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Food intake patterns and associations with gestational weight gain and postpartum weight retention in women living with and without HIV in Cape Town, South Africa

by

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DECLARATION

I, Siphesihle Mandisa Sithole hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Thesis Abstract

Background: Maternal nutrition during pregnancy and postpartum may significantly impacts weight outcomes and long-term maternal health. However, dietary habits and weight outcomes during these periods remains poorly understood particularly in obesogenic environments like Gugulethu township (Cape Town, South Africa). In addition, dietary habits among persons living HIV may differ from the general public due to increased nutritional demands. However, there is limited data on food intake and weight outcomes in low-income resource settings. Therefore, the aim of this study was to investigate food intake patterns during pregnancy and postpartum, and associations with gestational weight gain (GWG) and postpartum weight retention (PPWR) among women living with and without HIV.

Methods: This Master of Public Health mini-dissertation presents a research protocol (section A) and a journal-formatted manuscript (Section C). This study was a retrospective secondary data analysis study which builds on the Cardiometabolic Risk in Pregnancy (CAMP) a prospective cohort study of 400 pregnant women (n = 200 living with HIV and n = 200 living without HIV) recruited and enrolled from November 2019 to October 2022. Food intake was assessed using the Minimum Dietary Diversity for Women (MDD-W). Food intake was stratified using HIV, GWG and PPWR respectively. Weight assessments in pregnancy and postpartum periods were conducted by a trained study nurse and GWG was categorised as adequate, inadequate, and excessive weight gain according to the Institute of Medicine (IOM) guidelines and PPWR was categorised as weight loss (<0kg), normal weight retention (0-5kg) and excessive weight retention (>5kg). Multinomial regression models examined associations between food intake, GWG and PPWR while controlling for confounders including parity, income marital status as well education level.

Results: Overall, 82% of women were multigravida while the overall median age was 30.1 (IQR, 25.4-34.0). Women living with HIV exhibited higher food intake and dietary diversity during gestation, with significant differences in starchy staples 38% and meats 37% consumption compared to women without HIV (26% and 26% respectively). Women living with HIV compared to those living without HIV were more likely to experience inadequate weight gain as opposed to adequate weight gain (OR = 2.24 95% CI 1.12, 4.46). Postpartum, excessive weight retention was associated with milk and milk product consumption, where women consuming milk and milk products compared to those not consuming milk and milk products, were more likely to experience excessive weight retention relative to those who experienced normal weight retention (OR = 2.278 95% CI, 1.10,7.05) while holding all other covariates constant.

Conclusion: Our results add valuable insights to the current knowledge by offering detailed perspectives on the complex connections between dietary diversity and its broader consequences on maternal aspects such as GWG and PPWR. Targeted nutritional interventions are needed to promote healthy weight during pregnancy and postpartum periods, particularly among women living with HIV.

List of Abbreviations

ART	Antiretroviral Therapy
AUDIT	Alcohol Use Disorders Identification Test
BDI-II	Beck Depression Inventory
BMI	Body Mass Index
CAMP	Cardiometabolic Risk in Pregnancy
CI	Confidence Interval
DTG	Dolutegravir
EFV	Efavirenz
EPDS	Edinburg Postnatal Depression Scale
FAO	Food and Agricultural Organisation
FFQ	Food Frequency Questionnaire
GWG	Gestational Weight Gain
GI	Glycaemic Index
HIV	Human Immunodeficiency Virus
IOM	Institute of Medicine
IQR	Inter-Quartile Range
LMIC	low-middle-income communities
MDD-W	Minimum Dietary Diversity for Women
OR	Odds Ration
PP	Postpartum
PPWR	Postpartum Weight Retention
V1	Visit 1 (24 to 28 weeks of pregnancy)
V2	Visit 2 (34 to 36 weeks of pregnancy)
V3	Visit 3 (6-monthss postpartum)
WHO	World Health Organisation

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Section A: Research Protocol

1. Introduction

The prevalence of obesity has tripled from 1975 to 2016 [1]. Since 2016, at least 2 billion adults (>18 years) are obese/overweight [1]. This means, 39% of the global population is overweight (40% female & 39% male) and 650 million adults (13% total population, of which 11% male and 15% female) are obese [2]. Having an elevated Body Mass Index (BMI) (overweight, ≥ 25 kg/m^2 and obese, ≥ 30 kg/m^2) exposes one to other risk factors such as cardiovascular diseases, type 2 diabetes mellitus, hypertension, and some cancers[3]. Such exposures reduce an individual's quality of life and life expectancy by at least 3.3 years [3]. In 2003 and 2005, at least 50% of maternal deaths in the United Kingdom were associated with overweight/obesity [4]. The rising prevalence of individuals classified as overweight or obese increases the burden of disease, especially in low-middle-income countries (LMIC) [5]. These countries are predisposed to a multi-burden of diseases such as undernutrition and obesity existing in the same country, whilst also suffering the rise of communicable diseases such as Covid-19. In light of the COVID-19 pandemic, research has shown that there are higher mortality rates among those who are overweight /obese, especially with underlying conditions such as diabetes, hypertension and other respiratory conditions [6]. Obesity is an invasive public health problem which is entirely preventable[7].

The rates of obesity are different between men and women, hence there is a need to search for strategies that target both genders differently according to exposures to help rectify this growing public health problem. In South Africa, women face the highest burden of obesity, at least 41% of females have a mean BMI score ≥ 30 kg/m2 as of 2016 (NCD-RisC) et al., 2021) [9]. From this statistic, there are at least 2 times more females classified as obese for every 1 man classified as overweight. There is a gap of knowledge that needs to be filled to understand factors that specifically contribute to obesity among women among women in Sub-Saharan Africa. On a rudimentary scale, it is understood that the key drivers of obesity include high-calorie intake low energy expenditure, and exposure to an obesogenic environment [10]. An obesogenic environment is an environment that perpetuates a lifestyle that yields to obesity [11]. Such an obesogenic environment has easy access to energy-dense foods and usually, these foods are relatively cheap compared to foods considered as a healthier option. In such environments, there is ample advertisement of sugary drinks, snacks and readily made oily foods which contributes to creating an obesogenic environment. Coupled with a lack of access to physical activity equipment such as a safe neighbourhood or even a walkway/bike lane, all these factors contribute to creating an obesogenic environment and perpetuate a sedentary

lifestyle. Beauty expectations in LMICs exert harsh standards on women, especially regarding their weight and weight management [12]. It is expected that women should maintain a certain look to be classified as socially beautiful. In the Western world, women are expected to look undernourished, bony and skinny to be considered "beautiful" [13]. However this is contrary to the African beauty context, women are considered "beautiful" if they are fully figured, meaty and voluptuous, of which in most instances these women are likely to be medically obese [14].

Pregnancy is one big factor that contributes to high rates of overweight and obesity among women of childbearing age [15]. Pregnancy is perceived as a time to relax and not focus on how much weight one gains [16]. During pregnancy, it is common to find pregnant women exponentially indulging in high-calorie content foods. It is seen as socially acceptable to eat unhealthy foods because of cravings or the notion of "eating for two" [17]. During pregnancy, women who are already overweight/obese are at higher risk of gaining excessive weight. Generally, at least 45% of women are overweight/obese at the beginning of their pregnancy [18]. A study conducted by Gunderson, (2009) [9] found that women who are already classified as overweight/obese pre-pregnancy are 6 times more likely to surpass the recommended weight gain during their pregnancy. *Table 1* below shows the recommended weight gain during pregnancy according to the Institute of Medicine [IOM] calculated using Kg's [19]. The IOM developed these weight gain guidelines in 2009 to help curb the rising number of pregnant women gaining excessive weight in an unhealthy manner during pregnancy.

Table 1: IOM guidelines for recommended weight gain during pregnancy [19].

Pre-Pregnancy Weight Category	Body Mass Index (BMI)*	Recommended Range of Total Weight (Kg)	Recommended Rates of Weight Gain† in the 2nd & 3rd Trimester (Kg) Mean Range [Kg/week]
Underweight	Less than 18.5	12.5Kg – 18Kg	0.5 (0.5 - 5.9)
Normal Weight	18.5 – 24.9	11.5Kg – 16Kg	0.5 (0.4 - 0.5)
Overweight	25 – 29.9	7Kg - 11.5Kg	0.3 (0.2 - 0.3)
Obese	30 >	5Kg – 9Kg	0.2 (0.2 - 0.3)

***BMI is calculated as weight in Kg's divided by height in m^2.**
†Calculations assume a 0.5 – 2kg weight gain in the first trimester.

Pregnancy weight gain that exceeds the recommended rates imposes adverse maternal and infant outcomes [20]. Adverse risks such as gestational diabetes, delivery complications, adiposity and lower cognitive skills in the offspring, obesogenic infant appetitive traits (an infant who has reduced satiety response to food leading to overeating/undereating), as well as other chronic diseases [21]. High GWG is a proven contributor to the current childhood obesity epidemic, the unfortunate outcome is that many pregnant women gain far too much weight, continuously exposing them to a greater risk of

adverse health concerns for both the mother and their unborn child [22]. Literature shows that there is a lack of counselling on the recommended weight gain amongst pregnant women, perpetuating the stereotype that it is excusable to excessively "eat for two" [23]. In addition, a common sedentary lifestyle in pregnancy exacerbates the excessive GWG [23].Therefore, it is imperative that one of the strategies for preventing excessive GWG is to influence women's perception of GWG before they consider getting pregnant, rather than during pregnancy because by then they have developed bad eating habits.

Excessive weight gain during pregnancy is a major predictor of postpartum weight retention (PPWR) which is associated with long-term adverse health outcomes. PPWR is the weight difference between pre-pregnancy and weight measured postpartum. Studies show that women ought to lose their gestational weight gain (GWG), 1 year after giving birth[25]. A study which followed 1666 Vietnamese women from 24 weeks gestation showed that at least 16.15% of women in the study gained excessive weight and experienced difficulties returning to their pre-pregnancy weight 12 months after delivery[26]. At least 14% to 26% of women are 5 kg heavier postpartum compared to preconception, this increases their risk of overweight/obesity which has an impact on subsequent pregnancies [27]. Retaining the weight gained in pregnancy during the postpartum period increases comorbidities such as type 2 diabetes after pregnancy, mental health disorders and maternal mortality rates [28]. Although GWG is a major predictor of PPWR, it is not the only factor that exacerbates PPWR. Ronnberg et al., (2016) [23], found in their study where they were assessing antenatal lifestyle interventions, that such interventions only reduced short-term weight retention (up until 6 months after giving birth), and at one year postpartum, the intervention's effects were no longer noticeable. Hence, it is important to understand what it is exactly that continuously promotes PPWR.

Other factors contribute to PPWR, such as genetical susceptibility and biological factors, however behavioural factors like food intake patterns are the most prominent contributing factors. Increasing consumption of unhealthy foods, such as processed meals and saturated fats that are high in calories and a high Glycaemic Index (GI) impact both short-term PPWR as well as long-term(>12 months) PPWR [30]. This is corroborated through a study conducted by Bertz et al., (2012) [23] assessing the contribution of diet and exercise in a weight-loss trial of 68 lactating overweight/obese Swedish women. In this study, they compared a low-calorie intake diet, exercise, a combination of diet and exercise and no intervention. The authors found that a low-calorie intake diet was significantly associated with weight loss at 12 weeks post-intervention and 1 year ($P < 0.001$ and $P = 0.002$), respectively. On the other hand, exercise was not significantly associated with weight loss. Although there was a significant association between a combination of diet and exercise, the authors noted this

was due to the low-calorie intake diet rather than exercise. These results suggest that a change in diet independently can reduce the amount of weight retained. Hence, it is beneficial to understand how food intake patterns during pregnancy and postpartum can assist curb the rise in obesity among women of childbearing age. It is evident that many of the studies done on food intake and PPWR, focus mostly on women in Western countries. Therefore, there is a need to understand how food intake patterns contribute to the South African population between pregnancy and postpartum and how it impacts PPWR in the latter.

Food intake is known to be a sub-system of social structure, an ideology that defines an individual's overall status, especially in African communities. These food intake patterns are influenced by economic, social, political, and cultural systems. In this regard, a nutritional shift due to globalisation is noticed in most African countries. Studies have shown that this shift is a key contributor to the obesity epidemic caused by the change of diet from traditional foods to a more common Western diet of readily made, cheap oily fried foods that are dense in energy and deficient in nutrition [32]. In many studies, food intake based on food insecurity has shown a negative relationship with health outcomes, such as the development of mental health issues, deficiencies, chronic infections as well as being overweight/obese [33]. Seeing that food intake driven by food insecurity is associated with a plethora of negative health outcomes, it is imperative to assess the role it could have on PPWR. South Africa is a heterogeneous socio-economy as well as a multicultural society, the majority of the Low Middle-Income Countries (LMIC) have a high prevalence of household poverty [34]. Henceforth, there needs to be a dive into the food intake consumed by those who are most susceptible to food insecurity in South Africa. This will help link how common food choices may impact BMI and subsequent GWG and PPWR. In turn, understanding the relationship between food intake and PPWR will inform the design of interventions targeted at curbing the obesity epidemic, particularly among women of childbearing age; thus, alleviating the burden of disease in South Africa.

In parallel to rising obesity, South Africa is challenged by high rates of human immunodeficiency virus (HIV) [35], which mostly affects women. Those living with HIV have at least 10-15% increased energy requirement as compared to those with HIV seronegative [36]. In addition, pregnancy is characterised by extra nutritional demands for the growing foetus. Historically, research on HIV commonly focuses on the impact of undernutrition during pregnancy. Malnutrition is widespread in HIV-positive people, particularly those on ART. This is owing to insufficient dietary intake, appetite loss, nutritional losses, metabolic alterations, and increased requirements for both macro- and micronutrients [36]. As a result, there was an increased need for people living with HIV and on ART to gain weight to perceive themselves as healthy (Hurley et al., 2011) [9]. This need was induced by the

stigma previously known that individuals with HIV are skinny and wasting away. However, with the rapid rates of obesity in the HIV group (at least 68% of individuals enrolled in a study conducted Hanley et al., (2021) [23], were overweight/obese), it is clear that research needs to be redirected on the impact of HIV and obesity during pregnancy and postpartum. There are at least 40% of pregnant women living with HIV and 45% of those women are obese [39]. Therefore, it would be a disservice to ignore the effect of HIV status especially with the current exponential rates of obesity among pregnant HIV-positive women. Henceforth, in this study, it is necessary to investigate the possible differences in food intake amongst those living with HIV using ART and those HIV-seronegative and to understand how the double burden of HIV and obesity influence PPWR.

This research aims to establish the prevalence of PPWR and to identify possible predictors associated with PPWR among women in the township of Gugulethu, Western Cape, South Africa. In particular, the study will investigate patterns of food intake during gestation and postpartum periods; and how it impacts PPWR. This knowledge is likely to improve the dearth of information on PPWR in South Africa and the African context and identify possibly modifiable risk factors. This research might be a stepping stone for the implementation of policy changes for obesity intervention strategies that may help mitigate the rising obesity epidemic in the country. Understanding the window of opportunity to decrease obesity induced by PPWR among women of reproductive age, might in return trickle down to reduce the overall prevalence of female obesity in the country.

2. Purpose of the study

2.1. Research Questions

- Is there a difference in food intake patterns during pregnancy and postpartum periods, and do they differ by HIV status?
- What are the risk factors associated with the intake of high-calorie foods?
- What is the prevalence of GWG? and PPWR, and do they differ by HIV status?
- What is the association of food intake in pregnancy with GWG? and PPWR?

2.3. Aim and Objectives

- This study aims to investigate patterns of food intake during pregnancy and postpartum periods; and associations with GWG and PPWR among women living with and without HIV.
- The objectives of the study are to:

- Describe food intake patterns during pregnancy and postpartum periods, overall and stratified by HIV status.
- Examine risk factors associated with the intake of high-calorie foods.
- Describe the prevalence of GWG and PPWR, overall and stratified by HIV status.
- Examine the association of food intake in pregnancy with GWG and PPWR.

3. Methodology

3.1. Study Design

This study has analysed secondary data of the 'Cardiometabolic Risk in Pregnancy' (CAMP) Cohort. The parent study aimed to address the dual burden of HIV and non-communicable diseases in pregnancy in South Africa. This study will expand on the aims of the parent study by focusing on GWG and PPWR and associated risk factors. According to the literature, there was no recommended sample size for PPWR outcomes as cited by Zanotti et al., (2015) [9] and Jayasinghe et al., (2022) [41]. Based on the 400 people enrolled in the parent study, the estimated sample size for this study was 195 (calculated using the Raosoft® sample calculator). This number is similar to the amount used in the study conducted by Jayasinghe et al., (2022) [41]. The estimated prevalence was set at 50%, the margin of error was set to 5% and a 95% confidence interval, were the recommended values used to calculate sample size [9]. The *finite* formula was chosen since this study will be using the 400 participants enrolled from the parent study as the population of this secondary study. Figure 1 below shows the finite formula used to calculate the sample size.

$$n^1 = \frac{n}{1 + \frac{Z^2 * \hat{p}(1-\hat{p})}{\epsilon^2 N}} = \frac{197}{1 + \frac{1.96^2 * \widehat{0.5}(1-\widehat{0.5})}{0.5^2 * 400}} = 195{,}13$$

Figure 1: Sample size calculation based on PPWR outcome.

The primary exposure of this study was food intake. Studies show that a typical South African household consumes foods that are known to be obesogenic such as very oily fried foods, processed meats, bread as a staple and high glycaemic index grains such as mealie meal [42,43]. Although food intake has been researched globally, not a lot of research has been done regarding the relationship between GWG, PPWR and the kind of food consumed in the South African context of pregnancy and postpartum periods. Further, risk factors associated with energy-dense food intake will be assessed in this study.

3.2. Characteristics of the Study Setting

Participants of this study were sampled from the Gugulethu Community Health Centre located in the township of Gugulethu, Western Cape province of South Africa. According to the census conducted in 2011, there are approximately 98000 people in the township of Gugulethu and 99% of this population is predominately black. 60% of the population (age 15-64) is employed with 71% of households earning a monthly income of R3200 or less. At least 46% of the population live in an informal structure such as a shack, whilst 52% of the population live in a formal structure [44]. The CAMP study was a prospective cohort study among pregnant women aged ≥18 years in the township of Gugulethu. The study concentrates on singleton pregnant women who were able to show up for their follow-up appointments at the Gugulethu Community Health Centre during visit 1 at 24-28 weeks of pregnancy, visit 2 at 34-36 weeks, and 6-24 months postpartum.

3.3. Recruitment & Enrolment

Sampling was done at the Gugulethu Community Health Centre, where 400 participants were enrolled. Participants were enrolled using the convenience sampling method in the main study by study staff who were trained to collect data for the CAMP study. The inclusion and exclusion criteria for this study are the same as the one used in the main study.

Inclusion Criteria

- Pregnant women who are ≥18 years of age
- Both women living with HIV and living without HIV

Exclusion criteria

- Those who are < 18 years old.
- Those with type 2 diabetes and on diabetic medication, hypertension, and other weight-altering conditions.
- Those who do not have complete data entries.

The exclusion of individuals with type 2 diabetes, hypertension and other weight-altering conditions is convenient for this study as diabetes and hypertension are plausible confounders [26,40]. This study was interested in women with singleton pregnancies and with complete data entries at the end of 6 months follow-up from commencement.

3.4. Data Collection Methods

As this was secondary data analysis participants were not subjected to any procedures. Data was collected using questionnaire tools broadly described under section 3.5 data analysis. This study was interested in the following sections from the data tool:

- Demographics, clinical information, obstetric information, physical activity and BMI, household food insecurity and food intake during gestation, and the Edinburg Postnatal Depression scale.
- During the first visit, a detailed food frequency indicator questionnaire was again used to capture additional information on food intake. During this visit, participants were also asked questions about other variables of interest such as social support.
- Permission was granted to the parent study to access the hospital records of the participant using the provincial health data centre.

Each visit in the parent study was approximately 2.5 hours per participant, with 3 visits in total. Data was collected through face-to-face interviews.

Table 2: Variables to be included in this analysis.

Variables	Variable Type	Justification for choice
Age (in years)	Numeric – discrete	Date of birth
Education	Categorical – nominal	No education, Primary/secondary, Tertiary
Employment	Categorical – binary	Employed, Not employed
Income	Categorical – ordinal	< R5 000 per month, ≥ R5 000 per month
Marital Status	Categorical - nominal	Living together, Not living together, Not in a relationship
Parity	Numeric – discrete	Nulliparous, Primiparous, Multiparous
Gravidity	Numeric – discrete	Nulligravida, Primigravida, Multigravida
London Measure of Unplanned Pregnancy (LMUP)	Categorical - ordinal	0-3 (unplanned), 4-9 (ambivalent), 10-12(planned)
Physical activity (using a grading system)	Categorical	Less Active, Moderately Active & Highly Active
Food insecurity	Categorical – nominal	Food insecure (≥ 2 yeses), food secure (<2 yeses)
Edinburgh Postnatal Depression Scale (EPDS)	Categorical - binary	<10 (possibly not depressed), ≥ 10 (possible depression)
Alcohol Use Disorders Identification Test (AUDIT)	Categorical – binary	<15 (no dependency), ≥ 15(dependency)
BMI	Continuous & Categorical – nominal	Collected as a continuous & underweight, normal, overweight & obese
Preconception/1st trimester weight	Numeric- Continuous	Continuous (kg)

Variables	Variable Type	Justification for choice
GWG (kg) according to IOM guidelines	Categorical – nominal	Inadequate, Adequate & Excessive
Food Intake	Categorical – nominal	Protein, starch, legumes, fats, dairy, fruits, vegetables, n (%)
Social Support	Categorical – nominal	Spouse, friends, family member, midwife/government, n (%)

3.5. Data Analysis

3.5.1. Analysis of Outcome

The calculation for PPWR is:

$$\mathrm{PPWR}_{6\mathrm{months}} = \mathrm{Wt}_{\mathrm{v2}} - \mathrm{Wt}_{\mathrm{pre}}$$

As there is no data on pre-conception weight, this study will correct for this using the method described by Santos et al., (2018) [23]. As there is no specific guideline to categorise PPWR, the study set categories for PPWR as <0 weight loss, 0-5kg normal weight retention and greater than 5 kg as excessive PPWR after 6 months of delivery [46] [27]. The outcome was collected as a continuous variable and analysed as a categorical variable. Multivariable regression models with an odds ratio coefficient of (95% CI) were used to assess association.

3.5.2. Analysis of Food Intake

Food intake was assessed at the first visit which was between 24 to 28 weeks of gestation and 6 months postpartum. Unhealthy gestational weight gain can influence the inability to lose weight postpartum [41]. Therefore, Gestational Weight Gain was calculated as:

$$\mathrm{GWG} = \mathrm{Wt}_{\mathrm{Before\ Delivery}} - \mathrm{Wt}_{\mathrm{visit1}}$$

Food intake was again assessed during month 6 postpartum follow-up, this was done to help the researcher understand if dietary habits have changed since delivery or stayed the same. The data collection tool used to assess food intake was a food frequency indicator questionnaire, specifically developed for the South African adult context [47]. A modified 76-food frequency questionnaire is adopted for this study similarly used by Madlala et al,. (2021)[42] in their study for pregnant subjects. The foods found on this questionnaire are common South African foods available at the local shops. The questionnaire assessed the frequency of consumption on the daily as well as on average, per week. In this study, the questionnaire assessed the consumption frequency of 10 food groups using the Minimum Dietary Diversity for Women (MDD-W) developed by the Food and Agricultural Organisation [FAO] [48]. The MDD-W is a dichotomous indicator based on 10 main food groups

namely: meat, eggs, milk and milk products, starchy staples, nuts and seeds, vitamin-A green leafy vegetables, other vitamin-A fruits and vegetables, other vegetables, as well as other fruits. Mixed dishes, such as stews or sandwiches were categorized based on their main components. The questionnaire was in-depth and intense to ensure it was very inclusive of every item. Food frequency questionnaires are not commonly used amongst pregnant women, however, there is no reason to doubt the suitability of this questionnaire because it only looks at the number of times the woman ate the food item in the past week. Food intake will be reported as per the 10 food groups listed above, as a frequency n (%). Food intake will be stratified by HIV, GWG and PPWR at 6 months.

3.5.3. Analysis of Other Risks

This study assessed other key risk variables collected from the parent study. Amongst these was the postpartum depression among the participants that was assessed using the Edinburg postnatal depression questionnaire. This scale was reported as a categorical variable with a score ≥10 meaning possible depression [49]. This postpartum depression questionnaire was asked during the first visit and will be presented using median (IQR). Cultural norms are very important in motherhood and understanding how a mother receives social support from the health system, life partner and family is crucial. Therefore, during the second visit data was collected asking about the social support structure available to the mother. Social support questions are measured on a Likert scale. Social support questions were analysed as categorical variables using frequency (%) as described by Faleschini et al., (2019) [23].

Height and weight were measured by a trained nurse using an adult scale for weight and a tape measure for height. Based on the height and weight measurements Body Mass Index (BMI) was calculated. BMI is = $\text{Weight/Height}m^2$. BMI was classified using the WHO guidelines BMI for adults [51]. BMI was calculated for all visits, and it was analysed as both continuous and categorical variables presented using mean (SD) or median (IQR). The Alcohol Use Disorders Identification Test (AUDIT) was used to assess alcohol disorders. The AUDIT was analysed as a categorical variable with a score ≥15 meaning dependency on alcohol according to WHO, (2020) [52]. Alongside the above-mentioned risk factors, other risks that were measured include physical activity which is self-reported. Physical activity was categorised into low, moderate, and high physical activity using a grading scale of 1-3 respectively. Other risk variables that were measured are income (including grant money),

level of education and demographics analysed using a regression model and significant variables with a p-value ≤ .05 was used for reporting.

Descriptive statistics were used to summarise the population, presented in the form of a median (IQR), mean (SD) or frequency (%) accordingly. The influence of predictors on the main outcome (PPWR) was estimated using an odds ratio (95% CI) model. A priori confounders in this study were referenced in the literature including smoking, employment status, parity, education level and maternal age will be adjusted for in the regression model [26]. HIV status was considered as an effect modifier. All statistical analysis were done using R software, R version 4.2.0 (2022-04-22) or the latest version of R software.

3.6. Data Safety & Monitoring

The Human Research Ethics Committee (HREC), University of Cape Town approved the parent study; HREC REF: 505/2020 and all procedures of the parent study were conducted following strict protocols. All data collected during the parent study was saved on a password-protected redcap system. Hardcopy data was kept in a locked cabinet for files with restricted access. The current study used de-identified datasets. Data for this secondary analysis study was only shared with the lead author under the supervision of Dr Hlengiwe Madlala. All upcoming data was monitored as per the parent study protocol and shared with this study as and when new developments occur. The sharing of data was only done with the elected individual for this study. Consent was obtained from the parent study. This study is a secondary data analysis, therefore, no further contact with participants took place, and minimal risk was posed to the participants.

4. Ethical Considerations

4.1. Description of Risks & Benefits

In this retrospective secondary data analysis, there was no potential risk or discomfort experienced by the participant. All data used for this research was secondary with no intention to gather further information from the participants. From this research, there is no benefit for participants. However, this research will assist in influencing policy change and better understanding of the outcome thus improving society at a greater scale. This research aims to bring evidence-based decision-making to influence policy change on how to improve obesity

in South Africa. In return, this research will advance the context-specific knowledge gap that is currently explicit, not only for South Africa but for Africa in general.

4.2. Informed consent process

Consent was obtained from the parent study HREC REF: 505/2020. In the main consent form, participants acknowledge the use of their data/specimens for further studies and analysis post-completion of the main study. In the initial study, participants were spoken to in their preferred language for a better understanding of the study. Allowing participants to take their time before deciding, allows them to discuss their involvement in the study with family, friends, or physicians. This is encouraged so that the participant can make a well-rounded decision. The informed consent speaks on what will be done and if there are any questions participants know who they can contact. Participants were also informed that they did not have to consent immediately. To ease the pressure, follow-up was conducted at the initial location, which was the Gugulethu community health centre where participants were initially recruited. Participants were reimbursed for their time and travel expenses for each follow-up visit.

4.3. Privacy & Confidentiality

All data that was reviewed for this study has been de-identified. Therefore, any identification that links to the participant was not shared with the researcher conducting this secondary study. This is done to ensure that confidentiality and privacy are protected as per the consent form. All data is currently stored on Redcap, and the researcher for this study will be given access to a subset of the data on Redcap. All data was continuously stored on redcap and once this research is completed, the holder of the primary data will change login details to maintain singular accessibility again. No data was stored on the researcher's personal computer or cloud storage. Any other storage platform used was at the discretion of the primary data holder.

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Section C: Manuscript

Food intake patterns and associations with gestational weight gain and postpartum weight retention in women living with and without HIV in Cape Town, South Africa

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Abstract

Background: Excessive gestational weight gain (GWG) and postpartum weight retention (PPWR) contribute significantly to elevated rates of overweight and obesity in women of reproductive age, increasing their risk for long-term health issues like type 2 diabetes, hypertension, and certain cancers. Women living with HIV experience heightened energy needs, compounded by the nutritional demands of pregnancy. This study in Gugulethu, South Africa, investigates the impact of dietary patterns during gestation and postpartum on GWG and PPWR among this population. **Methods:** This retrospective secondary data analysis used the prospective Cardiometabolic Risk in Pregnancy (CAMP) cohort study, which enrolled 400 pregnant women (200 with HIV, 200 without HIV) from November 2019 to October 2022, with a 6-month postpartum follow-up. Food intake was assessed using the Minimum Dietary Diversity for Women (MDD-W).Food intake was stratified using HIV, GWG and PPWR respectively. Weight assessments in pregnancy and postpartum periods were conducted by a trained study nurse and GWG was categorised as adequate, inadequate, and excessive weight gain according to the Institute of Medicine (IOM) guidelines and PPWR was categorised as weight loss (<0kg), normal weight retention (0-5kg) and excessive weight retention (>5kg). Multinomial regression models examined associations between food intake, GWG, and PPWR while adjusting for confounding variables including parity, education, food security as well as income. **Results:** The median age of the women was 30.1 years (IQR 25.4-34.0), and 82% were multigravida, indicating potential influences from previous pregnancies on health behaviours and outcomes. Women living with HIV showed higher food intake and dietary diversity during gestation, particularly in starchy staples (38%) and meats (37%) compared to women living without HIV (26% each), suggesting a need for dietary interventions. Women living with HIV compared to women living without HIV, were more likely to experience inadequate weight gain during pregnancy as opposed those with adequate weight gain (OR = 2.24, 95% CI 1.12-4.46), leading to adverse outcomes like low birth weight and preterm delivery, highlighting the necessity for specialized nutritional support. Postpartum, excessive weight retention was associated with milk and milk product consumption, where women consuming milk and milk products compared to those not consuming milk and milk products, were more likely to experience excessive weight retention relative to those who experienced normal weight retention (OR = 2.278 95% CI, 1.10,7.05), emphasizing the need for dietary counselling. **Conclusion:** Our results add valuable insights to the current knowledge by offering detailed perspectives on the complex connections between dietary diversity and its broader consequences on maternal aspects such as GWG and PPWR. Targeted nutritional interventions are needed to promote healthy weight during pregnancy and postpartum periods, particularly among women living with HIV.

1. Introduction

Since 2016, over 2 billion adults (>18 years) worldwide have grappled with obesity or overweight conditions [1]. Notably, 40% of the global female population is overweight and 15% are classified as obese [1]. In South Africa, women bear the highest burden of obesity, with at least 41% of women having a mean Body Mass Index (BMI) score ≥ 30 kg/m2 as of 2016 [2]. Individuals with an elevated BMI, signifying overweight (≥ 25 kg/m2) or obesity (≥ 30 kg/m2), are at risk of developing a range of comorbidities, including cardiovascular diseases, type 2 diabetes mellitus, hypertension, and certain cancers [3]. Such health risks not only diminish an individual's quality of life but also reduce life expectancy by at least 3.3 years [3].

Pregnancy stands out as a significant contributor to the high prevalence of overweight and obesity among women of childbearing age [4]. Approximately 45% of women enter pregnancy already overweight or obese [5]. Shockingly, between 2003 and 2005, half of the maternal deaths in the United Kingdom were linked to overweight or obesity [6]. Pregnancy weight gain beyond recommended ranges, as defined by the Institute of Medicine (IOM), leads to adverse outcomes for both mothers and infants[7]. These outcomes include gestational diabetes, delivery complications, infant adiposity, lower cognitive skills, and obesogenic appetitive traits in the offspring [8,9]. The adverse impacts extend to long-term health outcomes, connecting high gestational weight gain (GWG) to the childhood obesity epidemic [10].

Importantly, excessive weight gain during pregnancy serves as a significant predictor of postpartum weight retention (PPWR), defined as the weight difference between pre-pregnancy and postpartum, further exacerbating the risk of adverse health outcomes[11]. PPWR often persist beyond the recommended postpartum year, with 14% to 26% of women retaining 5 kg or more, increasing the risk of subsequent overweight or obesity [12,13]. This prolonged weight retention poses risks such as type 2 diabetes, mental health disorders, and elevated maternal mortality rates [14]. While GWG is a crucial predictor of PPWR, other factors, including genetic and biological elements, play a role, with behavioural factors, especially food intake patterns, emerging as prominent contributors[15].

Unhealthy food consumption, marked by increased intake of processed meals, saturated fats, and high-calorie foods with a high Glycaemic Index (GI), is associated with both short-term and long-term (>12 months) PPWR [16]. Furthermore, economic, social, political, and cultural systems influence food intake patterns, with South Africa's diverse socio-economic landscape contributing to variations in food choices [17,18]. Distinctively in Low-Middle-Income Countries (LMIC), prevalent household poverty needs to be explored in the context of food insecurity, offering insights into the relationship between common food choices, BMI, and subsequent GWG and PPWR[19].

This research aimed to ascertain the prevalence of GWG and PPWR and identify its potential predictors in the township of Gugulethu, Western Cape, South Africa. In addition, the research investigated the impact of food intake patterns during gestation and postpartum periods. By enhancing our understanding of GWG and PPWR in the South African context, this study sought to identify modifiable risk factors, potentially catalysing policy changes in obesity intervention strategies. Henceforth, it was critical to recognise the window of opportunity to address obesity induced by GWG and PPWR among women of childbearing age, which might lead to broader initiatives that mitigate the escalating obesity epidemic in the country. This research aimed to contribute valuable insights that could inform interventions, ultimately reducing the overall prevalence of female obesity in South Africa and beyond.

2. Methodology

2.1. Study Setting.

Gugulethu is a township located in the Western Cape province of South Africa, had a population of approximate 98,000 [20]. According to the 2011 census with 99% of the population being predominately Black and aged between 15-64 years [20]. 60% of people in this population were employed and 71% earn a monthly income of R3,200 or less [20]. The living conditions were varied with 46% residing in informal structures such as shack and 52% in formal housing [20].

2.2. Study Sample

In this context, a prospective cohort study was conducted in which 400 pregnant women (n= 200 women living with HIV, n= 200 women living without HIV) were enrolled in the parent study 'Cardiometabolic Risk in Pregnancy' (CAMP). The participants were attending antenatal care at the Gugulethu Community Health Centre. The study included pregnant women who were ≥18 years old and living with or without HIV. In this population, women living with HIV were primarily on the treatment of Efavirenz (EFV) and dolutegravir (DTG). Participants were excluded from the study if they did not meet the criteria such as being below 18 years of age, having type 2 diabetes and taking diabetic medication, or having hypertension or other conditions associated with weight change as these are plausible confounders in the study [21]. The study ran from November 2019 to October 2022 and followed the participants throughout pregnancy and up to 6 months after delivery. The study included study visit 1, which occurred between 24 to 28 weeks of pregnancy, study visit 2, which occurred between 34 to 36 weeks of pregnancy, and study visit 3, which occurred 6 months after delivery.

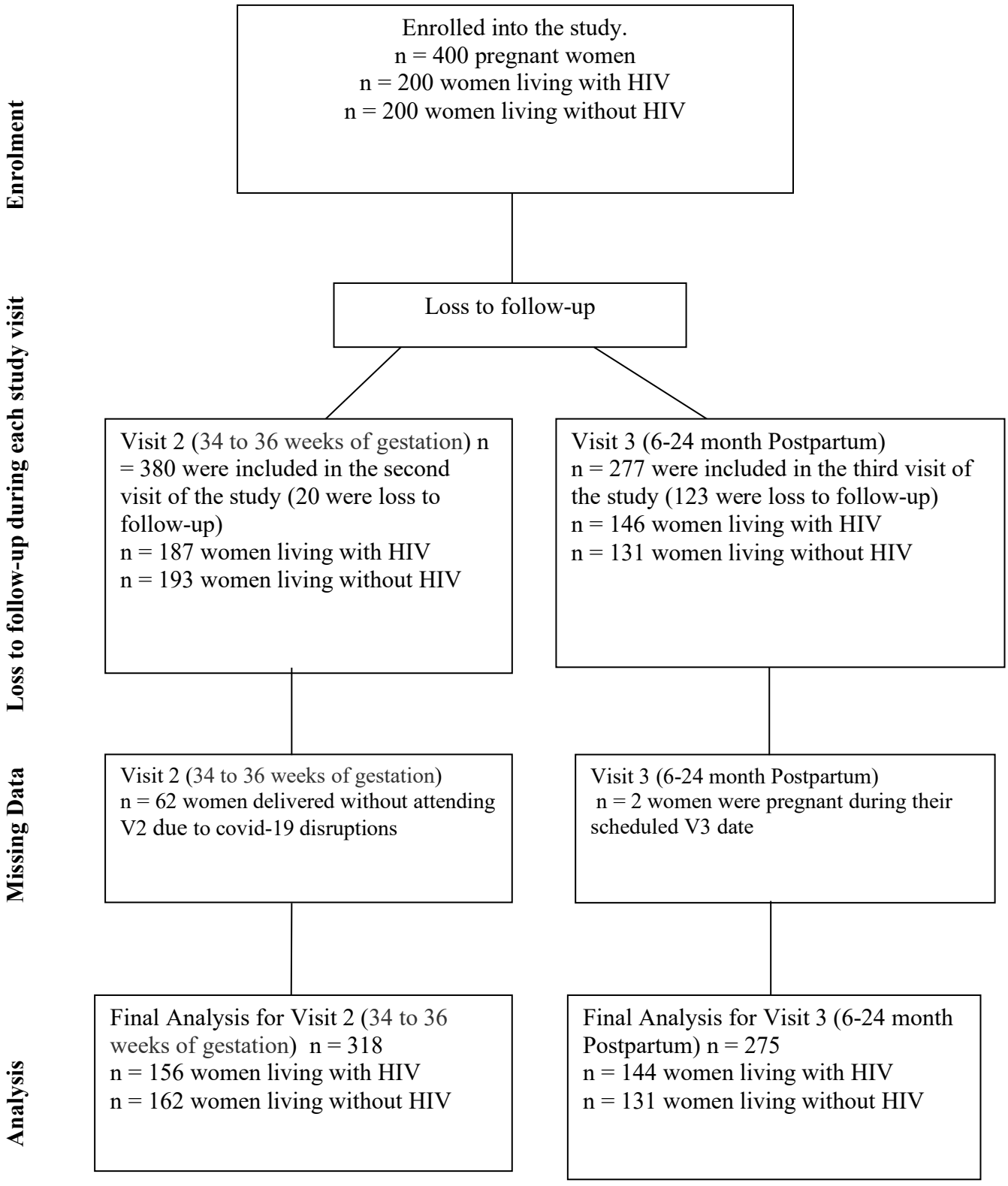

Figure 1: Consort diagram of secondary data analysis of the parent CAMP prospective cohort study

2.1. Exposure assessment

To assess food intake during pregnancy and postpartum, the CAMP study adopted the 76-question food frequency questionnaire (FFQ) used by Madlala et al., 2021; Senekal et al., 2009)[22,23]. The FFQ is specifically tailored to the South African context to investigate food intake. Using this tool participants were required to recall the frequency at which they consumed a specific food item weekly. For this study, items from the FFQ were analysed using the updated Minimum Dietary Diversity for Women (MDD-W) developed by the Food and Agricultural Organisation (FAO) [24]. The MDD-W is a dichotomous indicator that is used to assess whether women have consumed at least 5 of the 10 main food groups[24]. The 10 main food groups are meat, eggs, milk and milk products, starchy staples, nuts and seeds, vitamin-A green leafy vegetables, other vitamin-A fruits and vegetables, other vegetables, and other fruits. Mixed dishes, such as stews or sandwiches were categorized based on their main components. Using the MDD-W helps describe the proportion of women consuming each food group, and assists in viewing changes in dietary patterns between pregnancy and postpartum periods [24]. Foods such as sweets, fried foods, sugar-sweetened beverages, condiments, and non-dairy products are grouped as additional foods according to the MDD-W guideline. These additional foods do not count towards the scoring of the MDD-W however, they assist in describing the proportion of women who consume such foods [24].

2.2. Outcome assessment

Gestational weight gain: At enrolment, weight and height measurements were collected by a trained nurse. Using these measurements, Body Mass Index (BMI) was calculated and divided into four subgroups: those with a BMI < 18.5kg/m^2 are underweight, those with a BMI < 24.9kg/ m^2, are normal weight, those with a BMI < 25.0kg/ m^2 are overweight and those with a BMI > 30.0kg/m^2 are obese [25]. GWG was calculated as the difference between visit 2 weight before delivery (34 – 36 weeks) and the weight at visit 1 (24 – 28 weeks).

$$\text{GWG} = \frac{Measured\ Weight\ (visit\ 2) - Measured\ Weight\ (visit\ 1)}{Weeks\ between\ visit\ 1\ and\ 2}$$

Using the above formulae, GWG was calculated following the IOM guidelines and classified into three categories: inadequate, adequate and excessive weight gain as described in Radwan et al., (2022) [26,27]. According to the IOM, the recommended weight gain ranges in the 2nd and 3rd trimester (Kg/week) are 0.5 (0.5 - 5.9)kg for women whose BMI is underweight, 0.5 (0.4 - 0.5)kg for women with normal weight BMI, 0.3 (0.2 - 0.3)kg for women whose BMI is overweight, and 0.2 (0.2 - 0.3)kg for women whose BMI is obese (Table 1: supplementary material) [7].

Postpartum weight retention: The computation of PPWR was performed by determining the difference between the weight at visit 3, which occurred 6 months postpartum, and visit 1 pre-pregnancy weight, which was self-reported [28]. As there is a lack of established guidelines for classifying PPWR, this study adopted the methodology employed by Fadzil et al., (2018) [11], where the categories for PPWR were defined as follows: weight loss (<0kg), normal weight retention (0-5kg), and >5kg is excessive PPWR six months post-delivery. This categorization helps in identifying and analysing the extent of weight changes postpartum, allowing for a better understanding of maternal health outcomes.

2.3. Other covariates

Baseline characteristics were collected during enrolment (visit 1, 24-28 weeks of pregnancy). These include demographic indicators such as age at enrolment, education status, employment status, marital status, monthly household income, antiretroviral medication, gravidity, and parity. Other indicators were food insecurity, depression during pregnancy, alcohol dependency, and physical activity.

2.4. Data analysis

Continuous and categorical variables were assessed using descriptive summary statistics, including frequencies and proportions, as well as medians with interquartile ranges (IQR). Independent t-tests or the Wilcoxon rank-sum test were employed to compare distributions of continuous variables, depending on normality assessed by the Shapiro-Wilks test, while Chi-squared tests were used for categorical variables to assess differences in baseline characteristics by HIV status. Differences in food intake by HIV status were also evaluated. PPWR prevalence was described using descriptive statistics overall and stratified by HIV status. Multinomial regression models were employed to investigate the association between food intake during gestation and postpartum periods, assessing GWG and PPWR. These models were adjusted for a priori confounding variables, including employment status, parity, education level, and maternal age, as identified in the literature [29]. All analyses were performed using R software version 4.2.2 [30], with p-values lower than 0.05 considered statistically significant.

3. Results

3.1. Baseline characteristics

Table 1 shows the baseline characteristics of a cohort comprising 400 women, overall and categorized by HIV status. The median age for the overall cohort was 30.1 (IQR, 25.4-34.0) years, with significant variations between women living with HIV 31.8 (IQR, 27.7-35.9) years and those without HIV 27.6 (IQR, 24.0-31.7) years (p-value <0.01). Notably, 18% (n=71) of women were classified as food insecure, with 20% (n=39) of them being women living with HIV and 16% (n=32) being women living without HIV (p-value = 0.400). Examining BMI, 52% (n=206) of the overall sample exhibited obesity, 48% (n=98) of women living with HIV were classified as obese in contrast to the 55% (n = 110) of women without HIV (p-value = 0.300). Physical activity status revealed that 91% (n = 363) of the entire cohort lived a less active lifestyle, with 90% (n=179) of women living with HIV and 92% (184) of women living without HIV were less active (p-value = 0.500). Among women living with HIV, 56% (n=111) were on EFV while 44% (n=89) were on DTG.

3.2. Food intake patterns during pregnancy and postpartum periods

Figure 2 describes the differential food intake patterns during pregnancy and postpartum, by HIV status. Notably, women living with HIV exhibited heightened proportions of food item consumption compared to their counterparts without HIV. The analysis reveals statistically significant disparities in the consumption of eggs during the gestation period of V1 (during pregnancy), (p-value = 0.007). However, during V3 (during postpartum), egg consumption was not statistically significant (p-value = 0.555). Nevertheless, there is an observed increase in the proportion of egg consumption among women without HIV at V3 compared to V1. Legumes emerge as the least consumed food items within this population, with a proportion of 14% of women reporting legume consumption at V1 and 11% at V3. Conversely, starchy staples rank as the most frequently consumed food category, with over 38% of women incorporating starchy staples into their dietary regimen evident at V1, (p-value <0.001) in the consumption of starchy foods among women living with HIV compared to those without HIV. Meats rank as the second most consumed item, with 37% of women living with HIV exhibiting a heightened proportion of meat consumption during V1, (p-value <0.001). Meat consumption remains relatively elevated among women with HIV for V3 compared to those without HIV, these differences are not statistically significant (p-value >0.584). The overall assessment of the Minimum Dietary Diversity for Women (MDD-W) (Figure 2) during V1, reveals a notably high dietary diversity score among at least 35% of women living with HIV in contrast to the 25% of women without HIV, p-value <0.001.

Figure 3 illustrates food items categorized as additional foods. Among these, sugar-sweetened beverages emerge as the most consumed, with a proportion of at least 38% of women living with HIV exhibiting the highest consumption during V1 (p-value <0.001). A similar trend is observed during V3, sugar-sweetened beverages are most consumed among those living with HIV as compared to those without HIV; however, these results lack statistical significance (p-value = 0.584). During V1, women living with HIV demonstrated a consumption of at least 30% of fried and salty foods compared to women without HIV (p-value of 0.005). At V3, an increase in the proportion of fried and salty foods is noted in both groups of women, irrespective of HIV status. Nevertheless, these findings are not statistically significant (p-value = 1.000). In the broader context, women living with HIV exhibit the highest proportion of additional food consumption, approaching 38% during V1, (p-value <0.001).

3.3. Gestational weight gain and postpartum weight retention

Figures 4 and 5 present a comprehensive overview of the median weight changes during gestation and the postpartum period, respectively, with a detailed stratification by HIV status. **Figure 4** shows an increased overall weight gain trajectory from pre-pregnancy until 34-36 weeks of gestation (V2 the last antenatal study visit) among individuals exhibiting excessive weight gain. Conversely, those with inadequate weight gain show a weight increase from pre-pregnancy to V1, followed by a minor gain at V2. Among individuals living with HIV in the adequate and excessive weight gain categories, there is a discernible reduction in weight gain from self-reported pre-pregnancy weight to V1 weight. Conversely, those living with HIV in the inadequate weight gain category experience a sharp increase in weight gain between pre-pregnancy and V1, followed by a subsequent decrease at V2 of gestation. Women without HIV display an increase in GWG for both the adequate and excessive weight gain groups, however, in the inadequate weight gain group there is a decrease in weight gain during V2. **Figure 5** extends the analysis to the postpartum period, providing insights into the overall change in median weight. Among those with excessive weight retention, the median change in weight for women living with HIV was 90.45kg (IQR, 61.98kg-130.83kg) and 80.90kg (61.98kg-132.68kg) for women living without HIV. Women living with HIV had a change in median weight of 67.90kg (IQR, 54.40kg-108.38kg) and for women living without HIV was 88.40kg (IQR, 58.20kg-110.24kg) among those with normal weight retention. The median change in weight for women living with HIV who experienced weight loss at postpartum was 73.60kg (IQR, 45.95kg-113.80kg) and 76.50kg (IQR, 52.05kg-112.82kg) for women living without HIV.

3.4. Association of food intake with GWG and PPWR

Table 2 displays outputs from the univariable multinomial regression models assessing the association of food intake during gestation and the postpartum period. Women who consumed meat compared to those who did not consume meat, are less likely to have excessive weight gain during gestation as opposed to adequate weight gain (OR = 0.49, 95% CI 0.25, 0.96). Furthermore women who consumed meat compared to those who did not consume meat, are less likely to have inadequate weight gain during gestation as opposed to adequate weight gain (OR = 0.51, 95% CI 0.26, 1.00). Among women who consumed milk and milk products compared to those who did not consume milk and milk products, are less likely to have excessive weight gain during gestation as opposed to adequate weight gain (OR = 0.40, 95% CI 0.20, 0.79). Women who consumed starchy staples compared to those who did not consume starchy staples, are less likely to have excessive weight gain during gestation as opposed to those with adequate weight gain (OR = 0.42, 95% CI 0.21, 0.85). Those who consumed other fruits compared to those who did not consume other fruits, are less likely to have inadequate weight gain during gestation as opposed to adequate weight gain (OR = 0.44, 95% CI 0.23, 0.83). Women who consumed fried and salty foods compared to those who did not consume fried and salty foods, were less likely to have excessive weight gain during gestation as opposed to normal weight gain(OR = 0.51, 95% CI 0.27, 0.97). During the postpartum period, women who consumed milk and milk products compared to those who did not consume milk and milk products, are more likely to have excessive weight retention as opposed to those with normal weight retention (OR = 2.78, 95% CI 1.10, 7.05). Other univariable models on food intake and PPWR did not converge, and others were not statistically significant.

Table 3 presents the output from the multivariable multinomial regression models on the predictors of GWG and PPWR. Women living with HIV compared to those living without HIV, are more likely to experience inadequate weight gain during gestation as opposed to normal weight gain (OR = 2.24 95% CI 1.12, 4.46). Similarly, in the postpartum period, those living with HIV compared to those living without HIV, are more likely to encounter weight loss as opposed to normal weight retention (OR = 2.16 95% CI 1.09, 4.27). These observed associations remain statistically significant, adjusting for all other covariates. No statistically significant associations are evident between age and PPWR. Furthermore, women who met the MDD-W requirements compared to those who did not meet the MDD-W requirements, are more likely to experience excessive GWG as opposed to normal weight retention (OR = 1.38 95% CI 0.39, 4.87). In postpartum, women who met the MDD-W requirements compare to those who did not meet the MDD-W requirements, were more likely to experience excessive weight gain as opposed to women with normal weight retention (OR = 2.81 95% CI 0.83,

9.50). However, these associations do not attain statistical significance while adjusting for other covariates. Among women who consumed additional foods compared to those who did not consume additional foods, are less likely to have excessive weight gain during gestation, as opposed to those with adequate weight gain (OR = 0.34 95% CI 0.09, 1.28). Conversely in postpartum, women who consumed additional foods as compared to those who did not consume additional foods, are more likely to have excessive weight retention as opposed to normal weight retention (OR = 1.04 95% CI 0.17,6.23). Albeit these associations did not reach statistical significance. Within the context of food insecurity, education, employment, income, marital status, and parity there were no statistically significant associations evident between GWG and PPWR.

4. Discussion

In this study, we examined potential variations in food intake between gestation and postpartum, and how does it differ by HIV status. We found that the overall prevalence of postpartum weight retention (PPWR), defined as retaining more than 5kg postpartum, stands at 35% (n=97) of the sample. Using the MDD-W as a measure to assess food intake variation in this population, women with HIV exhibited a significantly higher food intake and dietary diversity during gestation compared to their HIV-negative counterparts, these findings reaching statistical significance for V1. Meat, starchy staples, milk, and milk products as well as sugar-sweetened beverages were the most consumed items during gestation and postpartum. Furthermore, our findings suggest that women living with HIV were more likely to have inadequate weight gain during gestation and experience weight loss or no retention during the postpartum period.

These findings suggest that women living with HIV, despite potential challenges (such as unemployment and the majority living on <R5000 a month), tend to exhibit increased dietary diversity and are less likely to retain postpartum weight. The elevated food consumption among women with HIV might be attributed to the stigma associated with avoiding wasting (uncontrolled weight loss), leading to a proactive increase in food intake compared to those without HIV, as suggested by Panza et al., (2020)[28]. Henceforth, an observable heightened food intake pattern among women living with HIV transcends the 10 main food groups and follows across the additional food groups, where only sweets have a decreased consumption compared to other items (excluding non-dairy). Existing research suggests that breastfeeding women living with HIV face a risk of weight loss due to increased caloric demand from breastfeeding [26]. While women living with HIV in this population consumed larger quantities of starchy staples, fried and salty foods, and sugar-sweetened beverages, the increased caloric demand during breastfeeding might have led to a deficit hence findings showing

inadequate weight gain at 6 months postpartum. Even though breastfeeding is calorically demanding, maintaining unhealthy eating habits with prolonged exposure to high-calorie dense foods increases the risk of long-term health implications such as type 2 diabetes mellitus, cardiovascular disease and other diseases exacerbated by an obesogenic environment [32]. A striking observation from this study is that the women were classified as less active, further underscoring the prevalence of an obesogenic environment in this cohort. Notably, prolonged exposure to high-calorie foods not only affects the mother's postpartum health but also extends to the child [33]. The first 1000 days of a child's life, from conception to age two, are critically important for establishing a foundation for long-term health, encompassing aspects such as brain development, body composition, metabolism, and immune system function [34]. The quality of a mother's diet significantly influences her child's eating habits during these formative days. It is essential to recognize that a malnourished diet has far-reaching implications, leading to a myriad of negative health outcomes for both the mother and the developing child. This underscores the interconnectedness of maternal nutrition and its impact on the health trajectory of the child.

Strengths of this study include the comprehensive assessment of GWG and PPWR, the exploration of dietary patterns during gestation and postpartum, and the consideration of HIV status as a potential influencing factor. Nevertheless, limitations, such as the brief postpartum follow-up, have hindered the ability to thoroughly assess the impact of high caloric food intake and weight retention in this population when mothers decrease their breastfeeding rate as the child grows. Recall bias was another limitation when assessing food consumption, particularly during the postpartum period, those categorized as having excessive weight retention had a lower response rate compared to those who had normal weight retention and those who had experienced weight loss or did not retain any weight. Loss to follow-up diminished statistical power during postpartum assessments, resulting in non-convergent findings and thereby limiting the ability to comprehensively evaluate variations in food intake during the postpartum period based on HIV status. As the quantity of foods consumed was not recorded another limitation of the study is that we cannot ascertain the quality of the diet. Furthermore, the MDD-W has not been validated for use in pregnant women. The utilization of the MDD-W serves as a proxy for reflecting the micronutrient adequacy in a woman's diet, is constrained by its reliance on time point recall (specifically, the 24-hour recall or 7-day recall, as applied in this study) and only captures the frequency of consumption [24]. The MDD-W cannot accommodate everyday variability in food intake and quantity of food consumed [35]. Consequently, in this population, particularly during gestation (visit 1, 24-28 weeks of gestation), the MDD-W values indicate that women consuming at least 5 of the 10 food items are likely to exhibit higher

micronutrient adequacy compared to those without HIV. However, they are more likely to lose weight. Consequently, it is recommended that further studies assessing food intake, GWG and PPWR be conducted to assess the diet quality in such a population to gain a more comprehensive understanding of these findings. Furthermore, future research endeavours should address these limitations and further elucidate the complex interplay between maternal nutrition, PPWR, and long-term health outcomes.

5. Conclusion

In summary, this study contributes to the existing body of knowledge by providing nuanced insights into the intricate relationships between dietary diversity, and their broader implications on maternal in terms of GWG and PPWR. The findings underscore the necessity for targeted interventions addressing the unique challenges faced by pregnant women, especially those living with HIV, to promote healthier pregnancy and postpartum outcomes and break the cycle of potential adverse health effects on the next generation.

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Manuscript Tables

Table 1: Baseline characteristics, overall and by HIV status

Characteristic	Overall, N = 400	Women living without HIV, N = 200	Women living with HIV, N = 200	p-value
Median Age (IQR), years	30.1 (25.4, 34.0)	27.6 (24.0, 31.7)	31.8 (27.7, 35.9)	<0.001
Marital status, n (%)				0.300
Living together	171 (43)	85 (42)	86 (43)	
Not living together	197 (49)	103 (52)	94 (47)	
Not in a relationship	32 (8.0)	12 (6)	20 (10)	
Gravidity, n (%)				<0.001
Primigravida	73 (18)	51 (26)	22 (11)	
Multigravida	327 (82)	149 (74)	178 (89)	
Parity, n(%)				<0.001
Nulliparous	79 (20)	55 (28)	24 (12)	
Primiparous	151 (38)	75 (38)	76 (38)	
Multiparous	170 (42)	70 (35)	100 (50)	
Education status, n (%)				<0.001
Completed Primary	246 (62)	105 (52)	141 (70)	
Completed High School or Tertiary	154 (38)	95 (48)	59 (30)	
Employment status, n(%)				0.900
Unemployed	279 (70)	140 (70)	139 (70)	
Employed	121 (30)	60 (30)	61 (30)	
Household income status per month, n(%)				0.048
< R5 000 per month	331 (83)	158 (79)	173 (87)	
≥R5 000 per month	68 (17)	42 (21)	26 (13)	
Missing	1	0	1	
Alcohol dependency (AUDIT), n(%)				0.700

No Dependency	392 (98)	195 (98)	197 (98)	
Dependency	8 (2.0)	5 (2.5)	3 (1.5)	
Household food insecurity, n(%)				0.400
Food Secure	329 (82)	168 (84)	161 (80)	
Food Insecure	71 (18)	32 (16)	39 (20)	
Edinburgh Postnatal Depression Scale (EPDS), n(%)				0.300
Possibly not Depressed	383 (96)	194 (97)	189 (94)	
Possibly depressed	17 (4.2)	6 (3.0)	11 (5.5)	
Body Mass Index (BMI) before Pregnancy, n(%)				0.300
Normal weight (18.5 – 24.9)	82 (21)	38 (19)	44 (22)	
Overweight (25.0 29.9)	111 (28)	51 (26)	60 (30)	
Obese (≥ 30.0)	206 (52)	110 (55)	96 (48)	
Missing	1	1	0	
Physical activity status, n(%)				0.500
Less Active	363 (91)	184 (92)	179 (90)	
Moderately Active	37 (9.2)	16 (8.0)	21 (10%)	
Antiretroviral Therapy (ART) regimen, n(%)				
Efavirenz	111 (56)	-	111 (56)	
Dolutegravir	89 (44)	0	89 (44)	
P-values calculated using Wilcoxon rank sum test; Pearson's Chi-squared test				

Table 2: Univariable Multinomial Regression Models for food intake associated with Gestational Weight Gain (GWG) and Postpartum Weight retention (PPWR)

	Gestational Weight Gain (GWG)				**Postpartum Weight Retention (PPWR)**			
	Excessive Weight Gain (GWG)		**Inadequate (GWG))**		**Weight loss**		**Excessive Weight Retention**	
Food Variables	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
Meats	0.49 (0.25, 0.96)	0.038	0.51 (0.26, 1.00)	0.049	0.00 (NC)	0.900	0.00 (NC)	0.800

Eggs	0.59 (0.32, 1.09)	0.091	0.73 (0.40, 1.34)	0.300	1.06 (0.55, 2.06)	0.900	1.00 (0.51, 1.97)	0.900
Milk and Milk Products	0.40 (0.20, 0.79)	0.008	0.40 (0.21, 0.80)	0.009	1.25 (0.58, 2.71)	0.600	2.78 (1.10, 7.05)	0.031
Nuts and Seeds	0.84 (0.43, 1.65)	0.600	0.99 (0.51, 1.92)	0.900	0.69 (0.38, 1.26)	0.200	1.07 (0.58, 1.99)	0.800
Starchy Staples	0.42 (0.21, 0.85)	0.016	0.46 (0.23, 0.94)	0.033	0.00 (NC)	0.800	0.00 (NC)	0.700
Legumes	0.71 (0.36, 1.41)	0.300	0.88 (0.45, 1.73)	0.700	0.75 (0.39, 1.45)	0.400	0.79 (0.40, 1.54)	0.500
Other Vitamin A Rich Fruits and Vegetable	0.88 (0.47, 1.63)	0.700	0.78 (0.42, 1.45)	0.400	1.46 (0.68, 3.16)	0.300	1.20 (0.56, 2.58)	0.600
Vitamin-A Rich Leafy Vegetables	0.62 (0.32, 1.20)	0.200	0.76 (0.40, 1.45)	0.400	0.69 (0.38, 1.26)	0.200	1.85 (0.99, 3.47)	0.054
Other Vegetables	0.61 (0.33, 1.15)	0.130	0.73 (0.39, 1.36)	0.300	0.68 (0.23, 2.04)	0.500	0.99 (0.30, 3.25)	0.900
Other Fruits	0.61 (0.32, 1.17)	0.140	0.44 (0.23, 0.83)	0.012	0.82 (0.37, 1.84)	0.600	1.02 (0.44, 2.38)	0.900
Non-dairy	0.63 (0.28, 1.42)	0.300	0.66 (0.29, 1.47)	0.300	0.71 (0.36, 1.42)	0.300	1.07 (0.54, 2.10)	0.900
Condiments	0.59 (0.32, 1.09)	0.091	0.39 (0.21, 0.73)	0.003	1.03 (0.55, 1.90)	0.900	1.22 (0.64, 2.31)	0.500
Fried and Salty	0.51 (0.27, 0.97)	0.039	0.47 (0.25, 0.89)	0.021	0.91 (0.38, 2.22)	0.800	1.28 (0.49, 3.35)	0.600
Sweets	0.84 (0.46, 1.56)	0.600	0.92 (0.50, 1.69)	0.800	0.74 (0.40, 1.37)	0.300	1.53 (0.79, 2.96)	0.200
Sugar Sweetened Beverages	0.50 (0.25, 0.97)	0.041	0.61 (0.31, 1.19)	0.150	0.00 (NC)	0.900	0.00 (NC)	0.800
Minimum Dietary Diversity Women (MDD-W)	0.57 (0.30, 1.09)	0.091	0.62 (0.32, 1.17)	0.140	0.74 (0.31, 1.75)	0.500	2.24 (0.76, 6.61)	0.140
Additional Foods	0.46 (0.23, 0.90)	0.024	0.54 (0.27, 1.07)	0.076	0.80 (0.40, 1.61)	0.500	1.02 (0.47, 2.19)	0.900
NC- No convergence, OR-Odds Ratio, CI- Confidence Interval, P-values calculated using Wilcoxon rank sum test; Pearson's Chi-squared test								

Table 3: Multivariable Multinomial Regression Models for predictors of Gestational Weight Gain (GWG) and Postpartum Weight Retention (PPWR)

	Gestational Weight Gain (GWG)				**Postpartum Weight Retention (PPWR)**			
	Excessive Weight Gain (GWG)		**Inadequate (GWG))**		**Weight loss**		**Excessive Weight Retention**	
Characteristics	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**	**OR (95% CI)**	**p-value**
HIV Status								
Women living without HIV	—		—		—		—	
Women living with HIV	1.15 (0.57, 2.29)	0.700	2.24 (1.12, 4.46)	0.022	2.16 (1.09, 4.27)	0.027	1.06 (0.54, 2.08)	0.900

Age (in Years)	0.94 (0.87, 1.01)	0.100	0.97 (0.90, 1.05)	0.500	1.08 (1.00, 1.16)	0.043	1.07 (1.00, 1.15)	0.060
Household food insecurity								
Food Secure	—		—		—		—	
Food Insecure	0.96 (0.41, 2.23)	0.900	1.16 (0.52, 2.63)	0.700	1.30 (0.57, 2.95)	0.500	1.13 (0.49, 2.63)	0.800
Education Status								
Completed Primary	—		—		—		—	
Completed High School	1.35 (0.67, 2.72)	0.400	0.82 (0.40, 1.70)	0.600	1.35 (0.67, 2.74)	0.4	1.25 (0.63, 2.52)	0.500
Employment Status								
Unemployed	—		—		—		—	
Employed	1.41 (0.66, 3.00)	0.400	1.36 (0.63, 2.96)	0.400	0.81 (0.39, 1.69)	0.600	0.96 (0.47, 1.97)	0.900
Household Income status per month								
< R5 000 per month	—		—		—		—	
≥ R5 000 per month	0.90 (0.37, 2.17)	0.800	1.19 (0.48, 2.93)	0.700	0.77 (0.28, 2.08)	0.600	1.40 (0.58, 3.36)	0.500
Marital Status								
Not in a relationship	—		—		—		—	
Living Together	1.46 (0.45, 4.66)	0.500	1.27 (0.38, 4.17)	0.700	0.25 (0.04, 1.43)	0.120	0.45 (0.07, 2.85)	0.400
Not living together	1.09 (0.36, 3.33)	0.900	1.64 (0.51, 5.27)	0.400	0.35 (0.06, 1.95)	0.200	0.49 (0.08, 3.01)	0.400
Parity								
Nulliparous	—		—		—		—	
Primiparous	1.05 (0.42, 2.64)	0.900	2.79 (0.98, 7.93)	0.055	0.39 (0.14, 1.13)	0.083	0.56 (0.19, 1.60)	0.300
Multiparous	1.04 (0.34, 3.17)	0.900	4.11 (1.23, 13.7)	0.021	0.73 (0.22, 2.46)	0.600	0.69 (0.20, 2.36)	0.600
Minimum Dietary Diversity Women								
No	—		—		—		—	
Yes	1.38 (0.39, 4.87)	0.600	1.04 (0.31, 3.50)	0.900	0.87 (0.33, 2.29)	0.800	2.81 (0.83, 9.50)	0.100
Additional Foods								
No	—		—		—		—	
Yes	0.34 (0.09, 1.28)	0.110	0.44 (0.12, 1.60)	0.200	0.83 (0.18, 3.91)	0.800	1.04 (0.17, 6.23)	0.900

OR-Odds Ratio, CI- Confidence Interval, P-values calculated using Wilcoxon rank sum test; Pearson's Chi-squared test

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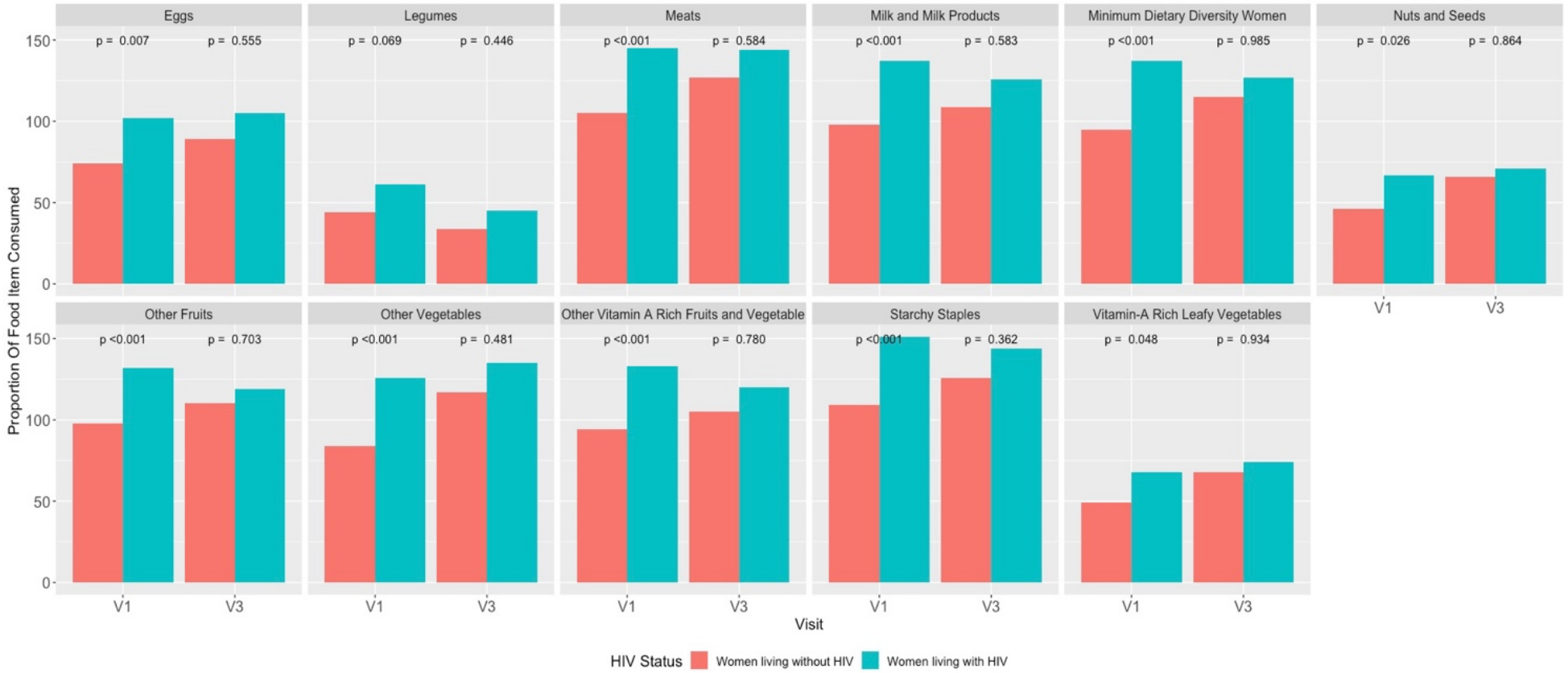

Figure 2: Difference in food intake proportions using 10 food groups and overall MDD-W by HIV status during pregnancy (V1) and postpartum**(V3)**

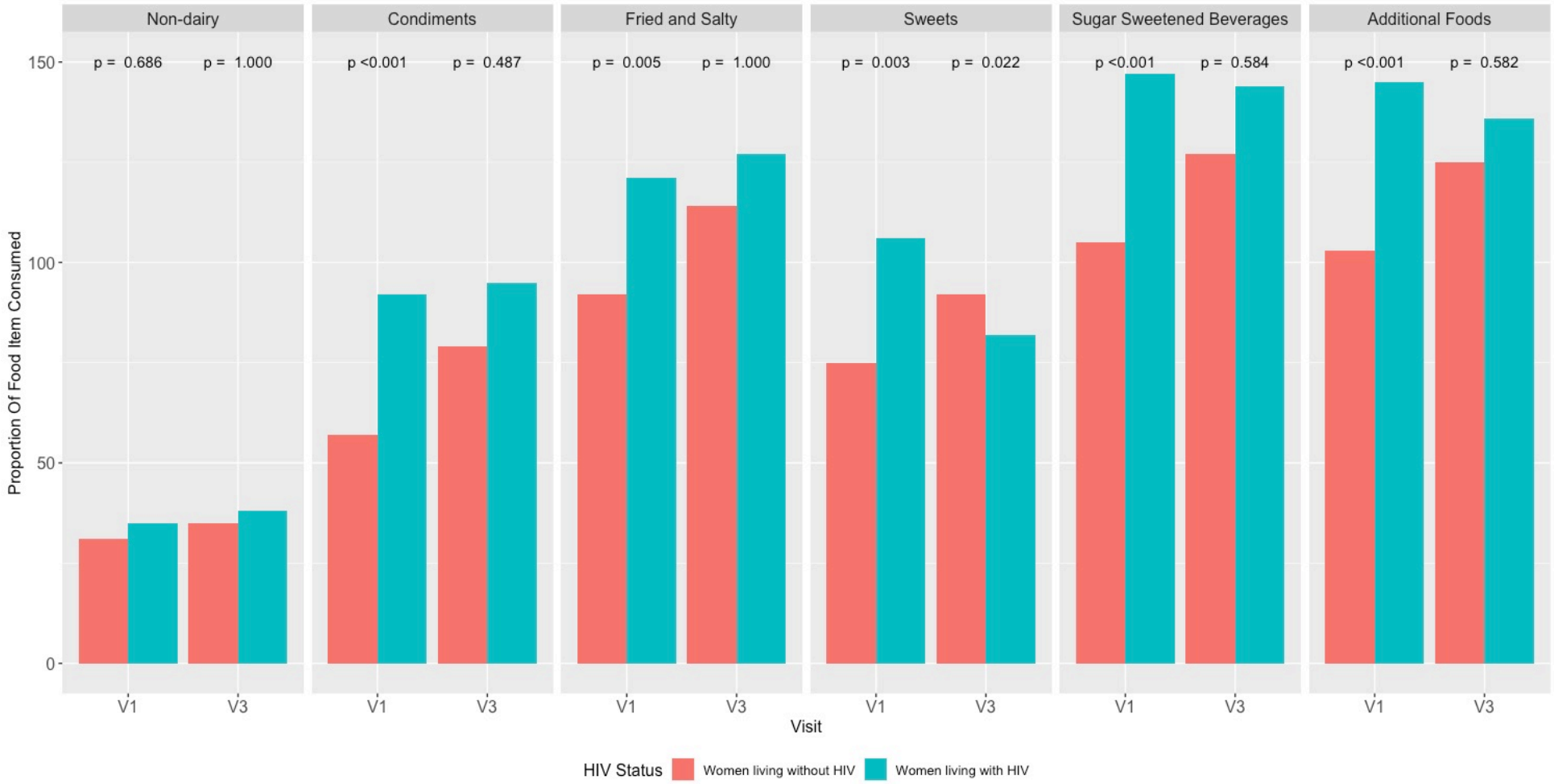

Figure 3: Difference in food intake proportions using additional food groups stratified by HIV status during pregnancy (V1) and postpartum (V3)

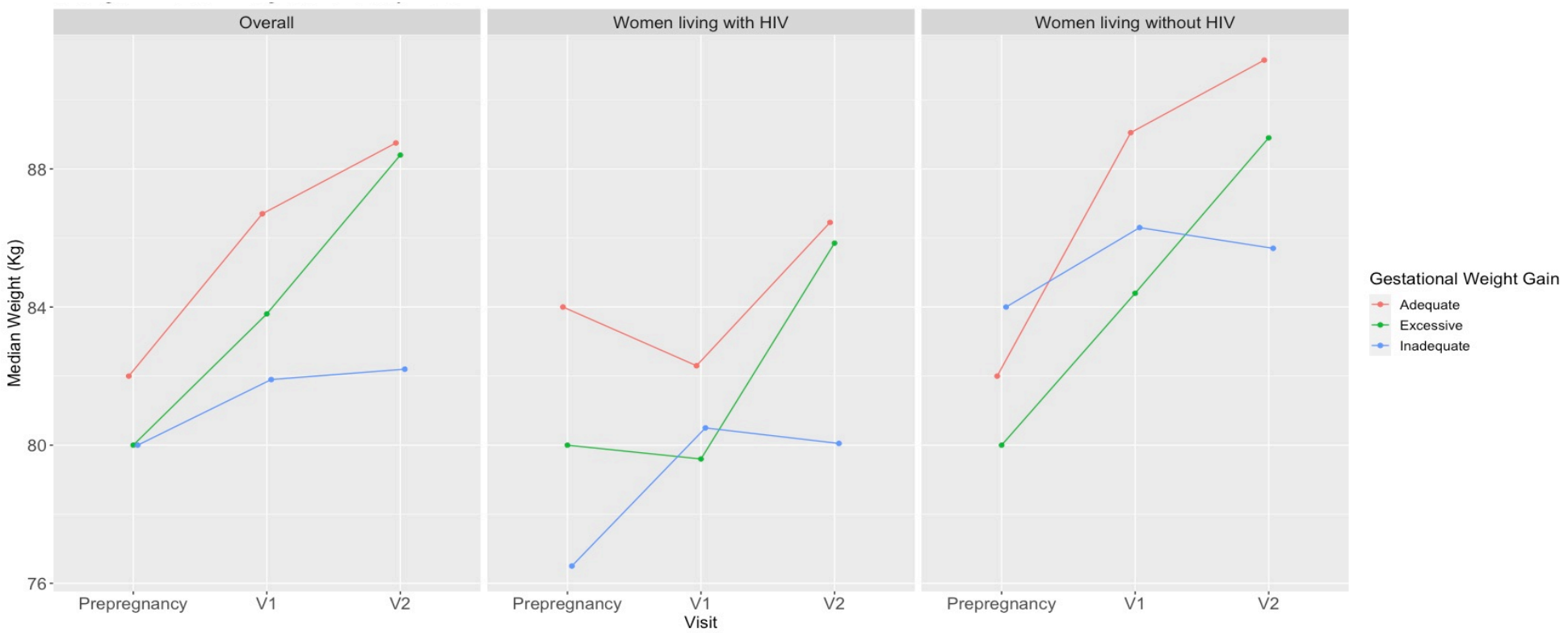

Figure 4: Overall change in median weight during the gestational period and stratified by HIV status during pregnancy (V1) and postpartum (V3).

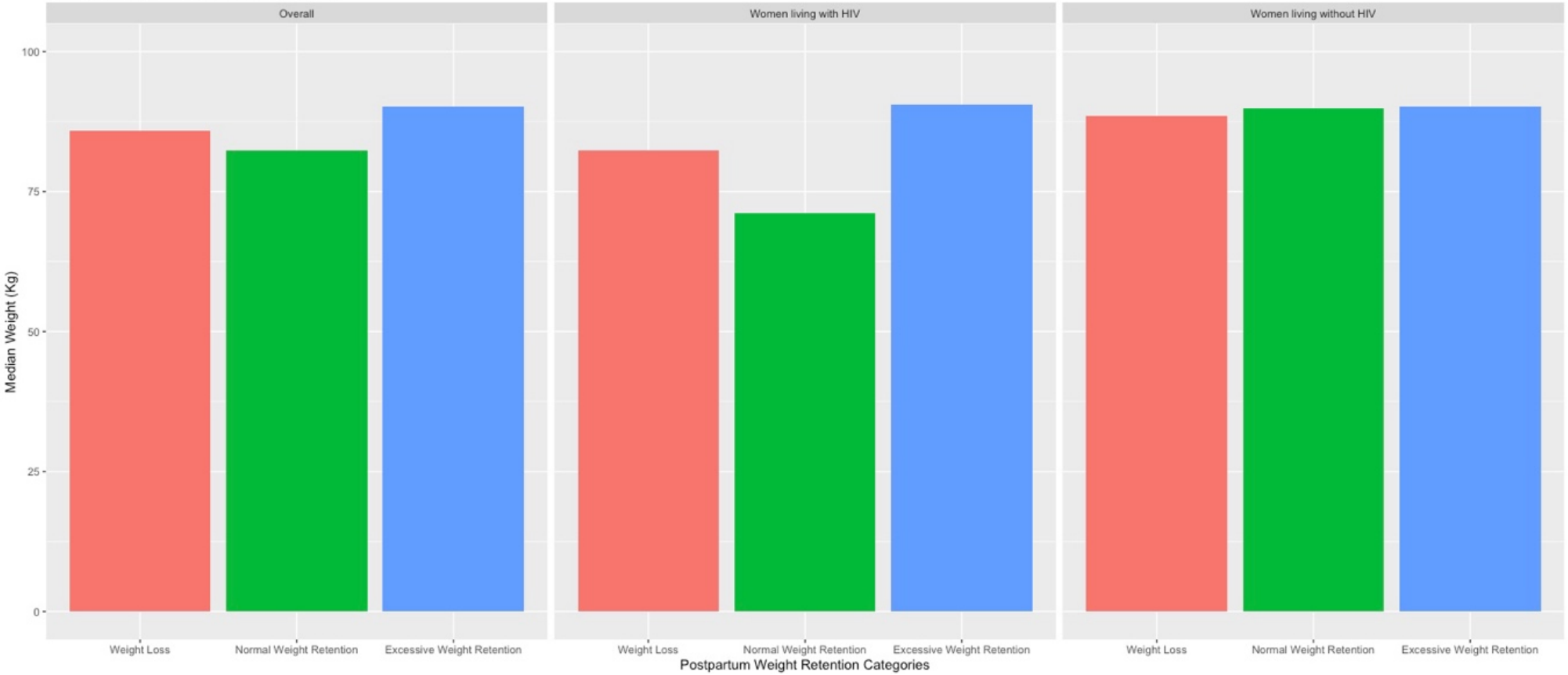

Figure 5: Overall change in median weight during the postpartum period and stratified by HIV status during pregnancy (V1) and postpartum (V3).

Supplementary Material

Supplementary Tables

Table 1: IOM guidelines for recommended weight gain during pregnancy [7].

Pre-Pregnancy Weight Category	Body Mass Index (BMI)*	Recommended Range of Total Weight (Kg)	Recommended Rates of Weight Gain† in the 2nd & 3rd Trimester (Kg) Mean Range [Kg/week]
Underweight	Less than 18.5	12.5Kg – 18Kg	0.5 (0.5 - 5.9)
Normal Weight	18.5 – 24.9	11.5Kg – 16Kg	0.5 (0.4 - 0.5)
Overweight	25 – 29.9	7Kg - 11.5Kg	0.3 (0.2 - 0.3)
Obese	30 >	5Kg – 9Kg	0.2 (0.2 - 0.3)

***BMI is calculated as weight in Kg's divided by height in m^2.**
†Calculations assume a 0.5 – 2kg weight gain in the first trimester.

Table 2: Minimum Dietary Diversity for Women (MDD-W) 10-food groups adapted for the South African context.

10 MDD-W Food Groups	**Food List**
Starchy staples	White bread/rolls, Brown or whole wheat bread/rolls, Roti, naan bread, Cereals low in fibre & sugar e.g. Corn Flakes, Rice Krispies, Breakfast cereals high in fibre like All Bran, Weet Bix, Pronutro, Raisin Bran, Oats, Breakfast cereals high in sugar like Sugar loops, Honey smacks, Nestle Cheerios, Milo, O-tees, Oat-so-easy, Frosted Crunchies, Funky strawberry, Frosted flakes, Special K, Frosties, Coco Pops, Brown rice, wheat rice (stamp koring), barley, Maize porridge at any meal, Sweet potato, corn, sweetcorn, Potato boiled, mashed, in stews (not fried), Fried potatoes (slap chips), Margarine, butter, lard on bread/ in porridge, Instant noodles
Nuts and seeds	Peanut butter, Salted peanuts
Legumes	Legumes e.g. dry beans, lentils
Eggs	Fried egg
Milk/Milk Products	Full cream milk or sour milk to drink, in tea or on cereal/porridge, custard, Low fat/fat free milk or sour milk to drink, in tea or on cereal/porridge, Full cream yoghurt, Low fat/ fat free yoghurt, Hard cheese e.g. gouda, cheddar, Soft cheese e.g. cottage cheese, Processed cheese spread or wedges, Cream.

Meats (Flesh foods)	Sausages like pork, boerewors of any kind, Processed meats like polony, viennas, salami, Russians, bacon, Biltong and droëwors, Meat like meatballs and corned beef, Chicken with the skin, Fried chicken, Fried fish, fish cakes, fish fingers, Organ meats like liver, stomach, kidneys
Vitamin A–rich dark green vegetables (Leafy Vegetables)	Green leafy vegetables like spinach, morogo, beetroot leaves
Other vitamin A–rich fruits and vegetables	Citrus fruits like oranges, naartjies, grapefruit, Apricot, peaches, plums, Pumpkin, butternut, carrots, gem squash
Other vegetables	Cabbage, cauliflower, Brussels sprouts, broccoli, Green beans, peas, mixed vegetables, baby marrows, Green salad (lettuce, cucumber, tomato, onions, peppers), Beetroot, Tomatoes cooked/ relish
Other fruits	Bananas, Apples and pears, Guavas, strawberries and other berries, Melon, watermelon, grapes, Paw-paw, mango, pineapple, litchis, avocado, Prickly pears & figs, Fruit salad, Dry fruit
Additional Foods	**Food list**
Non-dairy Products	Non-dairy creamer
Condiments	Mayonnaise, salad dressing, Instant soup, cup of soup, Bovril, marmite, fish paste on bread or salty biscuits, Tomato sauce/ketch-up on food
Fried/Salty Foods	Fat cakes, Pies, sausage rolls, samosas, Doughnuts, eclairs, Crisps like Lays, Nik-Naks, papas, pretzels, Take outs (e.g. KFC, McDonalds, Steers), Salty popcorn
Sweets	Condensed milk, Chocolate and chocolate spread, Jam, syrup, honey, Sweets e.g. boiled, lollipops, jelly type, sweet popcorn, Cake, sweet biscuits, tarts, baked puddings, Jelly, instant pudding, Ice cream
Sugar Sweetened Beverages	Drinking yoghurt, Flavoured milk cold or hot milk: chocolate, milo, Sugar in tea/coffee or on porridge, Tea or coffee, Sweetened fruit juice, Fizzy drinks like Coke, Cream Soda (not diet drinks), Cold drinks made with water eg Oros, ice lollies.

Table 3: Difference in food intake during pregnancy and 6 months postpartum, categorized by Gestational Weight Gain and Postpartum Weight Retention Categories.

	Gestational Weight Gain (GWG)	**Postpartum Weight Retention (PPWR)**

Characteristics	Overall, N = 318	Adequate, N = 61	Excessive, N = 127	Inadequate, N = 130	P-value	Overall, N = 275	Weight Loss/No retention, N = 108	Normal Weight Retention, N = 70	Excessive Weight Retention, N = 97	P-value
Meat n(%)					0.088					0.200
No	117 (37)	15 (25)	51 (40)	51 (39)		4 (1.5)	1 (0.9)	0 (0)	3 (3.1)	
Yes	201 (63)	46 (75)	76 (60)	79 (61)		271 (99)	107 (99)	70 (100)	94 (97)	
Eggs n(%)					0.200					0.900
No	173 (54)	28 (46)	75 (59)	70 (54)		81 (29)	31 (29)	21 (30)	29 (30)	
Yes	145 (46)	33 (54)	52 (41)	60 (46)		194 (71)	77 (71)	49 (70)	68 (70)	
Milk and Milk Products n(%)					0.016					0.076
No	130 (41)	15 (25)	57 (45)	58 (45)		40 (15)	18 (17)	14 (20)	8 (8.2)	
Yes	188 (59)	46 (75)	70 (55)	72 (55)		235 (85)	90 (83)	56 (80)	89 (92)	
Nuts and Seeds n(%)					0.800					0.200
No	229 (72)	43 (70)	94 (74)	92 (71)		138 (50)	61 (56)	33 (47)	44 (45)	
Yes	89 (28)	18 (30)	33 (26)	38 (29)		137 (50)	47 (44)	37 (53)	53 (55)	
Starchy Staples n(%)					0.043					0.300
No	111 (35)	13 (21)	50 (39)	48 (37)		5 (1.8)	2 (1.9)	0 (0)	3 (3.1)	
Yes	207 (65)	48 (79)	77 (61)	82 (63)		270 (98)	106 (98)	70 (100)	94 (97)	
Legumes n(%)					0.600					0.700
No	236 (74)	43 (70)	98 (77)	95 (73)		196 (71)	79 (73)	47 (67)	70 (72)	
Yes	82 (26)	18 (30)	29 (23)	35 (27)		79 (29)	29 (27)	23 (33)	27 (28)	
Other Vitamin A Rich Fruits and Vegetable n(%)					0.700					0.600
No	137 (43)	24 (39)	54 (43)	59 (45)		50 (18)	17 (16)	15 (21)	18 (19)	
Yes	181 (57)	37 (61)	73 (57)	71 (55)		225 (82)	91 (84)	55 (79)	79 (81)	
Vitamin-A Rich Leafy Vegetables n(%)					0.400					0.002
No	224 (70)	39 (64)	94 (74)	91 (70)		133 (48)	64 (59)	35 (50)	34 (35)	
Yes	94 (30)	22 (36)	33 (26)	39 (30)		142 (52)	44 (41)	35 (50)	63 (65)	
Other Vegetables n(%)					0.300					0.700

No	145 (46)	23 (38)	63 (50)	59 (45)		23 (8.4)	11 (10)	5 (7.1)	7 (7.2)	
Yes	173 (54)	38 (62)	64 (50)	71 (55)		252 (92)	97 (90)	65 (93)	90 (93)	
Other Fruits n(%)					0.037					0.800
No	139 (44)	19 (31)	54 (43)	66 (51)		46 (17)	20 (19)	11 (16)	15 (15)	
Yes	179 (56)	42 (69)	73 (57)	64 (49)		229 (83)	88 (81)	59 (84)	82 (85)	
Non-dairy n(%)					0.500					0.400
No	271 (85)	49 (80)	110 (87)	112 (86)		202 (73)	84 (78)	50 (71)	68 (70)	
Yes	47 (15)	12 (20)	17 (13)	18 (14)		73 (27)	24 (22)	20 (29)	29 (30)	
Condiments n(%)					0.011					0.800
No	197 (62)	29 (48)	77 (61)	91 (70)		101 (37)	41 (38)	27 (39)	33 (34)	
Yes	121 (38)	32 (52)	50 (39)	39 (30)		174 (63)	67 (62)	43 (61)	64 (66)	
Fried and Salty n(%)					0.054					0.700
No	148 (47)	20 (33)	62 (49)	66 (51)		34 (12)	15 (14)	9 (13)	10 (10)	
Yes	170 (53)	41 (67)	65 (51)	64 (49)		241 (88)	93 (86)	61 (87)	87 (90)	
Sweets n(%)					0.900					0.048
No	175 (55)	32 (52)	72 (57)	71 (55)		101 (37)	48 (44)	26 (37)	27 (28)	
Yes	143 (45)	29 (48)	55 (43)	59 (45)		174 (63)	60 (56)	44 (63)	70 (72)	
Sugar Sweetened Beverages n(%)					0.120					0.200
No	117 (37)	16 (26)	53 (42)	48 (37)		4 (1.5)	1 (0.9)	0 (0)	3 (3.1)	
Yes	201 (63)	45 (74)	74 (58)	82 (63)		271 (99)	107 (99)	70 (100)	94 (97)	
Minimum Dietary Diversity Women n(%)					0.200					0.068
No	130 (41)	19 (31)	56 (44)	55 (42)		33 (12)	18 (17)	9 (13)	6 (6.2)	
Yes	188 (59)	42 (69)	71 (56)	75 (58)		242 (88)	90 (83)	61 (87)	91 (94)	
Additional Foods n(%)					0.071					0.700
No	117 (37)	15 (25)	53 (42)	49 (38)		14 (5.1)	7 (6.5)	3 (4.3)	4 (4.1)	
Yes	201 (63)	46 (75)	74 (58)	81 (62)		261 (95)	101 (94)	67 (96)	93 (96)	

Table 4: Univariable Multinomial Regression Models for predictors of Gestational Weight Gain (GWG)

Characteristic	**Excessive Gestational Weight Gain**		**Inadequate Gestational Weight Gain**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**

Age (in Years)	0.95 (0.92, 0.99)	0.006	1.05 (1.02, 1.09)	0.003
Alcohol dependency (AUDIT)				
No dependency	—		—	
Dependency	0.60 (0.13, 2.72)	0.500	1.81 (0.50, 6.50)	0.400
Household food insecurity				
Food Secure	—		—	
Food Insecure	0.73 (0.45, 1.17)	0.200	1.07 (0.68, 1.69)	0.800
Edinburgh Postnatal Depression Scale (EPDS)				
Possibly not Depressed	—		—	
Possibly depressed	1.14 (0.35, 3.69)	0.800	1.70 (0.56, 5.21)	0.400
Body Mass Index (BMI) before Pregnancy				
Normal weight	—		—	
Overweight	0.47 (0.24, 0.91)	0.024	0.27 (0.14, 0.52)	<0.001
Obese	0.58 (0.31, 1.07)	0.083	0.38 (0.21, 0.69)	0.002
Education Status				
Completed Primary	—		—	
Completed High School or Tertiary	1.52 (1.04, 2.24)	0.032	0.70 (0.47, 1.04)	0.075
Employment Status				
Unemployed	—		—	
Employed	1.40 (0.92, 2.14)	0.120	1.13 (0.73, 1.73)	0.600
Household Income status per month				
< R5 000 per month	—		—	
≥ R5 000 per month	1.26 (0.75, 2.10)	0.400	1.08 (0.64, 1.81)	0.800
Marital Status				
Not in a relationship	—		—	
Living Together	1.45 (0.74, 2.82)	0.300	1.75 (0.88, 3.480	0.110
Not living together	1.23 (0.64, 2.37)	0.500	1.59 (0.81, 3.13)	0.200
Physical Activity Status				
Less Active	—		—	
Moderately Active	1.04 (0.69, 1.59)	0.800	1.05 (0.69, 1.59)	0.800
Highly Active	1.28 (0.66, 2.47)	0.500	1.00 (0.51, 1.96)	0.900
Gravidity				

Nulligravida	—		—	
Primigravida	1.52 (1.16, 1.98)	0.002	0.53 (0.37, 0.76)	<0.001
Multigravida	1.17 (0.96, 1.41)	0.120	2.26 91.81, 2.83)	<0.001
Parity				
Nulliparous	—		—	
Primiparous	0.76 (0.47, 1.23)	0.300	3.31 (1.84, 5.98)	<0.001
Multiparous	0.66 (0.41, 1.09)	0.100	4.49 (2.49, 8.07)	<0.001
HIV Status				
Women living without HIV	—		—	
Women living with HIV	0.75 (0.51, 1.10)	0.140	2.06 (1.41, 3.01)	<0.001
HIV Treatment Regimen				
Dolutegravir	—		—	
Efavirenz	1.17 (0.46, 3.01)	0.700	1.57 (0.65, 3.76)	0.300
OR-Odds Ratio, CI- Confidence Interval, P-values calculated using Wilcoxon rank sum test; Pearson's Chi-squared test				

Table 5: Univariable Multinomial Regression Models for predictors of Postpartum Weight Retention (PPWR)

Characteristic	**Weight loss (PPWR <0kg)**		**Excessive Weight Retention (PPWR >5kg)**	
	OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Age (in Years)	1.08 (1.04, 1.11)	<0.001	1.05 (1.01, 1.08)	0.004
Alcohol dependency (AUDIT)				
No dependency	—		—	
Dependency	0.98 (0.35, 2.81)	0.90	0.59 (0.18, 1.97)	0.400
Household food insecurity				
Food Secure	—		—	
Food Insecure	1.69 (1.09, 2.62)	0.018	1.10 (0.69, 1.75)	0.700
Edinburgh Postnatal Depression Scale (EPDS)				
Possibly not Depressed	—		—	
Possibly depressed	2.53 (0.83, 7.74)	0.100	1.46 (0.43, 4.90)	0.500
Body Mass Index (BMI) before Pregnancy				
Normal weight	—		—	
Overweight	0.58 (0.34, 1.00)	0.052	1.03 (0.59, 1.80)	0.900
Obese	1.06 (0.65, 1.72)	0.80	1.29 (0.77, 2.15)	0.300

Education Status				
Completed Primary	—		—	
Completed High School or Tertiary	1.02 (0.71, 1.47)	0.90	1.23 (0.85, 1.79)	0.300
Employment Status				
Unemployed	—		—	
Employed	0.82 (0.56, 1.20)	0.300	1.10 (0.75, 1.61)	0.600
Household Income status per month				
< R5 000 per month	—		—	
≥ R5 000 per month	0.56 (0.33, 0.95)	0.032	1.31 (0.82, 2.09)	0.300
Marital Status				
Not in a relationship	—		—	
Living Together	0.24 (0.10, 0.59)	0.002	0.56 (0.21, 1.49)	0.200
Not living together	0.27 (0.11, 0.67)	0.005	0.53 (0.20, 1.40)	0.200
Physical Activity Status				
Less Active	—		—	
Moderately Active	1.45 (0.98, 2.13)	0.061	1.10 (0.74, 1.64)	0.600
Highly Active	1.30 (0.70, 2.43)	0.40	1.22 (0.65, 2.29)	0.500
Gravidity				
Nulligravida	—		—	
Primigravida	1.16 (0.86, 1.57)	0.300	0.99 (0.72, 1.36)	0.900
Multigravida	1.14 (0.94, 1.39)	0.200	1.20 (0.98, 1.46)	0.079
Parity				
Nulliparous	—		—	
Primiparous	0.59 (0.35, 0.98)	0.042	0.84 (0.50, 1.42)	0.500
Multiparous	1.37 (0.82, 2.28)	0.200	1.26 (0.74, 2.15)	0.400
HIV Status				
Women living without HIV	—		—	
Women living with HIV	2.66 (1.86, 3.81)	<0.001	1.17 (0.82, 1.68)	0.400
Gestational Weight Gain (GWG)				
Adequate	—		—	
Excessive	1.03 (0.58, 1.84)	0.900	1.52 (0.85, 2.71)	0.200
Inadequate	0.89 (0.51, 1.55)	0.700	0.69 (0.39, 1.23)	0.200

HIV Treatment Regimen				
Dolutegravir	—		—	
Efavirenz	0.49 ()	0.110	1.36 (0.52, 3.59)	0.500
OR-Odds Ratio, CI- Confidence Interval, P-values calculated using Wilcoxon rank sum test; Pearson's Chi-squared test				

Supplementary Figures

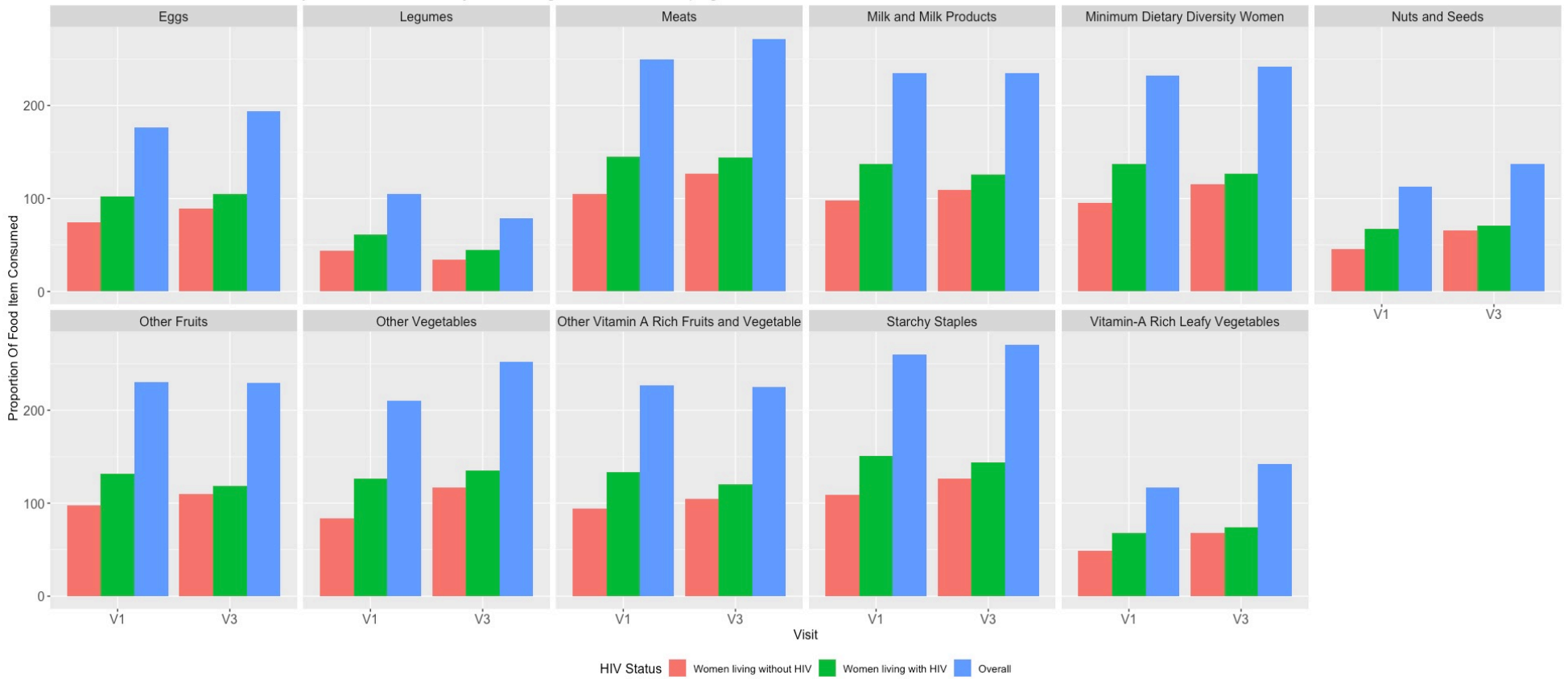

Figure 1: Difference in food intake proportions using 10 food groups overall and by HIV status during pregnancy (V1) and postpartum (V3)

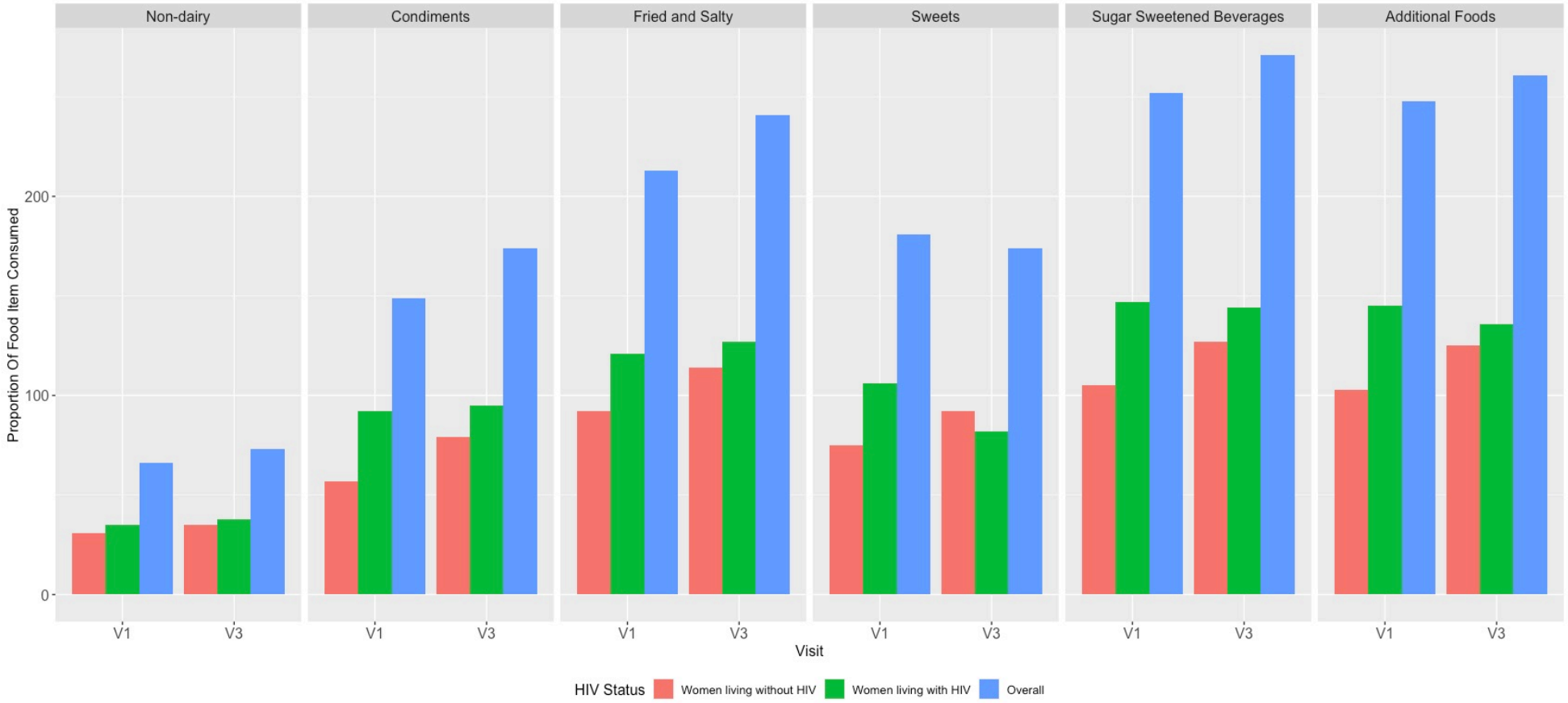

Figure 2: Difference in food intake proportions using the additional food groups by overall and HIV status during pregnancy (V1) and postpartum (V3)

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room 45 E-52-E-Floor- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-submissions@uct.ac.za
Website: www.health.uct.ac.za/home/human-research-ethics

07 March 2023

HREC REF: 124/2023

Prof L Myer
Division of Epidemiology & Biostatistics
Public Health & Family Medicine-FHS
Email: Landon.myer@uct.ac.za
Student:sthsip033@myuct.ac.za

Dear Prof Myer

PROJECT TITLE: FOOD INTAKE PATTERNS AND ASSOCIATIONS WITH POSTPARTUM WEIGHT RETENTION IN WOMEN LIVING WITH AND WITHOUT HIV IN CAPE TOWN, SOUTH AFRICA-
(MASTER'S DEGREE-MS SIPHESIHLE SITHOLE-SUB-STUDY 505/2020)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 March 2024.

Please submit a progress form, using the standardised Annual Report Form (FHS016) if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Ms Siphesihle Sithole will also be involved in this study.

Please quote the HREC REF 124/2023 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

22 September 2020

HREC REF: 505/2020

Prof L Myer
Division of Epidemiology & Biostatistics
Office 5.51, Level 5 Falmouth Building
FHS
Email: landon.myer@uct.ac.za

Dear Prof Myer

PROJECT TITLE: ADDRESSING THE DUAL BURDEN OF HIV AND NON-COMMUNICABLE DISEASE IN PREGNANCY IN SOUTH AFRICA"

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study, subject to ensuring that participants are appropriately followed up & treated should diagnoses of NCDs be made.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020 & 06 July 2020.

Approval is granted for one year until the 30 September 2021.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Western Cape Government
Health

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5th Floor, Norton Rose House,, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za)

REFERENCE: WC_202011_024
ENQUIRIES: Dr Sabela Petros

University of Cape Town
Anzio Road
Observatory
Cape Town
7925

For attention: Prof Landon Myer, Dr Hlengiwe Madlala

Re: Addressing the dual burden of HIV and non-communicable disease in pregnancy in South Africa

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.
Please contact the following people to assist you with any further enquiries in accessing the following sites:

Gugulethu CHC	**Lunga Makamba**	**021 633 0020**

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.
2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final feedback (**annexure 9**) within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).
3. In the event where the research project goes beyond the *estimated completion* date which was submitted, researchers are expected to complete and submit a progress report (**Annexure 8**) to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).
4. The reference number above should be quoted in all future correspondence.

Yours sincerely

DR M MOODLEY
DIRECTOR: HEALTH IMPACT ASSESSMENT
DATE: 14/01/2021
CC

PWID: _ _ _ _ _ _ - _ _

CAMP2 COHORT STUDY: PREGNANT WOMEN

INFORMED CONSENT

STUDY TITLE: Addressing the dual burden of HIV and non-communicable disease in pregnancy in South Africa

Study Implementers: University of Cape Town School of Public Health and Family Medicine (South Africa) & Brown University School of Public Health (USA)
Study Sponsors: USA Providence/Boston Center for AIDS Research
Principal Investigator: Dr. Angela Bengtson
UCT Principal Investigator: Prof. Landon Myer

INTRODUCTION

You are invited to participate in a research study conducted with the University of Cape Town together with the Brown University School of Public Health (USA). This is a voluntary research study, which means that you do not have to take part if you do not wish to. This is a research study about pregnancy, pregnancy complications, healthcare, chronic diseases after delivery, and for some women how pregnancy complications may be affected by HIV and HIV medications.

Research studies only include people who chose to take part. Please take your time to make a decision about taking part. If you have any questions, you may ask me now or at any point while we read over the consent form together. Because of the kind of study we are doing, you are being asked to take part in this study because you are a pregnant women, at least 24 weeks gestation, over the age of 18, and have not been diagnosed or are currently taking medication for Type 2 diabetes or hypertension.

WHY IS THIS STUDY BEING DONE?

We do not know much about how having certain pregnancy complications, including hypertension, metabolic syndrome, and gestational diabetes, affect the health of women and their infants in South Africa. We also do not know that much about how HIV status and ART use may affect getting these pregnancy complications; or affect the outcomes of these pregnancy complications. This study is being funded by the National Institutes of Health in the United States. The information gathered from this study will be useful to the researchers, who are thinking about conducting more studies on how to meet the healthcare needs of pregnant and postpartum women here, and in other places in South Africa, southern Africa and internationally.

HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?

We plan to enroll about 600 pregnant women to take part in this study.

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WHAT WILL HAPPEN IF I TAKE PART IN THIS RESEARCH STUDY?

First, we will schedule a study visit when you are at least 24 weeks pregnant and this visit will take about 2 ½ hours, we will do the following:

1. I will take your blood pressure two times
2. I will prick your finger to test for blood sugar levels
3. I will take a 25ml blood samples from your arm (about 2 tablespoons) for testing fasting levels of your sugar and hormones that control sugar levels
4. I will ask you to drink a sugary glass of water.
5. I will take blood samples (10ml – about 1 tablespoon at each timepoint) after 1 and 2 hours after drinking the sugary glass of water
6. I will prick your finger to test for blood sugar levels at 1 and 2 hours after drinking the sugary glass of water
7. I will take your weight and height measurements and mid-upper arm circumference (MUAC)
8. Finally, I will go through a questionnaire with you. This questionnaire will ask you about demographic information, clinical and obstetric history, including previous diagnoses of medical conditions, adherence to medications, food intake, behavioral health, and your weight before you became pregnant.

Second, we will schedule you for another study visit at 34-39 weeks' gestation and it will take about 30 minutes, we will do the following:

1. I will take your blood pressure two times
2. I will take your weight and MUAC measurements
3. I will ask you about food intake and the development of any pregnancy complications or issues since the last visit.

Third, we will schedule you for another study visit at 6-14 months postpartum and it will take about 2 ½ hours, we will do the following:

1. I will take your blood pressure two times
2. I will prick your finger to test for blood sugar levels
3. I will take a 25ml blood samples from your arm (about 2 tablespoons) for testing fasting levels of your sugar and hormones that control sugar levels
4. I will ask you to drink a sugary glass of water.
5. I will take blood samples (10ml – about 1 tablespoon at each timepoint) after 1 and 2 hours after drinking the sugary glass of water
6. I will prick your finger to test for blood sugar levels at 1 and 2 hours after drinking the sugary glass of water
7. I will take your weight, MUAC, hip and waist circumferences
8. Just before the morning feed, I will take blood from your baby's arm (4ml - about 1 teaspoon) for testing levels of your baby's sugar and hormones that control sugar levels
9. I will take your baby's weight, length, head circumference and MUAC
10. Finally, I will ask you questions about adherence to medications, behavioral health, food intake. We will also ask you questions about your baby's health, feeding practices and immunisations since the birth.

In addition, to your study visits, researchers involved in this study will access clinical information in your routine medical records, and the records of your baby. This information will include clinical history, past medical diagnoses, medications you are taking, laboratory tests results, complications you may develop during pregnancy, and information about your baby's health. We would like your permission to access your Maternity Case Record and electronic databases that include all of these records. The Department of Health stores all of this information centrally at the Provincial Health Data Centre. We will use your and your baby's provincial folder number (or name and date of birth) to ask for this information directly from the Department of Health or access this information directly from the Provincial health databases. All data that we review will be kept confidential. Your name and your baby's name will not be recorded with these records.

HOW LONG WILL I BE IN THE STUDY?

Taking part in the study will take approximately 6 hours over three study visits. These visits will occur when you are ≥ 24 weeks' gestation, 34-39 weeks' gestation and at 6-14 months after delivery of your baby.

CAN I STOP BEING IN THE STUDY?

Yes. You can decide to stop at any time. Just tell the study researcher right away if you wish to stop being in the study. Also, the study researcher may stop you from taking part in this study at any time if she thinks that this is best for you, or if the study is stopped for some reason.

WHAT ARE THE RISKS OF INCONVENIENCES OF THE STUDY?

You will be asked to complete surveys that include sensitive topics about your experiences with pregnancy and delivery, your health and your medications.

- ✓ Completing the questionnaires can be long and you may get tired and you may need to take breaks.
- ✓ While taking blood, you and your baby may experience discomfort and pain. For your baby, we will place a skin plaster for 30 minutes in the area from which we will take blood, this will help to decrease the pain. For you, after pricking your vein, the study nurse will place a small tubing that will remain in your arm for the collection of blood after 1 and 2 hours, this tube is not painful and it will minimize the pain since we will not have to prick you multiple times.
- ✓ Being tested for sugar disease and abnormal body function related to metabolism requires having your blood drawn while you are fasted (have not eaten since 10 PM the night before). This may make you experience physical discomfort including hunger, dizziness and nausea. Also, after drinking a sugary drink, you may have nausea. Your child may also experience hunger and irritability due to restricted feeding on the morning of the blood sugar test. The study nurse will monitor these signs and will make sure you are comfortable with proceeding until the end of the test. At each visit, we will provide you with food so you can be re-energised before leaving the study site.
- ✓ Some of these questions may make you uncomfortable or cause you to become upset. Some of these questions will ask about HIV status and adherence to HIV medications. You do not have to answer any question that you do not want to and you can stop

participating at any time. If you become distressed, we will have someone for you to talk with.

- ✓ For women living with HIV, by coming to the Project office it is possible others could find out that you are living with HIV/AIDS.
- ✓ Having to come to the Project office to complete the questionnaire may be inconvenient and may require you to get transportation and other forms of assistance, such as childcare, to participate.
- ✓ The total time to complete the study will be 5-6 hours.

ARE THERE BENEFITS TO TAKING PART IN THE STUDY?

It is hoped that the information that you provide in this study will give us better knowledge about how to take care of women who develop hypertension, metabolic syndrome, or gestational diabetes during pregnancy and after delivery. Knowing whether you have these conditions during pregnancy and/or after delivery is important to protect your health and protect the health of your baby. There may be other no direct benefits to you.

WHAT OTHER CHOICES DO I HAVE IF I DO NOT PARTICIPATE IN THIS STUDY?

You are free to choose not to participate in the study. If you decide not to take part in this study, it will in no way impact the care that you receive here at the clinic and no one will be mad at you for deciding not to participate.

WILL INFORMATION ABOUT ME BE KEPT PRIVATE?

Only the researchers will have access to the information you provide.

We cannot protect your confidentiality if…

- ✓ we discover that you plan to cause serious harm to yourself or others
- ✓ you tell us that you have a plan to have high-risk sex with a named person who does not know your HIV status, if applicable. We may be legally required to protect that person.

Your name will not be put on any of your questionnaires, urine or blood samples. You will be given a secret code number. The list linking your secret code to any of your information will be kept separate. The list will be destroyed within 6- months of completion of the study. Any questionnaires completed will be kept on a computer that is protected by password and only the researchers directly involved in this study will be able to see this.
Your name will not appear in any publication. Your name will not be given to anyone else without your written consent.

During the course of the study you will receive calls from Project staff members. The calls are made to remind you of upcoming appointments or to reschedule appointments. Prior to beginning a conversation the Project staff member will verify your identity by asking you to answer two security questions -"What was your favorite toy as a child?" and "Who was your childhood hero?" Your contact details will be kept separate from all other information provided by you. If a Project staff member calls a number that you have provided, a message will only be left on an answering machine or with the person who answers if you have given permission for messages to be left at that number.

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You should also know that the University of Cape Town and/or Brown Institutional Review Board (IRB) and the Office of Research Compliance may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants

WHAT ARE THE COSTS OF TAKING PART IN THIS STUDY?

Apart from travel and your time costs, which we will reimburse you for, it will not cost you to participate in this study.

WILL I BE PAID FOR TAKING PART IN THIS STUDY?

For your time commitment to our project, you will be compensated for each time you complete a study activity. You will receive:

Baseline visit (24-28 weeks' gestation)		150 Rand
Follow-up visit (34-39 weeks' gestation)		150 Rand
Follow-up visit (6-14 months' postpartum)		150 Rand
	Total up to:	450 Rand

WHAT ARE MY RIGHTS IF I TAKE PART IN THIS STUDY?

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you can drop out at any time. There are no penalties or consequences of any kind if you decide that you do not want to participate.

You will be notified of all significant new findings during the course of the study that may impact your willingness to continue.

FUTURE USE OF SPECIMENS

If you agree, some of the blood drawn from you as part of the study may be used for future research. At this time, we cannot provide details of when this testing may be conducted, or exactly what tests we would like to do. However, additional testing will not be done using these stored samples without the approval of the appropriate research ethics committees involved in this research. If you agree to let us store samples from you for future research, they may be kept in a locked freezer for up to 10 years after the study is finished. If we do use these samples in the future, the names or other identifiers will not be included with this information (as with the rest of the information we collect for this study).

Please initial below to indicate whether or not you give permission for your blood samples to be stored for future research. You may still remain in the study, no matter which you choose.

_____ (initial) I agree to have my blood stored for future research.

_____ (initial) I do **NOT** agree to have my blood stored for future research.

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WHO CAN ANSWER MY QUESTIONS ABOUT THE STUDY?

Take as long as you would like before you decide. We will answer any questions that you have now about this study, including if anything was unclear or if you need further information. Do you have any questions?

WHO DO I CONTACT FOR ADDITIONAL INFORMATION?

If you have questions later or any problems while taking part in this research, you may call the Principal Investigator, Dr. Angela Bengtson (Telephone: +1 401 893 5929, Email: angela_bengtson@brown.edu) or the local investigator Professor Landon Myer (Telephone: 021 406 6661, Email: landon.myer@uct.ac.za). If you fall ill, suffer side effects, or if you are injured during study activities, please immediately contact Dr. Angela Bengtson or Prof. Landon Myer. The ongoing ethical conduct of the study remains the responsibility of the principal investigators.

If you have any complaints about participation in this study, or would like more information about the rules for research studies, or the rights and welfare of people who take part in this study, you may contact the Chair of the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee, Professor Marc Blockman (Telephone: 021 406 6338) or Brown University Research Protections Office (Telephone: +1 401-863-3050 or toll-free at: +1 866-309-2095).

DOCUMENTATION OF CONSENT

If you accept to participate, please read the statements below and circle the appropriate responses below. If you need assistance, we will help you. Then, write your name, sign and date this form. You will receive a copy of this document for your future reference and so that you will have the contact information in case you have any questions or concerns.

I have read and understood this consent form.	☐ YES	☐ NO
All my questions have been answered to my satisfaction.	☐ YES	☐ NO
I agree to take part in the study.	☐ YES	☐ NO
I give permission to be contacted for follow-up for this study.	☐ YES	☐ NO
I can be contacted for future follow-up studies. (OPTIONAL)	☐ YES	☐ NO

_____ _____

Name and Surname of Participant Today's Date (day/month/year)

_____

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Signature

- -

For the researcher to complete:

I have discussed the proposed research with this participant and provided ample time for questions and answered all questions. In my opinion, this participant understands the risks, benefits and alternatives (including non-participation) and is capable of freely consenting to participate in this research.

____
Name and Surname of Person Obtaining Consent

____________________________ ______________________
Signature of Person Obtaining Consent Today's Date (day/month/year)

CAMP2 STUDY DIETARY INTAKE

INDICATOR FOOD FREQUENCY QUESTIONNAIRE

EA: | | | | | | | | **Household number:** | | |

Interviewer…… | |

Please think very carefully about what (child name) or you (if the child is 6 years or older) ate and drank for the **whole of last week**. Please look at these photo cards and place them in two piles, the one pile will be those that you did not eat last week, the other pile will be all the foods/drinks you had last week. The fieldworker now discusses each card on the second pile with the respondent(s) to determine how many times in the week and per day each food item was eaten.

	Times per week	**Times per day**
1. High fat red meat cuts like beef, mutton and pork with fat on, pork ribs or belly, brisket, burger patties		
2. Sausages like pork, boerewors of any kind		
3. Processed meats like polony, viennas, salami, Russians, bacon		
4. Biltong and droëwors		
5. Tinned meat like meatballs and corned beef		
6. Chicken with the skin		
7. Fried chicken		
8. Fried fish, fish cakes, fish fingers		
9. Fried egg		
10. Organ meats like liver, stomach, kidneys		
11. Full cream milk or sour milk to drink, in tea or on cereal/porridge, custard		
12. Low fat/fat free milk or sour milk to drink, in tea or on cereal/porridge		
13. Non-dairy creamer		
14. Full cream yoghurt		
15. Low fat/ fat free yoghurt		
16. Drinking yoghurt		
17. Flavoured milk cold or hot milk: chocolate, milo		
18. Condensed milk		
19. Hard cheese e.g. gouda, cheddar,		
20. Soft cheese e.g. cottage cheese		
21. Processed cheese spread or wedges		
22. White bread/rolls		

23. Brown or whole wheat bread/rolls		
24. Roti, naan bread		
25. Cereals low in fibre & sugar e.g. Corn Flakes, Rice Krispies		
26. Breakfast cereals high in fibre like All Bran, Weet Bix, Pronutro, Raisin Bran, Oats		
27. Breakfast cereals high in sugar like Sugar loops, Honey smacks, Nestle Cheerios, Milo, O-tees, Oatso easy, Frosted Crunchies, Funkydz strawberry, Frosted flakes, Special K, Frosties, Coco Pops.		
28. Legumes e.g. dry beans, lentils		
29. Peanut butter		
30. Brown rice, wheat rice (stamp koring), barley		
31. Maize porridge at any meal		
32. Bananas		
33. Apples and pears		
34. Citrus fruits like oranges, naartjies, grapefruit		
35. Guavas, strawberries and other berries		
36. Melon, watermelon, grapes		
37. Paw-paw, mango, pineapple, litchis, avocado		
38. Apricot, peaches, plums		
39. Prickly pears & figs		
40. Fruit salad		
41. Dry fruit		
42. Sweet potato, corn, sweetcorn		
43. Pumpkin, butternut, carrots, gem squash		
44. Green leafy vegetables like spinach, morogo, beetroot leaves		
45. Cabbage, cauliflower, Brussels sprouts, broccoli		
46. Green beans, peas, mixed vegetables, baby marrows		
47. Green salad (lettuce, cucumber, tomato, onions, peppers)		
48. Beetroot		
49. Tomatoes cooked/ relish		
50. Potato boiled, mashed, in stews (not fried)		
51. Fried potatoes (slap chips)		
52. Margarine, butter, lard on bread/ in porridge		
53. Mayonnaise, salad dressing		
54. Cream		
55. Fat cakes		
56. Pies, sausage rolls, samosas		
57. Doughnuts, eclairs		
58. Chocolate and chocolate spread		
59. Sugar in tea/coffee or on porridge		
60. Jam, syrup, honey		

61. Sweets e.g. boiled, lollipops, jelly type, sweet popcorn		
62. Cake, sweet biscuits, tarts, baked puddings		
63. Jelly, instant pudding		
64. Ice cream		
65. Crisps like Lays, Nik-Naks, papas, pretzels		
66. Take outs (e.g. KFC, McDonalds, Steers)		
67. Tea or coffee		
68. Sweetened fruit juice		
69. Fizzy drinks like Coke, Cream Soda (not diet drinks)		
70. Cold drinks made with water eg Oros, ice lollies		
71. Instant soup, cup of soup		
72. Instant noodles		
73. Bovril, marmite, fish paste on bread or salty biscuits		
74. Salty popcorn		
75. Salted peanuts		
76. Tomato sauce/ketch-up on food		