 kg/m$^{2)}$	3.8(32)	1.8(7)	5.5(25)	9.12	**0.01**
Normal (BMI ≥ 18.5 kg/m^2)	76.3(646)	76.2(297)	76.4(349)		
Overweight/obese (BMI >25.0 kg/m^2)	20.0(169)	22.1(86)	18.2(83)		
BMI [Mean, SD]	23.06[2.89]	23.46[2.97]	22.73[2.78]	3.71	**<0.001**[a]
Estimated average weight gain					
Estimated average weight in first trimester [SD][b]	60.09[8.83]	61.86[9.14]	58.57[7.67]	5.64	**<0.001**[a]
Estimated average weight in third trimester [SD][c]	64.86[8.78]	66.74[9.52]	63.26[7.76]	5.86	**<0.001**[a]
Estimated average weight gain between third and first trimester [SD][d]	4.76[2.02]	4.88[2.17]	4.66[1.88]	1.56	0.119[a]
Overall maternal undernutrition					
Undernourished[e]	11.4 (125)	4.7(26)	18.2(99)	49.17	**<0.001**
Normal	88.6 (972)	95.3(526)	81.8(446)		

' [a]Mean was compared using independent t test'

'[b]Overall total = 847; Intervention = 390; Control = 457'

' [c]Overall total = 849; Intervention = 389; Control = 460'

' [d]Overall total = 843; Intervention = 389; Control = 454; the weight gain is an estimate between any time within third trimester and first trimester which are retrieved from ANC records'

' [e]Maternal undernutrition was assessed using low MUAC (<23cm) during delivery or low BMI (<18.5 kg/m^2) in first trimester or both'.

' Abbreviations: BMI = Body mass index; Hb = hemoglobin; MUAC = Mid-upper arm circumference; SD = Standard deviation'

3.5 Effect of the integrated nutrition intervention package on maternal undernutrition

As shown in Table 2.5, the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package was recognized as an independent factor linked to maternal undernutrition. After controlling for potential confounders with multivariable logistic regression, maternal undernutrition was 77% less likely to occur among pregnant women in the intervention group compared to those in the control group [aOR= 0.23; 95%CI= 0.15-0.36; p<0.001].

Table 2.5. Effect of the intervention package on maternal undernutrition

Group	Maternal undernutrition[a]; %(95%CI)	Unadjusted		Adjusted[b]	
		OR, 95%CI	p value	OR, 95%CI	p value
Control	18.2(15.02-21.66)	1.00		1.00	
Intervention	4.7(3.10-6.83)	0.22(0.14-0.35)	<0.001	0.23(0.15-0.36)	<0.001

' [a]Maternal undernutrition was defined as low MUAC (<23cm) during delivery or low BMI (<18.5 kg/m^2) in first trimester or both.'

' [b]The odds ratio is adjusted with fuel/energy for lighting, having household items, alcohol consumption, smoking, exposure to secondary smoke and HIV status'

'Abbreviation: OR = Odds Ratio; CI= Confidence Interval'

4. DISCUSSION

This study discovered a link between reduced maternal undernutrition during pregnancy and combined 'nutrition-specific' and 'nutrition-sensitive' intervention package. This is consistent with the research and evidence currently available, which suggests that integrated 'nutrition-specific' and 'nutrition-sensitive' intervention programs have a greater impact on nutritional outcomes than either type of intervention alone (Abdullahi et al. 2021). Additionally, it endorses the *Lancet* Series from 2008, 2013, and 2021 addressing the suggested effectiveness of evidence-based intervention in reducing maternal undernutrition '(Bhutta et al. 2008, 2013; Keats et al. 2021)'.

However, the discrepancies in the components used in the intervention package make it challenging to compare and contrast our findings with those of other studies. In contrast to the majority of other research, this one used a combination of interventions, such as 'nutrition counseling, promotion of financial literacy/economic resilience, agricultural productivity promotion and improved access to WASH services'. Moreover, the evidence for these single

interventions varied, ranging from none to moderate to strong '(Dangour et al. 2013; Demilew et al. 2020; Headey 2012; Kadiyala et al. 2021; Michaux et al. 2019; Olney et al. 2016; Osei et al. 2017; Ruel et al. 2013; Sharma et al. 2021)'.

The fact that the underlying causes of undernutrition are not fully addressed is one of the key reasons why a single intervention has a limited impact on reducing it. It was stated that, for instance, increasing agricultural output, integrated multiple intervention, and other measures can address the immediate and underlying causes of undernutrition (Ruel et al. 2018), these various sectors may cover WASH, social safety nets, and nutrition instruction and counseling. Another factor can be the limited duration of intervention programs, which might not adequately address the root causes of undernutrition (Ruel et al. 2018).

However, these voids were filled in by our investigation. In order to address the root causes of maternal undernutrition, the 'nutrition-specific' intervention of nutritional education and counseling promoted dietary diversity. Food security and hygiene/sanitation were improved as a result of the 'nutrition-sensitive' intervention in the package, which also included the promotion of financial literacy/economic resilience, agricultural productivity promotion, and improved access to WASH services. This addressed the root causes of maternal undernutrition.

Therefore, the combination intervention that operated in synergy could be the likely reason for the larger reduction of undernutrition among pregnant women in this study. Additionally, there is proof that gender-sensitive policies benefit society by empowering women (Kumar et al. 2018). Women's nutritional status may be further improved by this empowerment since it may encourage decision-making, gender equality, social capital, partner communication, and access to resources.

Even though 'nutrition-specific' interventions can significantly reduce undernutrition, they may not be enough to completely eradicate it. However, it could have a significant influence on the eradication of undernutrition if implemented with 'nutrition-sensitive' intervention (Abdullahi et al. 2021). Malnutrition is thought to be reduced by 80% with 'nutrition-sensitive' interventions that target its root causes, compared to just 20% with 'nutrition-specific' interventions, even when scaled up to 90% coverage (IFPRI 2016). Additionally, 'nutrition-sensitive' interventions show significant promise for optimizing the coverage and efficiency of 'nutrition-specific' interventions as well as nutritional outcomes (Ruel et al. 2013). Therefore, a combined package of interventions

that includes both ‘nutrition-specific’ and ‘nutrition-sensitive’ has more encouraging outcomes than a single intervention.

The use of a strong evaluation design (a well-designed post quasi experiment), a well-powered sample size, and the influence of the program assessment over a long period of time (5 years) are the strengths of the current study. But there are some restrictions that need to be considered. Our study's use of merely end-line postprogram evaluation has some limitations, including the inability to fully understand the trajectory of nutritional indicators during pregnancy. Another drawback was the absence of randomization to reduce bias. However, bias may have been lessened by having a control group and enrolling those women in the intervention before becoming pregnant. Additionally, it was discovered that the two groups' fundamental traits were comparable, raising the probability that the observed variations in results were brought on by the combined intervention.

5. CONCLUSION

Our research demonstrated that an integrated ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention, including nutrition counseling and education, economic/financial literacy promotion, agricultural productivity promotion, and improved access to WASH activities, can lower levels of maternal malnutrition, including anemia. In order to address undernutrition among pregnant women, there is a strong rationale for considering a national scale-up of the combined ‘nutrition-specific’ and ‘nutrition-sensitive’ intervention. To further inform the expansion of the intervention, it should be noted that our study only took into account the end-line assessment of nutritional status. As a result, we advise studies that take into account both baseline and end-line assessment with randomization approach.

REFERENCES

1. Abdullahi, Leila H., Gilbert K. Rithaa, Bonface Muthomi, Florence Kyallo, Clementina Ngina, Mohamed A. Hassan, and Mohamed A. Farah. 2021. “Best Practices and Opportunities for Integrating Nutrition Specific into Nutrition Sensitive Intervention in Fragile Contexts: A Systematic Review.” BMC Nutrition 7(1):46. doi: 10.1186/s40795-021-00443-1.

2. Acharya, Shiva Raj, Jeevan Bhatta, and Diwash Prasad Timilsina. 2017. “Factors Associated with Nutritional Status of Women of Reproductive Age Group in Rural, Nepal.” Asian Pacific Journal of Health Sciences 4(4):19–24. doi: 10.21276/apjhs.2017.4.4.6.

3. Bhutta, Zulfiqar A., Tahmeed Ahmed, Robert E. Black, Simon Cousens, Kathryn Dewey, Elsa Giugliani, Batool A. Haider, Betty Kirkwood, Saul S. Morris, and H. P. S. Sachdev. 2008. “What Works? Intervention for Maternal and Child Undernutrition and Survival.” The *Lancet* 371(9610):417–40.

4. Bhutta, Zulfiqar A., Jai K. Das, Arjumand Rizvi, Michelle F. Gaffey, Neff Walker, Susan Horton, Patrick Webb, Anna Lartey, Robert E. Black, and *Lancet* Nutrition Intervention Review Group, the Maternal and Child Nutrition Study Group. 2013. “Evidence-Based Intervention for Improvement of Maternal and Child Nutrition: What Can Be Done and at What Cost?” *Lancet* (London, England) 382(9890):452–77. doi: 10.1016/S0140-6736(13)60996-4.

5. Black, Robert E., Cesar G. Victora, Susan P. Walker, Zulfiqar A. Bhutta, Parul Christian, Mercedes de Onis, Majid Ezzati, Sally Grantham-McGregor, Joanne Katz, Reynaldo Martorell, Ricardo Uauy, and Maternal and Child Nutrition Study Group. 2013. “Maternal and Child Undernutrition and Overweight in Low-Income and Middle-Income Countries.” *Lancet* (London, England) 382(9890):427–51. doi: 10.1016/S0140-6736(13)60937-X.

6. Bonde, D. 2016. “Impact of Agronomy and Livestock Intervention on Women’s and Child Dietary Diversity in Mali.” Field Exchange 51.

7. Carletto, Gero, Marie Ruel, Paul Winters, and Alberto Zezza. 2015. “Farm-Level Pathways to Improved Nutritional Status: Introduction to the Special Issue.” The Journal of Development Studies 51(8):945–57. doi: 10.1080/00220388.2015.1018908.

8. Casagrande, J. T., M. C. Pike, and P. G. Smith. 1978. “An Improved Approximate Formula for Calculating Sample Sizes for Comparing Two Binomial Distributions.” Biometrics 34(3):483. doi: 10.2307/2530613.

9. Dangour, Alan D., Louise Watson, Oliver Cumming, Sophie Boisson, Yan Che, Yael Velleman, Sue Cavill, Elizabeth Allen, and Ricardo Uauy. 2013. “Intervention to Improve Water Quality and Supply, Sanitation and Hygiene Practices, and Their Effects on the Nutritional Status of Children.” The Cochrane Database of Systematic Reviews (8):CD009382. doi: 10.1002/14651858.CD009382.pub2.

10. Dattijo, L., P. Daru, and N. Umar. 2016. “Anaemia in Pregnancy: Prevalence and Associated Factors in Azare, North-East Nigeria.” International Journal of TROPICAL DISEASE & Health 11(1):1–9. doi: 10.9734/IJTDH/2016/20791.

11. Demilew, Yeshalem Mulugeta, Getu Degu Alene, and Tefera Belachew. 2020. “Effect of Guided Counseling on Nutritional Status of Pregnant Women in West Gojjam Zone, Ethiopia: A Cluster-Randomized Controlled Trial.” Nutrition Journal 19(1):38. doi: 10.1186/s12937-020-00536-w.

12. Fenn, B., and E. Yakowenko. 2015. “Literature Review on Impact of Cash Transfers on Nutritional Outcomes.” Field Exchange (49):40.

13. Gebre, Abel, and Afework Mulugeta. 2015. “Prevalence of Anemia and Associated Factors among Pregnant Women in North Western Zone of Tigray, Northern Ethiopia: A Cross-Sectional Study.” Journal of Nutrition and Metabolism 2015:165430. doi: 10.1155/2015/165430.

14. Ghosh, Shibani, Kathryn Spielman, Meghan Kershaw, Kidane Ayele, Yitbarek Kidane, Krista Zillmer, Leslie Wentworth, Ashish Pokharel, Jeffrey K. Griffiths, and Tefera Belachew. 2019. “‘nutrition-specific’ and ‘nutrition-sensitive’ Factors Associated with Mid-Upper Arm Circumference as a Measure of Nutritional Status in Pregnant Ethiopian Women: Implications for Programming in the First 1000 Days.” PloS One 14(3):e0214358.

15. Gilligan, Daniel, Melissa Hidrobo, John Hoddinott, Shalini Roy, and Benjamin Schwab. 2014. Much Ado about Modalities: Multicountry Experiments on the Effects of Cash and Food Transfers on Consumption Patterns.

16. Gilmore, Brynne, and Eilish McAuliffe. 2013. "Effectiveness of Community Health Workers Delivering Preventive Intervention for Maternal and Child Health in Low-and Middle-Income Countries: A Systematic Review." BMC Public Health 13(1):847.

17. Girard, Amy Webb, and Oluwafunke Olude. 2012. "Nutrition Education and Counselling Provided during Pregnancy: Effects on Maternal, Neonatal and Child Health Outcomes." Paediatric and Perinatal Epidemiology 26:191–204.

18. Hambidge, K. Michael, and Nancy F. Krebs. 2018. "Strategies for Optimizing Maternal Nutrition to Promote Infant Development." Reproductive Health 15(1):87.

19. Hasan, Mehedi, Ipsita Sutradhar, A. S. M. Shahabuddin, and Malabika Sarker. 2017. "Double Burden of Malnutrition among Bangladeshi Women: A Literature Review." Cureus 9(12).

20. Headey, Derek. 2012. "Turning Economic Growth into 'nutrition-sensitive' Growth." Edited by Shenggen Fan and Rajul Pandya-Lorch 39.

21. IFPRI. 2016. International Food Policy Research Institute. 2016. Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Washington, D.C. Http://Dx.Doi.Org/10.2499/9780896295841.

22. Ismail, Imaad Mohammed, Azeez Kahkashan, Alwin Antony, and V. K. Sobhith. 2017. "Role of Socio-Demographic and Cultural Factors on Anemia in a Tribal Population of North Kerala, India." International Journal of Community Medicine and Public Health 3(5):1183–88.

23. Kadiyala, Suneetha, Helen Harris-Fry, Ronali Pradhan, Satyanarayan Mohanty, Shibanath Padhan, Suchitra Rath, Philip James, Emily Fivian, Peggy Koniz-Booher, and Nirmala Nair. 2021. "Effect of 'nutrition-sensitive' Agriculture Intervention with

Participatory Videos and Women's Group Meetings on Maternal and Child Nutritional Outcomes in Rural Odisha, India (UPAVAN Trial): A Four-Arm, Observer-Blind, Cluster-Randomised Controlled Trial." The *Lancet* Planetary Health 5(5):e263–76.

24. Keats, Emily C., Jai K. Das, Rehana A. Salam, Zohra S. Lassi, Aamer Imdad, Robert E. Black, and Zulfiqar A. Bhutta. 2021. "Effective Intervention to Address Maternal and Child Malnutrition: An Update of the Evidence." The *Lancet*. Child & Adolescent Health 5(5):367–84. doi: 10.1016/S2352-4642(20)30274-1.

25. Khalid, Hina, Sitara Gill, and Ashley M. Fox. 2019. "Global Aid for 'nutrition-specific' and 'nutrition-sensitive' Intervention and Proportion of Stunted Children across Low-and Middle-Income Countries: Does Aid Matter?" Health Policy and Planning 34(Supplement_2):ii18–27.

26. Kumar, Neha, Phuong Hong Nguyen, Jody Harris, Danny Harvey, Rahul Rawat, and Marie T. Ruel. 2018. "What It Takes: Evidence from a Nutrition-and Gender-Sensitive Agriculture Intervention in Rural Zambia." Journal of Development Effectiveness 10(3):341–72.

27. Loudyi, Fouzia Mnebhi, Jalal Kassouati, Meryem Kabiri, Naima Chahid, Aicha Kharbach, Hassan Aguenaou, and Amina Barkat. 2016. "Vitamin D Status in Moroccan Pregnant Women and Newborns: Reports of 102 Cases." The Pan African Medical Journal 24.

28. Masset, Edoardo, Lawrence Haddad, Alexander Cornelius, and Jairo Isaza-Castro. 2012. "Effectiveness of Agricultural Intervention That Aim to Improve Nutritional Status of Children: Systematic Review." Bmj 344:d8222.

29. Michaux, Kristina D., Kroeun Hou, Crystal D. Karakochuk, Kyly C. Whitfield, Sokhoing Ly, Vashti Verbowski, Ame Stormer, Keith Porter, Kathy H. Li, Lisa A. Houghton, Larry D. Lynd, Aminuzzaman Talukder, Judy McLean, and Timothy J. Green. 2019. "Effect of Enhanced Homestead Food Production on Anaemia among Cambodian Women and

Children: A Cluster Randomized Controlled Trial." Maternal & Child Nutrition 15 Suppl 3:e12757. doi: 10.1111/mcn.12757.

30. Mosha, Dominic, Chelsey R. Canavan, Alexandra L. Bellows, Mia M. Blakstad, Ramadhani Abdallah Noor, Honorati Masanja, Joyce Kinabo, and Wafaie Fawzi. 2018. "The Impact of Integrated 'nutrition-sensitive' Intervention on Nutrition and Health of Children and Women in Rural Tanzania: Study Protocol for a Cluster-Randomized Controlled Trial." BMC Nutrition 4(1):29.

31. Nana, Amanuel, and Tona Zema. 2018. "Dietary Practices and Associated Factors during Pregnancy in Northwestern Ethiopia." BMC Pregnancy and Childbirth 18(1):183.

32. Nielsen, Jennifer Notkin, Joel Gittelsohn, Jean Anliker, and Kimberly O'Brien. 2006. "Intervention to Improve Diet and Weight Gain among Pregnant Adolescents and Recommendations for Future Research." Journal of the American Dietetic Association 106(11):1825–40.

33. Nsereko, Etienne, Aline Uwase, Assumpta Mukabutera, Claude Mambo Muvunyi, Stephen Rulisa, David Ntirushwa, Patricia Moreland, Elizabeth J. Corwin, Nicole Santos, and Manasse Nzayirambaho. 2020. "Maternal Genitourinary Infections and Poor Nutritional Status Increase Risk of Preterm Birth in Gasabo District, Rwanda: A Prospective, Longitudinal, Cohort Study." BMC Pregnancy and Childbirth 20:1–13.

34. Obai, Gerald, Pancras Odongo, and Ronald Wanyama. 2016. "Prevalence of Anaemia and Associated Risk Factors among Pregnant Women Attending Antenatal Care in Gulu and Hoima Regional Hospitals in Uganda: A Cross Sectional Study." BMC Pregnancy and Childbirth 16(1):76.

35. Olney, Deanna K., Lilia Bliznashka, Abdoulaye Pedehombga, Andrew Dillon, Marie T. Ruel, and Jessica Heckert. 2016. "A 2-Year Integrated Agriculture and Nutrition Program Targeted to Mothers of Young Children in Burkina Faso Reduces Underweight among Mothers and Increases Their Empowerment: A Cluster-Randomized Controlled Trial." The Journal of Nutrition 146(5):1109–17. doi: 10.3945/jn.115.224261.

36. Osei, Akoto, Pooja Pandey, Jennifer Nielsen, Alissa Pries, David Spiro, Dale Davis, Victoria Quinn, and Nancy Haselow. 2017. “Combining Home Garden, Poultry, and Nutrition Education Program Targeted to Families With Young Children Improved Anemia Among Children and Anemia and Underweight Among Nonpregnant Women in Nepal.” Food and Nutrition Bulletin 38(1):49–64. doi: 10.1177/0379572116676427.

37. Ravaoarisoa, Lantonirina, Lalhyss Randriamanantsaina, Julio Rakotonirina, Jean de Dieu Marie Rakotomanga, Philippe Donnen, and Michèle Wilmet Dramaix. 2018. “Socioeconomic Determinants of Malnutrition among Mothers in the Amoron’i Mania Region of Madagascar: A Cross-Sectional Study.” BMC Nutrition 4(1):6.

38. RDHS. 2020. “National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. 2020. Rwanda Demographic and Health Survey 2019-20 Key Indicators Report. Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF.”

39. Reinhardt, Kristina, and Jessica Fanzo. 2014. “Addressing Chronic Malnutrition through Multi-Sectoral, Sustainable Approaches: A Review of the Causes and Consequences.” Frontiers in Nutrition 1:13.

40. Ruel, Marie T., Harold Alderman, Maternal, and Child Nutrition Study Group. 2013. “‘nutrition-sensitive’ Intervention and Programmes: How Can They Help to Accelerate Progress in Improving Maternal and Child Nutrition?” The *Lancet* 382(9891):536–51.

41. Ruel, Marie T., Agnes R. Quisumbing, and Mysbah Balagamwala. 2018. “‘nutrition-sensitive’ Agriculture: What Have We Learned so Far?” Global Food Security 17:128–53. doi: 10.1016/j.gfs.2018.01.002.

42. Salunkhe, A. H. 2018. “Nutritional Status of Mother and Gestational Age.” Online Journal of Health and Allied Sciences 16(4).

43. Sharma, Indu K., Sabina Di Prima, Dirk Essink, and Jacqueline E. W. Broerse. 2021. “‘nutrition-sensitive’ Agriculture: A Systematic Review of Impact Pathways to Nutrition Outcomes.” Advances in Nutrition 12(1):251–75. doi: 10.1093/advances/nmaa103.

44. da Silva Lopes, Katharina, Erika Ota, Prakash Shakya, Amarjargal Dagvadorj, Olukunmi Omobolanle Balogun, Juan Pablo Peña-Rosas, Luz Maria De-Regil, and Rintaro Mori. 2017. “Effects of Nutrition Intervention during Pregnancy on Low Birth Weight: An Overview of Systematic Reviews.” BMJ Global Health 2(3):e000389. doi: 10.1136/bmjgh-2017-000389.

45. Soltani, Hora, A. M. S. Duxbury, Rachel Rundle, and Lingtak-Neander Chan. 2015. “A Systematic Review of the Effects of Dietary Intervention on Neonatal Outcomes in Adolescent Pregnancy.” Evidence Based Midwifery 13(1):29–34.

46. Stevens, Gretchen A., Mariel M. Finucane, Christopher J. Paciorek, Seth R. Flaxman, Richard A. White, Abigail J. Donner, Majid Ezzati, and Nutrition Impact Model Study Group. 2012. “Trends in Mild, Moderate, and Severe Stunting and Underweight, and Progress towards MDG 1 in 141 Developing Countries: A Systematic Analysis of Population Representative Data.” The *Lancet* 380(9844):824–34.

47. Tang, Alice M., Mei Chung, Kimberly Dong, Norma Terrin, Andrew Edmonds, Nega Assefa, and Z. Maalouf-Manasseh. 2016. “Determining a Global Mid-Upper Arm Circumference Cutoff to Assess Malnutrition in Pregnant Women.” Food and Nutrition Technical Assistance.

48. UNICEF. 1990. Strategy for Improved Nutrition of Children and Women in Developing Countries. Unicef.

49. Victora, Cesar G., Jennifer Harris Requejo, Aluisio JD Barros, Peter Berman, Zulfiqar Bhutta, Ties Boerma, Mickey Chopra, Andres De Francisco, Bernadette Daelmans, and Elizabeth Hazel. 2016. “Countdown to 2015: A Decade of Tracking Progress for Maternal, Newborn, and Child Survival.” The *Lancet* 387(10032):2049–59.

50. WHO Reproductive Health Library. 2016. WHO Recommendation on Nutrition Education on Energy and Protein Intake during Pregnancy. The WHO Reproductive Health Library; Geneva: World Health Organization.

51. Williams, Pamela A., Courtney H. Schnefke, Valerie L. Flax, Solange Nyirampeta, Heather Stobaugh, Jesse Routte, Clarisse Musanabaganwa, Gilles Ndayisaba, Felix Sayinzoga, and Mary K. Muth. 2019. “Using Trials of Improved Practices to Identify Practices to Address the Double Burden of Malnutrition among Rwandan Children.” Public Health Nutrition 22(17):3175–86.

52. World Food Programme. 2018. Comprehensive Food Security and Vulnerability Analysis, 2018. Kigali.

53. Zerfu, Taddese A., Melaku Umeta, and Kaleab Baye. 2016. “Dietary Diversity during Pregnancy Is Associated with Reduced Risk of Maternal Anemia, Preterm Delivery, and Low Birth Weight in a Prospective Cohort Study in Rural Ethiopia.” The American Journal of Clinical Nutrition 103(6):1482–88.

CHAPTER 3: PAPER 2

Effectiveness of an integrated maternal nutrition intervention package on birth weight in Rwanda

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ABSTRACT

Low birth weight (LBW), a major risk factor for poor fetal development which leads to poor child development, is due to inadequate maternal nutrition during pregnancy. The majority of research concentrate on the effects of nutritional interventions made after delivery, while few interventions take an integrated nutrition intervention package into account. Therefore, there is little data to support the claim that comprehensive maternal nutrition interventions increase birthweight. To determine the impact of the integrated maternal nutrition intervention package on low birth weight in Rwanda, a post-program quasi-experimental research was conducted. The analysis included 551 mother-baby pairs from the intervention group and 545 from control group. A questionnaire was used to gather information on sociodemographic, lifestyle and obstetric factors as well as maternal anthropometric measurements and dietary diversity. Within a 24-hour period following delivery, the birth weight was measured. The effectiveness of the intervention on birth weight was assessed using logistic regression, linear regression, and mediation analysis. The research found that the intervention improved average birth weight by 219 grams ($p<0.001$) and lowered LBW by 66.99% ($p<0.001$). The intervention group had a significantly lower risk of LBW than the control group (AOR=0.23; 95%CI = 0.12-0.43; $p<0.001$). Furthermore, it was noted that the intervention's direct impact on birth weight was 0.17 (β =0.17; $p <0.001$) and maternal MUAC was the key indirect mediator (β =0.05; $p<0.001$). This study shows that an integrated maternal nutritional intervention package can statistically lower LBW in settings with low income, and as a result, it should be considered to increase birth weight.

Keywords: 'Birth weight, Effectiveness; Integrated nutrition intervention; Low birth weight; Rwanda'

BACKGROUND

Birth weight serves as a key predictor of both a newborn's current and future health condition, making low birth weight (LBW) a severe public health concern (1,2). Around the world, 15% to 20% of newborns are underweight at birth [3] which translates to almost 30 million infants each year (23.4% of all births) [4,5]. South Central Asia accounts for 27% of all LBW, and sub-Saharan Africa accounts for 15% of all LBW [4,6,7]. The prevalence of LBW has been estimated to be between 10 and 15.7% in several African nations [8]. The recent Demographic and Health Survey data indicates that the rate of LBW in Rwanda is 7% [9].

LBW remains to be the most important cause of neonatal morbidity and mortality worldwide [10,11]. It is responsible for 30% of all infant fatalities in African nations [12]. Compared to babies with normal birth weight, those with LBW are nearly 40 fold higher to die in the first one month of life [13]. Furthermore, it puts children at a high risk for infections or pediatric illnesses, undernutrition, persistent physical and mental disorders, and issues with behavior, learning, and psychosocial development [1,13–15].

The primary factor causing LBW is believed to be maternal malnutrition during pregnancy [16,17]. However, by enhancing pregnant women's nutritional status, LBW can be prevented. Pregnant women must utilize the appropriate nutrition intervention strategies to enhance maternal nutrition and the birth weight of their infants [18]. In order to optimize fetal nutrition and promote ideal growth and child development, the '*Lancet* Maternal and Child Nutrition series' advocated 'nutrition-specific' and 'nutrition-sensitive' intervention in 2013 [19,20].

A program called *Gikuriro*—which means "good growth"—was put into place between 2016 and 2020 in accordance with the '*Lancet* series and the Rwanda National Food and Nutrition Policy for 2013 to 2018' [21]. As of late 2014, the program targeted five districts: Kayonza and Ngoma in the Eastern Province, Nyabihu in the Western Province, Kicukiro and Nyarugenge in Kigali City. These areas were chosen due to undernutrition and lack of development partners. The program introduced a significant 'nutrition-specific' and 'nutrition-sensitive' intervention package to prevent pregnant and early childhood undernutrition. A key 'nutrition-sensitive' intervention included promoting increased agricultural productivity, economic strengthening through social safety nets, and improved access to Water, Hygiene, and Sanitation (WASH) services while nutrition education and counseling was among the 'nutrition-specific' interventions. The benefits of proper diet for pregnant women and their unborn children have long been recognized. However, it is still unclear how such an integrated intervention package throughout pregnancy may affect the child's nutritional status, including birth weight.

Most previous research done to examine the efficiency of individual intervention in the first 1000 days window period found a slight impact on linear growth [22]. For instance, a single pregnancy intervention resulted in a 50 gram increase in birth weight, with a 15% reduction of LBW [23,24]. Another investigation revealed that pregnant women who received balanced protein and energy

supplements had a 41-gram rise in birth weight [25]. A recent review analysis of 16 high-quality randomized controlled trials showed that LBW is significantly reduced when maternal nutritional status is addressed [3]. This was especially more effective when the intervention included both multi-micronutrient supplements and dietary education/counseling [3]. There is, however, a dearth of research whether an integrated nutritional intervention package throughout pregnancy affects birth weight. Thus, the objective of this study was to determine if an integrated maternal nutrition intervention program was effective in lowering low birth weight in Rwanda.

METHODS AND MATERIALS

Study design, settings and intervention

The investigation was carried out between November 2020 and June 2021 using a post-intervention quasi-experimental design. The intervention group was selected from the urban Kicukiro District and the rural Kayonza District, where the integrated nutrition intervention package ('nutrition-sensitive' and 'nutrition-specific') was implemented. The two districts were chosen based on their high proportion of food insecurity [26] and area (rural vs. urban). Similarly, three criteria were used to choose the control districts: high food insecurity, a lack of 'nutrition-specific' and 'nutrition-sensitive' intervention packages, and type of settlement (rural vs. urban). Following careful consideration of all the criteria, the comparative control group was chosen from the rural Gisagara District and the urban Gasabo District. The study covered all of the district's health centers as well as one public district hospital.

The integrated nutrition intervention package refers to one 'nutrition-specific' intervention component, namely nutrition counseling and education, as well as three 'nutrition-sensitive' components, including improving access to WASH services, promoting financial literacy/economic resilience, and promoting agricultural productivity. Between September 2016 and July 2020, the intervention was conducted. An extensive description of these interventions are presented in Table 1.1.

Study population, sampling and sample size estimation

Mother-newborn pairs made up the target population. Using the following inclusion criteria, all pregnant women coming for birth in the chosen district's selected health facilities were consecutively recruited: 1) aged between 15 and 49years, and a permanent resident in the research

area, 2) being enrolled in the chosen nutrition intervention program at least a year before conception, continuing in it for the intervention group until delivery but not the control group, 3) being in the first and second category of social class, 4) free of any known obstetric, surgical, or medical issues and 5) live singleton births with regular spontaneous deliveries.

The sample size was justified by the LBW proportion difference of 3.5% between the intervention and control groups. This indicates a decrease in low birth weight from the projected 7% [9] in the control group (general population) to 3.5% in the intervention group. To get the desired sample size, a power of 80%, a confidence interval of 95%, and a design effect of 1.25 were taken into account. Thus, the estimated sample size was 1144, with 572 mother-newborn pairs in each study group. However, due to incomplete data, 21 from the intervention group and 27 from the control group were not included in the analysis. Figure 3.1 depicts the flow chart for recruitment.

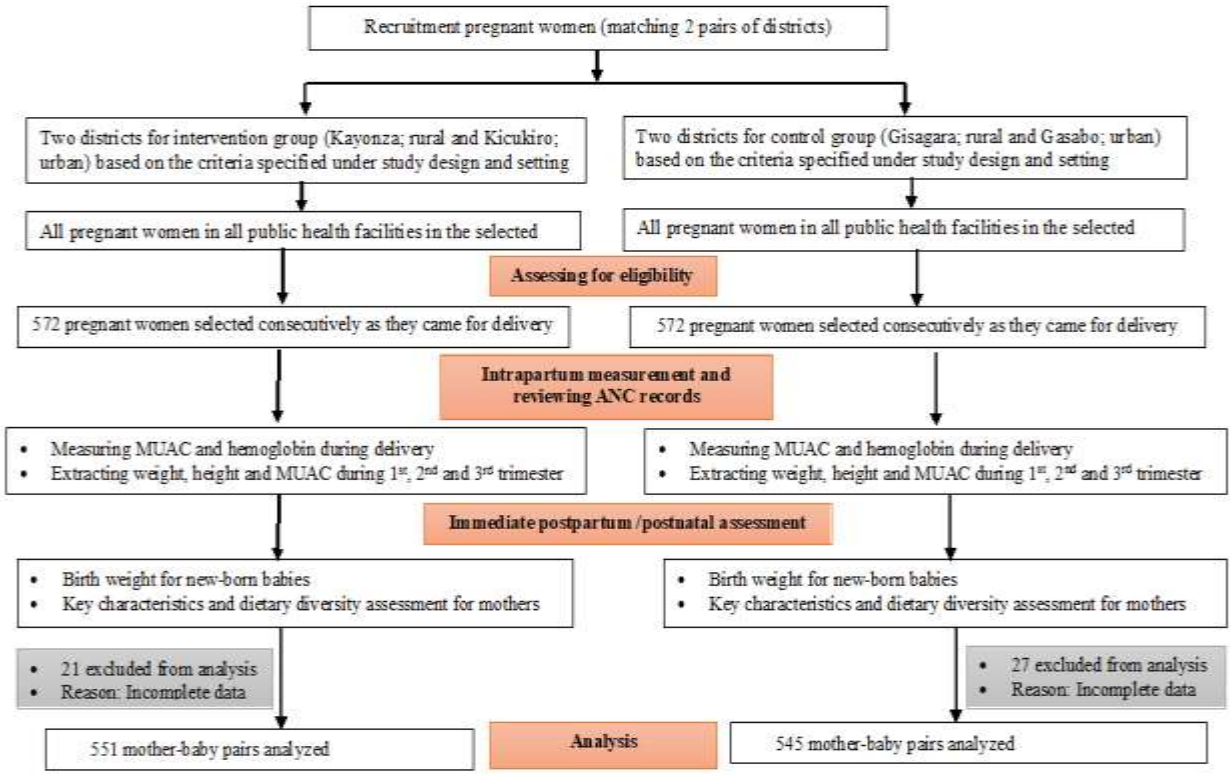

Figure 3. 1: Recruitment flow chart for mother-baby pair.

Data collection and measurements

Using a structured quantitative questionnaire, trained midwives and nurses gathered the data. It included demographic, lifestyle and obstetric factors, maternal dietary diversity as well as anthropometric and biological parameters. It was translated into the local language (Kinyarwanda). A standard operating procedure was created for each measure in order to ensure consistency in data gathering techniques. The questionnaire was used during in-person interviews with the mothers during the immediate postpartum period (within 24 hours of delivery). The study's goals, the selection of participants, and anthropometric measures were covered during the training for the data collectors.

For both the mothers and their newborns, anthropometric measurements were taken. Body mass index (BMI), wait gain, and mid-upper arm circumference (MUAC) were used to determine the mothers' nutritional status. MUAC has been found to have a good correlation with LBW and is unaffected by alterations such edema during pregnancy [28]. Based on numerous research conducted in Africa and the demand for an international comparison, the term "maternal undernutrition" was established as MUAC less than 23 cm [28]. Additionally, the MUAC, weight, and height measures that are taken during antenatal visits in accordance with the recommendations of the Rwandan Ministry of Health were extracted from antenatal care records. The measurement of body mass index (BMI) and weight gain was done using height and weight.

According to guidelines from the Rwandan Ministry of Health, hemoglobin was tested using a portable HEMOCUE B-Hb photometer at the time of recruitment that is just before delivery. Within 24 hours following delivery, weights of the newborns were recorded. On digital scales at the health facilities, the newborn babies were weighed to the nearest 100 grams. In accordance with the manufacturer's advice, the scales were routinely calibrated. Birth weight less than 2500 grams was deemed to be low birth weight.

To gather dietary data, a food frequency questionnaire (covering 9 food groups) was also used [29]. Cereals/tubers, pulses/legumes, vegetables, fruits, meat/fish/eggs, milk, oil, sugar, condiments/spices were included in the food groups. The women were asked about their eating habits for the previous 24 hours prior to the start of labor. Then, a score for dietary diversity was determined. Each food group that was consumed given a score of ‘1’, and those that weren't were

given a score of ‘0’. To determine the total maternal dietary diversity score (DDS), the scores were added together. Those who had a score below 5 were considered to have an inadequate DDS, whereas those who received a score of 5 or more were considered to have an adequate DDS.

Data analysis

For the analysis, IBM New York's Statistical Package for the Social Sciences (SPSS) version 25.0 was employed. Continuous data were summarized using means, and categorical data were summarized using percentages. Explanatory factors were evaluated between the intervention and control groups using a chi-square test to compare proportions or an independent sample *t* test to compare means. Less than 0.05 was the cutoff p-value for all statistical significance.

To determine the effectiveness of the intervention, logistic regression was used, taking into consideration all variables with a p value of 0.2 in the bivariate analysis. An adjusted odds ratio with a corresponding 95% confidence interval was used to show the degree of the connection between LBW and the intervention. The model fit the data well (p-value = 0.214), according to the findings of the Hosmer and Lemeshow Test, which was used to evaluate the model's fitness. The accuracy of the model classification was also guaranteed.

Some covariates linked to birth weight that were continuous variables were also subjected to linear regression. These comprised the mother's hemoglobin content (g/dL), MUAC (cm) during pregnancy or delivery, the first trimester's BMI, and DDS per 24-hour period. The model’s multicollinearity, linearity, and interaction were examined. Durbin-Watson (4) and the scatter plot proved linearity and independence of the observations/data, respectively. There was no multicollinearity as evidenced by the tolerance being larger than 0.1 and the inflation variance being less than 10.

Furthermore, the intervention may have an impact on the maternal nutritional status and dietary habits, which have a significant impact on fetal growth in the uterus. Taking this into account, the direct and indirect effects of the integrated nutrition intervention package on birth weight were assessed using a path and mediation analysis. In this instance, birth weight is the outcome variable and the intervention is the birth weight predictor. Using Hayes' PROCESS macro version 4.0 for SPSS, the pathway mediation was examined [30].

Ethics statement

The University of Rwanda College of Medicine and Health Sciences' Institutional Review Board reviewed and approved the research protocol (No 362/CMHS IRB/2020). Authorization to carry out the study was also granted from the Ministry of Health, Rwanda (Ref: NHRC/2020/PROT/046). The goals of the study were explained to each participant, and their written informed permission was requested and obtained.

RESULTS

Socio-demographic, obstetric and lifestyle characteristics of study population

Both groups were comparable in terms of the baby's gender, maternal age, marital status, religion, education, occupation, family size, number of pregnancies, and birth spacing. But the percentage of pregnant women who were drinking alcohol, smoking, and passive smoking exposure were statistically greater in the control group than in the intervention group (Table 3.1).

Table 3. 1: Socio-demographic, obstetric and lifestyle characteristics of study population

Variables	Intervention (n=551)		Control (n=545)		p value
	%	n	%	n	
Sex of the baby					
Male	43.9	242	47.0	256	0.31
Female	56.1	309	53.0	289	
Age of the mother (years)					
15-19	6.9	38	5.7	31	0.373
20-24	26.0	143	26.4	144	
25-29	28.5	157	26.4	144	
30-34	22.1	122	20.6	112	
35 and above	16.5	91	20.9	114	
Marital status of the mother					
Married/Cohabitating	90.0	496	87.0	474	0.114
Single/divorced	10.0	55	13.0	71	
Religion of the mother					
Christian	94.7	522	96.0	523	0.559
Muslim	4.4	24	3.1	17	
Others	0.9	5	0.9	5	
Level of education of the mother					
None	11.4	63	12.1	66	0.297
Primary	63.0	347	62.4	340	
Secondary	24.5	135	22.9	125	
Tertiary	1.1	6	2.6	14	
Occupation of the mother					
Salaried employee	3.6	20	3.1	17	0.701
Self-employed	75.0	413	77.1	420	
Unemployed	21.4	118	19.8	108	
Family size					
2 to 4	58.4	322	56.3	307	0.091
5 to 7	34.7	191	39.3	214	
8 and above	6.9	38	4.4	24	
Number of pregnancies					
≤ 2	59.5	328	55.6	303	0.062
3 to 4	29.0	160	28.1	153	
≥ 5	11.4	63	16.3	89	
Birth spacing (months)[a]					
≤ 24	39.3	147	40.2	154	0.799
≥ 25	60.7	227	59.8	229	
Taking alcohol or beer during pregnancy					
No	87.8	484	82.8	451	**0.017**

Yes	12.2	67	17.2	94	
Smoking during pregnancy					
No	98.9	545	95.8	522	**0.001**
Yes	1.1	6	4.2	23	
Passive smoking during pregnancy					
No	92.4	509	84.2	459	**<0.001**
Yes	7.6	42	15.8	86	

[a]Total intervention= 374; total controls =383, Remaining are first pregnancy

*Chi-square test was used to compare the proportions

Maternal nutrition and birth weight status by study group

The nutritional status of the mothers throughout pregnancy and the birth weight of the babies are shown in Table 3.2. The control group (10.3%) had a significantly ($p<0.001$) larger percentage of low birth weight than the intervention group (3.4%). Maternal anemia status varied significantly, with the control group experiencing higher levels of anemia than the intervention group (23.7% vs. 10.5%; $p<0.001$). When compared to the intervention group (3.4%), the proportion of pregnant women with MUACs less than 23 cm at birth was significantly greater ($p<0.001$) in the control group (14.5%). Similarly, the control group's rate of MUAC less than 23 cm throughout the first/second trimester was considerably greater (18.2%) than the intervention group's rate (4.5%) ($p<0.001$). The intervention group's average MUAC difference was noticeably larger than the control group's ($p = 0.020$). BMI of less than 18.5 kg/m^2 was also substantially lower in the intervention group (1.8%) compared to the control group (5.5%) in the first trimester ($p=0.010$). The intervention group's average weight gain during the first and third trimesters was significantly higher than that of the control group ($p<0.001$). Additionally, there were more mothers in the control group than in the intervention group who had maternal DDS of less than 5 out of 9 food groups (25.7% vs 18.3%; $p=0.003$)..

In the intervention group, the mean birth weight was 3216.34g, compared to 2997.34g in the control group. This difference was 219 grams more in the intervention group, which is significant ($p<0.001$). The intervention group also had significantly ($p<0.01$) higher mean maternal hemoglobin concentration, maternal MUAC during the first/second trimester and delivery, BMI in the first trimester, and dietary diversification scores than the control group (Table 3.2).

Table 3. 2: Maternal nutrition and birth weight status by study group

Variables	Intervention (n=551)		Control (n=545)		p value
	%	n	%	n	
Birth weight of the newborn baby					
Normal birth weight (≥ 2500gram)	96.6	532	89.7	489	<0.001φ
Low birth weight (<2500gram)	3.4	19	10.3	56	
Birth weight (mean±SD)	3216.34±464.35		2997.34±485.06		<0.001Ψ
Maternal anemia status					
Normal (Hb≥11g/dL)	89.5	493	76.3	416	<0.001φ
Anemic (Hb<11g/dL)	10.5	58	23.7	129	
Maternal hemoglobin concentration (mean+SD)	12.65±1.24		12.10±1.48		<0.001Ψ
Maternal MUAC (cm) at delivery					
≥23	96.6	532	85.5	466	<0.001φ
<23	3.4	19	14.5	79	
Maternal MUAC (mean+SD)	25.30±1.77		24.18±2.03		<0.001Ψ
Maternal MUAC (cm) in the first/second trimester[a]					
≥23	95.5	429	81.8	363	<0.001φ
<23	4.5	20	18.2	81	
Maternal MUAC (mean+SD)	25.46[1.88]		24.30[2.14]		<0.001Ψ
Maternal MUAC (cm) mean difference between first/second trimester and delivery	0.84±1.74		0.59±1.42		0.020 Ψ
Maternal BMI in first trimester[b]					
BMI < 18.5 kg/m^2	1.8	7	5.5	25	0.010φ
BMI ≥ 18.5 kg/m^2	76.1	296	76.4	349	
BMI >25.0 kg/m^2	22.1	86	18.2	83	
Maternal BMI in first trimester (mean+SD)	23.46±2.97		22.73±2.78		<0.001Ψ
Average weight gain					
Average weight in first trimester [SD][c]	61.86[9.15]		58.58[7.72]		<0.001Ψ
Average weight in third trimester [SD][d]	66.74[9.52]		63.36[7.75]		<0.001Ψ
Average weight gain between third and first trimester [SD][e]	4.91[2.13]		4.78[2.07]		0.394Ψ
Maternal dietary diversity score (DDS) (24 hours)					
High (≥ 5 DDS)	81.7	450	74.3	405	0.003φ
Low (<5 DDS)	18.3	101	25.7	140	
Maternal DDS (mean+SD)	5.791(1.60)		5.49(1.74)		0.003Ψ

φChi-square test was used to compare; ΨMean was compared using independent t test

[a]Intervention = 449; Control = 444

[b]Intervention = 389; Control = 457

[c]Intervention = 382; Control = 452

[d]Intervention = 389; Control = 460

[e]Intervention = '389; Control = 452; The weight gain is an estimate between the weight taken any time within third trimester and first trimester using ANC records'

Abbreviations: 'BMI = Body mass index; Hb = hemoglobin; Kg: Kilo-gram; MUAC = Mid-upper arm circumference; SD = Standard deviation'

Socio-demography, obstetric, lifestyle and other characteristics associated with LBW: Bivariate and multivariate analysis

After taking into account/adjusting for all variables with a p-value less than 0.2 during bivariate analysis, it was found that exposure to passive smoking at the time of pregnancy (AOR= 4.34; 95% CI =2.64-7.15; p<0.001) and maternal MUAC less than 23 cm (AOR= 2.95; 95% CI =1.66-5.24; p<0.001) were independent risk factors for LBW (Table 3.3).

Table 3. 3: Socio-demography, obstetric, lifestyle and other characteristics associated with LBW: Bivariate and multivariate analysis

Variables	Bivariate analysis				Multivariate analysis	
	LBW, %(n)	NBW, %(n)	COR(95%CI)	p value	[a]AOR(95%CI)	p value
Sex of the baby						
Male	8.8(44)	91.2(454)	1.14(0.74-1.75)	0.56		
Female	7.9(47)	92.1(551)	1.00			
Age of the mother (years)						
15-19	5.8(4)	94.2(65)	0.54(0.18-1.63)	0.274	0.57(0.14-2.27)	0.427
20-24	11.1(32)	88.9(255)	1.1(0.61-1.97)	0.749	1.36(0.63-2.94)	0.432
25-29	7.0(21)	93.0(280)	0.66(0.35-1.24)	0.193	0.84(0.38-1.87)	0.673
30-34	13(5.6)	94.4(221)	0.52(0.25-1.06)	0.071	0.57(0.25-1.32)	0.189
35 and above	21(10.2)	184(89.8)	1.00		1.00	
Marital status of the mother						
Married/Cohabitating	7.9(77)	92.1(893)	0.69(0.38-1.26)	0.227		
Single/divorced	11.1(14)	88.9(112)	1.00			
Level of education of the mother						
None	17.1(22)	82.9(107)	0.35(0.18-0.68)	**0.002**	1.13(0.52-2.46)	0.76
Primary	7.3(50)	92.7(637)	0.38(0.22-0.66)	**<0.001**	2.31(0.90-5.92)	0.081
Secondary and above	6.8(19)	93.2(261)	1.00		1	
Occupation of the mother						
Salaried employee	2.7(1)	97.3(36)	0.30(0.04-2.33)	0.251		
Self-employed	8.5(71)	91.5(762)	1.02(0.60-1.72)	0.956		
Unemployed	8.4(19)	91.6(207)	1.00			
Family size						
2 to 4	8.7(55)	91.3(574)	5.85(0.79-42.98)	0.083	5.81(0.73-46.01)	0.096
5 to 7	8.6(35)	91.4(370)	5.77(0.78-43.00)	0.087	6.24(0.79-48.93)	0.082
8 and above	1.6(1)	98.4(61)	1.00		1.00	
Number of pregnancies						
≤ 2	9(57)	91	1.27(0.65-2.49)	0.481		
3 to 4	7.3(23)	92.7	1.02(0.48-2.14)	0.965		

≥ 5	7.2(11)	92.8				
Taking alcohol or beer during pregnancy						
Yes	11.8(19)	88.2(142)	1.60(0.94-2.74)	0.084	1.19(0.59-2.40)	0.622
No	7.7(72)	92.3(863)	1.00		1.00	
Smoking during pregnancy						
Yes	17.2(5)	82.8(24)	2.38(0.88-6.38)	0.086	0.68(0.19-2.45)	0.555
No	8.1(86)	91.9(981)	1.00		1.00	
Passive smoking during pregnancy						
Yes	22.7(29)	77.3(99)	4.28(2.63-6.97)	**<0.001**	4.37(2.54-7.51)	<0.001
No	6.4(62)	93.6(906)	1.00		1.00	
Maternal anemia status at delivery						
Anemic (Hb<11g/dL)	9.6(18)	90.4(169)	1.22(0.71-2.10)	0.472		
Normal (Hb≥11g/dL)	8.0(73)	92.0(836)	1.00			
Maternal MUAC at delivery						
<23cm	19.4(19)	80.6(79)	3.09(1.78-5.39)	**<0.001**	3.08(1.67-5.66)	<0.001
≥23cm	7.2(72)	92.8(926)	1.00		1.00	
Maternal MUAC in the first/second trimester						
<23cm	16.8(17)	83.2(84)	4.19(0.57-31.17)	0.161	1.23(0.49-3.09)	0.659
≥23cm	7.2(57)	92.8(735)	1.00		1.00	
Maternal dietary diversity score (DDS) (24 hours)						
Low (<5 DDS)	10.8(26)	89.2(215)	1.47(0.91-2.37)	0.115	0.95(0.52-1.73)	0.865
High (≥ 5 DDS)	7.6(65)	92.4(790)	1.00		1.00	

[a] 'AOR is adjusted against those variables with p value less than 0.200 during bivariate analysis'

'Abbreviations: COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval'

Effectiveness of an integrated nutrition intervention package on low birth weight

Low birth weight risk was shown to be significantly lower for newborns in the intervention group (AOR=0.23; 95%CI = 0.12-0.43; p<0.001) after accounting for potential confounding factors using multivariable logistic regression. Furthermore, the results of the multiple linear regression showed that the intervention group's birth weight was significantly higher (β=0.16; 95%CI = 0.09-0.22; p<0.001) than among the control group (Table 3.4).

Table 3. 4: Regression analysis for effectiveness of an integrated nutrition intervention package on low birth weight

Study group	Logistic regression				Linear regression			
	[a]AOR	95%CI		p value	[b]Standardized beta coefficient	95%CI		p value
		Lower	Upper			Lower	Upper	
Intervention group	0.23	0.12	0.43	**<0.001**	0.16	0.09	0.22	**<0.001**
Control group	1.00							

[a] 'AOR (Adjusted odds ratio): adjusted for maternal age, level of education, family size, alcohol consumption, smoking, passive smoking, dietary diversity (<5 DDS) and MUAC <23cm'

[b] 'Standardized beta coefficient: adjusted for covariates of maternal hemoglobin concentration and maternal MUAC, BMI and DDS per 24 hours'

'MUAC: mid-upper arm circumference; CI= Confidence interval'

Pathway and mediation analysis for the intervention's direct and indirect impacts on birth weight

Similar outcomes from multiple linear regression were also seen in the mediation analysis. Comparing the intervention group to the control group, the average birth weight was considerably greater in the intervention group ('β =0.23; 95%CI = 0.18-0.28; p<0.001'). The intervention had a 0.17 direct impact on birth weight ('β =0.17; 95%CI = 0.10-0.22; p<0.001') while the indirect effect was 0.06 ('β =0.06; 95%CI = 0.04-0.10; p<0.001'). Among the maternal nutritional parameters, MUAC served as the primary indirect mediator ('β =0.05; 95%CI = 0.03-0.07; p<0.001') (Table 3.5).

Table 3. 5: Pathway and mediation analysis for the intervention's direct and indirect impacts on birth weight

Variable	Standardized Estimate	95% CI		p value
		Lower	Upper	
Overall total effect of the intervention on birth weight	0.23	0.18	0.28	<0.001
Direct effect of intervention on birth weight	0.17	0.10	0.22	<0.001
Total indirect effect of the intervention on birth weight	0.06	0.04	0.10	<0.001
Indirect effect 1	0.05	0.03	0.07	<0.001
Indirect effect 2	0.005	-0.006	0.017	0.394
Indirect effect 3	0.006	0.001	0.013	0.025
Effect of hemoglobin concentration on birth weight	0.02	-0.03	0.08	0.386
Effect of MUAC on birth weight	0.23	0.17	0.28	0.003
Effect of maternal DDS on birth weight	0.07	0.001	0.12	0.023
Effect intervention on hemoglobin concentration	0.20	0.14	0.25	0.001
Effect of intervention on MUAC	0.24	0.18	0.29	0.001
Effect of intervention on maternal DDS	0.09	0.03	0.16	0.004

Indirect effect 1: Intervention effect on birth weight through maternal MUAC
Indirect effect 2: Intervention effect on birth weight through maternal hemoglobin
Indirect effect 3: Intervention effect on birth weight through maternal DDS
MUAC: Mid Upper Arm Circumference; DDS =Dietary Diversity Score

DISCUSSION

According to the study's findings, babies born to pregnant women who participated in the integrated maternal nutrition intervention program had significantly higher birth weights. Comparing the intervention group to the control group, the occurrence of LBW was reduced by 66.99%. In a similar vein, the newborn babies in the intervention group had a mean birth weight that was 219 grams greater than that of the control group. This is in line with previous research on nutrition education and counseling interventions carried out in Ethiopia [31] and Kenya [32]. However, it is challenging to make comparisons with other studies because this study used a combination of interventions.

Multiple logistic and linear regression analyses showed that the implemented program or intervention was significantly linked with a decrease in low birth weight after potential confounders were taken into account. This may be the effect of the various interventions working together to enhance maternal nutrition, which decreased low birth weight. In terms of the single nutrition intervention on low birth weight and maternal undernutrition, however, numerous

evaluations and studies reported conflicting or varied outcomes. For instance, studies on interventions involving numerous micronutrients and maternal nutrition education demonstrated a decreased risk of low birth weight [23,25,33,34] while other reviews of interventions focusing solely on nutrition education demonstrated little to no impact [3,35–37]. In addition, there are further interventions using a single vitamin or mineral supplement including 'vitamin A [38], folic acid supplementation [39,40], iron [24], iodine [41] and zinc [42], marine oil and fatty acid supplementation [43]' did not find significant reduction of LBW.

In general, WASH intervention has been demonstrated to be more beneficial on newborn nutritional status when integrated with other interventions than when used alone [44,45]. Cash transfers and women's economic empowerment were linked to improve the birth weight and nutrition among pregnant women [37,46]. Even though there is no much information available about how the agriculture intervention affects birth weight [47], it is thought to have a significant impact when combined with the other elements such as educational initiatives and enhancing social safety nets [20].

Given the abovementioned, this study affirms that an integrated nutrition intervention package may have a synergistic effect. Birth weight was significantly affected directly by the intervention (β= 0.16; p= 0.001). Increased and better eating patterns among women are greatly influenced by maternal nutrition education and counseling [48,49]. By combining economic growth and nutrition education, women may be better able to utilize their resources and make necessary dietary adjustments, resulting in improved fetal growth and gestational weight gain [50]. When combined with agricultural intervention and nutrition education, nutritional outcome among women and children is more successful [20].

Overall, the combined intervention may enhance women's empowerment, household food security, maternal nutrition knowledge, safe food preparation, access to clean water and sanitation, and behavior change toward healthy habits. All of these may have contributed to the immediate increase in birth weight following the combined intervention. Therefore, increased birth weight might be achieved by increasing a number of multi-sectoral interventions during pregnancy. [19,20].

The study also discovered that the maternal MUAC and maternal food diversity intake, which were indirect effects of the intervention, significantly enhanced birth weight. In a similar manner, a systematic evaluation on the impact of a dietary intervention during pregnancy found that it had

an indirect impact on birth weight [3]. According to a few additional studies, pregnant women's dietary diversity can be increased by nutrition education, which can lower the risk of low birth weight [31,51]. Several studies have shown a high correlation between maternal MUAC and birth weight, where LBW among babies being linked to low maternal MUAC levels [1,28,52].

STRENGHS AND LIMITATIONS

The study's strong points are the adequate sample size, well-organized post-intervention quasi-experimental design, and long-term impact of program evaluation (5 years). Additionally, this study in Rwanda is the first to document the effects of an integrated nutrition intervention on birth weight to the best of our knowledge. The study did, however, have certain shortcomings. First, the capacity to understand the trend of the nutritional indicators throughout and before pregnancy is limited by the fact that we only employed end line post-program evaluation. Secondly, the absence of randomization to reduce some covert confounding bias. Lastly, given that the intervention was given as a package, it is impossible to determine which part of the combined intervention improves birth weight the most.

CONCLUSION

The findings of this study demonstrate that improving birth weight can be achieved through an integrated nutritional intervention package that includes nutrition instruction and counseling, agricultural output improvement, economic stabilization through social safety nets, and access to WASH services. Therefore, the various sectors and stakeholders should reinforce the interventions mentioned above in order to address the numerous and complex causes of maternal undernutrition and subsequently reduce the risk of low birth weight.

REFERENCES

1. Assefa N, Berhane Y, Worku A. Wealth status, mid upper arm circumference (MUAC) and antenatal care (ANC) are determinants for low birth weight in Kersa, Ethiopia. PloS One. 2012;7(6):e39957.
2. Rezende Chrisman J, Mattos IE, Koifman RJ, Koifman S, Moraes Mello Boccolini P, Meyer A. Prevalence of very low birthweight, malformation, and low Apgar score among newborns in Brazil according to maternal urban or rural residence at birth. J Obstet Gynaecol Res. 2016;42(5):496–504.

3. da Silva Lopes K, Ota E, Shakya P, Dagvadorj A, Balogun OO, Peña-Rosas JP, et al. Effects of nutrition intervention during pregnancy on low birth weight: an overview of systematic reviews. BMJ Glob Health. 2017;2(3):e000389.
4. Blencowe H, Krasevec J, de Onis M, Black RE, An X, Stevens GA, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. *Lancet* Glob Health. 2019 Jul;7(7):e849–60.
5. Hughes MM, Black RE, Katz J. 2500-g Low Birth Weight Cutoff: History and Implications for Future Research and Policy. Matern Child Health J. 2017 Feb;21(2):283–9.
6. Barros FC, Barros AJD, Villar J, Matijasevich A, Domingues MR, Victora CG. How many low birthweight babies in low- and middle-income countries are preterm? Rev Saude Publica. 2011 Jun;45(3):607–16.
7. Mahumud RA, Sultana M, Sarker AR. Distribution and determinants of low birth weight in developing countries. J Prev Med Pub Health. 2017;50(1):18.
8. He Z, Bishwajit G, Yaya S, Cheng Z, Zou D, Zhou Y. Prevalence of low birth weight and its association with maternal body weight status in selected countries in Africa: a cross-sectional study. BMJ Open. 2018 Aug 29;8(8):e020410.
9. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. Rwanda Demographic and Health Survey 2019-20 Final Report. Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF. 2021.
10. Ghimire R, Phalke DB, Phalke VD, Banjade B, Singh AK. Determinants of low birth weight: A case control study in Pravara Rural hospital in Western Maharashtra, India. Int J Sci Res. 2014;3:243–5.
11. Khan A, Nasrullah FD, Jaleel R. Frequency and risk factors of low birth weight in term pregnancy. Pak J Med Sci. 2016;32(1):138.
12. Grady SC, Frake AN, Zhang Q, Bene M, Jordan DR, Vertalka J, et al. Neonatal mortality in East Africa and West Africa: a geographic analysis of district-level demographic and health survey data. Geospatial Health. 2017;12(1).
13. Metgud CS, Naik VA, Mallapur MD. Factors affecting birth weight of a newborn--a community based study in rural Karnataka, India. PloS One. 2012;7(7):e40040.

14. Christian P, Lee SE, Donahue Angel M, Adair LS, Arifeen SE, Ashorn P, et al. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low-and middle-income countries. Int J Epidemiol. 2013;42(5):1340–55.
15. Katz J, Lee AC, Kozuki N, Lawn JE, Cousens S, Blencowe H, et al. Mortality risk in preterm and small-for-gestational-age infants in low-income and middle-income countries: a pooled country analysis. The *Lancet*. 2013;382(9890):417–25.
16. Figueiredo ACMG, Gomes-Filho IS, Silva RB, Pereira PPS, Mata FAFD, Lyrio AO, et al. Maternal Anemia and Low Birth Weight: A Systematic Review and Meta-Analysis. Nutrients. 2018 May 12;10(5).
17. Mosha D, Canavan CR, Bellows AL, Blakstad MM, Noor RA, Masanja H, et al. The impact of integrated 'nutrition-sensitive' intervention on nutrition and health of children and women in rural Tanzania: study protocol for a cluster-randomized controlled trial. BMC Nutr. 2018;4(1):29.
18. Sharma M, Mishra S. Effects of maternal health and nutrition on birth weight of infant. Int J Sci Res. 2014;3(6):855–8.
19. Bhutta ZA, Das JK, Rizvi A, Gaffey MF, Walker N, Horton S, et al. Evidence-based intervention for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet* Lond Engl. 2013;382(9890):452–77.
20. Ruel MT, Alderman H, Maternal and Child Nutrition Study Group. 'nutrition-sensitive' intervention and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* Lond Engl. 2013 Aug 10;382(9891):536–51.
21. Ministry of Health, Rwanda. Rwanda national food and nutrition policy 2013-2018. Republic of Rwanda. Ministry of Health (MoH). https://www.moh.gov.rw/fileadmin/user_upload/policies/National_Food_and_Nutrition_Policy_.pdf. 2014.
22. Taneja S, Chowdhury R, Dhabhai N, Mazumder S, Upadhyay RP, Sharma S, et al. Impact of an integrated nutrition, health, water sanitation and hygiene, psychosocial care and support intervention package delivered during the pre- and peri-conception period and/or during pregnancy and early childhood on linear growth of infants in the first two years of life, birth outcomes and nutritional status of mothers: study protocol of a factorial, individually randomized controlled trial in India. Trials. 2020 Jan 31;21(1):127.

23. Haider BA, Bhutta ZA. Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database Syst Rev. 2017 Apr 13;4:CD004905.
24. Peña-Rosas JP, De-Regil LM, Garcia-Casal MN, Dowswell T. Daily oral iron supplementation during pregnancy. Cochrane Database Syst Rev. 2015 Jul 22;(7):CD004736.
25. Ota E, Hori H, Mori R, Tobe-Gai R, Farrar D. Antenatal dietary education and supplementation to increase energy and protein intake. Cochrane Database Syst Rev. 2015 Jun 2;(6):CD000032.
26. World Food Programme. Comprehensive Food Security and Vulnerability Analysis, 2018. Kigali. 2018.
27. Organization WH. WHO recommendations on intrapartum care for a positive childbirth experience. World Health Organization; 2018.
28. Ververs MT, Antierens A, Sackl A, Staderini N, Captier V. Which anthropometric indicators identify a pregnant woman as acutely malnourished and predict adverse birth outcomes in the humanitarian context? PLoS Curr. 2013 Jun 7;5:ecurrents.dis.54a8b618c1bc031ea140e3f2934599c8.
29. FAO. Minimum dietary diversity for women: A guide for measurement. Rome: FAO. 2016.
30. Hayes AF. Introduction to mediation, moderation, and conditional process analysis second edition: A regression-based approach. N Y NY Ebook Guilford Press Google Sch. 2018;
31. Demilew YM, Alene GD, Belachew T. Effects of guided counseling during pregnancy on birth weight of newborns in West Gojjam Zone, Ethiopia: a cluster-randomized controlled trial. BMC Pediatr. 2020 Oct 6;20(1):466.
32. Nyamasege CK, Kimani-Murage EW, Wanjohi M, Kaindi DWM, Ma E, Fukushige M, et al. Determinants of low birth weight in the context of maternal nutrition education in urban informal settlements, Kenya. J Dev Orig Health Dis. 2019 Apr;10(2):237–45.
33. Girard AW, Olude O. Nutrition education and counselling provided during pregnancy: effects on maternal, neonatal and child health outcomes. Paediatr Perinat Epidemiol. 2012;26:191–204.

34. Ramakrishnan U, Grant F, Goldenberg T, Zongrone A, Martorell R. Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatr Perinat Epidemiol. 2012;26:285–301.
35. East CE, Biro MA, Fredericks S, Lau R. Support during pregnancy for women at increased risk of low birthweight babies. Cochrane Database Syst Rev. 2019 Apr 1;4:CD000198.
36. Park JJH, Fang ML, Harari O, Dron L, Siden EG, Majzoub R, et al. Association of Early Intervention With Birth Outcomes and Child Linear Growth in Low-Income and Middle-Income Countries: Bayesian Network Meta-analyses of Randomized Clinical Trials. JAMA Netw Open. 2019 Jul 3;2(7):e197871.
37. Victora CG, Barros FC, Assunção MC, Restrepo-Méndez MC, Matijasevich A, Martorell R. Scaling up maternal nutrition programs to improve birth outcomes: a review of implementation issues. Food Nutr Bull. 2012;33(2_suppl1):S6–26.
38. McCauley ME, van den Broek N, Dou L, Othman M. Vitamin A supplementation during pregnancy for maternal and newborn outcomes. Cochrane Database Syst Rev. 2015 Oct 27;(10):CD008666.
39. De-Regil LM, Peña-Rosas JP, Fernández-Gaxiola AC, Rayco-Solon P. Effects and safety of periconceptional oral folate supplementation for preventing birth defects. Cochrane Database Syst Rev. 2015 Dec 14;(12):CD007950.
40. Lassi ZS, Salam RA, Haider BA, Bhutta ZA. Folic acid supplementation during pregnancy for maternal health and pregnancy outcomes. Cochrane Database Syst Rev. 2013 Mar 28;(3):CD006896.
41. Harding KB, Peña-Rosas JP, Webster AC, Yap CM, Payne BA, Ota E, et al. Iodine supplementation for women during the preconception, pregnancy and postpartum period. Cochrane Database Syst Rev. 2017 Mar 5;3:CD011761.
42. Ota E, Mori R, Middleton P, Tobe-Gai R, Mahomed K, Miyazaki C, et al. Zinc supplementation for improving pregnancy and infant outcome. Cochrane Database Syst Rev. 2015 Feb 2;(2):CD000230.
43. Salvig JD, Lamont RF. Evidence regarding an effect of marine n-3 fatty acids on preterm birth: a systematic review and meta-analysis. Acta Obstet Gynecol Scand. 2011 Aug;90(8):825–38.

44. Dangour AD, Watson L, Cumming O, Boisson S, Che Y, Velleman Y, et al. Intervention to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. Cochrane Database Syst Rev. 2013 Aug 1;(8):CD009382.
45. Gizaw Z, Worku A. Effects of single and combined water, sanitation and hygiene (WASH) intervention on nutritional status of children: a systematic review and meta-analysis. Ital J Pediatr. 2019 Jul 4;45(1):77.
46. Taukobong HFG, Kincaid MM, Levy JK, Bloom SS, Platt JL, Henry SK, et al. Does addressing gender inequalities and empowering women and girls improve health and development programme outcomes? Health Policy Plan. 2016 Dec;31(10):1492–514.
47. Masset E, Haddad L, Cornelius A, Isaza-Castro J. Effectiveness of agricultural intervention that aim to improve nutritional status of children: systematic review. BMJ. 2012 Jan 17;344:d8222.
48. Demilew YM, Alene GD, Belachew T. Effect of guided counseling on dietary practices of pregnant women in West Gojjam Zone, Ethiopia. PloS One. 2020;15(5):e0233429.
49. Nikièma L, Huybregts L, Martin-Prevel Y, Donnen P, Lanou H, Grosemans J, et al. Effectiveness of facility-based personalized maternal nutrition counseling in improving child growth and morbidity up to 18 months: A cluster-randomized controlled trial in rural Burkina Faso. PloS One. 2017;12(5):e0177839.
50. von Salmuth V, Brennan E, Kerac M, McGrath M, Frison S, Lelijveld N. Maternal-focused intervention to improve infant growth and nutritional status in low-middle income countries: A systematic review of reviews. PloS One. 2021;16(8):e0256188.
51. Goodarzi-Khoigani M, Baghiani Moghadam MH, Nadjarzadeh A, Mardanian F, Fallahzadeh H, Mazloomy-Mahmoodabad S. Impact of Nutrition Education in Improving Dietary Pattern During Pregnancy Based on Pender's Health Promotion Model: A Randomized Clinical Trial. Iran J Nurs Midwifery Res. 2018 Feb;23(1):18–25.
52. Mingude AB, Gebretsadik W, Misker D, Woldeamanuel GG. Determinants of low birth weight among live birth newborns delivered at public hospitals in Gamo Gofa Zone, South Ethiopia: Unmatched case control study. SAGE Open Med. 2020;8:2050312120940544.

CHAPTER 4: PAPER 3

Effect and challenges of an integrated nutrition intervention package utilization among pregnant and lactating mothers in Rwanda: An exploratory qualitative study

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Abstract

Background: Malnutrition during pregnancy and lactation continues to be a public health problem in developing countries. In order to address this issue, the *Gikuriro* program, an integrated 'nutrition-sensitive' and 'nutrition-specific' intervention, was put into place for 5 years in 5 districts of Rwanda. Post-program quasi-experiments revealed a significant reduction of maternal undernutrition as a result of the intervention. However, in order to inform future interventions, a qualitative study was required to investigate the perspectives of the recipients and implementers regarding its advantages, difficulties, and limitations.

Objective: To explore the effect and challenges of an integrated nutrition-intervention program among pregnant women and lactating mothers.

Methods: This was a qualitative study with 80 participants in 10 focus group discussions as well as 25 community health officers and 27 nutritionists as key informants. All interviews and focus groups were audio recorded, followed by verbatim transcriptions that were then double coded and translated into English. With the aid of ATLAS.ti, version 9.15, a content analysis method combining deductive and inductive reasoning was applied.

Results: The study found multiple perceived beneficial outcomes, including increased nutrition-related knowledge and abilities, a favorable attitude toward a balanced diet, a perception of enhanced nutrition, and financial independence among expectant women and lactating mothers. However, the lack of knowledge about the program, unfavorable beliefs, poverty, lack of spouse support, and time limits were some of the challenges for using the integrated nutrition intervention program. The study also discovered a significant drawback: the absence of inclusivity for all social categories.

Conclusions: This study shows that integrated nutrition interventions have a perceived favorable impact on nutrition, although these programs may encounter challenges and have certain limitations. These findings imply that, in addition to adding to the body of research supporting the expansion of such intervention in settings with limited resources, economic issues and common misconceptions need to be addressed in order to maximize the impact of such interventions.

Keywords: challenges, implementation, integrated nutrition intervention, 'nutrition-specific', 'nutrition-sensitive' intervention

Introduction

Maternal undernutrition during pregnancy and after delivery remains a dire public health problem. It affects the well- being of mothers and their offspring and has a long-lasting effect on the survival, growth, and development of children during the first 1000 days and beyond [1, 2]. It is important to note that during the past ten years, Rwanda has seen a substantial improvement in children's nutritional status. The prevalence of stunting among children in Rwanda fell from 44% in 2010 to 38% in 2014–2015 and 33.1% in 2019–2020, whereas underweight declined from 18% in 2005 to 9% in 2014–2015 and a slight decline (8%) in 2019–2020 [3–6]. These improvements could be attributed to the high-level political commitment, multisectoral coordination efforts, and aggressive interventions of comprehensive nutrition programs by the government and its development partners. However, further progress is needed, especially on maternal and neonatal nutritional status, because the trend of maternal anemia and underweight and birth weight according to the demographic survey remain the same in the last decade [6].

Community-based intervention strategies using locally accessible personnel and resources to deliver key maternal and neonatal health and nutrition interventions are now widely recognized [7, 8]. To achieve long-term effect of improved nutrition, implementing an integrated multisectorial approach is important [9]. A 'nutrition-specific' and 'nutrition-sensitive' intervention package was created in 2013 by the '*Lancet* series for Maternal and Child Nutrition' in order to promote nutrition and, consequently, for the best fetal and child growth and development [7, 10]. The 'nutrition-specific' interventions are interventions that address the immediate determinants of maternal, fetal, and child malnutrition, such as deprived health and insufficient dietary intake. On the contrary, the 'nutrition-sensitive' program addresses the underlying and basic determinants of maternal, fetal, and child malnutrition by improving agricultural productivity, food security, social safety nets, women empowerment, early child development, and water, hygiene, and sanitation (WASH) [7, 10, 11]. Additionally, "nutrition-sensitive" interventions are thought to act as delivery mechanisms for "nutrition-specific" interventions, potentially enhancing their scope, reach, and efficacy [9, 10].

Considering that there is still high maternal and child undernutrition, the Government of Rwanda and its development partners implemented evidence-based 'nutrition-specific' and 'nutrition-sensitive' intervention package identified by The '*Lancet* Maternal and Child Nutrition series' [7,

10] through a project called *Gikuriro* (good growth as opposed to stunting). The project was funded by the US Agency for International Development (USAID), Rwanda. It was implemented by Catholic Relief Services (CRS) along with the Netherlands Development Organization and 6 local nongovernmental organization partners between November 2015 and November 2020 in 5 districts. With a focus on the 1000-day window of opportunity from pregnancy until a child's second birthday, the program's overall objective was to enhance the nutritional condition of women of reproductive age and children under the age of five.

Recent quantitative studies have been performed to assess the effect of the *Gikuriro* program on maternal nutritional status and birth weight. Both postprogram quasi-experiments revealed that the intervention led to significant reduction of low birth weight and maternal undernutrition [12, 13]. The main success factor having been attributed to the integration of 'nutrition-specific' and 'nutrition-sensitive' intervention package. However, there are various demand and supply barriers that limit pregnant women and lactating mothers from using integrated nutrition interventions. These include maternal factors (such as a lack of awareness or knowledge, low educational status, poor eating habits, and dependency syndrome); household factors (such as a busy schedule, inadequate husband support, and a lack of financial resources); community factors (such as food taboos and avoidances, sociocultural and religious influences, sales of food products, and a lack of nutrition information resources); and health/nutrition service factors (such as a lack of adequate facilities and staff) [14, 15].

Therefore, this study explored the perceived benefits, challenges, and limitations among beneficiaries (pregnant women and lactating mothers) and implementers of the program to inform future integrated nutrition interventions to improve their delivery. The findings of this study would further provide lessons on how the success of this program can be replicated.

Methods

Study design and setting

An exploratory qualitative approach was conducted to explore the effect, challenges, and limitations to the utilization of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package (*Gikuriro* program) among pregnant women and lactating mothers. The study was done in 5 districts where the *Gikuriro* program was implemented by CRS in close collaboration with the Government of Rwanda and other partners. The districts that were targeted were Nyabihu in the Western Province, Kayonza and Ngoma in the Eastern Province, and Kicukiro and Nyarugenge in Kigali City. Table 1.1 presents the detailed description of the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package (*Gikuriro* program).

Study participants

The target population comprised pregnant women and lactating mothers who were beneficiaries of the *Gikuriro* program from the 5 districts. Ten focus group discussions (FGDs), 2 from each district, were conducted among the pregnant women and lactating mothers. A total of 80 women (40 pregnant women and 40 lactating mothers) participated in the group discussions. Each FGD comprised 4 pregnant women and 4 lactating mothers. They were selected with the help of community health officers (CHOs) (supervisors of CHWs) who had the records of the participants, which assisted researchers to select participants who fulfilled the inclusion criteria. The women were selected based on their participation in the *Gikuriro* program and educational background. Only women who had been in the program for its full duration were included. Moreover, in each district, one FGD constituted women with postprimary education and the other FGD women with lower than secondary level education. The discussions were conducted at the health centers and round transport for the participants was covered.

In addition, key informant interviews (KIIs) were conducted among CHOs (n = 25) and nutritionists (n = 27) actively involved in the implementation of the project. One CHO and 1 nutritionist were selected from each health facility in the 5 districts. There was only 1 CHO and 1 nutritionist assigned to each health facility (health centers and district hospitals). However, those

newly assigned to the post and those with <1 year of experience with the *Gikuriro* program were excluded.

Data collection tool and procedure

Pre-tested modified FGD and KII guides were used to collect data based on the demand-side and supply-side barriers [14]. Demand-side barriers refer to the individual, household, or community factors that influence the demand for utilization of nutrition-intervention packages, whereas supply-side barriers refer to the characteristics of the intervention, such as quality, accessibility, and availability. The guides were translated into Kinyarwanda (the local dialect).

The discussions and interviews were conducted by 2 women (one with Master's degree in public health and the other with a Master's in nursing). Both were highly experienced as they had previously conducted several qualitative data collections. However, they were trained by the principal investigator regarding the objectives of the study, the guide questions, approach, recording, and confidentiality. The information was gathered face-to-face using Kinyarwanda. The FGDs and KIIs were audio-recorded where there was optimal privacy and low noise in the respective selected health centers. Discussions were held in a circle to facilitate face-to-face dialog and numbers from 1 to 8 were assigned to participants to allow anonymous transcription. A moderator and a note taker were assigned to each FGD, whereas, for KIIs, only 1 person was assigned for notetaking and interviewing. At the end of the FGDs and KIIs, the keynotes were shared/reviewed to validate what they had said. The audio-recorded data were saved on a personal computer for security and confidentiality. On average, the FGD lasted ∼1 hour and the interview ∼45 minutes.

Data analysis plan

The discussions and interviews were first transcribed verbatim in Kinyarwanda and translated into English. These transcriptions and translations were supervised and double checked to enhance validity. The translated data were saved using unique names and imported to ATLAS.ti version 9.15 (Atkas.ti) for coding and analysis. Four main stages— decontextualization, recontextualization, categorization, and compilation [16]—were followed. Decontextualization was used to familiarize and get sense of the transcriptions through reading and re-reading. In this

regard, coding was using with both a deductive approach using the codebook developed according to the study objectives and an inductive approach to allow for emerging themes during assigning quotations. There were 2 coders, and an agreement was reached through continuous discussion between them. Induction coding was performed independently. The second process of recontextualization was used to make sure that the original text and list of the final codes were covered/addressed according to the study objectives. Through categorization, similar thematic content was sorted and classified into subthemes according to the subtheme categories (codes). Finally, the categories were interpreted and descriptive quotes representing key themes were compiled for the final report.

Ethics statement

The study was reviewed and received ethical approval from the institutional review board of the University of Rwanda, College of Medicine, and Health Sciences (No. 362/CMHS IRB/2020), in compliance with the tenets of the Helsinki Declaration. Subsequently, the study received approval to collect data from the Ministry of Health's National Health Research Committee (No. NHRC/2020/PROT/046). Before data collection, each participant was aware of the objective, procedure, voluntary participation, and confidentiality of the study. A verbal audiotaped consent was obtained from each participant. Participants did not receive any compensation apart from the round trip transportation cost. From the start of recording, participants used an assigned number, and no identifiers were recorded. The principal investigator was responsible for the security of the data (transcripts). There were no direct benefits for participation

Results

Overview of core and sub-themes

Table 4.1 provides the core themes, subthemes, and categories for the FGDs and KIIs. The core themes were effect/benefits, challenges, and limitations of using the *Gikuriro* program (integrated 'nutrition-specific' and 'nutrition- sensitive' intervention package). The key subthemes identified for effect were as follows: 1) enhanced knowledge and skills on nutrition, 2) perceived improved nutritional status, and 3) women empowerment/independence. The following 4 subthemes were identified as key challenges in the utilization of this integrated 'nutrition-specific'

and nutrition- sensitive intervention: 1) lack of awareness, 2) negative attitude/beliefs, 3) poverty/economic constraints, and 4) lack of husband support and time constraints. Finally, 1 key limitation of the intervention emerged during the analysis, which is the lack of inclusiveness to all social groups.

Table 4. 1: Core themes, sub-themes and sub-theme categories

Main-themes	Subthemes	Subtheme categories (codes)
Effect	Enhanced knowledge and skills on nutrition behaviors	Cooking balanced diet
		Savings
		Cultivating/kitchen garden
		Hygiene practices
	Perceived improved nutrition	Perceived improved nutritional status
		Positive mindset on nutrition
	Independence/empowerment	Improved financial literacy
		Economic strengthening
Challenges	Lack of awareness	Ignorance on the program
		Lack of interest in the program
	Negative attitude and beliefs	Religion
		Misconceptions/beliefs/customs/traditions
		Negative mind-set (expecting only money)
	Economic constraints/poverty	Lack of food for demonstration
		Lack of money for buying food items
	Lack of support and time	Lack of spousal support
		Conflict with spouse
		Lack of caregiver at home
		Being busy looking for a job
		Busy at work
Limitation	Lack of inclusiveness for all social groups	Lack of inclusiveness
		Including only social class 1 and 2
		Excluding social class 3 and 4

The main themes are presented further followed by their subthemes. The findings are described with quotes generated from the FGDs and KIIs.

Effect/benefits of the *Gikuriro* program (core theme 1)

Subtheme 1: enhanced knowledge and skills on nutrition

Most of the pregnant women and lactating mothers expressed their views on the perceived positive effect of the intervention and the benefits gained from the *Gikuriro* program. One of the main advantages mentioned frequently was enhanced knowledge and skills gained in cooking a balanced diet. They claimed that they did not know how to cook a balanced diet before the program was implemented. They expressed how lucky they were to have got the opportunity to gain knowledge and skills, especially on having a balanced diet from readily available food. Some of the views expressed were as follows:

> "*Now we know how to cook a balanced diet with locally available items, which don't require us to be rich. Before Gikuriro, we were ignorant, and we didn't know how to cook a balanced diet. Now we have learned a lot from Gikuriro Program*." (Nyabihu district, FGD_9)

> "*There were so many who were getting sick with malnutrition, not because they did not have sufficient food but because they didn't know how to prepare a balanced diet.*" (Nyarugenge district, FGD_3)

The same benefit was expressed by nutritionists who observed an improvement in skills on cooking a balanced diet quoted as follows:

> "*Pregnant women and lactating mothers learned how to prepare a balanced diet. Before they used to think that a balanced diet meant eating meat but now, they know that it includes a variety of food*" (Kayonza district, Nutritionist KII_{25}).

Another benefit was that *Gikuriro* had a great effect on the economic wellbeing of the women by enhancing their economic growth through saving groups.

> "*Gikuriro project taught us how to save money, make money, borrow money, get into business, buy food, a farm and a lot of other things, I am*

satisfied, and I don't always have to ask for money from my husband." (Ngoma district, FGD$_7$)

This improved the livelihoods of the households, especially for women because they stated that they no longer asked money from their husbands to buy food and other items, which was reinforced by a KII.

"*Gikuriro project has changed a lot for people by teaching them how to improve their income by creating saving groups and now they can buy vegetables and fruits from their savings without waiting from their husbands.*" (Kicukiro district, Nutritionist KII$_2$)

Another subtheme category that emerged strongly was the improved knowledge and skills in kitchen garden and cultivation. Most participants claimed that the *Gikuriro* program had increased their knowledge and skills on how to promote increased agricultural productivity through kitchen gardens, which led to food security.

"*We have learned how to make different kitchen gardens which we did not know before Gikuriro came. Now we are planting different vegetables and fruits so that we have enough vegetables and fruits instead of buying them*." (Ngoma district, FGD$_7$).

In addition, rearing small domestic livestock improved significantly. For example, one key informant stated his views as follows:

"*Gikuriro encouraged people to start rearing small domestic animals to improve their livelihood. They have also been raising awareness about low-cost livestock breeding so that the family can earn a living from small livestock.*" (Kayonza district, Nutritionist KII$_{29}$).

The study further revealed an increased awareness of hygiene practices, including maintaining safe and clean water, food and household utensils hygiene, and hand washing.

"*We used to struggle with hygiene and you could find households and parents with poor hygiene, but Gikuriro taught and alerted us about*

hygiene and sanitation practices such as how to keep water, food, household utensils clean; and how to wash our hands and encourage us to construct handwashing station around the latrine." (Ngoma district, FGD_8).

"*Gikuriro has a special training program on the use of clean water, training of people called village social workers, and cleaning and sanitation to prevent disease from contamination.*" (Kicukiro district, CHO KII_{14}).

Subtheme 2: perceived improved nutritional status and a positive mindset toward nutrition

Most participants voiced that the *Gikuriro* program led to perceived improved nutritional status among lactating mothers and pregnant women and their children aged <5 years. In addition, they testified that before the *Gikuriro* program was implemented, there were some children who were previously malnourished, but at the time of the study, they nourishment improved. This is how the discussants and key informants expressed their views:

"*Gikuriro program brought a change in terms of nutrition because we have learned how to cook a balanced diet, and now the children are well off and have no problems with malnutrition.*" (Kayonza district, FGD_6).

"*Gikuriro really helped to reduce malnutrition significantly, for example, we used to have around 175 children with malnutrition in this sector but now after Gikuriro we have only about 10.*" (Ngoma district, CHO KII_{42}).

Participants indicated that they had been expecting to get some money or other goods, but the *Gikuriro* project mainly taught them how to properly use what they have by changing their mindset positively. It was reported that people had changed their practices regarding the way they were feeding their children and themselves.

> "*Gikuriro was a very good project, before people were used to being given money and they were wondering at the beginning what is the benefit, whether to get milk, rice, porridge, but the Gikuriro project was aimed at changing people's attitudes and training them to improve their lives based on what they already have.*" (Kicukiro district, Nutritionist KII_2).

> "*Before the Gikuriro program come, people were less likely to care about eating vegetables and fruits, but when the program came, people woke up and began to give importance to the inclusion of vegetables and fruits in their diet.*" (Kayonza district, Nutritionist KII_{25}).

Subtheme 3: women empowerment/independence

The women spoke out highly that the *Gikuriro* program empowered them economically through savings because they claimed that they are no longer dependent on their husbands and were able to help their families.

> "*Some of the saving groups they worked with made women less likely to expect anything from their husbands and be able to support their families.*" (Kicukiro district, CHO KII_5).

Moreover, they were taught how to start small businesses and projects, such as soap making, food processing, sewing, making skirts, and weaving clothes, which in turn supported the women to become economically empowered.

> "*Some women were isolated in their homes, but with the Gikuriro program, they are now in cooperatives. Some are producing soaps; others are doing other activities that allow them to be independent. They are no longer depending on their husbands.*" (Kayonza district, CHO KII_{26}).

Challenges of the *Gikuriro* program utilization (core theme 2)

Subtheme 1: lack of awareness on the importance of Gikuriro program

Under this subtheme, participants revealed that some women were ignorant and lacked awareness on the importance of *Gikuriro* program activities. They mentioned that the main challenges they faced were that some parents were not interested in *Gikuriro* project, which could be owing to poor knowledge of its importance.

> "*The goal was to change people's attitudes, but some people were not available to join groups. They didn't think that these nutrition services were relevant to them*." (Kayonza district, CHO KII_{32}).
>
> "*There is something I find that prevents pregnant and lactating mothers from attending the Gikuriro program which is ignorance, sometimes women do not understand the value of nutrition intervention projects.*" (Ngoma district, FGD_8).
>
> "*Some women initially were not interested but later they realized the importance of Gikuriro program and began to use the project.*" (Ngoma district, FGD_7)

Subtheme 2: negative attitudes and beliefs

The findings revealed that some of the interventions may not have been culturally appropriate for all religions. For instance, some participants from certain beliefs/religions were not comfortable rearing animals, such as pigs or rabbits.

> "*When Gikuriro proposed to give pig or rabbit, Adventists and Muslims refused though they were provided with options such as chickens.*" (Ngoma district, FGD_7 and Kicukiro district, Nutritionist KII_{11}).

Another barrier described was the misconception that some women thought the nutrition intervention was only for poor people or those having undernourished children, which led to low attendance at the beginning as some were ashamed to participate in the nutrition program.

> "*Some had misconceptions that Gikuriro was for poor people or for those who have children with malnutrition, and they did not want to join the program at the beginning because they felt very poor and ashamed. This was the obstacle to justifying poor participation at the beginning.*" (Kayonza district, Nutritionist KII_{31}).

> "*There were some rich parents who felt like going to sit with someone who is poor is so disrespectful which prevented them from attending and most of the time they were the ones who were found with children who are malnourished, and that obstacle prevented them from attending Gikuriro programs which were good for their babies and themselves.*" (Ngoma district, FGD_8)

It was observed that some of the participants were expecting to receive monetary benefits from the *Gikuriro* program rather than knowledge and skills.

> "*Participation was not for everyone because there were those who gave up because they are not getting money and goods as many people were expecting to be given money or other things.*" (Kicukiro district, Nutritionist KII_2).

However, contrary to this, other participants recommended that other projects should also not give money to participants for the projects to be sustainable.

> "*My advice is for other projects not to give money to the people, instead, they should give them lasting things, because often the community gives them money to do something and use it sometimes without producing the same profit as it was intended.*" (Kicukiro district, Nutritionist KII_9)

Subtheme 3: economic constraints/poverty

Regarding the demonstrations on cooking a balanced diet, participants were required to bring the food items from home. This was because the main aim of the project was to help the community become self-sustainable and teach them to prepare a balanced diet with what they have. However, the majority were informed that they did not have food or money to purchase those food items, which caused them to miss out and decreased participation.

> "*Some of the challenges pregnant women and lactating mothers face are lack of food because as it was time to go to the village kitchen, everyone had to bring food to come together to learn how to prepare a balanced diet and be ashamed of as they did not see what they had to do with others.*" (Nyabihu district, FGD_{10}).

> "*Women were asked to bring what they have at home to the nutrition education sessions but those poor women could not attend without bringing something, they thought that other women were going to laugh at them*." (Kayonza district, Nutritionist KII_{31}).

> "*They are poor because of the lack of means/money and they wanted to be given food and prepare it, and someone would say,* '*I don't have it.*'" (Nyarugenge district, CHO KII_{20}).

Although this mostly came off as a challenge, it was, however, seen as a positive effort to change the mindset of the community by other participants who expressed otherwise.

> *Sometimes we tell them to bring food and some don't have, but also the feeling that they had a responsibility to find food was useful, not like a project that comes and goes and brings food and then stops, which I see as a good thing that happened by Gikuriro program even though it was a challenge on the other hand that there were those who weren't able to get what they were asked to bring for the cooking demonstration sessions.* (Kicukiro district, CHO KII_7 and Kayonza district, CHO KII_{28}).

Subtheme 4: lack of spousal support and time constraints

Furthermore, participants described that some pregnant women and lactating mothers lacked support, especially from their husbands to attend the *Gikuriro* program. Some reported that their husbands indicated that the program was for poor people. Another obstacle that women often faced was the lack of a caregiver at home to take care of other children who are not attending kindergarten and often missed out the programs. Lack of time, being busy looking for jobs, or working was another barrier to women attending the program.

> "*Some people resist change. Here for instance, some men did not want their wives to attend Gikuriro activities thinking that those activities were for poor people*." (Kayonza district, Nutritionist KII_{31}).

> "*Women have a lot of responsibilities in their homes, and sometimes they find themselves being busy at home including caring for children which may result in missing out Gikuriro programs, because she does not have someone to leave with the children.*" (Nyabihu district, FGD_{10}).

> "*The challenge was that some women were very poor and are busy looking for jobs or are always at work and failed to attend educational sessions on nutrition*." (Kayonza district, CHO KII_{28}).

Limitations: lack of inclusiveness of the high social category (core theme 3)

Most participants felt that the *Gikuriro* program was excluding pregnant women and lactating mothers from the higher social categories because it was targeting those only from social categories 1 and 2. The socioeconomic situation in Rwanda is assessed using the social category for poverty that was developed by the Minister for Local Government and Social Affairs in 2015.These are 4 categories based on ascending income levels: category 1, extremely poor; category 2, poor; category 3, self-sustaining; and category 4, rich [17].

The program included mothers from higher social class only if their children were malnourished. The beneficiaries described that even women in high social classes may also lack the skills and knowledge on balanced diet, WASH, kitchen garden, and savings. Hence, the main

recommendation for the success of such projects emanating from the beneficiaries is inclusion of all social categories.

> "*The obstacles that existed are the Ubudehe social categories, because Gikuriro was for the first and second categories. A pregnant or breastfeeding mother in the third category who needed that help was not allowed into the program although they should be taught about nutrition.*" (Kayonza district, FGD_5).
>
> "*The only problem was that it was not accessible to all, it was only focused on women of the first and second wealth categories. Those in Ubudehe 3 and 4 were not allowed to participate though they wanted it.*" (Kicukiro district, Nutritionist KII_4 and KII_{13}; Kayonza district Nutritionist KII_{29}).
>
> "*It is also important to look at how targets in wealth categories 3 and 4 can be helped, as some of them have poor nutrition and find that this kind of help is not available to them as they do not know how to prepare a balanced diet.*" (Nyabihu district, CHO KII_{47}).
>
> "*My advice is that if there is another project, I wish it can give everyone the right to participate regardless of Ubudehe categories*." (Kicukiro district, CHO KII_7).

Discussion

This qualitative study has demonstrated the various potential impact of the 'integrated nutrition-intervention package' (*Gikuriro* program, in this case), such as enhanced knowledge and skills gained on cooking a balanced diet, kitchen gardening, saving and hygiene practices; perceived improved nutritional status; and a positive mindset regarding nutrition and women economic empowerment through social safety nets. However, various of factors—such as inadequate knowledge, unfavorable attitudes and beliefs, financial limitations, and a lack of spouse support and time—were noted as obstacles to the adoption of the 'integrated nutrition-intervention package'. Additionally, the study identified the program's lack of inclusivity for all social groups as a major limitation.

Most of the study participants indicated that before *Gikuriro*, they neither knew how to cook a balanced diet with what they had nor how to make a kitchen garden for planting vegetables and fruits. This finding adds to the literature that communities exposed to integrated nutrition interventions are significantly more likely to gain knowledge about nutrition and are more likely to practice the behavior [18]. It is evident that enhanced cooking skills affects positively balanced diet by improving confidence in cooking and consumption of vegetables and fruits, and this is found to be beneficial among vulnerable and those of low socioeconomic status [19]. Furthermore, it is documented that cooking skills expose individuals to various new foods and facilitate compliance with the desired dietary guidelines for vegetables and fruit consumption [20, 21]. However, a number of intervention studies have revealed that translation of nutrition knowledge into practice of behaviors in nutrition programs is affected by availability, affordably, and accessibility of food items and time or resources constraints and effect of family members [18, 22–26]. Therefore, nutrition-intervention implementers should consider these factors to translate the knowledge on nutrition into practice. Moreover, a follow-up study on nutrition behavior practice should be conducted for *Gikuriro* program to understand whether this knowledge has translated into practice and to explore the barriers of practice in Rwandan context.

Several studies in different countries have demonstrated that kitchen gardens improve food security of households [27–30]. Moreover, it is evident from the literature that homestead food production interventions increase micronutrient rich food production, such as crops and fruits [10, 27]. Moreover, most of the participants from the study reported enhanced knowledge and skills on clean water and sanitation, as well as healthy hygiene habits. There is evidence that these can reduce infectious diseases [31] because good nutrition requires safe water and sanitation [32].

Another effect of the *'nutrition-sensitive'* component mentioned highly in our study was the skills of group savings that led to women empowerment and economic independence to buy food items. This adds to the empirical evidence that women empowerment and autonomy improves nutritional status of mothers, their children, and other members of the household [33–35]. Literature shows that social safety nets increase income resilience, especially for the vulnerable groups, which leads to spending more on food and positive change in food consumption for pregnant women, lactating mothers, and children [10, 36] through improved access to resources [37]. However, women empowerment is a multidimensional domain where different domains, such as income, education,

gender parity, agricultural production, and group membership empowerment, may influence the nutritional status through various mechanisms [26, 38]. In this study, the *Gikuriro* program had 2 domains: economic and agricultural production empowerment. Economic empowerment helps women to buy specific foods, and agricultural production empowerment is associated with feeding practices [33, 39].

All these improved knowledge and skills; in addition, a changed positive mindset regarding nutrition and women empowerment could have affected on the perceived improved nutritional status by addressing both immediate and underlying causes of malnutrition as highly expressed by many of the key informants and FGDs participants in the study. This is supported by quasi-experimental studies conducted by the same authors, which found that the *Gikuriro* intervention was associated with a significant reduction of low birth weight and maternal undernutrition [12, 13].

Despite the positive effect/benefits of the integrated nutrition-intervention program, this study identified some challenges and limitations to the implementation or use of services from the program. One of the subthemes of the challenges was a lack of awareness and negative beliefs/misconceptions. Under this subtheme, being ignorant and lacking knowledge on the importance of a balanced diet emerged as a key barrier. Respondents mentioned that some women were not interested and did not care about nutritious food even if they had a diversity of food. According to some participants, if they are satisfied, there is no problem. This is acknowledged by findings from another study that some individuals are resistant to change in dietary practices [40]. Similarly, maternal nutritional misconceptions and lack of knowledge are reported as core reasons for not attending nutrition-intervention programs among women [14, 41]. Therefore, utilization of nutrition interventions may not be influenced by the availability and accessibility but rather by a readiness to change behavior. This suggests that nutrition program implementers should also engage to increased awareness and nutrition behavior change.

Negative attitudes, such as the belief that nutrition interventions are only for the poor or malnourished, feeling ashamed to participate in the nutrition-intervention program because such programs are associated with having a malnourished child, and expecting only money from projects instead of knowledge and skills were reported to negatively affect participation in the

integrated nutrition intervention. Although not very common, religious beliefs, which led to the refusal to rear animals, such as pigs, were also mentioned as barriers. Moreover, various studies have shown that community beliefs, cultural effects, and religious influences contribute to utilization of nutrition intervention [42–44]. These barriers may thwart pregnant women and lactating mothers from taking balanced and diversified nutritious food, which could affect their nutritional status and that of their babies [45]. Thus, integrated intervention programs should consider implementing culturally appropriate interventions for all beneficiaries in the community, with special considerations for groups with special belief-related barriers.

In this study, economic constraints were identified as a major barrier hampering attendance in the *Gikuriro* program. In the program, pregnant women and lactating mothers were required to bring food items to the village Kitchen School. The inability to obtain those foods was frequently mentioned by the study participants. Such a barrier may prevent pregnant women and lactating mothers from using nutrition interventions. Similarly, other studies reported that poverty and economic constraints were the key barriers to obtaining those foods and nutrition-intervention utilization among low social class families [45–48]. Moreover, resource shortages, such as poverty and discrimination based on socioeconomic status in the community may hinder the uptake of nutrition interventions [49].

Furthermore, most of the participants identified lack of support and time as the main hurdles to using the nutrition- intervention program. Under this subtheme, lack of spousal support and lack of time owing to hefty workload at home or at work were key barriers preventing the women from attending the nutrition program. Similarly, studies have evidenced that heavy workload and poor husband support are barriers that limit pregnant women and lactating mothers in using integrated nutrition intervention and services [14, 50, 51]. As reported, in developing countries, husbands are influential in decisions related to health care service utilization [52]. Therefore, such programs should consider husbands' involvement in the interventions. Moreover, offering nutrition-intervention programs at the workplace and house level might be more feasible for women with limited time or spousal support.

Strengths and limitations

The strengths of the study include using a big sample size of various community members, such as pregnant women, lactating women, nutritionists, and CHOs, involved in the integrated nutrition intervention. Another strength is the use of triangulation and confirmation from KIIs and FGDs by including different study groups to deeply explore the effect/benefits and challenges of using nutrition programs. However, attention should be given to the limitation of bias because of social desirability in which the study participants having been the beneficiaries and implementers of the program may over report the positive aspects of the program. To overcome this, to understand what the participants really felt about the barriers to the intervention, the investigators and facilitators clearly explained and emphasized that the purpose of the study was to inform future nutrition program implementation.

Conclusion

The integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package showed a significant reduction in maternal malnutrition. Similarly, an integrated nutrition intervention during pregnancy is associated with a lower risk of low birth weight. Furthermore, there was a positive impact (perceived improved nutrition, enhanced nutrition knowledge and women's' empowerment) of the integrated intervention and some challenges in using the intervention. Therefore, the positive aspects of the integrated intervention were an improved maternal nutrition and birth weight. However, the negative aspects raised by the study were lack of awareness of the importance of the intervention, negative attitudes and beliefs, economic constraints, lack of husband support, time constraints, and a lack of inclusiveness for all social groups.

References

[1] J. Ayensu, R.A. Annan, A. Edusei, E. Badu, Impact of maternal weight on pregnancy outcomes: a systematic review, Nutr Food Sci 46 (4) (2016) 542–556.

[2] R.E. Black, C.G. Victora, S.P. Walker, Z.A. Bhutta, P. Christian, M. de Onis, et al., Maternal and child undernutrition and overweight in low-income and middle-income countries, *Lancet* 382 (9890) (2013) 427–451.

[3] Institut National de la Statistique du Rwanda (INSR), ORC Macro, Rwanda Demographic and Health Survey 2005, INSR/ORC Macro, Calverton, MD, 2006.

[4] National Institute of Statistics of Rwanda (NISR); Ministry of Health (MOH), Rwanda; ICF International, Rwanda Demographic and Health Survey 2010, NISR/MOH/ICF International, Calverton, MD, 2012.

[5] NISR, MOH, ICF International, Rwanda Demographic and Health Survey 2014–15, NISR/MOH/ICF International, Rockville, MD, 2015.

[6] National Institute of Statistics of Rwanda (NISR); Ministry of Health (MOH), Rwanda; ICF, Rwanda Demographic and Health Survey 2019–20 Final Report, NISR/ICF, Kigali, Rwanda/Rockville, MD, 2021.

[7] Z.A. Bhutta, J.K. Das, A. Rizvi, M.F. Gaffey, N. Walker, S. Horton, et al., Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet* 382 (9890) (2013) 452–477.

[8] A. McFadden, A. Gavine, M.J. Renfrew, A. Wade, P. Buchanan, J.L. Taylor, et al., Support for healthy breastfeeding mothers with healthy term babies, Cochrane Database Syst Rev 2 (2017) CD001141.

[9] L.H. Abdullahi, G.K. Rithaa, B. Muthomi, F. Kyallo, C. Ngina, M.A. Hassan, et al., Best practices and opportunities for integrating nutrition specific into nutrition sensitive interventions in fragile contexts: a systematic review, BMC Nutr 7 (1) (2021) 46.

[10] M.T. Ruel, H. Alderman, Maternal and Child Nutrition Study Group, *'nutrition-sensitive'* interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* 382 (9891) (2013) 536–551.

[11] R. Horton, S. Lo, Nutrition: a quintessential sustainable development goal, *Lancet* 382 (9890) (2013) 371–372.

[12] M. Habtu, A.G. Agena, M. Umugwaneza, M. Mochama, C. Munyanshongore, Effect of integrated nutrition sensitive and specific intervention package on maternal malnutrition among pregnant women in Rwanda, Matern Child Nutr 18 (3) (2022) e13367.

[13] M. Habtu, A.G. Agena, M. Umugwaneza, M. Mochama, C. Munyanshongore, Effectiveness of integrated maternal nutrition intervention package on birth weight in Rwanda, Front Nutr 9 (2022) 874714.

[14] A.M. Bezabih, M.H. Wereta, Z.H. Kahsay, Z. Getahun, A.N. Bazzano, Demand and supply side barriers that limit the uptake of nutrition services among pregnant women from rural Ethiopia: an exploratory qualitative study, Nutrients 10 (11) (2018) E1687.

[15] H.A. Nguyen, Undernutrition during pregnancy, Complications of Pregnancy, IntechOpen, London, 9 January 2019, p. 1.

[16] M. Bengtsson, How to plan and perform a qualitative study using content analysis, NursingPlus Open 2 (2016) 8–14.

[17] T.P. Williams, S. Nzahabwanayo, T. Lavers, E. Ndushabandi, The Case of the Vision 2020 Umurenge Programme (VUP), The politics of distributing social transfers, OUP, Oxford, United Kingdom, 2022, p. 90.

[18] K. Cunningham, A. Singh, P. Pandey Rana, L. Brye, S. Alayon, K. Lapping, et al., Suaahara in Nepal: An at-scale, multi-sectoral nutrition program influences knowledge and practices while enhancing equity, Matern Child Nutr 13 (4) (2017) e12415.

[19] A.L. Garcia, R. Reardon, M. McDonald, E.J. Vargas-Garcia, Community interventions to improve cooking skills and their effects on confidence and eating behaviour, Curr Nutr Rep 5 (4) (2016) 315–322.

[20] A.L. Garcia, E. Vargas, P.S. Lam, D.B. Shennan, F. Smith, A. Parrett, Evaluation of a cooking skills programme in parents of young children—a longitudinal study, Public Health Nutr 17 (5) (2014) 1013–1021.

[21] J. Hutchinson, J.F. Watt, E.K. Strachan, J.E. Cade, Evaluation of the effectiveness of the Ministry of Food cooking programme on self-reported food consumption and confidence with cooking, Public Health Nutr 19 (18) (2016) 3417–3427.

[22] R. Adhikari, Effect of women's autonomy on maternal health service utilization in Nepal: a cross sectional study, BMC Womens Health 16 (2016) 26.

[23] W. Affleck, G. Pelto, Caregivers' responses to an intervention to improve young child feeding behaviors in rural Bangladesh: a mixed method study of the facilitators and barriers to change, Soc Sci Med 75 (4) (2012) 651–658.

[24] B.C. Yates, C.H. Pullen, J.B. Santo, L. Boeckner, P.A. Hageman, P.J. Dizona, et al., The influence of cognitive-perceptual variables on patterns of change over time in rural midlife and older women's healthy eating, Soc Sci Med 75 (4) (2012) 659–667.

[25] J. Choufani, Z. Jamaluddine, K. Cunningham, A multisectoral nutrition program in Nepal improves knowledge of dietary diversity, sick child feeding, and handwashing, but not all practices: a program impact pathways mediation analysis, Curr Dev Nutr 4 (1) (2020) nzz135.

[26] H.J.L. Malapit, S. Kadiyala, A.R. Quisumbing, K. Cunningham, P. Tyagi, Women's empowerment mitigates the negative effects of low production diversity on maternal and child nutrition in Nepal, J Dev Stud 51 (8) (2015) 1097–1123.

[27] D.H. Galhena, R. Freed, K.M. Maredia, Home gardens: a promising approach to enhance household food security and wellbeing, Agric Food Secur 2 (1) (2013) 1–13.

[28] S.K. Jindal, M.S. Dhaliwal, Development of vegetable nutrition garden model for diet diversification and improved nutrition security of urban and peri-urban households, Int J Hortic 7 (27) (2017) 419-228.

[29] S.M. Laurie, M. Faber, M.M. Maduna, Assessment of food gardens as nutrition tool in primary schools in South Africa, S Afr J Clin Nutr 30 (4) (2017) 80–86.

[30] P. Schreinemachers, D.R. Bhattarai, G.D. Subedi, T.P. Acharya, H.P. Chen, R.Y. Yang, et al., Impact of school gardens in Nepal: a cluster randomised controlled trial, J Dev Eff 9 (3) (2017) 329–343.

[31] A.D. Dangour, L. Watson, O. Cumming, S. Boisson, Y. Che, Y. Velleman, et al., Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children, Cochrane Database Syst Rev 8 (2013) CD009382.

[32] UNICEF, The state of food security and nutrition in the world 2018: building climate resilience for food security and nutrition, FAO, Rome, Italy, 2018.

[33] J. Heckert, D.K. Olney, M.T. Ruel, Is women's empowerment a pathway to improving child nutrition outcomes in a *'nutrition-sensitive'* agriculture program?: Evidence from a randomized controlled trial in Burkina Faso, Soc Sci Med 233 (2019) 93–102.

[34] P. Paul, R. Saha, Is maternal autonomy associated with child nutritional status? Evidence from a cross- sectional study in India, PLoS One 17 (5) (2022) e0268126.

[35] A. Kabir, M.M. Rashid, K. Hossain, A. Khan, S.S. Sikder, H.F. Gidding, Women's empowerment is associated with maternal nutrition and low birth weight: evidence from Bangladesh Demographic Health Survey, BMC Womens Health 20 (1) (2020) 93.

[36] D. Karlan, A.L. Ratan, J. Zinman, Savings by and for the poor: a research review and agenda, Rev Income Wealth 60 (1) (2014) 36–78.

[37] R. Bwalya, M. Zulu, The role of savings group on the nutritional and economic wellbeing of rural households: the case of world vision's savings for transformation (S4T) in Zambia, Bus Econ Res 11 (2) (2021) 44–61.

[38] S. Alkire, R. Meinzen-Dick, A. Peterman, A. Quisumbing, G. Seymour, A. Vaz, The women's empowerment in agriculture index, World Dev 52 (2013) 71–91.

[39] E. Sraboni, H.J. Malapit, A.R. Quisumbing, A.U. Ahmed, Women's empowerment in agriculture: what role for food security in Bangladesh? World Dev 61 (2014) 11–52.

[40] K.R. Arlinghaus, C.A. Johnston, Advocating for behavior change with education, Am J Lifestyle Med 12 (2) (2018) 113–116.

[41] T.A. Zerfu, S. Biadgilign, Pregnant mothers have limited knowledge and poor dietary diversity practices, but favorable attitude towards nutritional recommendations in rural Ethiopia: evidence from community-based study, BMC Nutr 4 (2018) 43.

[42] N. Choudhury, A.C. Moran, M.A. Alam, K.Z. Ahsan, S.F. Rashid, P.K. Streatfield, Beliefs and practices during pregnancy and childbirth in urban slums of Dhaka, Bangladesh, BMC Public Health 12 (2012) 791.

[43] E. D'Haene, S. Desiere, M. D'Haese, W. Verbeke, K. Schoors, Religion, food choices, and demand seasonality: evidence from the Ethiopian milk market, Foods 8 (5) (2019) E167.

[44] L.S. Saldanha, L. Buback, J.M. White, A. Mulugeta, S.G. Mariam, A.C. Roba, et al., Policies and program implementation experience to improve maternal nutrition in Ethiopia, Food Nutr Bull 33 (Suppl 2) (2012) S27-50.

[45] S.A. Beyene, L. Weldegerima, F.G. Tela, O. Seid, A.T. Brown, A.M. Bezabih, Barriers to utilize nutrition interventions among lactating women in rural communities of Tigray, northern Ethiopia: an exploratory study, PloS One 16 (4) (2021) e0250696.

[46] J. Di Noia, C. Byrd-Bredbenner, Determinants of fruit and vegetable intake in low-income children and adolescents, Nutr Rev 72 (9) (2014) 575–590.

[47] A.W. Girard, C. Dzingina, O. Akogun, J.B. Mason, D.A. McFarland, Public health interventions, barriers, and opportunities for improving maternal nutrition in northeast Nigeria, Food Nutr Bull 33 (Suppl 2) (2012) S51-70.

[48] J.A. Kavle, M. Landry, Addressing barriers to maternal nutrition in low- and middle-income countries: a review of the evidence and programme implications, Matern Child Nutr 14 (1) (2018) e12508.

[49] E.A. Noznesky, U. Ramakrishnan, R. Martorell, A situation analysis of public health interventions, barriers, and opportunities for improving maternal nutrition in Bihar, India, Food Nutr Bull 33 (Suppl 2) (2012) S93-103.

[50] K.E. McManus, A. Bertrand, A.M. Snelling, E.W. Cotter, In their own words: parents and key informants' views on nutrition education and family health behaviors, Int J Environ Res Public Health 18 (15) (2021) 8155.

[51] P.H. Nguyen, S. Kachwaha, R. Avula, M. Young, L.M. Tran, S. Ghosh, et al., Maternal nutrition practices in Uttar Pradesh, India: role of key influential demand and supply factors, Matern Child Nutr 15 (4) (2019) e12839.

[52] L.N. Nyandieka, M.K. Njeru, Z. Ng'ang'a, E. Echoka, Y. Kombe, Male involvement in maternal health planning key to utilization of skilled birth services in Malindi Subcounty, Kenya, Adv Public Health (2016) 2016 5608198.

CHAPTER 5: RESULTS

The findings of this study were obtained through three main objectives. The first objective was set 'to determine the effect of an integrated nutrition-specific and nutrition-sensitive intervention package on maternal undernutrition among pregnant women in Rwanda'. The second was 'to establish the impact of a combined package of interventions for maternal nutrition on birth weight in Rwanda'. The last objective was 'to explore the effect and challenges of integrated nutrition intervention package utilization among pregnant women and lactating mothers'. The first and second objectives were assessed using a quasi-experimental design, while the third objective was assessed using a qualitative study approach.

5.1. Socio-demographic characteristics of the study population

The study participants for the sub-study 1 were pregnant women coming for delivery in the health facilities of the selected districts for both the intervention group and control group. In this sub-study, a total of 545 and 552 women were considered for analysis respectively, in the control group and the intervention group. The highest percentages in both groups were among those aged 20 to 24 years, 26.2% and 25 to 29 years, 27.3%. Similarly, 46.1% of the women were married, followed by those who were cohabitating at 42.4%. The majority of the women, 62.6% had a primary level of education, and majority of them, 95.4% were Christians. After carrying out a Chi-square test, there was no statistically significant difference between the intervention group and control group.

For the sub-study 2, 551 mother-baby pairs from the intervention group and 545 from the control group were used in the final analysis. The mothers recruited for the sub-study 2 were the same as those for the sub-study 1. The proportion of female babies were 56.1% in the intervention group, while it was 53.0% in the control group. There was no statistically significant variation regarding the demographic characteristics of the mothers between the intervention group and control group. Nevertheless, the percentages of mothers taking alcohol, 17.2% vs 12.2%, mothers who smoked, 4.2% vs 1.1% and mothers exposed to passive smoking during pregnancy, 15.8% vs 7.6% were significantly higher in the control group compared to the intervention group.

For the third sub-study (a qualitative study), the target population was pregnant women and lactating mothers who were beneficiaries of the *Gikuriro* program implemented in five districts

(Kicukiro, Nyarugenge, Kayonza, Ngoma and Nyabihu). In addition, Community Health Officers (CHOs) and Nutritionists implementing the program participated in this study. There were a total of 10 FGDs done, each with four pregnant women and four lactating mothers. Moreover, 25 CHOs and 27 Nutritionists actively involved in the implementation of the program were considered for key informant interviews. They were selected purposefully based on at least one year of experience with the program at health facilities in the five districts (one CHO and one Nutritionist per health facility).

5.2. Effect of the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on nutritional status of pregnant women.

With regard to the effect of an integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package on nutritional status among pregnant women, the mean MUAC was greater in the intervention group, 26.06 cm as opposed to 24.87 cm in the control group ($p<0.001$). In the control group, the prevalence of MUAC < 23cm was greater ($p<0.001$) at 14.5% compared to 3.4% in the intervention group. Similar to this, 1.8% women in the intervention group had a BMI less than 18.5 kg/m^2 in the first trimester compared to 5.5% of those in the control group, a significant difference ($p=0.010$).

The overall prevalence of maternal undernutrition was 11.4% when MUAC and BMI were considered and this was significantly different ($p<0.001$) between the control group, 18.2% and intervention group, 4.7%. After adjusting for relevant confounders using a multivariate logistic regression model, pregnant women in the intervention group were 0.23 times less likely to have maternal undernutrition than those in the control group ['AOR= 0.23; 95%CI= 0.15-0.36; $p<0.001$']. Additionally, while the average hemoglobin concentration was significantly ($p< 0.001$) higher in the intervention group (12.65g/dL) than in the control group (12.10g/dL), anemia prevalence was significantly ($p<0.001$) greater in the control group compared to the intervention group (23.7% vs. 10.5%).

5.3. Effect of an integrated maternal nutrition intervention package on birth weight

The results showed that there was a significantly ($p<0.001$) greater prevalence of low birth weight in the control group (10.3%) compared to the intervention group (3.4%), indicating that the integrated maternal nutrition intervention package was improving the status of birth weight. After

adjusting for potential confounding variables, such as maternal nutritional indicators, a multivariable logistic regression model revealed that newborns in the intervention group had a significantly lower risk of low birth weight (‘AOR = 0.23; 95%CI = 0.12-0.43; p<0.001’).

Moreover, the intervention was significantly linked with increased birth weight, according to a multiple linear model (‘β = 0.16; 95%CI = 0.09-0.22; p<0.001’). The path analysis produced results that were comparable to those from multiple linear regression, with the direct effect of the intervention on birth weight being 0.17 (‘β = 0.17; 95%CI = 0.10-0.22; p<0.001’) and the indirect effect being 0.06 (‘β = 0.06; 95%CI = 0.04-0.10; p<0.001’). Among the maternal nutritional markers, MUAC was the main indirect mediator (‘β = 0.05; 95%CI = 0.03-0.07; p<0.001’).

5.4. Effect and challenges of the integrated nutrition intervention package utilization among pregnant women and lactating mothers

According to the qualitative study on the effect and challenges of using the integrated nutrition intervention package among pregnant women and lactating mothers, various advantages/benefits as well as some barriers and limitations were identified. The perceived positive effect of the integrated nutrition intervention package (*Gikuriro* program) recognized are improved knowledge and skills gained on cooking a balanced diet, kitchen gardening, saving and hygiene practices; perceived improved nutritional status; a positive mindset regarding nutrition; and women's economic empowerment through social safety nets.

Although the integrated nutrition intervention program had favorable effects and advantages, this study found that there are some obstacles that may prevent some beneficiaries from using the program. Lack of awareness, unfavorable attitudes and views, financial restrictions, a lack of spouse support, and time constraints were some of the obstacles that were noted as impeding the usage of the program. The study also discovered that the program's main limitation was its lack of inclusivity for all social categories.

CHAPTER 6: DISCUSSION

The study aimed at determining the effect of integrated 'nutrition-specific' and 'nutrition-sensitive' intervention on maternal nutritional status and birth weight. The prevention of maternal undernutrition can be achieved by a community-based intervention that focuses on a 'nutrition-specific' and 'nutrition-sensitive' intervention package, building on the '*Lancet* Maternal and Child Nutrition Series' proposed in 2013 [43]. Prior to this, there had only been research on individual intervention, and these had different degrees of evidence, from weak to moderate. Furthermore, some nutritional programs, but not all, have shown an effect on undernutrition reduction [44]. The results of a combined intervention may be more positive than those of a solo intervention. However, sufficient evidence is lacking on the impact of combined 'nutrition-specific' and 'nutrition-sensitive' intervention. According to our knowledge, this is the first quasi-experimental comparison investigation on the impact of an intervention package that combines 'nutrition-sensitive' and 'nutrition-specific' programs on the nutritional status of women and their babies in Rwanda.

The quantitative method produced satisfactory results for sub-study 1 and sub-study 2, where the integrated nutrition intervention had a favorable impact on reducing maternal undernutrition during pregnancy and increasing infant birth weight. The qualitative method of sub-study 3, which demonstrated a perceived positive effect of the intervention on improvements in maternal and child nutrition, provides strong support for these findings. However, it also identified some challenges that hinder utilization of the intervention for pregnant women and lactating mothers.

It was found that the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention significantly reduce maternal undernutrition. This is supported by current literature and the *Lancet* Series, which show that integrated 'nutrition-sensitive' intervention and 'nutrition-specific' programs outperform either 'nutrition-specific' or 'nutrition-sensitive' intervention alone in terms of nutritional outcomes [43, 83–85]. However, due to the distinctions in the components used in the intervention, it is challenging to compare and contrast our findings with those of other studies. The majority of previously carried out research included individual intervention, such as WASH, economic strengthening, nutrition education, or agriculture-sensitive interventions that were occasionally combined with or without nutrition education. This study, on the other hand, used

combination interventions. The level of evidence in these single interventions ranged from none to high (2, 6 –15).

The fact that the underlying causes of undernutrition are not fully addressed is one of the key reasons why a single intervention has a limited impact on reducing it. It was mentioned that, for instance, boosting agricultural output and implementing coordinated multiple interventions can address the immediate and underlying causes of undernourishment [44], these several sectors can include WASH, social safety nets, as well as counseling and education in nutrition. Another factor can be the limited duration of intervention programs, which might not adequately address the root causes of undernutrition [60]. However, this study addressed these gaps.

Therefore, the integrated and combined intervention that is 'nutrition-specific' and 'nutrition sensitive' intervention package may account for the significant decrease in undernutrition and anemia among pregnant women in this study. The reason could be because the combined intervention may increase household food security, access to and usage of numerous services, high maternal nutrition awareness, women's empowerment, and WASH improvements. For example, there is evidence that an intervention of nutrition and gender sensitive agriculture had positive impact on empowering women [91] and gender equality, social capital, partner communication, and resource access may all be encouraged by this empowerment..

The prevalence of low birth weight was significantly lower and average weight was higher in the intervention group compared to the comparison control group. Additionally, multiple logistic and linear regression results showed that the intervention significantly decreased the low birth weight after potential confounders had been taken into account. This may be the effect of the various interventions working together to enhance maternal nutrition, which decreased low birth weight. Regarding the efficacy of a single intervention on maternal nutritional status and birth weight, however, numerous evaluations and studies reported conflicting or varied outcomes. For instance, studies on interventions involving numerous micronutrients and maternal nutrition education demonstrated a decreased risk of low birth weight [50, 92–94], whereas other studies on only a single vitamin or mineral supplementation or nutrition education intervention revealed little to no effect [31, 67, 93, 95–103].

In addition, WASH intervention has been demonstrated to be more beneficial on baby nutritional status when paired with other interventions than when used alone [54, 103]. Cash transfers and women's economic empowerment were linked to better nutritional status and birth weight [67, 104]. Despite the fact that there is little information available about how agricultural intervention affects birth weight [105], it is thought to have a significant impact when used in conjunction with the other elements (social safety nets and educational initiatives) [106].

Therefore, this study supports the possibility that the 'integrated nutrition intervention package' may have a synergistic effect. The combined intervention may improve women's empowerment, access to clean water and sanitation, safe food preparation, household food security, use of various health services, and other factors. It may also increase maternal nutrition knowledge and behavior change toward healthy practices. All of these may be among the explanations for the direct impact of the combined intervention's improvement in birth weight. Consequently, expanding a number of multi-sectoral interventions during pregnancy may result in a greater birth weight [106, 107].

Furthermore, the qualitative study has shown various potential effects of the 'integrated nutrition intervention package' (*Gikuriro* program in this case), including improved knowledge and skills gained on cooking a balanced diet, kitchen gardening, saving and hygiene practices; perceived improved nutritional status; a positive mindset regarding nutrition; and women's economic empowerment through social safety nets.

The majority of research participants stated that, prior to *Gikuriro*, neither they nor their families knew how to create a kitchen garden for growing vegetables and fruits or how to prepare a balanced diet using what they had on hand. This study adds to the body of research showing that communities exposed to integrated nutrition intervention are much more likely to be knowledgeable about nutrition [108]. However, a number of intervention studies have shown that the affordability, accessibility, and availability of food items, as well as time or resource limitations and the influence of family members, have an impact on how nutrition knowledge is put into practice in nutrition programs [108–113]. The abilities of group savings, which facilitated women's empowerment and financial independence to purchase food, were another effect of the 'nutrition-sensitive' component that was prominently spoken in this study. This strengthens the empirical evidence that women's empowerment and autonomy improve mothers', their children's, and other

household members' nutritional status [114–116]. As strongly expressed by many of the key informants and FGD participants in the study, all these improved knowledge and skills as well as a changed positive mindset regarding nutrition and women's empowerment may have had an impact on the perceived improved nutritional status by addressing both the immediate and underlying causes of malnutrition. This is supported by the quantitative approach (quasi-experimental studies) as indicated above that low birth weight and maternal undernutrition were significantly reduced as a result of the 'integrated nutrition intervention package' (*Gikuriro* program).

Despite the integrated nutrition intervention program's beneficial effects, this study discovered certain implementation or use-related difficulties and restrictions. For instance, respondents indicated that some women were uninterested in and unconcerned with eating balanced diet, even if they had access to a variety of foods. According to certain participants, they indicate that if their stomach is full, they don't care about the nutrition. Findings from a different study suggesting some people are resistant to changing their eating habits [117]. Similar to this, maternal nutritional misunderstandings and ignorance are cited as the main reasons why women do not attend nutrition intervention programs [118, 119].

Participation in the integrated nutrition intervention has been reported to be negatively impacted by unfavorable attitudes such as the idea that nutrition intervention are only for the underprivileged or malnourished, the feeling of shame at taking part in such programs because they are linked to having a child who is undernourished, and expecting only financial rewards from projects rather than knowledge and skills. Although uncommon, religious convictions that resulted in an unwillingness to raise animals like pigs were also highlighted as obstacles. Numerous research have also demonstrated that community attitudes, cultural, and religious effects all influence how nutrition intervention is used [120–122]. These obstacles may prevent pregnant women and lactating mothers from consuming a variety of balanced, healthy foods, which may affect both their own and their children's nutritional status [123].

Economic difficulties were shown to be a significant obstacle impeding participation in the *Gikuriro* program in the qualitative analysis. During the demonstration of cooking, pregnant women and lactating mothers were asked to bring food supplies to the community kitchen school.

The study participants repeatedly brought up the difficulty in obtaining particular foods. Such a barrier would make it difficult for mothers who are breastfeeding and pregnant to use dietary programs. In agreement with this, several comparable results found that the main obstacles for low socioeconomic class families to accessing those foods and utilizing nutrition intervention were poverty and financial restrictions [123–126]. Literature also suggests that the adoption of nutrition intervention may be hampered by a lack of resources, such as poverty and prejudice based on socioeconomic standing in the community [127].

In addition, the majority of participants cited a lack of support and time as the main barriers to using the nutrition intervention program. The women's inability to attend the nutrition program was primarily due to a lack of marital support and a time crunch brought on by a heavy burden at home or at work, according to this sub-theme. Similar studies have shown that lactating mothers and pregnant women face obstacles in using integrated nutrition services due to their husbands' lack of support and busy job [128–130]. According to reports, husbands play a significant role in decisions about the use of healthcare services in underdeveloped nations [131].

Study limitations

The use of merely end-line postprogram evaluation was one of the study's shortcomings. The absence of randomization to reduce bias was another drawback. However, bias may have been lessened by having a control group and enrolling those women in the intervention before becoming pregnant. Additionally, it was discovered that the two groups' fundamental traits were comparable, raising the probability that the observed variations in results were brought on by the combined intervention. Thirdly, attention should be given to the limitation of bias for qualitative approach due to social desirability where the study participants may report what they believe is acceptable to the facilitator. To overcome this, in order to get what the participants really felt about the barriers to the intervention, the investigator and facilitator clearly explained the objectives of the study.

Policy implications

Both maternal undernutrition and low birth weight are the major public health problems globally [2] and locally [4]. With existing evidence that various 'nutrition-specific' and 'nutrition-sensitive' intervention package can reduce maternal undernutrition and low birthweight. There has been an increasing number of governments, benefactor agencies, and development institutions dedicated to supporting these intervention to attain their development goals. Most studies investigating effect of such intervention have mainly focused on high-income settings, thus leaving little or no evidence to inform policy and practice in low income settings. Moreover, evidence from developing countries has laid a lot more emphasis on malnutrition among children hence paucity of evidence to inform intervention targeting pregnant women. This is due to weak targeting, design and intervention of programs, as well as sub-optimal appraisal designs. Hence, constructing a robust body of evidence from rigorous evaluation designs is crucial to provide the desired guidance for future investments for improving nutrition [82].

The findings from this study are, therefore, not only inform scale-up of the current intervention package within Rwanda but also generate much needed evidence for policy makers and health intervention designers elsewhere to establish appropriate prevention protocols to optimize maternal nutrition and consequently child nutrition particularly in similar settings. Therefore, the neighboring countries in the Eastern and Central African regions should consider this integrated nutrition intervention after conducting cost effectiveness analysis.

Based on the findings of the study for the first and second objectives, it was found that the integrated nutrition intervention package significantly decreased the prevalence of maternal undernutrition and low birth weight. The possible explanation for this reduction could be the combined intervention which worked in synergy. The combined intervention may enhance women's empowerment, home food security, maternal nutrition education, utilization of various health services, and behavior modification toward healthy habits. Hence, compared to a single intervention, the combined package of 'nutrition-specific' and 'nutrition-sensitive' interventions shows more promising effects. Scaling up various multi-sectoral interventions during pregnancy could therefore result in reduced maternal undernutrition and higher birth weight.

Despite the benefits highlighted in the third objective, there were some challenges and limitations identified that hindered pregnant women and lactating mothers from utilizing the integrated nutrition intervention package including poverty/economic restriction, lack of husband support and time, and lack of awareness and negative beliefs about the nutrition, and excluding of social categories 3 and 4. Therefore, these challenges and limitations should be taken into consideration in future nutrition programs or intervention for more robust outcomes.

Ethical considerations

Ethical consideration was considered at various levels including study participants, data collectors and authorizations. The University of Rwanda College of Medicine and Health Sciences (CMHS) Institutional Review Board (IRB) granted the ethical clearance (Appendix I). Approval to go to field was sought from Ministry of Health (Appendix II). Appendix III presents the consent form and informed consent was sought and obtained from each participant. The form included purpose, procedure, voluntary participation, potential risks and benefits and privacy and confidentiality. Since participation in the study was entirely voluntary, participants were free to leave at any moment, without having to give a reason. The study's goals were explained to each participant. Then, the participants were informed that the study wouldn’t pose any potential risk and their characteristics and personal details were kept strictly confidential.

Conclusion and recommendations

Conclusion

The results of this study demonstrated that an integrated, 'nutrition-specific', and 'nutrition-sensitive' intervention, including nutrition counseling and education, economic and financial literacy promotion, agricultural productivity promotion, and improved access to WASH services, can significantly lower maternal undernutrition. Similarly, pregnant women benefiting from integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package had significantly low birth weight. Furthermore, there was a positive perceived effect of the intervention (improved knowledge and skills on nutrition, perceived improved nutrition, enhanced nutrition knowledge and economic independence). Despite these benefits, there were some challenges preventing utilizing the intervention/program were lack of awareness of the program, negative attitude towards nutrition, economic constraints, lack of husband support, time constraints and a lack of inclusiveness for all social groups.

Recommendations

Based on the findings of the study, it can be recommended to (i) health policy in Rwanda; (ii) health service delivery; (iii) intersectoral action; (iv) community mobilization and action; as well as (v) further research.

Health policy

- The policy makers should consider strengthening and scaling up of the integrated 'nutrition-specific' and 'nutrition-sensitive' intervention package to address the numerous and intricate factors that contribute to maternal malnutrition in order to enhance their nutritional status and, as a result, lower the risk of low birth weight.

Health service delivery

- Mid-Upper Arm circumference (<23cm) was found to be the key indirect predictor of low birth weight among the maternal nutritional indicators, thus this necessitates that the MoH to consider and provide nutritional advice among the pregnant women less than 23 cm MUAC in order to improve their nutritional status and for their newborn birth weight.

- Offering nutrition intervention programs at the workplace and household level might be more feasible for women with limited time, resources and spousal support.

Intersectoral action

- Stakeholders should strengthen women's empowerment and economic independence in order to improve the nutritional status of pregnant women, lactating mothers, and their children.
- Husbands' or partners' engagement in the intervention should be taken into account by nutrition programs.
- Integrated intervention package programs should consider implementing culturally appropriate intervention for all beneficiaries in the community, with special considerations for groups with special belief-related barriers.

Community mobilization and action

- Awareness campaigns on the misconceptions about nutrition interventions, support for pregnant women and lactating mothers, and economic growth should be enhanced.
- Resource limitations and the affluence of community members should be considered when designing nutrition intervention in order to give nutrition knowledge that can be put into practice.

Further research

- The study only took into account the end-line assessment of nutritional status, hence it is advised that future research take into account both baseline and end-line assessment with a randomization method concentrating on all demographic categories in order to better inform the expansion of the intervention.

REFERENCES

1. Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., … Maternal and Child Nutrition Study Group. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* (London, England), 382(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X
2. Salunkhe, A. H. (2018). Nutritional status of mother and gestational age. Online Journal of Health and Allied Sciences, 16(4).
3. RDHS. (2020). National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. 2020. Rwanda Demographic and Health Survey 2019-20 Key Indicators Report. Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF.
4. Williams, P. A., Schnefke, C. H., Flax, V. L., Nyirampeta, S., Stobaugh, H., Routte, J., … Muth, M. K. (2019). Using Trials of Improved Practices to identify practices to address the double burden of malnutrition among Rwandan children. Public health nutrition, 22(17), 3175–3186.
5. Tang, A. M., Chung, M., Dong, K., Terrin, N., Edmonds, A., Assefa, N., & Maalouf-Manasseh, Z. (2016). Determining a global mid-upper arm circumference cutoff to assess malnutrition in pregnant women. Food and Nutrition Technical Assistance.
6. Nana, A., & Zema, T. (2018). Dietary practices and associated factors during pregnancy in northwestern Ethiopia. BMC pregnancy and childbirth, 18(1), 183.
7. Ravaoarisoa, L., Randriamanantsaina, L., Rakotonirina, J., Rakotomanga, J. de D. M., Donnen, P., & Dramaix, M. W. (2018). Socioeconomic determinants of malnutrition among mothers in the Amoron'i Mania region of Madagascar: a cross-sectional study. BMC nutrition, 4(1), 6.
8. Loudyi, F. M., Kassouati, J., Kabiri, M., Chahid, N., Kharbach, A., Aguenaou, H., & Barkat, A. (2016). Vitamin D status in Moroccan pregnant women and newborns: reports of 102 cases. The Pan African medical journal, 24.
9. Victora, C. G., Requejo, J. H., Barros, A. J., Berman, P., Bhutta, Z., Boerma, T., … Hazel, E. (2016). Countdown to 2015: a decade of tracking progress for maternal, newborn, and child survival. The *Lancet*, 387(10032), 2049–2059.

10. Acharya, S. R., Bhatta, J., & Timilsina, D. P. (2017). Factors associated with nutritional status of women of reproductive age group in rural, Nepal. Asian Pacific Journal of Health Sciences, 4(4), 19–24. https://doi.org/10.21276/apjhs.2017.4.4.6
11. Hasan, M., Sutradhar, I., Shahabuddin, A. S. M., & Sarker, M. (2017). Double burden of malnutrition among Bangladeshi women: a literature review. Cureus, 9(12).
12. Mosha, D., Canavan, C. R., Bellows, A. L., Blakstad, M. M., Noor, R. A., Masanja, H., … Fawzi, W. (2018). The impact of integrated 'nutrition-sensitive' intervention on nutrition and health of children and women in rural Tanzania: study protocol for a cluster-randomized controlled trial. BMC nutrition, 4(1), 29.
13. Tang, A. M., Chung, M., Dong, K., Wanke, C., Bahwere, P., Bose, K., … Nguyen, P. (2017). Determining a global mid-upper arm circumference cutoff to assess underweight in adults (men and nonpregnant women).
14. Ghosh, S., Spielman, K., Kershaw, M., Ayele, K., Kidane, Y., Zillmer, K., … Belachew, T. (2019). 'nutrition-specific' and 'nutrition-sensitive' factors associated with mid-upper arm circumference as a measure of nutritional status in pregnant Ethiopian women: Implications for programming in the first 1000 days. PloS one, 14(3), e0214358.
15. Nsereko, E., Uwase, A., Mukabutera, A., Muvunyi, C. M., Rulisa, S., Ntirushwa, D., … Nzayirambaho, M. (2020). Maternal genitourinary infections and poor nutritional status increase risk of preterm birth in Gasabo District, Rwanda: a prospective, longitudinal, cohort study. BMC Pregnancy and Childbirth, 20, 1–13.
16. Food and Nutrition Technical Assistance III Project (FANTA). (2016). Nutrition Assessment, Counseling, and Support (NACS): A User's Guide—Module 2: Nutrition Assessment and Classification, Version 2. Washington, DC: FHI 360/FANTA.
17. Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., … Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet* (London, England), 371(9608), 243–260. https://doi.org/10.1016/S0140-6736(07)61690-0
18. Davis, R. R., Hofferth, S. L., & Shenassa, E. D. (2014). Gestational weight gain and risk of infant death in the United States. American journal of public health, 104(S1), S90–S95.
19. Hunt, K. J., Alanis, M. C., Johnson, E. R., Mayorga, M. E., & Korte, J. E. (2013). Maternal pre-pregnancy weight and gestational weight gain and their association with

birthweight with a focus on racial differences. Maternal and child health journal, 17(1), 85–94.

20. Liu, J., Gallagher, A. E., Carta, C. M., Torres, M. E., Moran, R., & Wilcox, S. (2014). Racial differences in gestational weight gain and pregnancy-related hypertension. Annals of epidemiology, 24(6), 441–447.
21. Stevens, G. A., Finucane, M. M., De-Regil, L. M., Paciorek, C. J., Flaxman, S. R., Branca, F., … Group, N. I. M. S. (2013). Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data. The *Lancet* Global Health, 1(1), e16–e25.
22. Figueiredo, A. C. M. G., Gomes-Filho, I. S., Silva, R. B., Pereira, P. P. S., Mata, F. A. F. D., Lyrio, A. O., … Pereira, M. G. (2018). Maternal Anemia and Low Birth Weight: A Systematic Review and Meta-Analysis. Nutrients, 10(5). https://doi.org/10.3390/nu10050601
23. World Bank. (2016). Reproductive, Maternal, Newborn, and Child Health. Washington, DC. Series: disease control priorities: vol. 2. http://www.worldbank.org/ (accessed December 2016).Google Scholar.
24. Derso, T., Abera, Z., & Tariku, A. (2017). Magnitude and associated factors of anemia among pregnant women in Dera District: a cross-sectional study in northwest Ethiopia. BMC research notes, 10(1), 359. https://doi.org/10.1186/s13104-017-2690-x
25. Getahun, W., Belachew, T., & Wolide, A. D. (2017). Burden and associated factors of anemia among pregnant women attending antenatal care in southern Ethiopia: cross sectional study. BMC research notes, 10(1), 276.
26. Liu, X., Behrman, J. R., Stein, A. D., Adair, L. S., Bhargava, S. K., Borja, J. B., … Norris, S. A. (2017). Prenatal care and child growth and schooling in four low-and medium-income countries. PloS one, 12(2), e0171299.
27. Zillmer, K., Pokharel, A., Spielman, K., Kershaw, M., Ayele, K., Kidane, Y., … Griffiths, J. K. (2017). Predictors of anemia in pregnant women residing in rural areas of the Oromiya region of Ethiopia. BMC nutrition, 3(1), 65.
28. Christian, P., Lee, S. E., Donahue Angel, M., Adair, L. S., Arifeen, S. E., Ashorn, P., … Hao, W. (2013). Risk of childhood undernutrition related to small-for-gestational age and

preterm birth in low-and middle-income countries. International journal of epidemiology, 42(5), 1340–1355.

29. Liu, X., Behrman, J. R., Stein, A. D., Adair, L. S., Bhargava, S. K., Borja, J. B., … Norris, S. A. (2017). Prenatal care and child growth and schooling in four low-and medium-income countries. PloS one, 12(2), e0171299.
30. WHO. (2014). Global Nutrition Targets 2025: Low birth weight policy brief. World Health Organization.
31. da Silva Lopes, K., Ota, E., Shakya, P., Dagvadorj, A., Balogun, O. O., Peña-Rosas, J. P., … Mori, R. (2017). Effects of nutrition intervention during pregnancy on low birth weight: an overview of systematic reviews. BMJ global health, 2(3), e000389. https://doi.org/10.1136/bmjgh-2017-000389
32. UNICEF. (2016). Undernourishment in the womb can lead to diminished potential and predispose infants to early death. New York: UNICEF.
33. Mahumud, R. A., Sultana, M., & Sarker, A. R. (2017). Distribution and determinants of low birth weight in developing countries. Journal of preventive medicine and public health, 50(1), 18.
34. Ghimire, R., Phalke, D. B., Phalke, V. D., Banjade, B., & Singh, A. K. (2014). Determinants of low birth weight: A case control study in Pravara Rural hospital in Western Maharashtra, India. Int J Sci Res, 3, 243–5.
35. Khan, A., Nasrullah, F. D., & Jaleel, R. (2016). Frequency and risk factors of low birth weight in term pregnancy. Pakistan journal of medical sciences, 32(1), 138.
36. Haddad, L., Cameron, L., & Barnett, I. (2015). The double burden of malnutrition in SE Asia and the Pacific: priorities, policies and politics. Health policy and planning, 30(9), 1193–1206.
37. Stevens, G. A., Finucane, M. M., Paciorek, C. J., Flaxman, S. R., White, R. A., Donner, A. J., … Group, N. I. M. S. (2012). Trends in mild, moderate, and severe stunting and underweight, and progress towards MDG 1 in 141 developing countries: a systematic analysis of population representative data. The *Lancet*, 380(9844), 824–834.
38. Gebre, A., & Mulugeta, A. (2015). Prevalence of Anemia and Associated Factors among Pregnant Women in North Western Zone of Tigray, Northern Ethiopia: A Cross-Sectional

Study. Journal of Nutrition and Metabolism, 2015, 165430. https://doi.org/10.1155/2015/165430

39. Obai, G., Odongo, P., & Wanyama, R. (2016). Prevalence of anaemia and associated risk factors among pregnant women attending antenatal care in Gulu and Hoima Regional Hospitals in Uganda: A cross sectional study. BMC pregnancy and childbirth, 16(1), 76.
40. Dattijo, L., Daru, P., & Umar, N. (2016). Anaemia in Pregnancy: Prevalence and Associated Factors in Azare, North-East Nigeria. International Journal of TROPICAL DISEASE & Health, 11(1), 1–9. https://doi.org/10.9734/IJTDH/2016/20791
41. Ismail, I. M., Kahkashan, A., Antony, A., & Sobhith, V. K. (2017). Role of socio-demographic and cultural factors on anemia in a tribal population of North Kerala, India. International journal of community medicine and public health, 3(5), 1183–8.
42. UNICEF. (1990). Strategy for improved nutrition of children and women in developing countries. Unicef.
43. Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., … *Lancet* Nutrition Intervention Review Group, the Maternal and Child Nutrition Study Group. (2013). Evidence-based intervention for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet* (London, England), 382(9890), 452–477. https://doi.org/10.1016/S0140-6736(13)60996-4
44. Ruel, M. T., Alderman, H., Maternal, & Group, C. N. S. (2013). 'nutrition-sensitive' intervention and programmes: how can they help to accelerate progress in improving maternal and child nutrition? The *Lancet*, 382(9891), 536–551.
45. Hambidge, K. M., & Krebs, N. F. (2018). Strategies for optimizing maternal nutrition to promote infant development. Reproductive health, 15(1), 87.
46. Demilew, Y. M., Alene, G. D., & Belachew, T. (2020). Effect of guided counseling on nutritional status of pregnant women in West Gojjam zone, Ethiopia: a cluster-randomized controlled trial. Nutrition Journal, 19(1), 38. https://doi.org/10.1186/s12937-020-00536-w
47. WHO Reproductive Health Library. (2016). WHO recommendation on nutrition education on energy and protein intake during pregnancy. The WHO Reproductive Health Library; Geneva: World Health Organization.

48. Nielsen, J. N., Gittelsohn, J., Anliker, J., & O'Brien, K. (2006). Intervention to improve diet and weight gain among pregnant adolescents and recommendations for future research. Journal of the American Dietetic Association, 106(11), 1825–1840.
49. Gilmore, B., & McAuliffe, E. (2013). Effectiveness of community health workers delivering preventive intervention for maternal and child health in low-and middle-income countries: a systematic review. BMC public health, 13(1), 847.
50. Girard, A. W., & Olude, O. (2012). Nutrition education and counselling provided during pregnancy: effects on maternal, neonatal and child health outcomes. Paediatric and perinatal epidemiology, 26, 191–204.
51. Masset, E., Haddad, L., Cornelius, A., & Isaza-Castro, J. (2012). Effectiveness of agricultural intervention that aim to improve nutritional status of children: systematic review. Bmj, 344, d8222.
52. Reinhardt, K., & Fanzo, J. (2014). Addressing chronic malnutrition through multi-sectoral, sustainable approaches: a review of the causes and consequences. Frontiers in nutrition, 1, 13.
53. Carletto, G., Ruel, M., Winters, P., & Zezza, A. (2015). Farm-Level Pathways to Improved Nutritional Status: Introduction to the Special Issue. The Journal of Development Studies, 51(8), 945–957. https://doi.org/10.1080/00220388.2015.1018908
54. Dangour, A. D., Watson, L., Cumming, O., Boisson, S., Che, Y., Velleman, Y., … Uauy, R. (2013). Intervention to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. The Cochrane Database of Systematic Reviews, (8), CD009382. https://doi.org/10.1002/14651858.CD009382.pub2
55. Gilligan, D., Hidrobo, M., Hoddinott, J., Roy, S., & Schwab, B. (2014). Much ado about modalities: multicountry experiments on the effects of cash and food transfers on consumption patterns.
56. Headey, D. (2012). Turning economic growth into 'nutrition-sensitive' growth. Edited by Shenggen Fan and Rajul Pandya-Lorch, 39.
57. Fenn, B., & Yakowenko, E. (2015). Literature review on impact of cash transfers on nutritional outcomes. Field Exchange, (49), 40.

58. Gautam, O. P., Esteves-Mills, J., Chitty, A., & Curtis, V. (2015). Complementary Food Hygiene: An overlooked opportunity in the WASH, nutrition and health sectors. London School of Hygiene and Tropical Medicine, London, UK.
59. Loevinsohn, M., Mehta, L., Cuming, K., Nicol, A., Cumming, O., & Ensink, J. H. (2015). The cost of a knowledge silo: a systematic re-review of water, sanitation and hygiene intervention. Health policy and planning, 30(5), 660–674.
60. Ruel, M. T., Quisumbing, A. R., & Balagamwala, M. (2018). 'nutrition-sensitive' agriculture: What have we learned so far? Global Food Security, 17, 128–153. https://doi.org/10.1016/j.gfs.2018.01.002
61. Bonde, D. (2016). Impact of agronomy and livestock intervention on women's and child dietary diversity in Mali. Field Exchange, 51.
62. Soltani, H., Duxbury, A. M. S., Rundle, R., & Chan, L.-N. (2015). A systematic review of the effects of dietary intervention on neonatal outcomes in adolescent pregnancy. Evidence Based Midwifery, 13(1), 29–34.
63. Zerfu, T. A., Umeta, M., & Baye, K. (2016). Dietary diversity during pregnancy is associated with reduced risk of maternal anemia, preterm delivery, and low birth weight in a prospective cohort study in rural Ethiopia. The American journal of clinical nutrition, 103(6), 1482–1488.
64. Khalid, H., Gill, S., & Fox, A. M. (2019). Global aid for 'nutrition-specific' and 'nutrition-sensitive' intervention and proportion of stunted children across low-and middle-income countries: does aid matter? Health policy and planning, 34(Supplement_2), ii18–ii27.
65. WHO, UNICEF, United Nations Goup, Department of Economic and Social Affairs, Population Division, & World Bank. (2015). Trends in maternal mortality: 1990 to 2015 : estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division.
66. Whiting, C. (2018). Recommended Intervention for Enhanced Nutrition in Pregnancy: An Integrated Literature Review. Journal of Pregnancy and Child Health, 05(04). https://doi.org/10.4172/2376-127X.1000385
67. Victora, C. G., Barros, F. C., Assunção, M. C., Restrepo-Méndez, M. C., Matijasevich, A., & Martorell, R. (2012). Scaling up maternal nutrition programs to improve birth

outcomes: a review of implementation issues. Food and nutrition bulletin, 33(2_suppl1), S6–S26.

68. Lee, S. E., Talegawkar, S. A., Merialdi, M., & Caulfield, L. E. (2013). Dietary intakes of women during pregnancy in low-and middle-income countries. Public health nutrition, 16(8), 1340–1353.
69. Christian, P., Lee, S. E., Donahue Angel, M., Adair, L. S., Arifeen, S. E., Ashorn, P., … Black, R. E. (2013). Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. International Journal of Epidemiology, 42(5), 1340–1355. https://doi.org/10.1093/ije/dyt109
70. Abubakari, A., & Jahn, A. (2016). Maternal Dietary Patterns and Practices and Birth Weight in Northern Ghana. PloS One, 11(9), e0162285. https://doi.org/10.1371/journal.pone.0162285
71. WHO, UNICEF, United Nations Fund for Population Activities, World Bank, United Nations, Department of Economic and Social Affairs, & Population Division. (2014). Trends in maternal mortality, 1990 to 2013: estimates by WHO, UNICEF, UNFPA, the World Bank estimates, and the United Nations Population Division. Retrieved from http://apps.who.int/iris/bitstream/10665/112697/1/WHO_RHR_14.13_eng.pdf?ua=1
72. IFPRI. (2016). International Food Policy Research Institute. 2016. Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030. Washington, D.C. http://dx.doi.org/10.2499/9780896295841.
73. World Food Programme. (2018). Comprehensive Food Security and Vulnerability Analysis, 2018. Kigali.
74. Casagrande, J. T., Pike, M. C., & Smith, P. G. (1978). An Improved Approximate Formula for Calculating Sample Sizes for Comparing Two Binomial Distributions. Biometrics, 34(3), 483. https://doi.org/10.2307/2530613
75. Ghosh, S., Spielman, K., Kershaw, M., Ayele, K., Kidane, Y., Zillmer, K., … Belachew, T. (2019). 'nutrition-specific' and 'nutrition-sensitive' factors associated with mid-upper arm circumference as a measure of nutritional status in pregnant Ethiopian women: Implications for programming in the first 1000 days. PloS one, 14(3), e0214358.

76. Hayes, A. F. (2018). Introduction to mediation, moderation, and conditional process analysis second edition: A regression-based approach. New York, NY: Ebook The Guilford Press. Google Scholar.
77. National Institute of Statistics of Rwanda (NISR) [Rwanda], Ministry of Health (MOH) [Rwanda], and ICF. (2021). Rwanda Demographic and Health Survey 2019-20 Final Report. Kigali, Rwanda, and Rockville, Maryland, USA: NISR and ICF.
78. Ververs, M.-T., Antierens, A., Sackl, A., Staderini, N., & Captier, V. (2013). Which anthropometric indicators identify a pregnant woman as acutely malnourished and predict adverse birth outcomes in the humanitarian context? PLoS currents, 5, ecurrents.dis.54a8b618c1bc031ea140e3f2934599c8. https://doi.org/10.1371/currents.dis.54a8b618c1bc031ea140e3f2934599c8
79. FAO, F. (2016). Minimum dietary diversity for women: a guide for measurement. Rome: FAO, 82.
80. Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. NursingPlus Open, 2, 8–14. https://doi.org/10.1016/j.npls.2016.01.001
81. Bezabih, A. M., Wereta, M. H., Kahsay, Z. H., Getahun, Z., & Bazzano, A. N. (2018). Demand and Supply Side Barriers that Limit the Uptake of Nutrition Services among Pregnant Women from Rural Ethiopia: An Exploratory Qualitative Study. Nutrients, 10(11). https://doi.org/10.3390/nu10111687
82. Olney, D. K., Leroy, J. L., & Ruel, M. T. (2017). Evaluation of 'nutrition-sensitive' programs. In Nutrition and health in a developing world (pp. 603–624). Springer.
83. Abdullahi, L. H., Rithaa, G. K., Muthomi, B., Kyallo, F., Ngina, C., Hassan, M. A., & Farah, M. A. (2021). Best practices and opportunities for integrating nutrition specific into nutrition sensitive intervention in fragile contexts: a systematic review. BMC Nutrition, 7(1), 46. https://doi.org/10.1186/s40795-021-00443-1
84. Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K., Giugliani, E., … Sachdev, H. P. S. (2008). What works? Intervention for maternal and child undernutrition and survival. The *Lancet,* 371(9610), 417–440.
85. Keats, E. C., Das, J. K., Salam, R. A., Lassi, Z. S., Imdad, A., Black, R. E., & Bhutta, Z. A. (2021). Effective intervention to address maternal and child malnutrition: an update of

the evidence. The *Lancet*. Child & Adolescent Health, 5(5), 367–384. https://doi.org/10.1016/S2352-4642(20)30274-1

86. Sharma, I. K., Di Prima, S., Essink, D., & Broerse, J. E. W. (2021). 'nutrition-sensitive' Agriculture: A Systematic Review of Impact Pathways to Nutrition Outcomes. Advances in Nutrition, 12(1), 251–275. https://doi.org/10.1093/advances/nmaa103
87. Kadiyala, S., Harris-Fry, H., Pradhan, R., Mohanty, S., Padhan, S., Rath, S., … Nair, N. (2021). Effect of 'nutrition-sensitive' agriculture intervention with participatory videos and women's group meetings on maternal and child nutritional outcomes in rural Odisha, India (UPAVAN trial): a four-arm, observer-blind, cluster-randomised controlled trial. The *Lancet* Planetary Health, 5(5), e263–e276.
88. Olney, D. K., Bliznashka, L., Pedehombga, A., Dillon, A., Ruel, M. T., & Heckert, J. (2016). A 2-Year Integrated Agriculture and Nutrition Program Targeted to Mothers of Young Children in Burkina Faso Reduces Underweight among Mothers and Increases Their Empowerment: A Cluster-Randomized Controlled Trial. The Journal of Nutrition, 146(5), 1109–1117. https://doi.org/10.3945/jn.115.224261
89. Osei, A., Pandey, P., Nielsen, J., Pries, A., Spiro, D., Davis, D., … Haselow, N. (2017). Combining Home Garden, Poultry, and Nutrition Education Program Targeted to Families With Young Children Improved Anemia Among Children and Anemia and Underweight Among Nonpregnant Women in Nepal. Food and Nutrition Bulletin, 38(1), 49–64. https://doi.org/10.1177/0379572116676427
90. Michaux, K. D., Hou, K., Karakochuk, C. D., Whitfield, K. C., Ly, S., Verbowski, V., … Green, T. J. (2019). Effect of enhanced homestead food production on anaemia among Cambodian women and children: A cluster randomized controlled trial. Maternal & Child Nutrition, 15 Suppl 3, e12757. https://doi.org/10.1111/mcn.12757
91. Kumar, N., Nguyen, P. H., Harris, J., Harvey, D., Rawat, R., & Ruel, M. T. (2018). What it takes: evidence from a nutrition-and gender-sensitive agriculture intervention in rural Zambia. Journal of Development Effectiveness, 10(3), 341–372.
92. Haider, B. A., & Bhutta, Z. A. (2017). Multiple-micronutrient supplementation for women during pregnancy. The Cochrane Database of Systematic Reviews, 4, CD004905. https://doi.org/10.1002/14651858.CD004905.pub5

93. Ota, E., Hori, H., Mori, R., Tobe-Gai, R., & Farrar, D. (2015). Antenatal dietary education and supplementation to increase energy and protein intake. The Cochrane Database of Systematic Reviews, (6), CD000032. https://doi.org/10.1002/14651858.CD000032.pub3
94. Ramakrishnan, U., Grant, F., Goldenberg, T., Zongrone, A., & Martorell, R. (2012). Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatric and perinatal epidemiology, 26, 285–301.
95. East, C. E., Biro, M. A., Fredericks, S., & Lau, R. (2019). Support during pregnancy for women at increased risk of low birthweight babies. The Cochrane Database of Systematic Reviews, 4, CD000198. https://doi.org/10.1002/14651858.CD000198.pub3
96. Park, J. J. H., Fang, M. L., Harari, O., Dron, L., Siden, E. G., Majzoub, R., … Bhutta, Z. A. (2019). Association of Early Intervention With Birth Outcomes and Child Linear Growth in Low-Income and Middle-Income Countries: Bayesian Network Meta-analyses of Randomized Clinical Trials. JAMA network open, 2(7), e197871. https://doi.org/10.1001/jamanetworkopen.2019.7871
97. McCauley, M. E., van den Broek, N., Dou, L., & Othman, M. (2015). Vitamin A supplementation during pregnancy for maternal and newborn outcomes. The Cochrane Database of Systematic Reviews, (10), CD008666. https://doi.org/10.1002/14651858.CD008666.pub3
98. De-Regil, L. M., Peña-Rosas, J. P., Fernández-Gaxiola, A. C., & Rayco-Solon, P. (2015). Effects and safety of periconceptional oral folate supplementation for preventing birth defects. The Cochrane Database of Systematic Reviews, (12), CD007950. https://doi.org/10.1002/14651858.CD007950.pub3
99. Lassi, Z. S., Salam, R. A., Haider, B. A., & Bhutta, Z. A. (2013). Folic acid supplementation during pregnancy for maternal health and pregnancy outcomes. The Cochrane Database of Systematic Reviews, (3), CD006896. https://doi.org/10.1002/14651858.CD006896.pub2
100. Peña-Rosas, J. P., De-Regil, L. M., Garcia-Casal, M. N., & Dowswell, T. (2015). Daily oral iron supplementation during pregnancy. The Cochrane Database of Systematic Reviews, (7), CD004736. https://doi.org/10.1002/14651858.CD004736.pub5
101. Harding, K. B., Peña-Rosas, J. P., Webster, A. C., Yap, C. M., Payne, B. A., Ota, E., & De-Regil, L. M. (2017). Iodine supplementation for women during the preconception,

pregnancy and postpartum period. The Cochrane Database of Systematic Reviews, 3, CD011761. https://doi.org/10.1002/14651858.CD011761.pub2

102. Salvig, J. D., & Lamont, R. F. (2011). Evidence regarding an effect of marine n-3 fatty acids on preterm birth: a systematic review and meta-analysis. Acta Obstetricia Et Gynecologica Scandinavica, 90(8), 825–838. https://doi.org/10.1111/j.1600-0412.2011.01171.x
103. Gizaw, Z., & Worku, A. (2019). Effects of single and combined water, sanitation and hygiene (WASH) intervention on nutritional status of children: a systematic review and meta-analysis. Italian Journal of Pediatrics, 45(1), 77. https://doi.org/10.1186/s13052-019-0666-2
104. Taukobong, H. F. G., Kincaid, M. M., Levy, J. K., Bloom, S. S., Platt, J. L., Henry, S. K., & Darmstadt, G. L. (2016). Does addressing gender inequalities and empowering women and girls improve health and development programme outcomes? Health Policy and Planning, 31(10), 1492–1514. https://doi.org/10.1093/heapol/czw074
105. Masset, E., Haddad, L., Cornelius, A., & Isaza-Castro, J. (2012). Effectiveness of agricultural intervention that aim to improve nutritional status of children: systematic review. BMJ (Clinical research ed.), 344, d8222. https://doi.org/10.1136/bmj.d8222
106. Ruel, M. T., Alderman, H., & Maternal and Child Nutrition Study Group. (2013). 'nutrition-sensitive' intervention and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* (London, England), 382(9891), 536–551. https://doi.org/10.1016/S0140-6736(13)60843-0
107. Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., … *Lancet* Nutrition Intervention Review Group, the Maternal and Child Nutrition Study Group. (2013). Evidence-based intervention for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet* (London, England), 382(9890), 452–477. https://doi.org/10.1016/S0140-6736(13)60996-4
108. Cunningham, K., Singh, A., Pandey Rana, P., Brye, L., Alayon, S., Lapping, K., … Klemm, R. D. W. (2017). Suaahara in Nepal: An at-scale, multi-sectoral nutrition program influences knowledge and practices while enhancing equity. Maternal & Child Nutrition, 13(4). https://doi.org/10.1111/mcn.12415

109. Adhikari, R. (2016). Effect of Women's autonomy on maternal health service utilization in Nepal: a cross sectional study. BMC women's health, 16, 26. https://doi.org/10.1186/s12905-016-0305-7
110. Affleck, W., & Pelto, G. (2012). Caregivers' responses to an intervention to improve young child feeding behaviors in rural Bangladesh: a mixed method study of the facilitators and barriers to change. Social Science & Medicine (1982), 75(4), 651–658. https://doi.org/10.1016/j.socscimed.2012.03.030
111. Yates, B. C., Pullen, C. H., Santo, J. B., Boeckner, L., Hageman, P. A., Dizona, P. J., & Walker, S. N. (2012). The influence of cognitive-perceptual variables on patterns of change over time in rural midlife and older women's healthy eating. Social Science & Medicine (1982), 75(4), 659–667. https://doi.org/10.1016/j.socscimed.2012.01.001
112. Choufani, J., Jamaluddine, Z., & Cunningham, K. (2020). A Multisectoral Nutrition Program in Nepal Improves Knowledge of Dietary Diversity, Sick Child Feeding, and Handwashing, but Not All Practices: a Program Impact Pathways Mediation Analysis. Current Developments in Nutrition, 4(1), nzz135. https://doi.org/10.1093/cdn/nzz135
113. Malapit, H. J. L., Kadiyala, S., Quisumbing, A. R., Cunningham, K., & Tyagi, P. (2015). Women's empowerment mitigates the negative effects of low production diversity on maternal and child nutrition in Nepal. The journal of development studies, 51(8), 1097–1123.
114. Heckert, J., Olney, D. K., & Ruel, M. T. (2019). Is women's empowerment a pathway to improving child nutrition outcomes in a 'nutrition-sensitive' agriculture program?: Evidence from a randomized controlled trial in Burkina Faso. Social Science & Medicine (1982), 233, 93–102. https://doi.org/10.1016/j.socscimed.2019.05.016
115. Paul, P., & Saha, R. (2022). Is maternal autonomy associated with child nutritional status? Evidence from a cross-sectional study in India. PLOS ONE, 17(5), e0268126. https://doi.org/10.1371/journal.pone.0268126
116. Kabir, A., Rashid, M. M., Hossain, K., Khan, A., Sikder, S. S., & Gidding, H. F. (2020). Women's empowerment is associated with maternal nutrition and low birth weight: evidence from Bangladesh Demographic Health Survey. BMC women's health, 20(1), 93. https://doi.org/10.1186/s12905-020-00952-4

117. Arlinghaus, K. R., & Johnston, C. A. (2018). Advocating for Behavior Change With Education. American Journal of Lifestyle Medicine, 12(2), 113–116. https://doi.org/10.1177/1559827617745479
118. Bezabih, A. M., Wereta, M. H., Kahsay, Z. H., Getahun, Z., & Bazzano, A. N. (2018). Demand and Supply Side Barriers that Limit the Uptake of Nutrition Services among Pregnant Women from Rural Ethiopia: An Exploratory Qualitative Study. Nutrients, 10(11), E1687. https://doi.org/10.3390/nu10111687
119. Zerfu, T. A., & Biadgilign, S. (2018). Pregnant mothers have limited knowledge and poor dietary diversity practices, but favorable attitude towards nutritional recommendations in rural Ethiopia: evidence from community-based study. BMC nutrition, 4, 43. https://doi.org/10.1186/s40795-018-0251-x
120. Choudhury, N., Moran, A. C., Alam, M. A., Ahsan, K. Z., Rashid, S. F., & Streatfield, P. K. (2012). Beliefs and practices during pregnancy and childbirth in urban slums of Dhaka, Bangladesh. BMC public health, 12, 791. https://doi.org/10.1186/1471-2458-12-791
121. D'Haene, E., Desiere, S., D'Haese, M., Verbeke, W., & Schoors, K. (2019). Religion, Food Choices, and Demand Seasonality: Evidence from the Ethiopian Milk Market. Foods (Basel, Switzerland), 8(5), E167. https://doi.org/10.3390/foods8050167
122. Saldanha, L. S., Buback, L., White, J. M., Mulugeta, A., Mariam, S. G., Roba, A. C., … Mason, J. B. (2012). Policies and program implementation experience to improve maternal nutrition in Ethiopia. Food and Nutrition Bulletin, 33(2 Suppl), S27-50. https://doi.org/10.1177/15648265120332S103
123. Beyene, S. A., Weldegerima, L., Tela, F. G., Seid, O., Brown, A. T., & Bezabih, A. M. (2021). Barriers to utilize nutrition intervention among lactating women in rural communities of Tigray, northern Ethiopia: An exploratory study. PloS One, 16(4), e0250696. https://doi.org/10.1371/journal.pone.0250696
124. Di Noia, J., & Byrd-Bredbenner, C. (2014). Determinants of fruit and vegetable intake in low-income children and adolescents. Nutrition Reviews, 72(9), 575–590. https://doi.org/10.1111/nure.12126
125. Girard, A. W., Dzingina, C., Akogun, O., Mason, J. B., & McFarland, D. A. (2012). Public Health Intervention, Barriers, and Opportunities for Improving Maternal Nutrition

in Northeast Nigeria. Food and Nutrition Bulletin, 33(2_suppl1), S51–S70. https://doi.org/10.1177/15648265120332S104

126. Kavle, J. A., & Landry, M. (2018). Addressing barriers to maternal nutrition in low- and middle-income countries: A review of the evidence and programme implications. Maternal & Child Nutrition, 14(1). https://doi.org/10.1111/mcn.12508
127. Noznesky, E. A., Ramakrishnan, U., & Martorell, R. (2012). A situation analysis of public health intervention, barriers, and opportunities for improving maternal nutrition in Bihar, India. Food and Nutrition Bulletin, 33(2 Suppl), S93-103. https://doi.org/10.1177/15648265120332S106
128. Bezabih, A. M., Wereta, M. H., Kahsay, Z. H., Getahun, Z., & Bazzano, A. N. (2018). Demand and Supply Side Barriers that Limit the Uptake of Nutrition Services among Pregnant Women from Rural Ethiopia: An Exploratory Qualitative Study. Nutrients, 10(11). https://doi.org/10.3390/nu10111687
129. McManus, K. E., Bertrand, A., Snelling, A. M., & Cotter, E. W. (2021). In Their Own Words: Parents and Key Informants' Views on Nutrition Education and Family Health Behaviors. International Journal of Environmental Research and Public Health, 18(15), 8155. https://doi.org/10.3390/ijerph18158155
130. Nguyen, P. H., Kachwaha, S., Avula, R., Young, M., Tran, L. M., Ghosh, S., … Menon, P. (2019). Maternal nutrition practices in Uttar Pradesh, India: Role of key influential demand and supply factors. Maternal & Child Nutrition, 15(4). https://doi.org/10.1111/mcn.12839
131. Nyandieka, L. N., Njeru, M. K., Ng'ang'a, Z., Echoka, E., & Kombe, Y. (2016). Male involvement in maternal health planning key to utilization of skilled birth services in Malindi Subcounty, Kenya. Advances in Public Health, 2016.
132. Naghashpour M, Shakerinejad G, Lourizadeh MR, Hajinajaf S, Jarvandi F. (2014). Nutrition education based on health belief model improves dietary calcium intake among female students of junior high schools. J Health Popul Nutr. 32(3):420-9.
133. De Silva MJ, Breuer E, Lee L, Asher L, Chowdhary N, Lund C, et al. (2014). Theory of Change: a theory-driven approach to enhance the Medical Research Council's framework for complex interventions. Trials. 2014;15:267.

APPENDICES

Appendix I: CMHS Institutional Review Board Approval

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 16th/November/2020

MICHAEL HABTU FISSEHAYE

School of Public Health, CMHS, UR

Approval Notice: No 362/CMHS IRB/2020

Your Project Title ***"Effect of Integrated Nutrition Package Intervention on Maternal Nutritional Status and Birth Weight in Rwanda"*** has been evaluated by CMHS Institutional Review Board.

		Involved in the decision		
			No (Reason)	
Name of Members	**Institute**	Yes	**Absent**	**Withdrawn from the proceeding**
Prof Kato J. Njunwa	UR-CMHS	X		
Dr Stefan Jansen	UR-CMHS	X		
Dr Brenda Asiimwe-Kateera	UR-CMHS	X		
Prof Ntaganira Joseph	UR-CMHS	X		
Dr Tumusiime K. David	UR-CMHS			X
Dr Kayonga N. Egide	UR-CMHS	X		
Mr Kanyoni Maurice	UR-CMHS		X	
Prof Munyanshongore Cyprien	UR-CMHS	X		X
Mrs Ruzindana Landrine	Kicukiro district		X	
Dr Gishoma Darius	UR-CMHS	X		
Dr Donatilla Mukamana	UR-CMHS	X		
Prof Kyamanywa Patrick	UR-CMHS		X	
Prof Condo Umutesi Jeannine	UR-CMHS		X	
Dr Nyirazinyoye Laetitia	UR-CMHS	X		
Dr Nkeramihigo Emmanuel	UR-CMHS		X	
Sr Maliboli Marie Josee	CHUK	X		
Dr Mudenge Charles	Centre Psycho-Social	X		

After reviewing your protocol during the IRB meeting of where quorum was met and revisions made on the advice of the CMHS IRB submitted on 16th November 2020, **Approval has been granted to your study.**

Please note that approval of the protocol and consent form is valid for **12 months**.

Email: researchcenter@ur.ac.rw P.O Box 3286 Kigali, Rwanda www.ur.ac.rw

You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.
2. Only approved consent forms are to be used in the enrolment of participants.
3. All consent forms signed by subjects should be retained on file. The IRB may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the IRB in a timely fashion and before expiry of this approval
5. Failure to submit a continuing review application will result in termination of the study
6. Notify the IRB committee once the study is finished

Sincerely,

Date of Approval: The 16th November 2020

Expiration date: The 16th November 2021

Dr Stefan Jansen
Ag. Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:
- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate Studies, UR

Appendix II: Approval letter from Ministry of Health

Republic of Rwanda

MINISTRY OF HEALTH

National Health Research Committee
Ref: NHRC/2020/PROT/046

To: **Mr. Michael Habtu Fisschaye**
Principal Investigator

Scientific Review Approval Notice

With reference to your request for approval of the Research Protocol entitled; **"Effect of integrated nutrition package intervention on maternal nutritional status and birth weight in Rwanda";**

We are pleased to inform you that, following a thorough review and critical analysis of your proposal **(NHRC/2020/PROT/046),** National Health Research Committee has approved your Research Protocol.

However,

1) Changes amendments on approach and methodology must be submitted to the NHRC for review and approval to validate the changes.
2) Submission to NHRC of final results using the attached template is mandatory
3) Failure to fulfill the above requirements will result in termination of study

Once again National Health Research Committee appreciates your interest in research.

Your final approval reference number is **NHRC/2020/PROT/046.**

Sincerely,

Dr. Parfait UWALIRAYE
Chairperson of NHRC

Date: 30/12/2020

Appendix III: Consent form

Ingingo ya gatatu: Ifishi y'amasezerano kw'ikusanya ry'amakuru abarika

Serial No. / ***Nomero y'icyiciro*** ……. Date / ***Italiki*** …….

Title of study / *Umutwe w'inyigo*:

'Effect of integrated nutrition intervention package on maternal nutritional status and birth weight in Rwanda'/

Akamaro k'urusobe rw'ingamba z'imirire myiza ku miterere ndangamirire y'ababyeyi n'uburemere bw'impinja zikivuka mu Rwanda

Introduction / *Intangiriro*

Investigator / *Umushakashatsi*: Mr. Michael Habtu Fissehaye, PhD student, School of Public Health, University of Rwanda

Supervisors / *Abagenzuzi*:

1. Prof. Cyprien Munyanshongore**,**
2. Dr. Alemayehu Gebremariam
3. Dr. Maryse Umugwaneza

Part I: Investigator's Statement / *Ijambo ry'umushakashatsi*

Introduction / *Intangiriro*

I study at the University of Rwanda. I am conducting research on nutrition interventions in Rwanda. You are being asked to take part in this study because you are qualified to do so. You will respond to a series of questions and have your anthropometric measurements recorded if you decide to take part in the study. Before agreeing to participate, please carefully read this form and ask any concerns you may have regarding the study. You can learn more about the study through this form. You are always welcome to ask any questions you may have. /

Ndi umunyeshuri muri Kaminuza y'u Rwanda. Ndi gukora ubushakashatsi ku rusobe rw'ibikorwa kugira ngo habeho imirire myiza mu Rwanda. Urasabwa gutanga ibitekerezo byawe muri ubu bushakashatsi kuko wujuje ibisabwa. Niwemera kugira uruhare muri ubu bushakashatsi, urabazwa ibibazo bitandukanye kandi ibipimo ndangamiterere bizafatwa. Iyi fishi iragusobanurira ibijyanye n'bushakashatsi bwavuzwe hejuru. Mbere yo kwemera kugira uruhare muri ubu bushakashatsi, banza usome iyi fishi witonze maze usobanuze aho utumva.

Being in the study is your choice / *Kugira uruhare muri ubu bushakashatsi ni amahitamo yawe*

This consent form explains the study, its advantages and disadvantages, as well as the procedure that will be explained to you. You will be asked to sign in this form once you understand the study and decide to participate. A copy will be given to you.

Prior to learning about the study, it's critical that you are aware of the following:

- You may resign from this study at any moment without incurring any repercussions
- Your participation is purely voluntary.

Iyi fishi iraguha amakuru yose yerekeranye n'ubu bushakashatsi; inyungu n'ibyago bishobora guterwa nabwo, ndetse n'uburyo buzakorwamo. Numara gusobanukirwa byose maze ukemera gutanga ubufasha bwawe, uraza gusabwa gushyira umukono cyangwa ikindi kimenyetso cyawe cyihariye aho byagenewe kuri iyi fishi. Nyuma yo kuzuza iyi fishi ugomba kuyisubiza abashinzwe kuzakira hanyuma nawe ugahabwa kopi yayo utahana mu rugo. Ibi ngibi ukwiye kubimenya:

- *Kugira uruhare muri ubu bushakashatsi ni ubushake bwawe rwose*
- *Ushobora guhitamo kwikura muri ubu bushakashatsi igihe icyo ari cyo cyose, kandi ntibikugireho ingaruka iyo ari yo yose*

Purpose of the study / *Intego y'ubushakashatsi*

The main objective of the study is to assess the effect of integrated nutrition intervention package on maternal nutritional status and birth weight in Rwanda /

Intego y'ubu bushakashatsi ni ukugenzura akamaro k'urusobe rw'ingamba z'imirire myiza ku miterere ndangamirire y'umubyeyi n'uburemere bw'impinja zikiivuka mu Rwanda

Description of the process and procedures / *Ubusobanuro ku bizakorwa n'uburyo bizakorwamo*

Data for this study will be collected from two sources including directly from pregnant women during delivery and from ANC records both. The data will be collected using a questionnaire from each participant before discharge. The information will cover maternal socio-demographics, socio-economics and household asset ownership, index women health status and pregnancy (obstetric factors), women dietary diversity score (WDDS), food frequency questionnaires (FFQ) and antenatal care services.

By qualified midwives, measurements of the mid upper arm circumference and blood hemoglobin level will be taken before delivery. However, both MUAC and Hb during the first 20 weeks of gestation will be extracted from ANC file or CHWs *Animatrice de santé maternelle* (ASM) register during the first and second trimester/

Amakuru azakusanywa mu buryo bubiri (2). Hari amakuru azatangwa na ba nyiri ubwite (ni ukuvuga abagore batwite mu gihe cyabo cyo kubyara) hamwe n'amakuru azakurwa mu mu bubiko bwo mu bigo nderabuzima ndetse no mu bitabo by'abajyanama b'ubuzima. Amakuru azakusanywa hifashishijwe ifishi y'uruhererekane rw'ibibazo izahabwa buri mugore mbere yuko asezererwa na muganga. Bene ayo makuru azibanda ku bukungu, imibereho n'imitungo y'urugo, ubuzima bw'abagore batwite, ubumenyi ku mirire n'indyo yuzuye, ndetse n'ibindi byerekeye kwitabwaho mu gihe cy'itwita.

Ibipimo by'umuzenguruko w'ukuboko ndetse n'ibipimo bya proteyine zo mu nsoro zitukura zitwa hemoglobin bizapimwa n'ababyaza bahuguwe, bipimwe igihe cyo kubyara cyegereje. Gusa ariko amakuru yerekeye bene ibyo bipimo mu byumweru 20 bya mbere mu gihe cyo gutwita azakurwa mu bubiko bw'amakuru (yo mu gihembwe cya mbere n'icya kabiri) bwo mu bigo nderabuzima ndetse no mu bitabo by'abajyanama b'ubuzima bo mu midugudu abo bagore babarizwamo.

Voluntary participation / *Kwitabira ku bushake*

Despite the fact that your comments are greatly valued, you have the freedom to reject to take part in the study. You won't be penalized if you decide not to participate in the study or if you leave the study in the middle of an interview. You will get the same care and consideration whether you opt to take part in the study or not /

Nubwo ibitekerezo byawe ari ingirakamaro, ufite uburenganzira bwo kutagira uruhare ugira muri ubu bushakashatsi. Nuhitamo kutagira icyo ufasha kuri ubu bushakashatsi cyangwa se ugahitamo kwikuramo mu gihe cy'ibazwa, ufite uburenganzira bwose bwo kubikora kandi ntibikugireho ingaruka iyo ari yo yose. Uzitabwaho kimwe, unahabwe ubufasha bumwe hadashingiwe ku cyemezo wafashe.

Privacy, anonymity, and confidentiality / *Ubuzima bwite, ukutamenyekana, no kurinda amabanga*

Individually identifiable data gathered for this study will not be disclosed to the public without consent from the participants. The information will be handled with the strictest secrecy and will only be used for the study's objectives. The information will include your address, medical history, and data from your medical consultations. You will be identified by a code number in each report for publication produced based on this study. We will make every attempt to keep the information you provide confidential. /

Imyirondoro y'utanga amakuru ku bushakashatsi n'ibindi byose byerekeye ubuzima bwe bwite bigirwa ibanga. Amakuru yose uzatanga azakoreshwa mw'ibanga ryuzuye kandi akoreshwe ibiri mu murongo w'intego y'ubushakashatsi gusa. Ibishoboka byose bizakorwa kugira ngo ubuzima bwawe bwite burindwe.

Possible benefits / ***Inyungu zishobora guturuka kuri ubu bushakashatsi***

Although the advantages of this study may not be immediately apparent, the relevant stakeholder may find the results helpful in starting an intervention aimed at enhancing women and infant health. Understanding your present dietary and nutritional condition will be beneficial to you as well. If a problem is discovered, advice on the best course of action will be given. The study will not provide any additional material or monetary incentives to volunteers, though. /

Inyungu zakomoka kuri ubu bushakashatsi zishobora kudahita zigaragara mbere y'ubushakashatsi ariko amakuru azakusanywa ashobora kuzagira akamaro gakomeye ku barebwa n'ikibazo mu gutuma hari icyakorwa kugira ngo imirire y'abagore batwite n'ubuzima bw'impinja zabo byitabweho neza kandi binozwe. Ubu bushakashatsi buzagufasha kumenya no gusobanukirwa imiterere ndangamirire yawe kandi nibiramuka bigaragaye ko hari ikibazo kibyerekeyeho ufite, ubujyanama ku cyakorwa uzabuhabwa. Gusa, nta nyungu mu bifatika cyangwa amafaranga, abazitabira gutanga amakuru muri ubu bushakashatsi bazahabwa.

Risks/discomforts / ***Ibyago/ingorane zishobora guterwa n'ubu bushakashatsi***

Throughout this investigation, I don't foresee any hazards or discomforts for you. You will be asked to make yourself available for an interview at a time and location that suit you best. All the anthropmetric measurements will not cause any discomfort, however, it will require inserting a tiny needle into your finger, which could cause some minor pain and discomfort where the needle was inserted. We will make every attempt to keep your information private and confidential while you take part in the study. /

Nta ngorane cyangwa ibyago biteganywa kuzakubaho mu gihe uzaba utanga amakuru kuri ubu bushakashatsi. Uzasabwa kwishakira igihe n'ahantu hakunogeye ho kuganirira. Ibipimo byose ndanga miterere bizagukorerwaho nta ngorane bizaguteza. Icyakora, uzasabwa guterwa urushinje ku gikumwe, ibi bishobora kuzagutera uburibwe bw'akanya gato. Hazakorwa Ibishoboka byose kugira ngo ubuzima bwawe bwite burindwe.

Whom to contact / ***Uwo ushobora guhamagara cyangwa kwitabaza mu gihe ugize ikibazo***

This protocol has been examined and approved by the Internal Review Board (IRB) of the University of Rwanda, College of Medicine and Health Sciences, whose duty it is to guarantee the security of study participants. A copy of this form will be provided to you. If you have any inquiries regarding this study, please contact my supervisor Prof Cyprien Munyanshongore 0788524550, or e-mail to: munyacyp@yahoo.fr or Mr. Michael Habtu; Email: mikel.habtu@gmail.com

If you would like more information about this study or if you have any queries regarding the consent process or your rights as a subject, or if you believe that your participation in this study has caused you harm in any way you may contact: Chairperson (**0788 490 522) or** Deputy Chairperson (**0783 340 040**)

Internal Board Review
School of Public Health
College of Medicine and Health Sciences
University of Rwanda

Uwo ushobora guhamagara cyangwa kwitabaza mu gihe ugize ikibazo

Ishyirwa mu bikorwa ry'ubu bushakashatsi ryaragenzuwe, kandi ryemezwa n'akanama gashinzwe kugenzura ibikorwa by'ubushakashatsi bukorwa n'abanyeshuri bo muri Kaminuza y'u Rwanda, ishami ry'ubuvuzi n'ubuzima ndetse no kurengera inyungu z'abakorerabushake bagira uruhare muri ubwo bushakashatsi (IRB).

Nyuma yo kuzuza iyi fishi, uzahabwa kopi yayo uzabasha gutahana. Ubaye ufite ikibazo kerekeye ubu bushakashatsi cyangwa ushaka kugira icyo usobanuza, wahamagara umugenzuzi wanjye Prof Cyprien Munyanshongore kuri nomero ya telephone 0788524550, cyangwa ukamwandikira kuri e-mail: munyacyp@yahoo.fr.

Ushobora no kwandikira Mr. Michael Habtu kuri e-mail: mikel.habtu@gmail.com.

*Ubaye ufite ikibazo kerekeranye n'amasezerano akubiye muri iyi nyandiko cyangwa ikibazo kerekeye uburenganzira bwawe nk'umukorerabushake, cyangwa ikibazo kerekeranye n'ingorane watewe n'ubu bushakashatsi cyangwa ushaka kubaza andi makuru yerekeranye n'ubu bushakashatsi ushobora kwegera IRB muri kaminuza y'u Rwanda, ishuri ry'ubuzima rusange,ishami ry'ubuvuzi n'ubuzima; ugahabwa ubufasha ukeneye (*Chairperson (**0788 490 522) or** Deputy Chairperson (**0783 340 040**).

Part II: Participants Declaration and Consent Form:

Igice cya Kabiri: Amasezerano y'umukorerabushake:

If you understand the information in the informed consent and have read it or had it read to you, and you freely agree to participate in this study, please carefully read the following statements and consider your decision before signing your name:

- I have had an opportunity to ask any questions I might have, and I'm happy with the responses to all of them.
- I am aware that any information I provide will be kept private and that I have the right to withdraw from this study at any time.
- I am aware that there won't be any consequences if I leave the study early or refuse to participate.
- I have been instructed who to call in an emergency and have been provided their name, phone number, and address in writing.
- I understand that I will be a volunteer in this study and will receive a copy of this informed consent form to retain./

  Umaze gusoma cyangwa gusomerwa ibyerekeye ubu bushakashatsi byose, ukabisobanurirwa, ukabyumva ndetse ukemera ku bushake kugira uruhare muri ubu bushakashatsi, urasabwa gusoma neza witonze amasezerano akurikira, ukayatekerezaho nuko wamara kumva unyuzwe n'ibikubiyemo ukaza kuyashyiraho umukono wawe nk' icyimenyetso ko ubyemeye.

  - *Nahawe uburenganzira bwose bwo kubaza ikibazo icyo ari cyo cyose kandi nanyuzwe n'ibisubizo byose nahawe*
  - *Nzi neza ko amakuru yose nzatanga anyerekeyeho azagirwa ibanga kandi ko nshobora kwikura muri ubu bushakashatsi igihe icyo ari cyo cyose nabyifuza.*
  - *Nindamuka mpagaritse cyangwa nkanga kugira uruhare muri ubu bushakashatsi, ndabyumva neza ko nta ngaruka n'imwe bizangiraho*
  - *Amazina, nimero ya telephone n'indi myirondoro yerekeye uwo nakwitabaza mu gihe cy'ubufasha bwihuse narabibwiwe ndetse mbihabwa no mu nyandiko*
  - *Nemeye kuba umukorerabushake muri ubu bushakashatsi kandi nzahabwa kopi y'aya masezerano kugira ngo nanjye nyatunge.*

Signature/*Ahashyirwa imikono*

Signature of Participant: _____ Date: _____
Umukono w'umukorerabushake *Itariki*
Signature of research assistant _____ Date: _____
Umukono w'uwafashije umushakashatsi *Itariki*
Signature of principal investigator _____ Date: _____
Umukono w'umugenzuzi mukuru *Itariki*

Appendix IV: Questionnaire

Umugereka wa kane: Uruhererekane
Questionnaire number/*Nomero y'ifishi ……...*

Section 1: Household Information & Characteristics
Igice cya mbere: Imyirondoro ya ba nyir' urugo

Part 1: Interview Information
Icyiciro cya mbere: Amakuru yerekeye ibazwa

No	Interview data /***italiki y'ibazwa***: |____|____||____| (dd/mm/yyyy)
1.	Name of district / ***Akarere***:
2.	Name of sector / ***Umurenge:***
3.	Cell name/ ***Akagali***:
4.	Health facility /***Ikigo nderabuzima:***
5.	Interviewer /***Ubaza:***
6.	Supervisor / ***Umugenzuzi:***

Part 2: Nutritional status indicators just before delivery
Igice cya kane: Imiterere ndangamirire: Ibipimo ndangamiterere y'umubiri

No	**Questions/*Ibibazo***	**Responses/*Ibisubizo***	**Remark *Icyitonderwa***
Q1.	Hemoglobin test / ***Ibipimo bya poroteyine***	Hb level: _____ g/dL	
Q2.	Maternal MUAC / ***Igipimo cy'umuzenguruko w'ukuboko k'umubyeyi***	_____cm	

Part 3: Demographic characteristics of women
Ikiciro cya kabiri: Ibyerekeye imiterere ndangamibereho y'abagore

No	**Questions/*Ibibazo***	**Responses/*Ibisubizo***	**Code/ *Kode***	**Skip/ *Simbuka***
Q100.	Age in years / ***Imyaka afite***	15-19 20-24 25-29 30-34 35-39 40-44 45-49	1 2 3 4 5 6 7	
Q101.	Religion / ***Idini***	Christian / ***Umukristo*** Muslim / ***Umusilamu*** Other (specify)/ ***Irindi dini***: _____	1 2 99	
Q102.	Marital status / ***Ibyerekeranye n'ishyingirwa***	Married (Monogamy)/)/***yarashatse (umugore umwe***) Married (Polygamy)/) (***yarashatse (abagore benshi)*** Cohabitating (but not married)/)/***Abana n'umugabo (batarasezeranye)*** Never been married/single/***Ntabwo yigeze ashaka /ingaragu***	1 2 3 4	

		Divorced or Separated/***yatanyijwe mumategeko cg baratandukanye gusa*** Widowed/ ***Umupfakazi*** Other (specify)/ ***Ibindi (Sobanura)***: _____	5 6 99	
Q103.	Level of education completed / ***Amashuri yasoje***	None/***Ntacyo*** Primary/***amashuri abanza*** Secondary/***amashuri yisumbuye*** vocational/***amashuri y'imyuga*** Higher education/***Amashuri makuru***	1 2 3 4 5	
Q104.	Spouse's/Partner's completed level of education/ ***Amashuri uwo bashakanye yasoje***	None/***Ntacyo*** Primary/***amashuri abanza*** Secondary/***amashuri yisumbuye*** Vocational/***amashuri yimyuga*** Higher education/***Amashuri makuru*** Don't Know/***Simbizi***	1 2 3 4 5 88	
Q105.	Household size / ***Umubare w'abatuye mu rugo bose***	Total/***Bose*** |_____| Male/***Igitsina gabo*** |_____| Female/***Igitsina gore*** | _____|		

Part 4: Socioeconomic and household asset ownership

Icyiciro cya gatatu: Ibyerekeye ubukungu, imibereho n'imitungo y'urugo

No	**Questions/*Ibibazo***	**Responses/*Ibisubizo***	**Code/ *Kode***	**Skip/ *Simbuka***
Q1.	Occupation ***Umurimo akora***	Farming/agriculture/***Umworozi/umuhinzi*** House wife/***Umugore w'urugo*** Salaried employee/ ***Umukozi uhembwa ku kwezi*** Self-employed/***Arikorera*** Casual wage/***Akora ibiraka*** Unemployed/***Nta kazi afite*** Student/***Umunyeshuri*** Other (specify)/ ***Ibindi (sobanura)***: _____	1 2 3 4 5 6 7 99	
Q2.	Spouse's/partner's employment status ***Umurimo w'uwo bashakanye***	Farming/agriculture/***Umworozi/umuhinzi*** Salaried employee/ ***Umukozi uhembwa ku kwezi*** Self-employed/***Arikorera*** Casual wage/***Akora ibiraka*** Unemployed/***Nta kazi afite*** Student/***Umunyeshuri*** Other (specify)/ ***Ibindi (sobanura)***: _____	1 2 3 4 5 6 99	Skip if Single/widowed to Q4
Q3.	Ownership of the house currently reside in / ***Nyiri nzu abamo***	Self/ ***Niwe nyiri nzu*** Rental/***arakodesha*** Other (specify)/ ***Ibindi (Sobanura)*** _____	1 2 99	

Q4.	What is the most common cooking fuel used in the household? / ***Ni ubuhe buryo bwo guteka bukoreshwa cyane?***	Wood/***Inkwi*** Charcoal/***Amakara*** Gas or biogas Electricity/***Umuriro w'amashanyarazi*** Cows dung/***Amase*** Other (specify)/ ***Ibindi (Sobanura)*** _____	1 2 3 4 5 99	
Q5.	What is your household's main source of fuel or energy for lighting? / ***Ni iyihe soko y'ingufu z'umuriro n'urumuri ikoreshwa mu rugo?***	Electricity/***Amashanyarazi*** Solar/***Ingufu zituruka ku mirasire y'izuba*** Gas Other (specify)/ ***Ibindi (Sobanura)*** _____	1 2 3 99	
Q6.	Are there any of the following objects in the household: Radio TV Telephone – fixed line Mobile phone, Car, Motorcycle / ***Ese hari kimwe muri ibi bikoresho gikoreshwa mu rugo: Radiyo, televiziyo, telefone itagendanwa, telefone igendanwa, imodoka, ipikipiki?***	Yes/ ***Yego*** No/ ***Oya*** If yes specify/ ***Niba ari yego, garagaza icyo*** Radio/***Radiyo*** TV/***Televiziyo*** Telephone – fixed line/***Telefone itagendanwa*** Mobile phone/***Telefone igendanwa*** Car/***Imodoka*** Motorcycle/***Ipikipiki***	1 2 1 2 3 4 5 6	
Q7.	Does the household own any livestock? ***Ese hari amatungo mufite?***	Yes/ ***Yego*** No/ ***Oya*** ***If yes, which ones and how many/ Niba ari yego, ni ayahe kandi ugaragaze umubare wayo*** Goats/***Ihene***: Nº/***Umubare***_____ Sheep/***Intama***: Nº/***Umubare***_____ Cows/***Inka***: Nº/***Umubare***_____ Chicken/***Inkoko***: Nº/***Umubare***_____ Pigs/***Ingurube***: Nº/***Umubare***_____ Rabbits/***Inkwavu***: Nº/***Umubare***_____ Other (specify)/ ***Andi (Sobanura)*** _____ Number / ***Umubare*** _____	1 2	

Part 5. Obstetric and lifestyle factors /*Icyiciro cya kane: Ibijyanye n'ubuzima bw'umugore utwite*

No	**Questions/*Ibibazo***	**Responses/ *Ibisubizo***	**Code/ *Kode***	**Skip/ *Simbuka***
Q123.	In the past two weeks, have you had any illness? ***Wigeze ugira uburwayi ubwo ari bwo bwose mu byumweru bibiri bishize?***	Yes/ ***Yego*** No/ ***Oya*** If yes state, the illness ***Niba ari yego, busobanure***	1 2	
Q124.	Do you take any form of alcohol or beer during this current pregnancy? / ***Ese ujya ufata inzoga cyangwa ibindi binyobwa bisembuye muri iki gihe cyo gutwita?***	Yes/ ***Yego*** No/ ***Oya***	1 2	
Q125.	Do you smoke? / ***Ese unywa itabi?***	Yes/ ***Yego*** No/ ***Oya***	1 2	

Q126.	Is there anyone who smokes nearby, either at home or at work? / ***Ese hari uwo mubana mu rugo cyangwa se uwo mukorana ku kazi unywa itabi?***	Yes/ ***Yego*** No/ ***Oya***	1 2	
Former Pregnancies/ ***Ugutwita mu gihe cyashize***				
No	**Questions/*Ibibazo***	**Responses/ *Ibisubizo***	**Code/ *Kode***	**Skip/ *Simb***
Q127.	How many pregnancies have you ever had? / ***Umaze gutwita inshuro zingahe?***	***Inshuro*** _____ pregnancies		
Q128.	How long ago was your last pregnancy? /***Ubwo uheruka gutwita hashize igihe kingana iki? (Mu mezi)***	***Amezi*** _____ months		

Section 2: Women dietary diversity score and food consumption survey
Icyiciro cya kabiri: ***igipimo cy'imirire n'indyo yuzuye ku bagore***

'Please list the foods (meals and snacks) and beverages you consumed yesterday during the day and at night, whether at home or elsewhere'. Start with the morning first meal or beverage. Note down every meal and beverage mentioned. Whenever composite dishes are mentioned, request the ingredient list. Check any unmentioned meals and snacks when the respondent is done. /
Turabasaba ngo mutubwire ibiribwa (Amafunguro n'ibindi byo kurya byoroheje) mwariye cg mwanyoye ejo ku manywa na nijoro, yaba imuhira cg ahandi. Uhere ku biribwa cg ibinyobwa mwafashe mu gitondo. Mu gihe ibigize amafunguro byagaragajwe, baza ibyari bibigize/ibirungo. Namara gusubiza genzura, umubaze andi amafunguro n'ibindi byo kurya byoroheje ashobora kuba yarafashe ariko ntabigaragaze.

Q1.	
Breakfast/ Ifunguro rya mugitondo	
Snack/ ***Ifungoro ryoroheje***	
Lunch/ Ifunguro rya Saa sita	
Snack / ***Ifungoro ryoroheje***	
Dinner/ ***Ifunguro rya nijoro***	
Snack/ ***Ifungoro ryoroheje***	

Then ask the woman how many times yesterday did she eat the following foods, and how many days in the last 7 days and what was the source of the food she ate: /
Hanyuma baza umubyeyi inshuro zingahe yariye ibiribwa bikurikira ku munsi w'ejo, nurangiza umubaze n'inshuro yabiriye mu minsi 7 ishize ndetse n'aho ibyo biribwa byaturukaga

'Food Source codes: 1=Own production (crops, animals), 2=Hunting, fishing, gathering, 3=Exchange labor/items for food, 4=borrowed, 5=purchases, 6=Gift (food) from family/relatives, 7=Food aid/subsidized food (NGOs, govt)'
Kode z'aho ibiribwa byaturutse: 1*= Umusaruro w'ibyo yahinze (ngandurarugo/umusaruro, ku matungo),* ***2****= Guhiga, uburobyi, Guca incuro;* ***3****= Kugurana ibiribwa ,* ***4****= Kugurizwa,* ***5****= Yarabiguze,* ***6****= Impano (y'ibiribwa) yahawe n'umuryango cg inshuti,* ***7****= Imfashanyo y'ibiribwa (itanzwe na leta cyangwa ikindi kigo gifasha kigenga)*

No	Food group/ *Ubwoko(Itsinda)ry'ibiribwa*	Details of Food group *Ubusobanuro ku bwoko bw'ibiribwa*	Example/ *Urugero*	Yes/ *Yego* =1 No/ *Oya* = 0	# of times yesterday (from the time you got up Yesterday morning to the time you got up today 24 hrs)/ *Umubare w'inshuro yabiriye ejo hashije (kuva igihe yabyukiye ukageza uyu munsi;nyuma y' amasaha 24)*	Main source of food/ *Inkomoko y'ingenzi y' ibyo biribwa*
Q1.	Cereals and Tubers / ***Ibinyampeke N'ibinyabijumba***	Cereals/ ***Ibinyampeke***	*"corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, nshima, porridge or paste"* / ***Ibigori, umuceri, ingano, amasaka, uburo cg n'ibindi binyampeke cg ibiribwa bikomoka muri byo (urugero: umukati, porici cg ibindi bikomoka ku binyampeke) hakiyongeraho n'ibiribwa by'iwacu urugero: igikoma cg ubugali***			
		White Roots and Tubers/ ***IbinyamiziN' ibinyabijumba***	*"white potatoes, white yam, white cassava, or other foods made from roots"*// ***Ibijumba, amateke, imyumbati, cg ibindi biribwa bikomoka ku mizi***			
Q2.	Pulses & Legumes / ***Ibinyamisogwe***	Legumes, Nuts and Seeds / ***Ibinyamisogwe, Ubunyobwa N'impeke***	*"dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)/"* ***Ibishyimbo byumye, amashaza yumye, iminyeganyege, ubunyobwa, impeke cg ibiribwa bikomoka kuri byo***			
Q3.	Vegetables ***Imboga***	Vitamin A Rich vegetables and Tubers / ***Imboga zikize Kuri Vitamine A N'ibinyabijumba***	*"Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A Rich vegetables (e.g. red sweet pepper)*" / ***Amadegede/Ibihaza, karoti, ibijumba by'umuhondo imbere, hakiyongeraho n'imboga z'iwacu (urugero; puwavuro zitukura)***			
		Dark Green Leafy Vegetables/ ***Imboga Rwatsi***	*"Dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, spinach /*" ***Imboga rwatsi harimo izo mu gasozi n'iziboneka imuhira. Imboga zikungahaye muri vitamin A harimo rengarenga/dodo, isombi, epinari***			
		Other Vegetables/ ***Izindi mboga***	*"other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables /*"			

			Izindi mboga (urugero: inyanya, ibitunguru, intoryi) + n'izindi mboga ziboneka iwacu			
Q4.	Fruits/ ***Imbuto***	Vitamin A Rich Fruits ***Imbuto zikize muri Vitamini A***	*"Ripe mango, ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits /*" ***Umwembe, ipapayi, pome n'umutobe ukozwe 100% muri izo mbuto n' izindi ziboneka iwacu***			
		Other Fruits ***Izindi mbuto***	*"Other fruits, including wild fruits and 100% fruit juice made from these*"/ ***Izindi mbuto, harimo izo mu gasozi n'umutobe ukozwe 100 % muri izo mbuto***			
Q5.	Meat, Fish and Eggs ***Inyama, amafi N'amagi***	Organ Meat/ ***Inyama z'ibice by'umubiri***	*"liver, kidney, heart or other organ meats or blood-based foods /*" ***Umwijima, umutima cg izindi nyama z'ibice by'umubiri cg ibiribwa bikomoka ku maraso***			
		Flesh Meats ***Inyama zikibagwa***	*"Beef, pork, lamb, goat, rabbit, game, chicken, duck or other birds.*"/ ***Inyama z'inka, ingurube, intama, urukwavu, inkoko, imbata cg ibindi biguruka***			
		Eggs/ ***Amagi***	*"eggs from chicken, duck, guinea fowl or any other egg /*" ***Amagi y'inkoko, amagi y'imbata, amagi y'inkanga cg andi magi***			
		Fish / ***Ifi***	"fresh or dried fish or shellfish/" ***Ifi mbisi cg ifi yumye***			
Q6.	Milk ***Amata***	Milk and Milk Products/ ***Amata N'ibiyakomo***	*"milk, cheese, yogurt or other milk products/*" ***Amata, foromaje, yawurute, cg ibindi bikomoka ku mata***			
Q7.	Oil ***Amavuta***	Oils and Fats / ***Amavuta N'ibivumbikisho/Ibinure***	*"oil, fats or butter added to food or used for cooking /*" ***Amavuta, ibivumbikisho/ibinure, cg amavuta y'inka yongewe mu biribwa cg yakoreshejwe mu guteka***			
		Red Palm Products / ***Ibikomoka ku mikindo***	*"Red palm oil, palm nut or palm nut pulp sauce /*" ***Amamesa***			
Q8.	Sugar ***Ibinya sukari***	Sweets ***Ibiiryohereye***	*"sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes/"* ***Isukari, ubuki, soda cg imitobe irimo isukari, ibiribwa biryohereye nka shokora, ibisuguti na keke***			
Q9.	Condiments/ Spices/	Spices, Condiments, Beverages / ***Ibirungo bisharira,***	*"spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages/*"			

	Ibirungo/Ibisharira	***Ibyongera Uburyohe, Ibinyobwa***	***Ibirungo bisharira (urusenda, umunyu), ibyongera uburyohe (isupu ya soya), ibinyobwa (ikawa, icyayi, inzoga)***			

Section 3: Antenatal care services and nutritional indicators to be extracted from records during pregnancy

No	**Questions/*Ibibazo***	**Responses/*Ibisubizo***	**Code/ *Kode***	**Remark**
Q100.	Have you received prenatal care during this pregnancy? / ***Waba warigeze ugana ikigo nderabuzima ushakisha ubufasha cg kwitabwaho mbere yuko ubyara?***	Yes/***Yego*** No/***Oya*** If yes, how many visits? ***Niba ari yego, umaze kujyayo kangahe?*** _____ visits / ***Inshuro***	1 2	Confirm from the record or registry / ***Genzura mu gitabo cy'ububiko nyandiko***
Q101.	HIV test / ***Ibipimo bya virusi itera SIDA***	Negative/ ***Ntayo afite*** Positive/***Arayifite*** ***Not done***	1 2 3	Extract from the file

No	**Questions/*Ibibazo***	**In the 1st trimester**	**In the 2nd trimester**	**3rd trimester**
Q102.	Maternal MUAC /***Igipimo umuzenguruko w'ukuboko k'umubyeyi***	_____cm	_____cm	_____cm
Q103.	Maternal weight / ***Igipimo cy'ibiro by'umubyeyi***	_____kg	_____kg	_____kg
Q104.	Maternal height / ***Igipimo cy'uburebure bw'umubyeyi***	_____cm	_____cm	_____cm
Q105.	Hemoglobin test / ***Ibipimo bya poroteyine yo mu nsoro zitukura***	Hb level: ____g/dL	Hb level: ____g/dL	Hb level: ____g/dL

Section 4: Babies characteristics and anthropometric measurement

No	**Questions/*Ibibazo***	**Responses/*Ibisubizo***	**Code/ *Kode***	**Remark *Icyitonderwa***
300.	Sex of the baby / ***Igitsina cy'umwana***	Male/ ***Gabo*** Female/ ***Gore***	1 2	
Anthropometric measurement /*Ibipimo ndangamiterere y'umubiri w'umwana ukivuka*				
301.	Head circumference of the newborn baby / ***Uburebure bw'umuzenguruko w'umutwe***	_____cm		
302.	Length/height of the newborn baby / ***Uburebure bw'umwana akivuka***	_____cm		
303.	Birth weight in grams / ***Ibiro yavukanye***	_____gm		

Appendix V: Focus Group Discussion Guide

Ingingo ya 11: Umurongo w'ibiganiro byo mu matsinda

District/ ***Akarere***: _____ Study site/ ***Aho ikiganiro gikorewe***: _____
Date/ ***Itariki***: _____ Start time/ ***Igihe cyo gutangira***_____
End time/ ***Igihe cyo kurangiza***_____
Time taken/ ***Ingano y'igihe cyakoreshejwe***_____
Moderator of the FGD/ ***Uyoboye ikiganiro***_____
No. of Group members/ ***Umubare w'abagize itsinda***: _____

Introduction

Welcome to today's discussion and thank you for being here. Before we start here are some ground rules to guide in our discussion.

Intangiriro

Ikaze mu kiganiro cy'uyu munsi, mwakoze kwitabira. Mbere yuko dutangira, dore amwe mu mabwiriza ari buyobore kino kiganiro.

Ground rules of the discussion / *Amabwiriza y'ibanze y'ikiganiro*

There are some guidelines that must be followed during the debates.

Muri iki kiganiro, hari amwe mu mabwirizwa ari bukurikizwe ari yo ayangaya akurikira:

1. All the views that we give are very important, there is no right or wrong answers. /
   Ibiri buvugirwe hano byose ni ingenzi. Nta gisubizo kiri bwitwe cyiza cyangwa se kibi.
2. Feel free to express your thoughts at any time. Since we are all adults, I won't single anyone out for speaking; feel free to talk whenever you want; we will all respect your time. We don't have to all agree because this isn't a contest, but we do need to respect one another's viewpoints while we're talking.
   Usabwe kwisanzura ugatanga ibitekerezo bigaragaza uko wowe ubyumva. Ntawe ndi butunge urutoki ngo nagire icyo avuga kuko twese turakuze, wowe ubohoke uvuge wisanzuye kandi abandi twese turagutega amatwi. Iri si irushanwa kandi ntabwo ari ngombwa ko twese twemeranya ku kintu runaka kivuzwe ariko ni ngombwa kubaha ibitekerezo bya buri umwe biri butangwe muri iki kiganiro.
3. Considering that this is a discussion, it would be nice if everyone could take part. For the purposes of this conversation, we are all on an equal footing and no one has more knowledge than the others since we want to hear everyone's ideas.
   Kuko icyi ari ikiganiro biraza kuba byiza twese nitukigiramo uruhare, tukavuga. Dukeneye ibitekerezo bya buri umwe. Rero kubw'impamvu z' ikiganiro, twese turangana, ntawe uzi ibyisumbuye ku bya mugenzi we.
4. Everyone is obligated to respect the other group members' personal space. The investigators request that none of the participants divulge anything mentioned during the conversation, but it's vital to realize that other group members may not keep everything private and confidential, which is out of their control.
   Buri wese arasabwa kubaha ubuzima bwite bw'abandi bose bagize itsinda. Abitabiriye bose barasabwa kutagira icyo batangariza undi muntu utarebwa n'ikiganiro. Ibiraza kuganirirwa hano byose ni ngombwa ko biba ibanga ry'abitabiriye. Gusa na none ni ngombwa kumva ko umuntu ashobora

kutubahiriza ibivuzwe hejuru mu buryo uyoboye ikiganiro adashobora kubihagarika cyangwa ngo abe yabikumira.

5. No one's name shall be mentioned at any point throughout this debate. But we must each define what we say.

   Muri iki kiganiro, nta mazina ari bukoreshwe. Gusa tugomba kubasha kumenya icyavuzwe na buri umwe muri twe.

6. In order to capture the conversations, we will like your permission to use the tape recorder you see here. As you can see, one of us will be taking notes on the conversation, but the hand will get fatigued as the conversation heats up. We would want to record since we value each and every viewpoint greatly. The only time the tape will be used is to complete the gaps left by the note-taker. None of the people not involved in this study will have access to the tapes. All of the tapes must be deleted after that.

   Turagusaba uburenganzira bwo gukoresha akuma gafata amajwi muri kubona hano kugira ngo ibivugirwa hano bigire ahantu bibikwa. Nkuko mubibona, hari umwe muri twe uraba ari kwandika ariko uko ikiganiro kigenda gikura, intoki n'amaboko biraruha. Ibiri buvugirwe hano byose ni ingenzi kuri twe, niyo mpamvu rero dushaka gufata amajwi. Amajwi ari bufatirwe hano nta wundi azasangizwa atarebwa n'ubu bushakashatsi. Nyuma y'ubushakashatsi, amajwi yose yafashwe azasibwa, ntabwo azabikwa.

Discussion / *Ikiganiro*

1. What do you think the common nutrition related problems are in the community for pregnant women? Probe further …. What are the greatest barriers, if any, to adequate food intake during pregnancy?
   Ese ni ibihe bibazo by'ingenzi byerekeye imirire ku bagore batwite ubona biri muri uyu mudugudu? Suzuma birushijeho…. Ese ni izihe mbogamizi zikomeye zibuza abagore batwite gufata indyo yuzuye?
2. How do you perceive/evaluate the project of *Gikuriro* which is implementing nutrition intervention in this community? How convenient are the nutrition services for pregnant women? How do you judge the commitment of the nutrition service providers during pregnancy?
   Ese umushinga wa Gikuriro wo kwita ku mirire iboneye muri uyu mudugudu, wowe uwubona ute? Ese guhabwa ubufasha ku mirire myiza byoroheye abagore batwite ku kihe kigero? Ese abakozi bashinzwe gutanga bene ubwo bufasha, ubona babikora bate?
3. How would you rate the project's impact on the following areas: food production; household food security; women's empowerment; household income creation; and access to clean water, sanitary conditions, and hygiene?
   Ese ubona umushinga hari icyo wahinduye ku byerekeye (1) ukuboneka kw'ibiribwa; (2) Imirire iboneye mu ngo; (4) kwigira kw'abagore; (5) Kwiteza imbere no kwizigama mu ngo (6) amazi meza, isuku n'isukura?

4. What are the barriers for pregnant women to utilize the current *'nutrition-sensitive'* intervention/services provided by *Gikuriro* program? Probe further …… What community related beliefs and norms are preventing access to nutrition intervention?
   Ese abagore batwite bahura ni izihe mbogamizi mu guhabwa serivise zikubiye mu mushinga wa Gikuriro? Suzuma birushijeho…. Ni iyihe migenzo n'imyumvire yo muri aka gace ibuza abantu guhabwa serivise zikubiye mu mushinga wa Gikuriro?

5. What are the opportunities for pregnant women to utilize the current *'nutrition-sensitive'* intervention/services provided by *Gikuriro* program?
   Ese abagore batwite bafite buryo ki bwo guhabwa serivise zikubiye mu mushinga wa Gikuriro?
6. What would be the best way to get nutrition information to pregnant women? Who should provide nutrition information during pregnancy? Why?
   Ubona ari ubuhe buryo buboneye bwakoreshwa mu guha abagore batwite amakuru yerekeye imirire? Ese ubona ari nde wagakwiye kubaha ayo makuru? Kubera iki? sobanura.
7. How can nutrition services utilization be improved among pregnant women in this community? And what are your recommendations for improving nutrition intervention
   Ese ubufasha (serivise) bwerekeye imirire myiza buhabwa abagore batwite, ubona bwanozwa gute (mu buhe buryo? gira inama utanga)
8. Is there anything else you would like to add?
   Ese hari ikindi ushobora kongeraho?

Appendix VI: Key informant interview Guide

Ingingo ya 12: Umurongo w'ikiganiro cy'ibazwa ryihariye
District/ ***Akarere***: _____ Study site/ ***Aho ikiganiro gikorewe***: _____
Date/ ***Itariki***: _____ Start time/ ***Igihe cyo gutangira***_____
End time/ ***Igihe cyo kurangiza***_____
Time taken/ ***Ingano y'igihe cyakoreshejwe***_____
Interviewer of the KIIs/ ***Ubaza***_____
Interviewee/ ***Icyo ubazwa akora***: CHW/ ***Umujyanama w'ubuzima*** ☐,
Nutitiionist/ ***Ushinzwe imirire*** ☐, Nurse/ ***Umuforomo*** ☐, Midwife/ ***Umubyaza*** ☐

Ground rules of the interview / *Amabwiriza y'ibanze y'ikiganiro*
During the interview, there are a few rules to be observed.
Muri iki kiganiro, hari amwe mu mabwirizwa ari bukurikizwe ari yo ayangaya akurikira:

1. All the views that we give are very important, there is no right or wrong answers.
   Ibiri buvugirwe hano byose ni ingenzi. Nta gisubizo kiri bwitwe cyiza cyangwa se kibi.
2. You are welcome to express your thoughts, and all information will be kept private and confidential.
   Usabwe kwisanzura ugatanga ibitekerezo bigaragaza uko wowe ubyumva kandi amakuru yose akwerekeye azagirwa ubwiru ndetse azarindwa mw'ibanga rikomeye.
3. We will not use anyone's name at any point in this conversation. We however need to identify what every one of us says.
   Muri iki kiganiro, nta mazina ari bukoreshwe.
4. I would like to ask for consent from you to use tape recorder as you can see here to record the interview. I want to record because I believe that every viewpoint is crucial. Only the gaps left by the note taker will be filled up with the tape. The tapes won't be given to anyone who isn't a part of our research. All of the tapes must then be erased.
   Turagusaba uburenganzira bwo gukoresha akuma gafata amajwi muri kubona hano kugira ngo ibivugirwa hano bigire ahantu bibikwa. Ibiri buvugirwe hano byose ni ingenzi kuritwe, niyo mpamvu rero nshaka gufata amajwi. Amajwi ari bufatirwe hano nta wundi azasangizwa atarebwa n'ubu bushakashatsi. Nyuma y'ubushakashatsi, amajwi yose yafashwe azasibwa, ntabwo azabikwa.

Discussion/ *Ikiganiro*

1. How do you assess the nutritional condition of pregnant women in this community? What are the perceived needs of nutrition services during pregnancy?
   Ese ubaye ugira icyo uvuga ku miterere ndangamirire y'abagore batwite bo muri aka gace wayivugaho iki? Ubona ari ubuhe bufasha bakeneye?
2. How do you perceive/evaluate the project of *Gikuriro* which is implementing *'nutrition-specific'* and *'nutrition-sensitive'* intervention package in this community? How convenient are the *'nutrition-sensitive'* services for pregnant women?
   Ese umushinga wa Gikuriro wo kwita ku mirire iboneye muri uyu mudugudu, wowe uwubona ute? Ese guhabwa ubufasha ku mirire myiza byoroheye abagore batwite ku kihe kigero?

3. How aware and interested are the pregnant women on the need to utilize the *'nutrition-sensitive'* intervention/services provided by *Gikuriro* program?
   Ese abagore batwite bo muri aka gace basobanukiwe umushinga wa Gikuriro? Ese ubona bitabira guhabwa serivise zikubiye mu mushinga?
4. How would you rate the project's impact on the following areas: food production, household food security, nutrition security, women's empowerment, household income generation, safe water, sanitation, and hygiene?
   Ese ubona umushinga hari icyo wahinduye ku byerekeye (1) ukuboneka kw'ibiribwa; (2) Imirire iboneye mu ngo; (3) kwihaza mu mirire; (4) kwigira kw'abagore; (5) Kwiteza imbere no kwizigama mu ngo (6) amazi meza, isuku n'isukura?
5. Do you believe the *Gikuriro* project activities have had a positive influence on food security and good nutrition outcomes since its implementation? Probe further How? What nutrition intervention for pregnant women are being implemented in an effective way? What are the best practices that can be implemented in other cities / districts?
   Ese ubona umushinga Gikuriro hari icyo wahinduye ku byerekeye kuboneka kw'ibiribwa n'imirire iboneye? Suzuma birushijeho… mu buhe buryo? Ni izhe ngamba ku mirire myiza ziri gushyirwa mu bikorwa? Ese ni iyihe mikorere indi mijyi n'uturere byabigiraho?
6. What are the main challenges in implementing *'nutrition-specific'* and nutrition sensitive intervention activities for pregnant women? ….. What community related beliefs and norms are preventing access to *'nutrition-sensitive'* intervention?
   Ese abagore batwite bahura ni izihe mbogamizi mu guhabwa serivise zikubiye mu mushinga wa Gikuriro? Ni iyihe migenzo n'imyumvire yo muri aka gace ibuza abantu guhabwa serivise zikubiye mu mushinga wa Gikuriro?
7. What are the main opportunities in implementing *'nutrition-specific'* and nutrition sensitive intervention activities for pregnant women? ….. What community related beliefs and norms are preventing access to *'nutrition-sensitive'* intervention?
   Ese abagore batwite bahura ni izihe mbogamizi mu guhabwa serivise zikubiye mu mushinga wa Gikuriro? Ni iyihe migenzo n'imyumvire yo muri aka gace ibuza abantu guhabwa serivise zikubiye mu mushinga wa Gikuriro?
8. What are your recommendations for improving nutrition intervention so as to improve their impact?
   Ese ubufasha (serivise) bwerekeye imirire myiza buhabwa abagore batwite, ubona bwanozwa gute (mu buhe buryo? gira inama utanga)
9. Is there anything else you would like to add?
   Ese hari ikindi ushaka kongeraho?