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Abstract

Background: Nutrition is a fundamental pillar of human life. Women have an increased risk of undernutrition than men. Undernutrition can result in adverse pregnancy outcomes and intergeneration cycle of undernutrition. The aim of this study is to determine the prevalence of undernutrition and the associated socio-economic determinants among adult women of reproductive age in Uganda.

Methods

A population based cross-sectional survey was conducted and 4,640 non-pregnant and non-post-partum women aged 20 to 49 were analyzed. Two stage stratified sampling was used to select study participants and data were collected using validated questionnaires. Multivariable logistic regression was used to model the association between socio-economic determinants and stunting and underweight using weighted data in SPSS version 24.

Results: The prevalence of underweight and stunting were 6.9% and 1.3% respectively. Women who belonged to middle (aOR = 2.49, 95% CI 1.25–4.99), poorer (aOR = 3.07, 95% CI 1.57–5.97) and poorest wealth index (aOR = 3.60, 95% CI 1.85–7.00) were more likely to be underweight compared to the richest. Belonging to rural residence (aOR = 0.63, 95% CI 0.41–0.96), Western (aOR = 0.30, 95% CI 0.20–0.44), Eastern (aOR = 0.42, 95% CI 0.28–0.63) and Central regions (aOR = 0.42, 95% CI 0.25–0.72) was associated with less odds of being underweight. Region was the only variable significantly associated with stunting. Wealth index was not significantly associated with stunting.
Conclusion: The prevalence of undernutrition in Uganda among women is less compared to most of the neighboring countries. There is need to address the socio-economic determinants including poverty, residence and reducing regional inequalities.

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Abbreviations

aOR    Adjusted Odds Ratio
CI  Confidence Interval

cOR  Crude Odds Ratio

DHS  Demographic Health Survey

UDHS  Uganda Demographic Health Survey

VIF  Variance Inflation Factor

HIV  Human Immunodeficiency virus
OR  Odds Ratio
PSU  Primary Sampling Unit
EA  Enumeration area
SD  Standard Deviation
WHO  World Health Organization
BMI  Body Mass Index
HAZ  Height for Age Z-scores
BAZ  BMI for Age Z-scores
GDP  Gross Domestic Product
SES  Social Economic Status
UNAP  Uganda Nutrition Action Plan
SDGs  Sustainable Development Goals
LBW  Low Birth Weight
WHA  World Health Assembly
MUAC  Mid Upper Arm Circumference
SPSS  Statistical Package for Social Science
UNDP  Uganda National Development Plan
USAID  United States Agency for International Development.
SUN  Scaling Up Nutrition
KGs  Kilograms
CMs  Centimetres
UNICEF  United Nations Children’s Fund
**Glossary of Terms**

**Cluster:** A cluster is the smallest geographical survey statistical unit for DHS surveys. It consists of several adjacent households in a geographical area. For DHS surveys, a cluster corresponds either to an enumeration area (EA) or a segment of a large EA.\(^a\)

**De Facto Population:** The de facto population includes all residents and nonresidents who stayed in the household the night before the interview.\(^b\)

**Household:** A household consists of a person or a group of related or unrelated persons, who live together in the same dwelling unit, who acknowledge one adult male or female 15 years old or older as the head of the household, who share the same housekeeping arrangements, and are considered as one unit.\(^c\)

**Preterm Birth:** Babies born alive before completed 37 weeks of pregnancy.\(^d\)

**Anthropometry:** The scientific study of the measurements and proportions of the human body and for this study, DHS took weight and height of the women that were not pregnant or post partum\(^b\)


\(^b\)Uganda Bureau of Statistics (UBOS) and ICF. 2018. Uganda Demographic and Health Survey 2016. Kampala, Uganda: UBOS, and Rockville, Maryland, USA: UBOS and ICF.


1.0 Introduction.

Nutrition is a fundamental pillar of human life, health, and development across the lifespan (1). Women have an increased risk of undernutrition compared to men due to reasons such as their reproductive biology, low social status, poverty, socio-cultural tradition and disparities of household work pattern (2). Undernutrition has far reaching consequences, especially in girls and women of reproductive age (3) and these consequences are intergenerational and are experienced at the individual, community, and national level (4). An estimated 450 million adult women in developing countries are stunted as a result of childhood malnutrition (2) Globally, the statistics of stunting among women are scarce as evidenced by even their absence in the global nutrition report (5).

With North Africa and sub-Saharan Africa having 30% of the global 15 to 19 year old girls’ stunting prevalence, (6) these will grow into adulthood while stunted. Stunting indicates chronic undernutrition (4) and in women, it is defined as height below 145 centimetres (7) while underweight indicates acute undernutrition (3). Stunting reflects prolonged exposure to inadequate nutrition, infection, and environmental stress (8). The last two decades have registered a slight but not significant reduction in undernutrition with 9.7% of women (aged 20–49) currently suffering from underweight (5). The greatest burden of underweight is seen in Asia and sub-Saharan Africa with some countries having as high as 36% of their women being underweight (7). More than 120 million women in developing countries are underweight (9)

Nube et al analyzed data from 31 countries in developing regions and showed that the burden of undernutrition was similar in men and women (10). However, a few regional differences showed Sub-Saharan Africa having a slightly higher prevalence of underweight in men compared to women, but it was the reverse in south and south eastern Asia (10). Underweight among Ugandan women of reproductive age is 9% (11) which was only defined using body mass index hence risking a partially correct prevalence since DHS included adolescents whose recommended indicator is BMI for age z-score. There is scarcity of statistics regarding stunting in women in Uganda as the DHS report also does not give the overall national prevalence (11). This study will provide generalizable weighted statistics of the socio-economic determinants of undernutrition among women of reproductive age in Uganda.

1.1 Determinants of Undernutrition

Undernutrition has been shown to be associated with various factors that interact with each other at various levels (8). Life course and social determinants of health are crucial to be looked regarding undernutrition (12). Cultural and gender norms are crucial as they can control amount and type of food females consume and economic activities done (12). Cultural norms
that have less value for females lead to practices like them feeding last in the households further predisposing them to inadequate nutrition (13). According to the adapted UNICEF concept map (figure 1), the direct causes include factors like inadequate dietary intake and increased needs due to infectious diseases (8). The underlying causes include inadequate care practices, food insecurity and inadequate access to water, sanitation and health services (14).

The socio-economic factors affect access to nutritious food at the community and household levels and hence risking undernutrition (15). The effect of social economic status on the health status and nutrition has been shown to start early in life most likely even prenatally and continue throughout life (16). It is beyond financial strength or education but also includes access to knowledge and opportunities (16). Low women socio-economic status influences maternal outcomes, negatively affects self and child care which leads to low BMI and risks childhood stunting (7). Inadequate income affects both the household’s purchasing power and food choices leading to a reduction in the quality and quantity of food eaten (16).

Ozaltin et al analyzed 109 national surveys in 54 countries and showed that having the lowest level of education and belonging to the lowest wealth quintile was associated with twice and 1.5 times of women being stunted respectively (7). Hong et al analyzed the 2000 Cambodia DHS data of 6922 women and showed that women from the 20% poorest households had 63% more odds of having under nutrition compared to those in the richest 20% households (17). Similarly, Smith et al with similar nationally representative data of 77,220 Indian women showed 96% more odds of under nutrition for women in the lowest wealth quintile compared to those in the highest quintile (18).

Education is one of the women empowering tools and has been shown to reduce the prevalence of childhood stunting, early marriages, teenage pregnancies and maternal underweight (7). Education increases the chances of more income which would lead to more household availability of enough good quality food, resources and nutritional awareness (16). Education also influences the level of knowledge of healthy behavior, nutrition literacy, sanitation practices and challenges existing negative cultural beliefs (19-21). Smith et al analyzed a nationally representative data of 15 to 49 year old 77,220 Indian women and showed that women who had no education had 38% more odds of being under nourished compared to those that had more than 15 years of education (18). Similarly, Kamal et al in Bangladesh showed that Women who had no education were 1.78 times more likely to be underweight compared to those with post-secondary level of education (22).

Figure 1. Conceptual Frame work showing the three levels of causes of under nutrition.

Some studies have shown residence to affect the prevalence of stunting and underweight with many studies showing rural areas being more at risk. Undernutrition in rural areas is usually linked to food habits and inadequate material resources (14). Smith et al showed that women who lived in the rural areas had 17% more odds of being undernourished compared to their counterparts that lived in large urban cities (18). Kamal et al also showed a similar finding with the Bangladesh 2011 DHS data of 16,273 15 to 49-year-old women (22).

Family size has also been shown to affect the nutritional status of household members. Families with a large size usually tend to be food insecure where inhabitants are given less quantities of food especially in the poor families (20). Large family size also risks spread of infections due
to overcrowding and with infections, there is an increased risk of poor nutrition status (20). Melaku et al in Ethiopia showed that family size was significant as more stunting was reported in families with more than four members compared to those that had a less number (3). Similarly, Acharya et al in Nepal showed that women who belonged to households having fewer individuals had a reduced risk of underweight compared to those with more individuals (9).

Studies have had different views regarding sex of the head of the household with some showing male heads being protective against undernutrition and others showing female heads being more protective against undernutrition. Given decision-making power, females tend to devote more household resources on their children and also make better health choices (23). Haidar et al looked at 144 heads of households in Ethiopia and showed that stunting and underweight were significantly higher in households that were headed by females compared to those headed by males (24). Similarly, Herrador in Northwestern Ethiopia showed participants rural areas had 197% more odds of being stunted if they belonged to female headed households compared to male headed households (14).

Occupation has also been shown to be a significant factor. Smith et al in India showed that women who worked in the agricultural sector and as manual workers had 6% more odds of being undernourished in comparison to their counterparts in the labor force (18). A similar finding was shown by Hong et al when he analyzed the 2000 Cambodia DHS data of 6922 women aged 15 to 49 years and showed a significant positive association between occupation status and nutritional status (17). Regarding marital status, Acharya et al looked at 229 women aged 15 to 49 years in rural Nepal where 32.3% were underweight and showed that prevalence of undernutrition particularly underweight was significantly higher among the married women compared to the unmarried ones (9). Unlike the above findings, Abdu et al in Ethiopia looked at 549 women with prevalence of underweight at 41.1% and showed that compared to the married women, the unmarried ones had 758% more odds of being underweight (25).

1.2 Effects of Undernutrition Among Women

Maternal undernourishment is estimated to be responsible for about 20% of childhood stunting (7). The nutritional status of women has been greatly showed to affect the outcome of pregnancy and child health (7). Maternal undernutrition is associated with poor mental health and poor obstetric complications such as preterm birth, low birthweight, increased risk of infant mortality and still births (22). This further risks the intergenerational cycle of undernutrition (8). Women who are undernourished are also most likely to be anemic which further increases the risks of poor obstetric outcomes (22).
The risk of intergenerational undernutrition is increased in situations of social, economic, and gender inequities (26) which are highly prevalent in developing countries. Addo et al showed that stunted mothers were three times more likely to have their children stunted at 24 months of age and as adults (7). Besides giving birth to LBW babies and not being able to care about themselves and their children, undernourished women are usually less productive in the labour force (27).

Stunting has been shown to be a risk factor for increased risk of developing metabolic diseases and reduced physical capacity (28-30). Reduced physical capacity negatively affects their working capacity. Some studies have shown people that are stunted to be earning 8–46% lower wages and owning up to 66% fewer assets (31). Childhood stunting has been linked to poor cognitive development (32), adverse schooling outcomes, including late or reduced enrollment and increased grade repetition as they grow (33) and without proper education, women in adulthood are prone to poverty.

Undernutrition leads to a higher risk of mortality as it increases vulnerability and susceptibility to morbidities through lowering of the immune system and subsequent long-term chronic health problems (4, 34). Walker et al in Jamaica showed that early childhood stunting is associated with poor psychological functioning in adolescence (35). This prospective cohort study showed adolescents that were stunted in their childhood had more anxiety, depression and low self-esteem compared to their adolescent counterparts that were not stunted during childhood (35).

1.3 Assessment of Undernutrition in Women
Undernutrition is mainly assessed by anthropometry taking height and weight measurements for macronutrient status and screening for biochemical and clinical markers (36) that detect micronutrient deficiencies. The common anthropometric indicators used to evaluate women’s undernutrition include; height below 145cm for stunting, body mass index (BMI) less than 18.5 kg/m² for underweight, weight below 45kg and mid-arm circumference (MUAC) less than 22.5cm (37). BMI is calculated by dividing weight in kilograms by height squared in meters (kg/m²) (37). BMI is the recommended and most common method of assessing population underweight (38). According to World Health Organization the BMI cutoffs are; less than 16 kg/m² severely underweight, 16–16.9 kg/m² moderately underweight, 17.0–18.49 kg/m² mildly underweight, 18.5–24.9 kg/m² normal, 25–29.9 kg/m² overweight and above or equal to 30 kg/m² obese (18).

Body composition measurement has also increasingly become important as there is need to assess changes in nutritional status that can differentially have an effect on body reserves (39). Body fat composition is analyzed with several techniques such as bio-impedance technique (40). Several methods can be used such as skin fold thickness measurements which can as well
be converted into standard deviation scores, waist circumference, hip circumference etc. (40). For this study, I am focusing on stunting (height below 145 cm) and underweight (BMI less than 18.5 for underweight) among adult women of reproductive age (20 to 49 years).

1.4 Problem Statement

Low agricultural productivity that has intensified over the years poses a big challenge to food security in many low income countries including Uganda (41). Women in developing countries experience more effects of undernutrition than men and the economic and cultural imbalance that favors men more than women puts women more at risk than men (22). Gender norms very prevalent in developing countries like Uganda leave many females disproportionately impacted by inadequate food intake, more prone to abuse than males and at a greater risk of dropping out of school, early marriage and teenage pregnancy all of which negatively affects their nutrition (42, 43) even in adulthood. Women in Uganda are economically disadvantaged as they have less control of resources like land, much involvement in unpaid care work, work longer hours than men and less access to credit services (44).

About 65% of Ugandan women in agriculture have no control of the income from agriculture which greatly affects their income, ability to expand and increase their produce and limits their access to welfare (44). The increased movement of the Ugandan youth and men from the rural areas to the urban ones has increased the workload of the women left behind as they must look after the households and carry out agriculture production (44). With limited time, their personal and children’s care and agricultural production are negatively affected which puts their health and nutrition and that of their children at risk (44). Despite women being more informed about nutrition than men, more men still decide on expenditure on food which affects the quality and quantity of food consumed hence putting the nutrition of children and women further at risk (44). Hence risking the intergenerational cycle of undernutrition.

Uganda has one of the highest fertility rates in sub-Saharan Africa which greatly strains household resources (45). This not only increase their risk to maternal and child mortality but also undernutrition (45). In addition, under nutrition has been shown in Uganda and other countries to increase the risk of HIV infection following exposure and accelerate progression to AIDS and death among those infected (46, 47) yet the prevalence of HIV in Uganda is more in females than males (48). Focusing on the nutrition of women will contribute to reduction of spread of HIV and progression to AIDS.

Currently, Uganda ranks 129th out of 157 countries in progress in meeting the Sustainable Development Goals (45) and with the current annual childhood stunting reduction rate at 0.45%, more children will grow into adolescence and adulthood undernourished (49). Women
who are undernourished are also most likely to be anemic which further increases the risks of poor obstetric outcomes (22). Women with severe anaemia have a 20% increased risk of maternal mortality (50). With anaemia prevalence in Uganda rising and also being more in women than men, Uganda’s progress of reducing maternal mortality to 70 deaths per 100,000 live births in the agenda 2030 might be greatly affected (11). In Uganda, women above 20 years of age are more affected with maternal deaths as 24.5% are in those aged 20-24, 20.3% in those aged 25-29, 19.2% in those aged 40-44, 19% in those aged 30-34 compared to 17.2% among those aged 15-19 (11).

Improving nutrition for women will speed up the progress of many SDG goals. Improving women’s nutrition has been proven to be one of the ways of reducing undernutrition in children (7) and a strong pillar in the global efforts of reducing maternal mortality (37). Uganda’s commitment to nutrition is ranked globally as low (51) and much nutrition focus has been put on under 5 children with little research among women of reproductive age. Health workers are currently focusing mainly on the adverse health effects of overnutrition with little attention given to the effects of undernutrition (52). This could be because undernutrition as evidenced by the UDHS is not as much as overnutrition and for some women underweight is commonly regarded as fashionable.

Little of the available literature is nationally representative which impedes the ability to guide maternal national nutrition policies and programs to break the intergenerational cycle of undernutrition. The UDHS 2016 summary report gave unweighted statistics of underweight and stunting and it combined adolescent women with their older counterparts and used BMI and height below 145cm respectively for all of them. This risks a partially accurate statistics as BMI and height below 145cms are not recommended for those below 20 years of age but BAZ and HAZ scores. This nationally representative study will give weighted statistics that are more generalizable regarding the prevalence of undernutrition and associated socio-economic factors among adult women of reproductive age in Uganda.

1.5 Objectives

1.5.1 Main Objective
To determine the prevalence of undernutrition and associated socio-economic factors among women of reproductive age in Uganda.

1.5.2 Specific Objectives
1. To determine the prevalence of underweight among women of reproductive age in Uganda.

2. To determine the prevalence of stunting among women of reproductive age in Uganda.
3. To determine the association between socio-economic factors (wealth index, age, education level, marital status, household size, sex of household head, region, residence and working status) and undernutrition among women of reproductive age in Uganda.

1.6 Research Question
What is the prevalence of underweight and stunting and associated socio-economic factors among adult women of reproductive age in Uganda?

2.0 Methods

2.1 Study design
This is a cross-sectional study conducted by a secondary analysis of Uganda’s Demographic and Health Survey (UDHS) data that was collected from 20th June 2016 to 16th December 2016 (11). It is conducted by the DHS program in collaboration with Uganda Bureau of Statistics and funded by the USAID. The UDHS 2016 was a population-based survey aimed at generating information that gives the current health status indicators of the population.

2.2 Study setting

Figure 2: Location of Uganda on the world and African Maps from Wikipedia 2019.

Uganda is in Eastern Africa with a population of 40,853,749 million people (53) up from 34.6 million people in 2014 and has a total area of 241,551 square kilometres (54). Uganda’s health system has six levels and ranks from the highest level of national referral hospitals with highest specialist care to the lowest level at the community level (55). It is a pluralistic health system with the government providing formal care at all levels as well as formal, informal private
sector and faith-based providers (55). Over 45% of the health facilities are owned by non-state actors (55). The maternal mortality ratio stands at 336 maternal deaths per 100,000 live births while infant and under 5 mortality stand at 43 and 64 deaths per 1000 live births respectively (11).

English is the official languages however there are many local languages spoken (54). Uganda is administratively divided into districts, counties, sub-counties, parishes and villages (44). Agriculture contributes about 24 percent of gross domestic product (GDP), and providing half of export earnings with 84 percent of Ugandans live in rural areas, agriculture is their main source of income (45). Uganda has one of the youngest and highly growing populations globally where about half of population is below 15 years old and about 55% are below 5 years (51). In age groups above 14 years, there are more females than males (54). Uganda has reported economic growth however, this growth has led to a rising social inequality and more than one-in-three Ugandans live below the international extreme poverty line of US$1.90 a day (51). Uganda has approximately 7.3 million households about a third are headed by females and the mean household size is 4.7 people (44, 54). Uganda’s overall literacy level is at 72% with females standing at 68% and males at 77% (44, 54). About 72% of Ugandans earn from agriculture with 76% and 63% being women and youths respectively and mostly in rural areas (44). Christians constitute 85 percent of Uganda’s population while Muslims make up 14% and the remaining 1% believing in traditional beliefs (44, 54).

2.3 Participants and the study size

2.3.1 Study population

Women aged 15 to 49 years who were either the permanent residents or slept the night before in the selected household were eligible for inclusion in the Uganda’s demographic health survey 2016 (11). Out of 20,800 selected households, 19088 women aged 15 to 49 years qualified were for individual interviews and 18,506 of these were successfully interviewed (11). The present study’s eligibility criteria for anthropometry was being not pregnant and having had no birth two months before the survey (11). Therefore, our sub-sample was consented 20 to 49-year-old women who were not pregnant and not had any birth two months before the survey. Of the 18506 women who consented and filled in the questionnaires, 14,242 were aged 20 to 49 years and of these, 4731 were eligible for anthropometry and 4640 had their anthropometry done (11). Adolescents aged 15 to 19 were excluded in this study as the recommended anthropometric indicators for assessing undernutrition for those above 20 are different from those of adolescents. This has been done in some studies like in Botswana (52) and Kenya (56) using DHS data.
2.4 Sampling

2.4.1 Sampling Design and Implementation

A two-stage stratified, cluster sampling technique was employed to get a representative sample at the national, regional and urban/rural levels (11). The sampling frame used was that of the 2014 Uganda National Population and Housing Census conducted (11). The frame had all the census enumeration areas and each EA covered about 130 households and it had all the necessary information about these households (11). By 2016, Uganda was divided into 112 districts which were divided into 15 regions for this survey and each region was stratified into urban and rural areas (11).

The first stage of sampling involved selecting 697 EAs including 162 urban and 535 rural EAs which are also the primary sampling units (PSUs) (11). One EA in Acholi region was excluded due to land disputes hence ending up with 696 EAs. EAs with over 300 households were segmented and only one segment selected with probability proportional to the segment size as this helped minimize the burden of household listing (11). The EAs that were involved in the survey were chosen independently from each stratum with probability proportional to size. The second stage of sampling involved selection of households through equal probability systematic sampling. A list containing all households and maps in the selected EA were made available and households that were in institutional living arrangements were excluded (11). Over Sampling was done in areas that were under-populated and areas with higher population were under-sampled to maintain representativeness of sample at the regional levels (11). About 30 households (HHs) were selected from each EA with equal probability systematic sampling, starting at random, giving a total of 20,800 households and 18,506 women that were individually interviewed (11).

2.4.2 Sample size

For UDHS 2016, a sample size of 20,800 households was estimated and the UDHS report does not specifically give information as to how this sample size was reached at (11). However, the overall sample size is the total the sample sizes for all the domains (57). An appropriate sample size for a survey domain is the minimum number of persons (e.g., women age 15-49, currently married women 15-49, children under age five) that achieves the desired survey precision for core indicators at the domain level (57). In situations where funding is limited, the highest number of people that the funding can accommodate becomes the sample size (57).

In almost every situation, the sample is appropriately allocated to make sure that the selected sample size ensures precision at the domain level (57). So apart from survey costs, the total sample size depends on the desired precision at domain level and the number of domains (57).
If a reasonable precision is required at domain level, experience from the MEASURE DHS program shows that a minimum number of 800 completed interviews with women is necessary for some of the woman-based indicators for high fertility countries and for low fertility countries, the minimum domain sample size can reach 1,000 completed interviews or more (57).

2.4.3 Sampling Weights
Given the uneven distribution of the population in Uganda, sampling with proportional allocation basing on the population’s distribution yields a limited number of respondents from certain region which doesn’t give precise representation of the data and estimates. Sampling more households and individuals in regions with small populations would yield adequate sample size, representative data and precise estimates for such regions however this would increase the sample size yet there is a challenge of limited resources. The DHS program therefore oversamples regions with small populations and under samples those with large populations and with this, the target sample size is kept within limits and reliable estimates are got. In order to maintain the representativeness of the sample and possible differences in response rates across regions, sampling weights are used (58).

Sampling weights avoid the over sampled regions from being over represented in the estimates as adjustments are applied to every participant’s response as it helps reflect the participant’s actual proportional occurrence in the population and hence meaningful generalizability of the results. The previous DHS manual 2006 only supported use of sampling weights in only indicator estimates but the current manual 2018 supports the use of weights also as part of complex sample parameters when standard errors, confidence intervals or significance testing is needed (58). Use of weights might increase standard errors and confidence intervals though not by large amounts which might risk making estimates less precise and more variable so the DHS manual advises that to limit this, when standard errors, confidence intervals or significance testing is needed, we should consider the complex sample design (58). Besides DHS support of use of weights, the most recent literature supports it as well and some peer reviewed articles like kamal et al in Bangladesh, Yang et al and Letamo et al in Botswana have used weights (22, 52, 58-61).

2.5 Data collection
UDHS 2016 had four different questionnaires that collected data on health indicators and background characteristics (11). The household; woman’s; man’s and biomarker questionnaires (11). These questionnaires were adapted to suit Uganda’s context from the DHS program’s model questionnaires. The questionnaires were made available in nine languages including English and eight other local languages that are majorly spoken in the country (11). The
questionnaires were also programmed into tablet computers to facilitate computer assisted personal interviewing (CAPI) with the ability to choose any of the nine languages (11). The household questionnaire covered information of the household permanent members, visitors, deaths and assets. Basic demographic information was collected on each of the person and this information was used to identify women who were eligible for individual interviews and anthropometry measurements (11).

The women’s questionnaire covered topics like background characteristics, reproduction, family planning, domestic violence, nutrition etc. (11). The men’s questionnaire collected information like that of the women however it was shorter. The Biomarker questionnaire covered information on anthropometric measurements and blood tests (11). One hundred seventy-three field workers worked on the survey ranging from supervisors to reserve interviewers (11). These already had some experience with household surveys, some had worked on the previous DHS surveys and were trained for two months (11). Twenty-one health technicians were trained on how to correctly take the anthropometric measurements from theoretical and practical classroom lectures to field practice at a health facility and they were evaluated through various ways afterwards.

Weight was recorded in kilograms to the nearest one decimal using an electronic SECA 878 flat scale (11). Height was recorded in centimetres to one decimal point. In children, it was measured using a Shorr board however the manual is not clear whether this was the same brand used for adolescents (11). Pre-testing of the questionnaires was done for two days in non-survey sampled EAs in Entebbe municipality and some changes were made (11). Pretesting of the translations was also done in the respective regions a week after the pre-testing in Entebbe (11). Fieldwork supervision was done by senior staff from School of Public Health at Makerere University, ministry of health, UBOS and from the DHS program (11).

2.6 variables

2.6.1 Dependent variables

The main outcome variables are underweight and stunting.

Underweight was defined as BMI<18.5 and No Underweight as BMI >=18.5 (less than 16 kg/m² severely underweight, 16–16.9 kg/m² moderately underweight, 17.0–18.49 kg/m² mildly underweight, 18.5–24.9 kg/m² normal, 25–29.9 kg/m² overweight and above or equal to 30 kg/m²obese). This has been used in DHS studies on women in similar contexts like Bitew et al in Ethiopia (37).

Stunting was defined as height <145cm (7, 11, 37) and No Stunting (Height >=145cm).
2.6.2 Independent variables

The following independent variables were assessed for their association with underweight and stunting and their choice was informed by the conceptual frame work, evidence from the literature and availability of data.

2.6.2.1 Exposure

Wealth Index

Wealth Index is a measure of relative household economic status and was calculated from information on household asset ownership using Principal Component Analysis (11, 62). The different household amenities were used to calculate separate wealth indices for rural and urban areas, combined into a national wealth index and then quintiles are calculated for each index (11, 62). The quintiles are categorical and include: the poorest, the poorer, the middle, the richer and the richest quintiles (11, 62). The richest quintile was taken as the reference category in this study.

Place of Residence

This was the women’s de facto place of residence at the time of survey, categorized as urban (reference category) and rural.

Region

This was the region where the women’s households were located. They were categorized into four; Northern (Teso, Karamoja, Lango, Acholi, West Nile), Central (Kampala, Central 1 and Central 2), Eastern (Busoga, Bugishu and Bukedi) and Western (Tooro, Ankole, Bunyoro and Kigezi). This categorization was based on Yang et al that used the same in 2018 on UDHS data (61). The Northern region is the reference category.

Level of Education

This is the highest level of women’s education attended at the time of the survey, categorized into: no education, primary education, secondary and higher education (reference category). The women were asked directly their highest level of school they had attended at the time of the survey.

Age

This is the age in completed years at the time of the survey. The ages were categorized into 20 -29, 30- 39 and 40-49 (reference). This is like what the UDHS used to present the summaries.

Household Size

This is the number of permanent household members and was categorized as less than 6 (reference) and Six and Above. There is no clear cut standard cut offs for this as different study use different categories, but I used this basing on some studies done in similar contexts (63) that used it and the fact that the mean household size in Uganda is 4.7 persons (54).

Sex of Household Head
This is the sex of the head of the household which was categorized as male (reference) or female.

*Working status*
This was categorized as: not working and working (reference). The women were asked what kind of work they do, and nine responses were recoded in the questionnaire. The nine working responses recoded in the questionnaire were further recoded in this study into working. These include: professional/technical/management, clerical, sales, agricultural-self-employed, agricultural-employed, household and domestic, services, skilled manual and unskilled manual. This categorization has also ever been used (64).

*Marital Status*
This was categorized into married and this included those in formal and informal unions and not married (reference) that include those that are widowed, divorced, separated or have never been in any form of union.

**2.7 Statistical methods**
IBM SPSS statistics version 24 was used for the analysis. The SPSS Complex Samples package was used to account for the sample design and weights in the analysis. Graphs and tables were produced using MS excel and MS Word. Statistical significance was set at p-value of < 0.2 at bivariate analysis and p-value < 0.05 at the multiple variable analysis level and 95% confidence interval (CI) was described for both crude and adjusted odds ratios.

**2.7.1 Data cleaning and variable management**
DHS’s women recode file in SPSS format contained all required variables. Codes for required variables were identified using DHS recode manual (65). Unnecessary variables were deleted, and dataset only had 20 to 49-year-old women. The analysis for nutritional status was restricted to only those who were not pregnant and had not given birth six weeks preceding the survey. Cases with missing values and don’t know responses on outcome variables were deleted however descriptive analysis was done for them. Finally, the variables were recoded, and sum scores computed where appropriate that were re-categorized as explained under variables section above.

**2.7.2 Descriptive statistics**
Relative and absolute frequencies were used to describe participants’ characteristics and the distribution of independent variables. Even though all final variables were categorical, some like age, weight, height, BMI and household family size were kept as numerical in descriptive analysis. Numerical summaries like mean, standard deviation (SD), histograms, bar graphs and pie charts were done to understand the data better. Sample weights that were pre-defined by DHS were applied to all descriptive statistics to produce unbiased estimates.
2.7.3 Inferential statistics

The SPSS Complex Samples package was used to determine and model the association between various predictors and the dichotomous outcome variables of underweight and stunting. Use of SPSS Complex Samples package accounted for the complex sampling strategy of DHS putting into consideration the PSUs, strata and weights. The normal binary logistic regression assumes simple random sampling method of data collection in which the participants have an equal probability of being selected (66). Ignoring sampling design when analyzing complex survey data using binary logistic regression may lead to biased estimates and hence making invalid inferences from the finite population (66, 67).

Initially, each exposure was assessed separately for its association with the outcome variable (crude odds ratio - cOR) in bivariate analysis with chi-square test and simple logistic regression. Multicollinearity between the exposure variables was checked with Variance Inflation Factors and they were all within the normal range (68). Independent variables found significant at p-value < 0.2 (69) were included in the multivariable logistic regression models with stunting and underweight as binary outcome variables (i.e. stunted and not stunted, underweight and not underweight) to assess their association. However, even variables that did not meet the 0.2 significance level and were found significant based on previous studies were also included. Goodness of fit of the models was assessed with the Hosmer and Lemeshow test which helps to show to what extent the model fits the data better than the null model. If its p-value is > 0.05, then the estimated model is a good fit, and this was the case for all the models in this analysis.

Two multivariate analysis models are presented. The first model adjusted for women characteristics (age, education level, working status and marital status). The second model which was also the final one included women characteristics and household characteristics (wealth index, residence, region, household size and sex of household head). Crude odds ratio and adjusted odds ratios were reported in both models with their corresponding 95% Confidence Intervals (CI) are reported. Adjusting allowed associations of the study variables to be measured while simultaneously controlling for potential confounding effects.

Sensitivity analysis was done by re-categorizing working status into not working, manual laborers and non-manual laborers. Sensitivity analysis was also done with only women who were underweight and normal after excluding those with BMI above 25.

2.8 Ethical considerations

High international ethical standards are ensured for DHS surveys as ethical approval from the country is obtained from a national ethical review board and local authorities before
implementing the survey (70, 71) and well-informed verbal consent is sought from the respondents prior to data collection (11, 71). The consent form explained the objectives of the survey, confidentiality and the participation being voluntary with the right to withdraw at any time or to avoid answering some questions if they wanted to and no respondent was coerced to participate (11, 71). Translating to the local languages and pretesting ensured that the respondents would be able to understand the nature of the survey which ensured informed decision making regarding consenting for participating (11, 71).

The benefits of participation were mainly indirect as the survey’s data can be used to design programs and policies for the country’s benefit. Some of these health technicians had worked in the previous surveys and were also further supervised by senior staff from School of Public Health at Makerere University, ministry of health, UBOS and from the DHS program (11). Measures were taken to ensure privacy and confidentiality (11, 70, 71). Names and addresses of participants are transformed into codes in DHS data files, thereby maintaining participants’ anonymity and confidentiality (71). Electronic files were stored on a password protected computer (11). Generally, the UDHS survey fulfilled the principles of medical research involving human subjects as laid down under the Declaration of Helsinki (72). This dataset had the entire participant’s identifying information removed. As the original DHS data was collected in line with ethical standards of scientific research, data was publicly available after consent of host country’s government and as participants could not be traced back in the available dataset, a formal ethical clearance for this study was not needed.

3.0 Results

3.1 Participant Flow

A total of 18,506 women were surveyed in the 2016 UDHS. However, for this study, after excluding women aged 15 to 19, those who were pregnant, postpartum and those with missing data on height and weight, a total of 4,640 women were analyzed.

Figure 3 (Below): Flowchart showing the flow of participants, based on a baseline population of all women studied in the 2016 UDHS
3.2 Descriptive Analysis

3.2.1 Characteristics of study population

The descriptive characteristics of the women are presented in table 1. About 73.6% resided in rural areas while the regional percentages did not vary much with the highest being 30.2% in the central and lowest 19.7% in Eastern region. More than 60% of the women belonged to male headed households, 84.3% were currently working and 73.4% were in some form of a union. About an equal number of women were living in households having six and more members and less than six members i.e. 46.1% and 53.9% respectively. Since wealth index is presented as quintiles, approximately 20% of the study population can be found in each wealth index category. Approximately 60% of women had earned primary education as the highest level. The mean age was 31 and the youngest age category 20 to 29 had the highest number of women which was 48%.
3.2.2 Nutritional status

3.2.2.1 Underweight
The mean weight, height, household size and BMI were 59.5 kgs, 158.9 cms, 5.7 people and 23.56 respectively. The prevalence of underweight was 6.9%, normal weight 65%, overweight 19.2% and obesity 8.9%. Of those who were underweight, 77.4% were mildly underweight, 18.2% moderately underweight and 4.4% severely underweight. (figure 4). As per regions, underweight was most prevalent in the Northern region 14.3% and lowest among the Western region with 4%. Women belonging to female headed households had a slightly higher prevalence of underweight 7.5% compared to 6.5% of those who belonged to male headed households but with almost similar figures. This partner of almost the same prevalence was seen among working status, residence, marital status and household size. Among the wealth quintiles, the poorest wealth index had the highest prevalence 14% and the richest had the lowest as 3%. According to education levels, women who had no education had the highest prevalence 11.2% and higher education had the lowest as 3%. In the age categories, the eldest age category 40 to 49 had the highest prevalence 8.4% while the other two had a difference of 0.1% almost the same prevalence.

3.2.2.2 Stunting
The prevalence of stunting was 1.3%. Education level had the biggest discrepancies with 2.5% of women with higher education being stunted compared to 0.6% of those with secondary level, 1.3% of primary level and 1.6% of no education. Place of residence had the same prevalence at 1.3% both in rural and urban areas. Among regions, Western region had the highest prevalence 1.8% while Northern region had the lowest at 0.5%. The youngest age category had the highest prevalence 1.6% while the middle one 30 to 39 had the lowest prevalence at 0.9%. Among the wealth quintiles, the middle one had the highest prevalence at 1.8% followed by the richest at 1.4% and the least prevalence was seen in the richer quintile as 0.8%. Working status, household size and sex of household head sub categories almost had the same prevalence (table 2).

Figures 5 and 6 show the distribution of underweight and stunting by wealth index and region. Among those who were underweight, the percentage and frequency distribution decreased with a better wealth index which was a bit different with stunting. The richest quintile had the highest percentage and frequency of stunted women followed by the middle and poorer quintiles.
Table 1: Background characteristics of women aged 20 to 49 years with data available from the 2016 UDHS.

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>N</th>
<th>%</th>
<th>MEAN (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td>31.2 (+/-8.18)</td>
</tr>
<tr>
<td>20 to 29</td>
<td>2225</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>30 to 39</td>
<td>1486</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>40 to 49</td>
<td>928</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td><strong>Residence</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>1223</td>
<td>26.4</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>3416</td>
<td>73.6</td>
<td></td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>1182</td>
<td>25.5</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>913</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>1400</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>1144</td>
<td>24.7</td>
<td></td>
</tr>
<tr>
<td><strong>Sex household head</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1648</td>
<td>35.5</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2991</td>
<td>64.5</td>
<td></td>
</tr>
<tr>
<td><strong>Household Size</strong></td>
<td></td>
<td></td>
<td>5.7 (2.74)</td>
</tr>
<tr>
<td>6 and Above</td>
<td>2138</td>
<td>46.1</td>
<td></td>
</tr>
<tr>
<td>Less than 6</td>
<td>2501</td>
<td>53.9</td>
<td></td>
</tr>
<tr>
<td><strong>Working statusa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Working</td>
<td>721</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>3913</td>
<td>84.4</td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>3406</td>
<td>73.4</td>
<td></td>
</tr>
<tr>
<td>Not Married</td>
<td>1234</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td><strong>Education Level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Education</td>
<td>555</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>Primary Education</td>
<td>2593</td>
<td>55.9</td>
<td></td>
</tr>
<tr>
<td>Secondary Education</td>
<td>1085</td>
<td>23.4</td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>407</td>
<td>8.7</td>
<td></td>
</tr>
<tr>
<td><strong>Underweight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>318</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>4322</td>
<td>93.1</td>
<td></td>
</tr>
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### Stunting

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>58</td>
<td>4581</td>
</tr>
</tbody>
</table>

**Wealth Index**<sup>b</sup>

<table>
<thead>
<tr>
<th>Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>158.9 (&lt;+6.37)</td>
</tr>
<tr>
<td>BMI</td>
<td>23.56 (&lt;+4.45)</td>
</tr>
<tr>
<td>Weight</td>
<td>59.5 (&lt;+11.86)</td>
</tr>
</tbody>
</table>

<sup>a</sup>6 missing responses  
<sup>b</sup>Advised in the group not to include them since they are quintiles approximated to 20%.
3.2.3 Characteristics of women excluded from the final analysis

Table a in the appendix summarizes the background characteristics of 1.9% (91/4731) of women who met the inclusion criteria but were excluded from the final analysis as they were either not present for measurements or refused to be measured. In contrast to the women included in the final analysis, the excluded group had a lower proportion of married women 47.5% compared to 73.4% in the final analysis group that had more married women. The rest of the characteristics remained almost the same but in the excluded group, 50.1% women belonged to rural areas compared to 73.6% in the final analysis group. 55.7% of women in the excluded group belonged to male headed households compared to 64.5% in the final group. Additionally, the excluded women were slightly younger with 53.6% of them aged 20 to 29 (mean age: 29.9 years (SD= -/+7.84, data not shown) compared to 31.3 and SD =/8.18 in the final analysis group where 48% of them belonged to the 20 to 29 years category.

3.3 Factors associated with undernutrition.

3.3.1 Underweight

In the bivariate analysis with the Chi-square (table 2), sex of household head, marital status and working status were not associated with underweight (p < 0.2). Factors found associated with underweight were residence, region, sex of household head, household size, age, wealth Index, and education level.
Table 2: Bivariate analysis of potential socio-economic determinants of underweight and stunting of women aged 20 to 49 years with data available from the 2016 UDHS.

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Underweight n (%)</th>
<th>No Underweight n (%)</th>
<th>p-value</th>
<th>Stunting n (%)</th>
<th>No Stunting n (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Head</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>124 (7.5)</td>
<td>1524 (92.5)</td>
<td>0.222</td>
<td>17 (1)</td>
<td>1631 (99)</td>
<td>0.409b</td>
</tr>
<tr>
<td>Male</td>
<td>193 (6.5)</td>
<td>2798 (93.5)</td>
<td></td>
<td>41 (1.4)</td>
<td>2950 (98.6)</td>
<td></td>
</tr>
<tr>
<td>Wealth Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorest</td>
<td>114 (14)</td>
<td>701 (86)</td>
<td>0.000a</td>
<td>8 (1)</td>
<td>808 (99)</td>
<td>0.526b</td>
</tr>
<tr>
<td>Poorer</td>
<td>74 (9.1)</td>
<td>741 (90.9)</td>
<td></td>
<td>10 (1.2)</td>
<td>805 (98.8)</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>54 (6.2)</td>
<td>817 (93.8)</td>
<td></td>
<td>16 (1.8)</td>
<td>855 (98.2)</td>
<td></td>
</tr>
<tr>
<td>Richer</td>
<td>39 (4.1)</td>
<td>903 (95.9)</td>
<td></td>
<td>8 (0.8)</td>
<td>935 (99.2)</td>
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<tr>
<td>Richest</td>
<td>36 (3)</td>
<td>1159 (97)</td>
<td></td>
<td>17 (1.4)</td>
<td>1178 (98.6)</td>
<td></td>
</tr>
<tr>
<td>Working Statusc</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Working</td>
<td>275 (7)</td>
<td>3638 (93)</td>
<td>0.334b</td>
<td>49 (1.3)</td>
<td>3864 (98.7)</td>
<td>0.732b</td>
</tr>
<tr>
<td>Not Working</td>
<td>43 (6)</td>
<td>678 (94)</td>
<td></td>
<td>8 (1.1)</td>
<td>714 (98.9)</td>
<td></td>
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<tr>
<td>Education Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Education</td>
<td>62 (11.2)</td>
<td>492 (88.8)</td>
<td>0.000a</td>
<td>9 (1.6)</td>
<td>546 (98.4)</td>
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<td>Primary</td>
<td>194 (7.5)</td>
<td>2399 (92.5)</td>
<td></td>
<td>33 (1.3)</td>
<td>2560 (98.7)</td>
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<tr>
<td>Secondary</td>
<td>49 (4.5)</td>
<td>1036 (95.5)</td>
<td></td>
<td>6 (0.6)</td>
<td>1079 (99.4)</td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>12 (3)</td>
<td>394 (97)</td>
<td></td>
<td>10 (2.5)</td>
<td>397 (97.5)</td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>47 (4)</td>
<td>1135 (96)</td>
<td>0.000a</td>
<td>21 (1.8)</td>
<td>1161 (98.2)</td>
<td>0.026a</td>
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<tr>
<td>Eastern</td>
<td>49 (5.4)</td>
<td>864 (94.6)</td>
<td></td>
<td>7 (0.8)</td>
<td>907 (99.2)</td>
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<tr>
<td>Central</td>
<td>57 (4.1)</td>
<td>1344 (95.9)</td>
<td></td>
<td>24 (1.7)</td>
<td>1376 (98.3)</td>
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<td>Northern</td>
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<td>979 (85.7)</td>
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<td>6 (0.5)</td>
<td>1138 (99.5)</td>
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<td>227 (6.7)</td>
<td>3179 (93.3)</td>
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<td>39 (1.1)</td>
<td>3367 (98.9)</td>
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<td>Not Married</td>
<td>91 (7.4)</td>
<td>1143 (92.6)</td>
<td></td>
<td>20 (1.6)</td>
<td>1214 (98.4)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>20 to 29</td>
<td>143 (6.4)</td>
<td>2083 (93.6)</td>
<td>0.130a</td>
<td>35 (1.6)</td>
<td>2190 (98.4)</td>
<td>0.175a</td>
</tr>
<tr>
<td>30 to 39</td>
<td>97 (6.5)</td>
<td>1389 (93.5)</td>
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<td>13 (0.9)</td>
<td>1473 (99.1)</td>
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</tr>
<tr>
<td>40 to 49</td>
<td>78 (8.4)</td>
<td>850 (91.6)</td>
<td></td>
<td>10 (1.1)</td>
<td>918 (98.9)</td>
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</tr>
<tr>
<td>Residence</td>
<td>Rural</td>
<td>Urban</td>
<td>( \chi^2 )</td>
<td>Urban</td>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------</td>
<td>---------</td>
<td>--------------</td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>253 (7.4)</td>
<td>3163 (92.6)</td>
<td>43 (1.3)</td>
<td>3374 (98.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>65 (5.3)</td>
<td>1158 (94.7)</td>
<td>16 (1.3)</td>
<td>1208 (98.7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Household Size</th>
<th>Six and Above</th>
<th>Less than 6</th>
<th>( \chi^2 )</th>
<th>Less than 6</th>
<th>Less than 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>165 (7.7)</td>
<td>1973 (92.3)</td>
<td>26 (1.2)</td>
<td>2112 (98.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>152 (6.1)</td>
<td>2349 (93.9)</td>
<td>32 (1.3)</td>
<td>2469 (98.7)</td>
<td></td>
</tr>
</tbody>
</table>

\( a \) Pearson’s Chi-square test, significant at \( p<0.2 \), \( b \) Pearson’s Chi-square test, not significant at \( p>0.2 \)
\( c \) Working status had 6 missing values which was 0.1%.

**Table b** in appendix shows Case processing summary that explains the \(-/+1\) difference noted above in the totals of **table 2**.

*Figure 5: Bar graph showing the percentage distribution of underweight and stunting by wealth index among women aged 20 to 49 years with data available from the 2016 UDHS.*
Figure 6: Bar graph showing the distribution of underweight and stunting by region among women aged 20 to 49 years with data available from the 2016 UDHS.

After adjusting for women individual level characteristics in model I table 3, only education level was found to be associated with underweight. After adjusting for both women individual level and household characteristics in model II table 3, only region, wealth index and residence were significantly associated with underweight. Women residing in rural areas had 37% less odds of underweight compared to those in urban areas (aOR=0.63; 95% confidence interval (CI): 0.41- 0.96). Women in the Western (aOR=0.30; 95% confidence interval (CI): 0.20- 0.44), Eastern (aOR=0.42; 95% confidence interval (CI): 0.28- 0.63) and Central (aOR=0.42; 95% confidence interval (CI): 0.25- 0.72) regions were 70%, 58% and 58% less likely respectively to be underweight compared to those in the Northern region. Women belonging to the poorest (aOR=3.60; 95% confidence interval (CI): 1.85- 7.00), poorer (aOR=3.07; 95% confidence interval (CI): 1.57- 5.97) and middle (aOR=2.49; 95% confidence interval (CI): 1.25- 4.99) wealth index quintiles were 267%, 207% and 149% more likely to be underweight compared to those in the richest wealth index quintile. The richer wealth index was not statistically significant.
Table 3: Socio-Economic determinants of underweight among women aged 20-49 years in Uganda, 2016. Text written in **bold** indicate values that are statistically significant at \( p<0.05 \)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>CRUDE ANALYSIS</th>
<th>MODEL I(^a)</th>
<th>MODEL II(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cOR (95% CI)</td>
<td>aOR (95% CI)</td>
<td>aOR (95% CI)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 to 49</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>30 to 39</td>
<td>0.76 (0.54 – 1.06)</td>
<td>0.84 (0.60-1.18)</td>
<td>0.83 (0.59-1.17)</td>
</tr>
<tr>
<td>20 to 29</td>
<td>0.74 (0.55 – 1.00)</td>
<td>0.96 (0.70-1.33)</td>
<td>0.92 (0.66-1.28)</td>
</tr>
<tr>
<td>Education Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Secondary</td>
<td>1.50 (0.66 – 3.43)</td>
<td>1.52 (0.66 – 3.49)</td>
<td>1.43 (0.63 – 3.23)</td>
</tr>
<tr>
<td>Primary</td>
<td><strong>2.56 (1.17 – 5.57)</strong></td>
<td><strong>2.62 (1.20 – 5.70)</strong>*</td>
<td>1.58 (0.75 – 3.30)</td>
</tr>
<tr>
<td>No Education</td>
<td><strong>4.00 (1.77 – 9.07)</strong></td>
<td><strong>4.17 (1.82 – 9.55)</strong>*</td>
<td>2.16 (0.97-4.81)</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Married</td>
<td>0.89 (0.68 – 1.17)</td>
<td>0.82 (0.63 – 1.07)</td>
<td>0.81 (0.60 – 1.11)</td>
</tr>
<tr>
<td>Working Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Not working</td>
<td>0.84 (0.59 – 1.20)</td>
<td>0.84 (0.59 – 1.21)</td>
<td>1.09 (0.75 – 1.58)</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Western</td>
<td><strong>0.25 (0.18 – 0.35)</strong></td>
<td><strong>0.30 (0.20 – 0.44)</strong>*</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td><strong>0.34 (0.23 – 0.50)</strong></td>
<td><strong>0.42 (0.28 – 0.63)</strong>*</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td><strong>0.25 (0.16 – 0.39)</strong></td>
<td><strong>0.42 (0.25 – 0.72)</strong>*</td>
<td></td>
</tr>
<tr>
<td>Household Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 6</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Six and above</td>
<td><strong>1.29 (1.01 – 1.65)</strong></td>
<td></td>
<td>1.13 (0.88 – 1.46)</td>
</tr>
<tr>
<td>Wealth Index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richest</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Richer</td>
<td>1.41 (0.80 – 2.49)</td>
<td></td>
<td>1.56 (0.86- 2.83)</td>
</tr>
</tbody>
</table>
### 3.3.2 Stunting

After adjusting for women characteristics in **model I table 4**, none of the women characteristics were significantly associated with stunting. After adjusting for both women and household characteristics in **model II table 3**, only region was significantly associated with stunting. All the other variables were not statistically significant. Women belonging to the central (aOR=4.77; 95% confidence interval (CI): 1.28-17.78) and Western (aOR=4.37; 95% confidence interval (CI): 1.44-13.20) regions had presented 377% and 337% more odds of being stunted respectively compared to those in the Northern region. The Eastern region unlike the Western and Eastern was not significantly associated with stunting.

*Bold*: Significant at p-value <0.05, a Includes women characteristics and b includes both women and household characteristics.

<table>
<thead>
<tr>
<th>Middle</th>
<th>2.15 (1.24 – 3.71)</th>
<th>2.49 (1.25- 4.99)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poorer</td>
<td>3.24 (1.92 – 5.46)</td>
<td>3.07 (1.57- 5.97)*</td>
</tr>
<tr>
<td>Poorest</td>
<td>5.28 (3.25- 8.57)</td>
<td>3.60 (1.85- 7.00)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Residence</th>
<th>Ref</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>1.43 (0.99 – 2.04)</td>
<td>0.63 (0.41 - 0.96)*</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex of Household</th>
<th>Ref</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Male</td>
<td>1.18 (0.91 – 1.54)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Socio-Economic determinants of stunting among women aged 20-49 years in Uganda, 2016. *Text written in bold indicate values that are statistically significant at p<0.05*
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>CRUDE ANALYSIS</th>
<th>MODEL I</th>
<th>MODEL II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cOR (95% CI)</td>
<td>aOR (95% CI)</td>
<td>aOR (95% CI)</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 to 49</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>30 to 39</td>
<td>0.78 (0.33 – 1.81)</td>
<td>0.72 (0.30 – 1.74)</td>
<td>0.67 (0.27-1.65)</td>
</tr>
<tr>
<td>20 to 29</td>
<td>1.47 (0.66– 3.28)</td>
<td>1.67 (0.74– 3.81)</td>
<td>1.51 (0.67-3.39)</td>
</tr>
<tr>
<td><strong>Education Level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.22 (0.05 – 0.94)</td>
<td>0.23 (0.05 – 0.98)</td>
<td>0.21 (0.05 – 0.88)</td>
</tr>
<tr>
<td>Primary</td>
<td>0.51 (0.16 – 1.61)</td>
<td>0.60 (0.18 – 1.99)</td>
<td>0.54 (0.17 – 1.68)</td>
</tr>
<tr>
<td>No Education</td>
<td>0.61 (0.16– 2.36)</td>
<td>0.71 (0.17– 2.87)</td>
<td>0.60 (0.16– 2.24)</td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not married</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Married</td>
<td>0.71 (0.37 – 1.37)</td>
<td>0.68 (0.33 – 1.41)</td>
<td>0.57 (0.28 – 1.13)</td>
</tr>
<tr>
<td><strong>Working Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Not working</td>
<td>0.85 (0.35 – 2.12)</td>
<td>0.80 (0.32 – 2.04)</td>
<td>0.71 (0.28 – 1.79)</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>Ref</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Western</td>
<td>3.63 (1.34-9.77)</td>
<td>4.37 (1.44-13.20)*</td>
<td>1.75 (0.46-6.71)</td>
</tr>
<tr>
<td>Eastern</td>
<td>1.48 (0.43-5.13)</td>
<td>1.75 (0.46-6.71)</td>
<td>4.77 (1.28-17.78)*</td>
</tr>
<tr>
<td>Central</td>
<td>3.54 (1.25-10.00)</td>
<td>4.77 (1.28-17.78)*</td>
<td></td>
</tr>
<tr>
<td><strong>Household Size</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 6</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Six and above</td>
<td>0.93 (0.49-1.76)</td>
<td>1.04 (0.54 – 2.04)</td>
<td></td>
</tr>
<tr>
<td><strong>Wealth Index</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richest</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Richer</td>
<td>0.60 (0.21 – 1.71)</td>
<td>0.69 (0.23 – 2.04)</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>1.31 (0.50 – 3.42)</td>
<td>1.33 (0.43 – 4.12)</td>
<td></td>
</tr>
<tr>
<td>Poorer</td>
<td>0.89 (0.33 – 2.41)</td>
<td>1.17 (0.36 – 3.75)</td>
<td></td>
</tr>
<tr>
<td>Poorest</td>
<td>0.70 (0.27- 1.80)</td>
<td>1.35 (0.38- 4.83)</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>0.98 (0.44 – 2.20)</td>
<td>1.34 (0.57 - 3.16)</td>
<td></td>
</tr>
<tr>
<td>Sex of Household</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Ref</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.75 (0.37 – 1.50)</td>
<td>0.59 (0.31 – 1.14)</td>
<td></td>
</tr>
</tbody>
</table>

*Bold: Significant at p-value <0.05,  a Includes women characteristics and b includes both women and household characteristics.

cOR: Crude Odds Ratio.
aOR: Adjusted Odds Ratio.

3.4 Sensitivity Analysis

3.4.1 Working Status Re-categorization

Working status was non-significant at both levels of analysis and in both outcomes. When it was recategorized into not working, non-manual labour and manual labour, there was an association at the bivariate level with underweight (p-value 0.010) but was not significant with stunting (p-value 0.897).

After adjusting for wealth index, age, residence, region, marital status, education level, household size and sex of household head, non-manual laborers were marginally significantly associated with underweight (aOR=0.75; 95% confidence interval (CI): 0.55- 1.03). Women not working were not statistically significant while the manual laborers were the reference category. The observed significant associations of wealth index, region and residence with underweight in table 3 model II remained almost the same here. All variables that were not significant in model II of table 3 remained non-significant here as well.

3.4.2 Analyzing after excluding obese and overweight women and considering only women with BMI < 25.

Here, the outcome underweight was divided into underweight (BMI < 18.5) coded 1 and normal BMI coded 0. At the bivariate level with the chi-square test, age, education, wealth index and region were significant at p-value < 0.05 while household size and sex of household head were having p-values between 0.05 and <0.2. Residence, working and marital status were not
significant. Contrary to bivariate analysis in table 2, sex of household head here was significant while residence here was not significant.

The final model after adjusting showed statistical significance with only residence and region. The odds of underweight among women in rural areas (aOR=0.60; 95% confidence interval (CI): 0.39- 0.94) were less compared to the urban ones and almost the same as those in table 3 above. Region statistics in this analysis were like those observed above in table 3 of the initial analysis. Wealth index here unlike in the main initial analysis table 3 was not significant.

4.0 Discussion

This is the first study that has investigated the socio-economic determinants of both underweight and stunting among Uganda women of reproductive age between 20 and 49 years using weighted data and complex samples package. Women belonging to the richest wealth index had the highest proportion of stunting. Underweight was significantly associated with residence, wealth index and region while stunting was only significantly associated with region.

The prevalence of underweight was 6.9% close to a study that showed 6.7% in Nigeria (73) but a little lower than that of 9% in Kenya (74), 10% in Tanzania (75) and 25% in Ethiopia (73). However, this prevalence is within the range of 5 to 20% reported for African women (73). The prevalence of stunting is 1.3% which is higher than the reported less than 1% prevalence in Kenya (74) and less than the 3% in Tanzania (75).

These differences in the prevalence of undernutrition among Uganda and its neighboring countries could be attributed to many reasons among them; the different environmental and socioeconomic situations in these countries. The other possible explanation for the observed prevalence variations could be the seasons during which the data was collected. The effect of seasons of data collection on nutritional status has been demonstrated in many studies and usually harvest seasons provide better nutritional results than lean season (76).

4.1 Interpretation of findings and their comparison to other studies.

4.1.1 Underweight

Marital status, education, working status, household size, sex of household head and age were not significantly associated with underweight. Stine et al showed similar findings in Northern Uganda where marital status, education and occupation were not significantly associated with undernutrition (77). Devgun et al in Indian women showed age, household size (joint/nuclear) and occupation were non-significantly associated with undernutrition (78). Masibo et al analyzed DHS data of Kenyan women aged 20 to 49 years and showed that sex of household head, age, marital status and working status were not significantly associated with undernutrition (56).
Region, residence and wealth index were significantly associated with underweight. Women who belonged to the Western, Eastern and Central regions were 70%, 58% and 58% respectively less likely to be underweight compared to women in the Northern region. Region has also been shown to be associated with undernutrition in similar low-income African settings (37, 56, 79) and in Afghanistan (80). These studies show that region correlates with nutrition status. There are varying degrees of economic, infrastructure and agricultural development in regions throughout many developing countries. Those that are economically underdeveloped tend to have difficulties in accessing enough and good quality food and health services which affects their nutrition status. The Northern region in Uganda is the most food insecure and the poorest (51). The food insecurity and poverty affect the quality and quantity of food consumed. Additionally, most people in the Northern region unlike the other regions are pastoral communities (some are nomadic) and this affects their required dietary intake from crop products. This has been shown in similar pastor communities in Ethiopia to have an increased risk of underweight (37).

Furthermore, some parts of Northern Uganda experienced a long civil war which greatly affected their agricultural production and the economy compared to the other regions that have been stable without wars (77). After controlling for all the variables, the region adjusted odds ratios increased slightly compared to the crude odds ratios. Western region was associated with the least odds of being underweight compared to Central and Eastern regions. The arguments here could be that the government in power comes from the Western region so most of the development and agricultural projects are well implemented there which enables cheap and easy access to food. The other possible reason could be since it is the most productive region regarding national food produce and one of the leading regions in economic development. This unlike the central region that is the most developed, the Western region has a lower proportion of the urban poor compared to the Central region.

The poorest, poorer and middle wealth index quintiles were significantly associated with underweight. The odds of being underweight were 257%, 201% and 143% more for women in the poorest, poorer and middle quintiles respectively compared to women in the richest quintile. Wealth Index/ socio-economic status has been shown to be significantly associated with underweight in many similar contexts (52, 56, 81). Households that are facing Poverty tend to have poor housing and inadequate access to clean environmental conditions like water and sanitation and good medical services hence risking undernutrition as elaborated by the conceptual frame work and evidenced by the observed association (odds) being highest in the poorest wealth index. Furthermore, these people have low purchasing power leading to scarcity of resources and hence inadequate quality and quantity of food. The rich tend to prioritize
purchase of good quality and enough foods, water and access to services such as medical care which translates to adequate dietary intake, improved health status hence good nutrition status.

The analysis also showed that women who belonged to rural areas were 37% less likely to be underweight compared to their counterparts in urban areas. Although most studies in the region or with similar contexts have shown rural areas to be more at risk (79, 81), a reverse association was observed here. In many developing countries, place of residence usually affects life styles, diet and socio-economic activities (82). Uganda is experiencing rapid urbanization that has led to the poorest and highly vulnerable people to settle in poorly organized informal urban areas (83). This has led to many challenges in urban areas such as sanitation facilities and environmental degradation (83). This has further led to people resorting to improvised unhygienic means of human excreta disposal that pose health risks (84) that increases the risk of underweight. Despite the availability of regular food supply in urban areas, the increasing number of the urban poor might affect access to good quality and quantity of food which leads to inadequate intake of food compared to the rural areas where most food is grown. This increased risk of underweight in urban areas was also shown by Akhter et al in Bangladesh (85).

4.1.2 Stunting

The prevalence of stunting was low at 1.3% however, excluding the pregnant and postpartum women could have led to underestimation of stunting. Unlike underweight, pregnancy or postpartum has no effect on adult attained height. The low prevalence could explain the many non-significant findings at the bivariate level as seen in table 2. There is extremely limited literature about stunting in women as most studies focus on only underweight in women and the readily available literature that can be used as a proxy is among older adolescents. This makes comparing results hard. The fact that stunting is chronic that starts in utero with the first two years of life and some literature including adolescence being the critical periods could explain why many of these socio-economic determinants at this level are not significant. However, this knowledge is crucial for targeted interventions to help reduce on the intergenerational cycle of undernutrition.

Surprisingly, women belonging to the richest wealth index had the highest proportion of stunting. This could be since Western and Central regions that had the highest number of stunted women had the highest proportion of women in the richest wealth quintile. The other possible argument could be that these people grew into adulthood with stunting from childhood and they got access to education and occupation and earned money or got married to rich husbands since wealth index was calculated at the household level but not individual level. Some of the insignificant variables in this study regarding stunting have also been shown
insignificant in some studies like wealth index (household asset score), age and residence (80, 86). In the adjusted final model, region was the only variable that was significantly associated with stunting.

Regarding regions, women in Central and Western regions had 377% and 337% respectively more odds of being stunted compared to those in the Northern region. This could be due to the intergenerational cycle of stunting where stunted children grow into stunted adolescents and adults. This is supported by the fact that according to the UDHS 2016 report and some studies that have looked at the trends of childhood stunting in Uganda since 1995, Western and Central regions have the highest prevalence (49, 61). Furthermore, these studies have shown slow annual stunting reduction rate of 0.45% which increases the chances of these children growing into stunted adults which could explain the high proportions and increased odds of stunting in Western and Central regions seen in this study. The other possible argument about this finding could be the fact that some of the neglected indigenous pygmy populations like the Batwa tribe are located in the Southern part of Western Uganda (87). This could possibly explain the observed association between stunting and the Western region as these people are genetically short and neglected. The odds of being stunted were higher in Central region than in Western region. Possible explanations could be argued regarding this. One of them could be the effect of migration as the Central region is the leading economic and political region so people who were already stunted could migrate from other regions to it. This region also had the highest frequency and proportion of stunted women as shown on figure 6.

4.2 Strengths
It is nationally representative and generalizable to women aged 20 to 49 years since weighted data has been used and the study design has been put into consideration during analysis with the complex sample package. This study gives data on both underweight and stunting yet the few studies focus on only underweight and are not nationally representative.

Another strength is the large sample size and the fact that DHS data is collected, entered and cleaned by a team of trained and highly experienced scientists limits mistakes in the data set. Lastly, of those who qualified for anthropometry, a small sample of 1.9% was excluded from the final analysis as they refused or could not be found home for the measurements.

4.3 Limitations
Excluding pregnant and post-partum women from height assessment could have led to underestimation of stunting. This could also have affected the analysis for the association between stunting and the predictors. Very few women in the wealth quintiles had stunting as shown in table 3. The cross-sectional design is also another limitation as we cannot infer causality here. We can only discuss the association but cannot define in what direction the
outcome and determinant are related. Most data on the predictors was based on self-reporting and could not be verified through records which risks socially acceptable answers hence information bias. The categorization of original numerical variables risks loss of information and statistical power.

Possible mis-classification of pregnant women mainly those in the first trimester as it is possible that some women are usually not aware that they are pregnant in the early stages of the pregnancies. BMI being a crude index that does not account for the distribution of fat that varies among individuals and populations. Statistical limitations can also be discussed regarding the set p-value of < 0.2 at the bivariate analysis level. This is more common for epidemiological research than for clear-cut statistical studies. The use of a cut off for including variables in the multiple logistic regression models instead of basing on things like literature reviews risks information loss. Excluding women aged 15 to 19 years due to the different recommended anthropometry indicators among adolescents and women above 20 years also reduced the number of participants for this analysis.

4.4 Internal validity
This study results hold good internal validity as the large sample size limits the possibility of random errors are small and DHS data has been known for its high-quality data. Lastly, the analysis put into consideration the survey design inorder to give unbiased estimates with the use of pre-defined sampling weights in descriptive statistics and complex sample package inferential statistics.

4.5 External validity
The possibility of selection bias cannot be ruled out in this study. Many women could not meet the inclusion criteria for anthropometry as they were either pregnant or postpartum thus could not be assessed for stunting which affected the findings of stunting as the numbers were less. These women as evidenced by the 91 excluded in the final analysis had some little socio-economic differences compared to those in the final analysis. It is likely that if these women had been included in the analysis, the findings could have been less affected. Nevertheless, the findings can be safely generalized to non-pregnant non-postpartum women aged 20 to 49 years. Generalizability of the study findings to contexts like Uganda is possible. The external validity of this study is also supported by the fact that its results are in the range of those reported for African women (5 to 20%) for underweight (73) and relatively similar stunting results reported in Kenya (74) and Tanzania (75).

4.6 Conclusion
The prevalence of underweight (6.9%) and stunting (1.3%) in Uganda among women of reproductive age between 20 and 49 years are less compared to most of the neighboring
countries. There are regional and wealth index differences in the prevalence of undernutrition in Uganda. Women belonging to the highest quintile had the highest and lowest frequency of stunting and underweight respectively. Wealth Index, residence and region is associated with underweight while stunting is associated with only region. The findings of this study highlight the importance of addressing the socio-economic determinants of health including poverty, residence and reducing regional inequalities. National nutrition policies that will help target the urban, poorest households and improving agriculture and nutrition education in the regions that are more at risk should be emphasized. More economic and infrastructural development projects are needed in the different Ugandan regions like the North that seem to be greatly affected by poverty and food insecurity. Further studies are needed to give more explanations regarding the richest wealth index having the highest frequency of stunted women.

5.0 References


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6.0 Appendix.

Table a: Background characteristics of women aged 20 to 49 years who were eligible for anthropometry but were excluded in the final analysis due to missing data in the 2016 UDHS

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>N</th>
<th>%</th>
<th>MEAN (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE</td>
<td></td>
<td></td>
<td>29.9(-/+7.84)</td>
</tr>
<tr>
<td>20 to 29</td>
<td>49</td>
<td>53.6</td>
<td></td>
</tr>
<tr>
<td>30 to 39</td>
<td>27</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>40 to 49</td>
<td>15</td>
<td>16.2</td>
<td></td>
</tr>
<tr>
<td>RESIDENCE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>45</td>
<td>49.9</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>46</td>
<td>50.1</td>
<td></td>
</tr>
</tbody>
</table>
### Table b: Case processing summary of underweight and the predictors that explains the -/+ 1 difference noted above in the totals of table 3.

<table>
<thead>
<tr>
<th>Case Processing Summary</th>
<th>Cases</th>
<th>Valid</th>
<th>Missing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Percent</td>
<td>N</td>
<td>Percent</td>
</tr>
<tr>
<td>Residence * Underweight</td>
<td>4639</td>
<td>100.0%</td>
<td>.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>Region * Underweight</td>
<td>4639</td>
<td>100.0%</td>
<td>.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>Household_Head_Sex</td>
<td>4639\textsuperscript{a}</td>
<td>100.0%</td>
<td>.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------</td>
<td>--------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>* Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household_Size</td>
<td>4639\textsuperscript{a}</td>
<td>100.0%</td>
<td>.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td>4634\textsuperscript{a}</td>
<td>99.9%</td>
<td>5.508</td>
<td>0.1%</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital_Status</td>
<td>4640\textsuperscript{a}</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age * Underweight</td>
<td>4640\textsuperscript{a}</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Education_Level</td>
<td>4638\textsuperscript{a}</td>
<td>100.0%</td>
<td>1.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wealth_Index_C</td>
<td>4638\textsuperscript{a}</td>
<td>100.0%</td>
<td>1.508</td>
<td>0.0%</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a.} Number of valid cases is different from the total count in the crosstabulation table because the cell counts have been rounded.