Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ 07/27/23

Fabien Mpitu

Assessing Factors Associated with Food Insecurity and Cardiometabolic Risk Factors by Household Head Gender in Nepal

By

Fabien Mpitu
Master of Public Health

Hubert Department of Global Health

_____ [Advisor's signature]

Unjali Gujral, Ph.D. MPH
Thesis Advisor

Assessing Factors Associated with Food Insecurity and Cardiometabolic Risk Factors by Household Head Gender in Nepal

By

Fabien Mpitu
Doctor of Medicine
University of Kinshasa
2003

Thesis Advisor: Unjali Gujral, Ph.D. MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
In partial fulfillment of the requirements for the degree of
Master of Public Health
In Global Health
2023

Abstract

Background and aims

Food insecurity is one of the most significant public health issues nowadays, and several studies have found that it is associated with poor cardiometabolic risk (CMR). However, none of those studies have determined the role that could play in the household head gender (HHG) in the association between food insecurity and CMR. This study aimed to explore that gap.

Methods

This study is cross-sectional using the 2016 Nepal Demographic and Health Survey dataset. Hypertension and Body Mass Index (BMI) were our outcomes and were measured. Food insecurity was our exposure and was obtained from responses to the survey. We used multilevel multivariate logistic regression to estimate the relationship between food insecurity, CMR, and HHG. Odds ratios were reported, along with a 95% confidence interval and p-values (<0.05).

Results

There were more overweight/obese (O/B) in FS households compared to FI households, no matter the gender of the household heads [in male-headed households (MHH): 65.75% FS-34.25% FI, and in female-headed households (FHH): 60.66 FS - 39.34 FI]. In logistic regression, an unadjusted model between food insecurity and household head gender showed that in MHHs, the odds of food insecurity was 19.2% less likely [0.808 (95%CI 0.662-0.985)] than the odds of food insecurity in FHHs. This remained the case even after adjusting for age, BMI, and hypertension [0.790 (95%CI 0.646-0.965)]. In fully adjusted models, including food security status and all relevant covariates, individuals living in MHHs were less likely to be O/B than those living in FHHs [0.757 (95%CI 0.659-0.869)] and more likely to have hypertension than those living in FHHs [1.049 (95%CI 0.895-1.229)].

Conclusion

Awareness of the benefits of healthy food and physical activity on CMR reduction should be raised in Nepal, and even more among food-secure people who were found as at high risk of cardiometabolic risk in this study.

Key words

Food insecurity, cardiometabolic risk, hypertension, overweight, obese, and household-head.

Assessing Factors Associated with Food Insecurity and Cardiometabolic Risk Factors by Household Head Gender in Nepal

By

Fabien Mpitu
Doctor of Medicine
University of Kinshasa
2003

Thesis Advisor: Unjali Gujral, Ph.D. MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
In partial fulfillment of the requirements for the degree of
Master of Public Health
In Global Health
2023

Acknowledgments

I want to express my sincere gratitude to my advisor Dr. Unjali Gujral who has supported me with my thesis. Without her guidance and tremendous assistance with patience through the many rounds of drafts, this thesis would not be possible. Thank you, Unjali!

I also want to thank all the Rollins School of Public Health Professors for helping me to grow intellectually. My thanks also to my friends and peers, especially those four who worked closely with me in a study group and with whom we encouraged each other even in the face of setbacks.

I cannot forget my parents, who are no longer in this world but who, during their lifetime, did not skimp on their means to see me going far in my education.

Lastly, I thank my beloved wife and children for their understanding, sacrifices, and encouragement throughout the two-year master's study. My thanks to my other family members and relatives for their terrific support for my training.

Table of Contents

Chapter One: Introduction

Food insecurity is defined as a lack of consistent access to enough food for every person in a household to live an active, healthy life (1). It is a major public health concern in many countries worldwide, particularly for Low-Income and-Lower-Middle-Income Countries (LMICs) where poverty aggravates the scale of this issue (2, 3). Around the world, food insecurity prevalence continues to rise and increases the risk of adverse effects on health, thus jeopardizing development, and heightening poverty. According to a 2022 FAO report, the prevalence of moderate and severe food insecurity worldwide was 29.3% in 2022, with a much higher prevalence in LMICs (Africa 57.9%, Latin America 40, 6%, and Southern Asia 27.3%) and much lower in the HICs (United States 8.3% and Europe 7.8) (4). Over the past five years, moderate and severe food insecurity has increased globally (from 22.7% to 29.3%) with an increase in LMICs (Africa, from 49.7% to 57.9%; Latin America, from 31 % to 40.6%; Southern Asia, from 27.3% to 40.6%) but a decrease in HICs (United States, from 8.3% to 7.8%; and Europe, from 8.6% to 7.8%) (4).

Evidence indicates a relationship between food insecurity and cardio-metabolic risk factors. For example, a cross-sectional study conducted in California involving 35,737 low-income Hispanic adults, assessed the relationship between food insecurity and cardiometabolic risk factors. The results of the study found that very low food security was associated with a higher risk of obesity and a higher BMI (5). Another cross-sectional study examined the association between household food insecurity and obesity in Iranian women. The results of the study found that the risk of abdominal obesity was almost three times higher in severe food insecure households than in food secure households.

Food insecurity is often a consequence of poverty (6). People with low socio-economic status may adapt to food insecurity by consuming cheap, usually less-quality food that lacks essential nutrients. Lack of access to fresh products leaves few options for people besides consuming low-quality food. This low-priced food often contains refined carbohydrates, high salt, and an unhealthy fat diet. Such an unhealthy diet

increases the risk of diabetes and cardiovascular disease including stroke and heart disease (7).

According to the World Food Program, food insecurity affects women and girls more often (4). For example, 60% of the 690 million people worldwide who are food insecure are women and girls. Systemic gender inequality granting more advantages to men than women can disadvantage women financially as they may have limited access to some specific jobs or positions, credits, the right to own land, and even education (8). This can lead to more food insecurity among women and contributes to the likelihood that female-headed households are more food insecure compared to male-headed households (9).

Many researchers have studied the association between food insecurity and cardiometabolic risks. However, studies evaluating the impact of household gender on the relationship between food insecurity and cardiometabolic risks in LMICs do not exist. Therefore, Using a nationally representative survey, we examined and tested whether the gender of the head of household could influence the association between food insecurity and cardiometabolic risk in Nepal, a country whose prevalence of food insecurity was 37.8%in the period between 2019 and 2021(10).

Chapter Two: Literature review/Background

Food insecurity in general and in LMICs

Food insecurity is described a household-level economic and social condition of sparse or uncertain access to enough good, healthy, and culturally appropriate food (11). A report from the Food and Agriculture Organization of the United Nations (FAO) states that nearly one in three people in the world (2.37 billion) did not have access to adequate food in 2020, and around 660 million people may still face hunger in 2030 (12). Other statistics from the FAO show that, in 2021, 9.8% of the world's population suffered from severe food insecurity, of which over half lived in Asia and approximately

40% lived in Africa. The remaining 10% was scattered between the Americas, Europe, and Oceania (11).

Food insecurity prevalence is still on the rise worldwide. As shown in The State of Food Security and Nutrition in the World 2022 report, food insecurity is a growing issue worldwide and even more in low- and middle-income countries (LMICs) (4). The prevalence of food insecurity increased from 9.3% in 2019, to 11.7% in 2021, meaning an additional 207 million more people became food insecure in the span of two years (4). Higher and rising prevalence at a global level, added to the fact that food insecurity has the potential to negatively impact nutrition, health, or well-being make food insecurity a severe public health issue. Food insecurity is a reality in both high-income countries as well as in low-and middle-income countries (13) (14).

The World Bank defines LMICs as countries where the population lives with a very low per capita Gross Domestic Product (GDP) of less than $12,475 (15). The risk of food insecurity is high in those countries given that a substantial proportion of the population cannot access nutritional food as they lack money or other resources. This trend is far from improving, making food insecurity almost pervasive in LMICS (16). In a 2020 report, FAO mentioned that about one in ten people in LMICs suffered severe food insecurity in 2019.

Food insecurity and cardiometabolic risks

When individuals cannot afford or have access to high-quality foods, they may become prone to conditions related to the foods they consume, in particular cardiometabolic risk (12). Cardiometabolic risk implies risk factors that increase the likelihood of experiencing vascular events or developing diabetes (17). Of these, obesity and hypertension are major factors.

There is a growing prevalence cardiometabolic disease worldwide, although cardiovascular death rates have been reduced over the past few decades, especially in High-income countries (HICs) (18). LMICs experience a disproportionate prevalence of cardiometabolic conditions such as cardiovascular disease, stroke, and diabetes (19), and bear a heavy load accordingly.

Researchers are working on understanding the risk factors and consequences of cardiovascular conditions. For instance, a study conducted in a semi-urban population of Nepal in 2019 assessing the burden and correlates of three cardiometabolic risk factors (hypertension, diabetes, and overweight/obesity) and their possible clustering patterns found that the prevalence of hypertension, diabetes, and overweight/obesity was 34.5%, 11.7%, and 52.9%, respectively (20). This high prevalence and clustering of multiple cardiometabolic risk factors among adults in semi-urban Nepal highlights the growing cardiometabolic syndemics from single to multiple risk factors. Also, a report from the Nepal Health Research Council in 2019, stated that Noncommunicable diseases (NCDs) accounted for 66% of deaths in Nepal, and 25% due to cardiometabolic conditions (21). NCDs are a group of conditions that are not mainly due to an acute infection and result in long-term consequences and, subsequently, the need for long-term treatment and care as defined by the WHO. NCDs include cancers, cardiovascular disease, stroke, diabetes, chronic lung illnesses, injuries, and mental health disorders. 71% of all deaths occurring in the world are due to NCDs. Of these NCDs, cardiovascular diseases represent the leading cause of death globally (22).

Several studies have shown that food insecurity is highly associated with cardiometabolic conditions. For example, a literature review in 2020 assessing the association between food insecurity and cardiometabolic risk factors in adults and the older adults found that food insecurity has a direct relationship with cardiometabolic risk factors, especially excess weight, hypertension, and dyslipidemias (2). Another literature review conducted in 2022 also found food insecurity to be a risk factor for diet-related NCDs (23). Likewise, a 2022 serial cross-sectional study that included data for noninstitutionalized US adults from the National Health and Nutrition Examination Survey (1999-2018) found an increase in the prevalence of food insecurity among patients with CVD.

Household-head gender and food insecurity in LMICs

While researchers have noted a link between food insecurity and cardiometabolic risks, there are also investigations that suggest that the gender of the head of household might impact food insecurity. A recent study found that female-headed households had 1.94 (95% CL 1.26, 3.01) times the odds of developing food insecurity compared to male-headed households in Ethiopia (24). Socio-economic and cultural differences linked to gender are possible explanations for this difference. Another study looking at the gender of the family head and food insecurity in urban and rural Nigeria observed that female-headed families were more vulnerable to higher incidences of food insecurity than male-headed families (25). Cultural rules that limit women's accessibility to certain types of education and certain types of work, which restricts women's income opportunities improvement may be implicated in the increased risk of food insecurity amongst female headed households.

Several investigations have indicated an association between gender of household head and poor-quality health. A qualitative study conducted in Iran assessing challenges and opportunities confronting female-headed households indicated that female-headed households are one of the most vulnerable groups in Iranian society and are confronted with many problems and challenges because of higher poverty rates and fewer job opportunities (26). An additional study from Iran assessing health-related quality of life in female-headed households has shown that female-headed households have poor health and quality of life, and the most critical factors associated with this low quality of life are low literacy and chronic diseases (27). Another study conducted in Nigeria examining whether the gender and occupation of household heads are significant determinants of malnutrition among children in Nigeria revealed that female-headed households living in rural areas in the northwest zone of the country had the most malnourished children (28).

These three studies conducted in two LMIC countries reveal the vulnerability in LMICs for female-headed households to food insecurity.

Global Burden of food insecurity and cardiometabolic risk factors in Nepal

Nepal, like many low-and middle-income countries (LMICs), faces high prevalence of food insecurity. For example, a 2022 FAO report stated that the prevalence of moderate or severe food insecurity in Nepal between 2019 and 2021 was 37.8% and further added that, in contrast, food insecurity in the same year was only 8.2% in the United States (12). Also, a report released by Nepal's Ministry of Health in 2017 revealed that 25% of Nepal's population lives in poverty, and over 50% of Nepali households experience food insecurity. Cardiometabolic risks worldwide are on the increase, and Nepal like many other low-and middle-income countries (LMICs) are undergoing to similar challenges. There are lots of studies finding increased cardio metabolic risk in Nepal. In this chapter, there is a study that explored household socio-economic and environmental factors associated with overweight and obesity among women in Nepal using the 2016 Nepal DHS (29). This study found that over the 20 years, the prevalence of overweight increased more than ten times, and the prevalence of obesity increased more than twenty times. Moreover, this study found a significant association between household socio-economic and environmental factors like age, marital status, wealth index, province of residence, cooking fuel, refrigerator, bicycle, level of education, religion, type of toilet, television, and mobile phone, and overweight and obesity. Among the reasons explaining the above association is gestational weight gain in older and married women, the use of hormonal contraceptives for women who were married or living with a partner, changes in body composition with increased age, particularly those associated with a decline in fat-free mass and subsequent rise in fat mass occurring around the 30s; more sedentary occupations in urban cities; increase in income and wealthy leading to increasing the ability to purchase and consume energy-dense food products, and diets high in saturated fat, cholesterol, refined carbohydrates, and sugar. Another study assessed the prevalence of underweight, overweight, and obesity in adults in Bhaktapur, Nepal, in 2015–2017. These researchers discovered age, occupation, wealth, education, and caste were identified as being significantly associated with BMI as they determine access to health care and food, also the level of physical activity/sedentary lifestyle. However, variances are seen due to gender, age, and type of work differences (30). In addition, there is a systematic review and meta-analysis conducted in Nepal assessing the prevalence, awareness, treatment, and

control of hypertension in Nepal between 2000 and 2025 that has found that the prevalence, as well as the trends, are increasing or going to increase significantly during this time and call for preventive approaches and strategies (31). This study revealed an increase in hypertension among men in Nepal, particularly those of middle age, also an increase in prehypertension in rural areas, reaching nearly 40% of the population (32).

While evidence indicates an association between food insecurity and cardiometabolic risks, there is little information regarding the impact of household gender on the relationship between food insecurity and cardiometabolic risks in LMICs. Therefore, using a nationally representative survey, we examined and tested whether the gender of the head of household could influence the association between food insecurity and cardiometabolic risk in Nepal.

Chapter Three: Materials and Methods

Data source

This study is a secondary data analysis from the 2016 Nepal Demographic Health Survey (DHS), a nationally representative survey commissioned by Nepal's Ministry of Health and administered by the New ERA, a non-profit, non-governmental research organization in Nepal. The United States Agency for International Development (USAID) provided financial support for the DHS, and Inner City Fund (ICF), a Virginia (USA)-based global consulting and technology service, provided technical support for the survey [21]. The DHS survey collects information on fertility, family planning, maternal and child health, adult, and child mortality; nutrition; women's empowerment and domestic violence; knowledge of HIV and AIDS; anthropometrics; demographics; and other health issues using standardized questionnaires, manuals, and field procedures.

Study design and sample

This was a cross-sectional study with a total of 11,040 households selected from 383 primary sampling units through stratified multi-stage cluster sampling. The survey selection of households used a stratified two-stage cluster sampling in rural areas and a three-stage cluster sampling in urban areas. The wards corresponded to the primary sampling units (PSUs) in the urban areas, and the enumeration area (EA) was derived from the PSUs. Households were then selected from the EAs. Like in urban areas, wards corresponded to PSUs. However, households were directly selected from PSUs, without going through EAs. To get a good representation, weighing factors were included in the results. Data was collected from June 19, 2016, to January 31, 2017. The survey administrators interviewed 49,064 persons aged 15-49 years old. Blood pressure was measured for 15,162 of those people. The interview section of this survey used six different questionnaires (Household Questionnaire, Woman's Questionnaire, Man's Questionnaire, Biomarker Questionnaire, Fieldworker Questionnaire, and Verbal Autopsy Questionnaire). This survey also collected anthropometric measurements among men and women aged 15 years and older, specifically height and weight. Additionally, the survey collected information about blood pressure assessments and hemoglobin. Three blood pressure measurements were obtained from consenting individuals aged 15 and above. Blood specimens for hemoglobin testing were obtained from women aged 15-49 who voluntarily consented to be tested and from all children aged 6-59 months for whom consent was obtained from their parents or their guardian.

Study Variables

Dependent variable (Outcome variable):

High blood pressure and BMI were our dependent variables and were evaluated through blood pressure measurement for high blood pressure and weight and height for BMI. BMI was categorized according to the World Health Organization (WHO) standards (underweight <18.5, normal weight 18.50 – 24.99, overweight ≥ 25, obese ≥ 30) (23) (24). The inclusion criteria for high blood pressure were having a systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg (24) and/or reporting taking medication to lower blood pressure. We divided the weight by the

squared height (kg/m2) to get the individual BMI. We considered both systolic and diastolic blood pressure to evaluate blood pressure. Of the three blood pressure measurements taken on participants, the second and third measurements were averaged. Body mass index and high blood pressure were the two elements used in our study to identify cardiometabolic risk in individuals.

Key Independent variable (exposure):

Food insecurity is the independent variable assessed in this study and was obtained from responses to questions on perceptions of food vulnerability or stress, and behavioral responses to food insecurity. This information was collected through the survey household questionnaire administered to heads of households, from the nine questions assessing households' food security. We classified households into dichotomous variables (food-secure and food-insecure) based on the responses to the questions. We used a similar scale to the one that assessed food insecurity in another study that used the 2016 Nepal DHS and looked at the prevalence and correlates of food insecurity among women of reproductive age in Nepal (22). Hence, respondents who answered positively at least once to one of the questions related to the food security assessment were considered food insecure and were coded 1. Those who did not answer positively to any questions were considered food secure and coded 0.

Moderator variable:

The **household head gender** is our moderator variable. The households headed by a male and the households headed by a female are the two categories for this variable and were obtained from the 2016 Nepal DHS.

Control variables:

Our control variables were the following: demographic (age, sex, marital status), socioeconomic (wealth index, family head education level, household size, urbanity), and behavioral characteristics (smoking status, alcohol consumption, and caffeine use).

Age (in years). We were interested in individuals aged 15 to 49 as only people in this age group had anthropometric measurements taken; We split this group into three sub-groups: very young adults aged 15-26, young adults aged 27-38, and middle-aged adults aged 39-49.

Sex was categorized into two groups females and males' groups.

Marital status was created from the original marital status variable deriving out of the 2016 Nepal DHS. Participants were grouped in four categories "single", "Widow", "Divorced", "Married" whether you are married or not or whether you live together with your partner.

Household size was classified into four groups. A household with 1-4 individuals was labeled as "normal", a household with 5-8 individuals was labeled as "large", a household with 9-12 individuals was labeled as "very large" and a household with more than 12 individuals was labeled as "extremely large".

Family head education level was created from the original variable deriving out of the 2016 Nepal DHS. This variable has three categories of which "high education" is for those who completed college or university education, "some education" for those who completed primary or secondary education, and no education for those who completed only preschool or less.

The wealth index was derived from the original wealth index combined collected from the household questionnaire. This variable stems from the score assigned to households about the goods at their disposal and their ability to access certain essential services for a high quality of life. This resulted in five categories: poorest, poorer, middle, richer, and most prosperous. The combined wealth index variable had been recorded in three categories "poor" for the poorest and poor responses, "no poor no rich" for the middle responses, and "rich" for the richer and richest responses.

Urbanity is the type of residence with either urban or rural options.

Smoking status, **alcohol consumption**, and **caffeine use** were dichotomous variables in responses on whether the participant self-reported that they consumed tobacco products, alcohol, or caffeine.

Descriptive and Analytical strategies

As the aim of our study was to investigate whether the sex of the household head influences the relationship between food insecurity and cardiometabolic risks, we estimated prevalence values and p-value by household head gender. Participants characteristics were compared by food security status using chi-square test for categorical variables or assessed normality of distributions for continuous variables while applying elements of survey design. The effect of the gender of the household head on the odds of household food insecurity and household food security was assessed.

We used logistic regression to estimate the relationship between food insecurity, cardiometabolic risks and household head. In Model 1, we run an unadjusted regression model to compare the association between food insecurity and household-head gender; subsequently, we adjusted that model for hypertension and BMI category in Model 2. And lastly, in Model 3, we created a multivariable model to adjust for covariates including marital status, urbanity, family head education, wealth index, smoking status, alcohol use status, and caffeine use status.

The significance was set at an alpha level of 0.05. Sampling weights, stratum and cluster were applied for all analyses to adjust for the selection probabilities in this study. All analyses were conducted using SAS 9.4.

Chapter Four: Results

Description of study Population participants

Table 1-a. Socio-demographic characteristics of participants in male-headed household Head (n=9,813) by food security status

Sociodemographic characteristics	**Secure (n=4,807)**	**Insecure (n=5,006)**	**p-value**
Household size, n (%)			
1-4	52.69	47.31	0.5804
5-8	49.21	50.79	
9-12	46.45	53.55	
>12	51.87	48.13	
Age (years old)			
Man	41.38	41.40	0.98
Woman	37.73	36.86	0.07
Age category			
<18 (No adult)	45.22	54.78	0.1221
18-28 (Young Adult)	51.96	48.04	
29-39 (Middle Adult)	50.46	49.54	
40-49 (Aged Adult)	50.66	49.34	
>49 (Old Adult)	50.04	49.96	
BMI (Kg/m2)			
	22.40	21.19	<.0001
BMI category			
Underweight/Normal weight	46.57	53.43	<.0001
Overweight/Obese	65.75	34.25	
Marital status			
Single	54.38	45.62	0.0009
Widow	47.30	52.70	
Divorced	27.97	72.03	
Married	49.71	50.29	
Urbanity			
Rural	40.33	59.67	<.0001
Urban	56.59	43.41	
Family head education, n (%)			
No education (preschool or less)	40.41	59.59	<.0001
Some education (1ary or 2ary)	50.99	49.01	
High education (Higher)	72.29	27.71	<.0001
Wealth index			
Poor	28.00	72.00	<.0001
No poor no rich	41.27	58.73	
Rich	72.41	27.59	
Smoking use status			
Yes	47.97	52.03	0.0027
Alcohol use status			
Yes	33.96	66.04	0.0003
Caffeine use status			
Yes	57.32	42.68	0.0008

Hypertension (mmHg)			
Yes	49.21	50.79	0.0005
SBP (average systolic BP)	117.2	114.7	0.0120
DBP (average diastolic BP)	78.14	76.72	0.0505

Two levels of food security status: food-secure household ("no" to all questions) and food-insecure household (any "yes" to questions). Data are expressed as percent (%) for categorical variables or means for continuous variables.
P: p-value was set at p<0.05
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure

Table 1-b. Socio-demographic characteristics of participants in female-headed household (n=3,163) by food security status

Sociodemographic characteristics	**Secure (n=1,393)**	**Insecure (n=1,770)**	**p-value**
Household size, n (%)			
1-4	44.74	55.26	0.4094
5-8	43.28	56.72	
9-12	47.74	52.26	
>12	73.01	26.99	
Age (years old)			
Man	31.42	32.18	0.5679
Woman	36.02	36.77	0.2689
Age category			
<18 (No adult)	41.90	58.10	0.2370
18-28 (Young Adult)	48.01	51.99	
29-39 (Middle Adult)	46.07	53.93	
40-49 (Aged Adult)	44.35	56.65	
>49 (Old Adult)	41.84	58.16	
BMI (Kg/m2)			
	22.82	21.34	<.0001
BMI category (Kg/m2)			
Underweight/ Normal weight	40.89	59.11	<.0001
Overweight/Obese	60.66	39.34	
Marital status			
Single	49.08	50.92	0.0548
Widow	38.85	61.15	
Divorced	45.46	54.54	
Married	44.95	55.05	
Urbanity			
Rural	35.12	64.88	0.0014
Urban	50.66	49.34	
Family head education, n (%)			
No education (preschool or less)	32.61	67.39	<.0001
Some education (1ary or 2ary)	47.71	52.29	
High education (Higher)	67.54	32.46	<.0001
Wealth index			

Poor	23.99	76.01	<.0001
No poor no rich	38.20	61.80	
Rich	65.87	34.13	
Smoking use status			
Yes	38.39	61.61	<.0001
Alcohol use status			
Yes	22.11	77.89	0.0541
Caffeine use status			
Yes	51.22	48.78	0.1799
Hypertension (mmHg)			
Yes	49.22	50.78	0.0693
SBP (average systolic BP)	113.80	113.00	0.2125
DBP (average diastolic BP)	77.19	76.19	0.0127

Two levels of food security status: food-secure household ("no" to all questions) and food-insecure household (any "yes" to questions). Data are expressed as percent (%) for categorical variables or means for continuous variables.
P: p-value was set at p<0.05
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure

Table 1 displays the characteristics of the overall study population (households) stratified by the two levels of food security (n=3,107). Depending on whether the head of the household is male or female, we subdivided Table 1 into two sub-tables: 1a (n=2,194) shows the characteristics of the population from households led by a male and 1b (n=913) shows the characteristics of the population from households led by a female.

Overall, demographic, and socioeconomic characteristics appear similar regardless of food security status for male- and female-headed households.

In male-headed households, compared to food-secure people, food-insecure people have lower BMI, higher prevalence of underweight/normal weight, and lower prevalence of overweight/obesity. Also, food-insecure people are more likely to be divorced, live in rural places, smoke, use alcohol, and are less likely to have higher education, be wealthy, and use caffeine than food-secure people. Furthermore, this table shows that in male-headed households, those who are food insecure are more likely to have hypertension than those who are food secure.

In female-headed households, compared to those who are food secure, food-insecure people have lower BMI, lower prevalence of overweight/obesity, and higher prevalence

of underweight/normal weight. In addition, food-insecure people are more likely to live in rural places, smoke, and use alcohol but less likely to have higher education, be wealthy, and use caffeine than those who are food secure. However, there are no significant differences in the prevalence of hypertension between food-secure and food-insecure people.

Regression analysis

Table 2. Crude association between household head gender and food security

		Food insecure HH		
Model	**Covariates**	**OR***	**95%CI**	***p***
1	**Household Head Gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	0.808	(0.662 0.985)	0.0353

**Unadjusted association*
HH: Household
OR: Odd Ratio
CI: Confidence Interval
P: p-value was set at p<0.05
Ref.: reference

Table 3. Adjusted association between household head gender and food security

		Food insecure HH		
Model	**Covariates**	**OR***	**95%CI**	***p***
2	**Household Head gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	0.790	(0.646 0.965)	0.0211
	Age Group			
	<18	Ref.		
	18-28	0.826	(0.713 0.956)	0.0108
	29-39	1.036	(0.883 1.216)	0.6632
	40-49	1.077	(0.918 1.262)	0.3625
	>49	1.023	(0.885 1.182)	0.7594
	BMI Category			
	Underweight/Normal Weight	Ref.		
	Overweight/Obese	0.446	(0.393 0.506)	<.0001
	Hypertension			
	No Hypertension	Ref.		
	Hypertension	0.866	(0.764 0.982)	0.0252

**The model adjusted for Age group, BMI category and Hypertension*
HH: Household

OR: Odd Ratio
CI: Confidence Interval
P: p-value was set at p<0.05
BMI: Body Mass Index
Ref.: reference

Table 4. Adjusted association between household head gender and Hypertension

		Hypertension		
Model	**Covariates**	**OR***	**95%CI**	***p***
3	**Household Head gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	0.962	(0.832 1.112)	0.6011
	Age group			
	<18	Ref.		
	18-28	2.147	(1.303 3.537)	0.0028
	29-39	7.187	(4.416 11.696)	<.0001
	40-49	14.781	(9.302 23.488)	<.0001
	>49	20.144	(12.384 32.768)	<.0001
	Food security			
	Food security	Ref.		
	Food insecurity	0.757	(0.666 0.860)	<.0001

**The model adjusted for Age group, and Food security*
OR: Odd Ratio
CI: Confidence Interval
P: p-value was set at p<0.05
Ref.: reference

Table 5. Adjusted association between household head gender and BMI

		Overweight/Obesity		
Model	**Covariates**	**OR***	**95%CI**	***p***
4	**Household Head gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	0.824	(0.724 0.938)	0.0036
	Age group			
	<18	Ref.		
	18-28	4.137	(2.602 6.576)	<.0001
	29-39	14.250	(8.788 23.108)	<.0001
	40-49	15.418	(9.652 24.629)	<.0001
	>49	7.886	(4.833 12.868)	<.0001
	Food security			
	Food security	Ref.		
	Food insecurity	0.436	(0.384 0.495)	<.0001

**The model adjusted for Age group, and Food security*
OR: Odd Ratio
CI: Confidence Interval

P: p-value was set at p<0.05
BMI: Body Mass Index
Ref.: reference

Table 6. Adjusted association between household head gender and Hypertension

		Hypertension		
Model	**Covariates**	**OR***	**95%CI**	***p***
5	**Household Head gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	1.049	(0.895 1.229)	0.5570
	Age group			
	<18	Ref.		
	18-28	2.061	(1.243 3.416)	0.0052+
	29-39	6.075	(3.645 10.126)	<.0001
	40-49	12.808	(7.874 20.835)	<.0001
	>49	17.151	(9.605 30.624)	<.0001
	BMI Category			
	Underweight/Normal Weight	Ref.		
	Overweight/Obese	2.453	(2.137 2.817)	<.0001
	Marital status			
	Single	Ref.		
	Widowed	1.370	(0.967 1.942)	0.0765
	Divorced	1.215	(0.689 2.143)	0.4995
	Married	0.928	(0.681 1.264)	0.6344
	Urbanity			
	Rural	Ref.		
	Urban	1.136	(0.948 1.362)	0.1678
	Wealth index			
	Poor	Ref.		
	Not poor Not Rich	0.814	(0.673 0.985)	0.0346
	Rich	0.840	(0.707 0.998)	0.0476
	Smoking status			
	No smoking	Ref.		
	Smoking	1.191	(0.883 1.607)	0.2506
	Alcohol use			
	No alcohol consumption	Ref.		
	Alcohol consumption	1.378	(0.956 1.986)	0.0856
	Caffeine use			
	No caffeine consumption	Ref.		
	Caffeine consumption	1.364	(1.149 1.620)	0.0004
	Education			
	No education	Ref.		
	Some education	1.395	(1.159 1.678)	0.0005
	Higher education	1.346	(1.012 1.792)	0.0413

	Food security			
	Food security	Ref.		
	Food insecurity	0.879	(0.766 1.008)	0.0648

**The model adjusted for demographics, socioeconomic status and Hypertension accounts for age group, BMI category, marital status. Urbanity, wealth index, smoking status, alcohol consumption, caffeine use, education, and food security.*
OR: Odd Ratio
CI: Confidence Interval
P: p-value was set at p<0.05
BMI: Body Mass Index
Ref.: reference

Table 7. Adjusted association between household head gender and BMI

		Overweight/Obesity		
Model	**Covariates**	**OR***	**95%CI**	***p***
6	**Household Head gender**			
	Female-Headed Household	Ref.		
	Male-Headed Household	0.757	(0.659 0.869)	<.0001
	Age group			
	<18	Ref.		
	18-28	2.326	(1.489 3.634)	0.0002
	29-39	6.093	(3.785 9.808)	<.0001
	40-49	6.859	(4.237 10.874)	<.0001
	>49	7.446	(4.090 13.555)	<.0001
	Hypertension			
	No Hypertension	Ref.		
	Hypertension	2.461	(2.149 2.819)	<.0001
	Marital status			
	Single	Ref.		
	Widowed	1.856	(1.141 3.019)	0.0128
	Divorced	2.249	(1.196 4.228)	0.0120
	Married	2.869	(2.034 4.044)	<.0001
	Urbanity			
	Rural	Ref.		
	Urban	1.529	(1.279 1.828)	<.0001
	Wealth index			
	Poor	Ref.		
	Not poor Not Rich	1.171	(0.959 1.430)	0.1205
	Rich	2.753	(2.320 3.267)	<.0001
	Smoking status			
	No smoking	Ref.		
	Smoking	0.514	(0.364 0.726)	0.0002
	Alcohol consumption			
	No alcohol consumption	Ref.		
	Alcohol consumption	0.459	(0.268 0.783)	0.0044
	Caffeine use			

	No caffeine consumption	Ref.		
	Caffeine consumption	1.114	(0.915 1.357)	0.2802
	Education			
	No education	Ref.		
	Some education	1.523	(1311 1.768)	<.0001
	Higher education	1.799	(1.450 2.234)	<.0001
	Food security			
	Food security	Ref.		
	Food insecurity	0.736	(0.640 0.848)	<.0001

**The model adjusted for demographics, socioeconomic status and BMI category accounts for age group, hypertension, marital status. Urbanity, wealth index, smoking status, alcohol consumption, caffeine use, education, and food security.*
OR: Odd Ratio
CI: Confidence Interval
P: p-value was set at p<0.05
BMI: Body Mass Index
Ref.: reference

Models Interpretation:

Model 1:

The odds of food insecurity in male-headed households is 19.2% less likely than the odds of food insecurity in female-headed households (reference group).

Model 2:

After accounting for age, BMI, and hypertension, food insecurity in male-headed households is 21% less likely than in female-headed households (reference group). In this model, the age group of 18-28 is less likely to have food insecurity than all other older groups, however this difference is not statistically significant.

Model 3:

After adjusting for age and food security status, there is 3.8% less likely odds of hypertension in male-headed households than in female-headed households, but the result is not statistically significant.

Model 4:

Accounting for age and food security status, there is 17.6% less likely odds of overweight-obesity in male-headed households than in female-headed households.

Model 5:

After accounting for age, BMI, marital status, urbanity, wealth index, smoking status, alcohol use, caffeine use, education and food security status, there is 4.9 % more likely the odds of hypertension in male-headed households than in female-headed households. However, this result is not statistically significant.

This model found strong associations between hypertension and older ages, overweight-obesity, being widowed and divorced, living in urban areas, smoking, consuming alcohol, consuming caffeine, and being educated, but it also found that being married, wealthy, or somehow wealthy as well as being food-insecure were associated with reduced odds of hypertension.

Model 6:

Controlling for age, hypertension, marital status, urbanity, wealth index, smoking status, alcohol use, caffeine use, education and food security status, there is a 24.3% less likely the odds of overweight or obesity in male-headed households compared to female-headed households.

This model shows strong associations for overweight-obesity among adults, people with hypertension, ever-married people, people living in urban areas, wealthy and somehow wealthy, caffeine users, and educated people. This model also shows that smoking, consuming alcohol, and being food-insecure is associated with reduced odds of overweight/obesity.

Chapter Five: Discussion/Limitations and Strengths/Conclusion and Recommendations

Discussion

Using the 2016 Nepal DHS, we examined patterns of food insecurity and cardiometabolic risk factors in male-headed households compared to female-headed households to understand how the household gender may impact the relationship between food insecurity and cardiometabolic risk factors in a low- and middle-income country.

In households headed by both males and females, those who were food secure were more likely to have higher BMI, be overweight/obese, be single, live in urban areas, have higher education, and be wealthy. Furthermore, those in male headed households who were food secure were also more likely to have hypertension.

In unadjusted logistic regression models, we found that male-headed households were more likely to be food secure compared to households headed by females. This remained the case even after adjustment for age, BMI, and hypertension. In fully adjusted models, individuals living in male-headed households were less likely to be overweight/obese than those living in female-headed households. Food security was also associated with overweight/obesity after adjustment for relevant covariates.

Several previous studies found a positive association between food insecurity and cardiometabolic risks in low-income or high-income countries. For example, a study that examined the association between food insecurity, sleep, and cardiometabolic risks in urban American Indian/Alaska Native youth and found that greater food insecurity was significantly associated with greater body mass index ($b = 0.12$, $p = .015$), higher systolic blood pressure ($b = 0.93$, $p = .03$), and severe sleep disturbance ($b = 1.49$, $p < .001$) (33).

Furthermore, a systematic literature review that examined the association between food insecurity and cardiometabolic risk in adults and the elderly found that food insecurity was directly associated with excess weight (BMI), hypertension, dyslipidemias (high total cholesterol, high low density lipoprotein, low high density lipoprotein), self-reported diabetes or high glycemia, and stress (2).

Contrary to these findings, our study found that food security was positively associated with a high cardiometabolic risk. These results are similar to the findings of a

few previous studies. For example, a cross-sectional study that examined the relationship between household food insecurity and metabolic syndrome among women of reproductive age in low-income communities in Malaysia (34) found that food-insecure women were 28.8% less likely to have metabolic syndrome compared to food-secure women. In addition, a longitudinal study in the US, that examined the association between household food insecurity and overweight status in young school children (35) found that the odds of being overweight was 80% more likely in children from food-secure households compare to their food-insecure counterparts. Some reasons for these findings may be that food security may be associated with lower levels of physical activity which may lead to cardio-metabolic risk.

There also may be a link between the nutrition transition, food security, and cardio-metabolic risk. Since the 1980s, a shift from traditional diets high in cereal and fiber to more Western-pattern diets high in sugars, salt, fat, and animal-source food has been happening in several countries, both developed and developing. This supported by the rise of the fast-food and sugary-food industry, paired with physical inactivity (36), accompanying changes in economic development, lifestyle, urbanization, and demography. Sugar, salt, and fat consumption have increased most rapidly in lower–middle–income countries and in most upper–middle-income countries but has slowed or declined in high-income countries (37).

In the context of Nepal, currently, urbanization is rapid, and the Nepalese economic structure has shifted away from an agricultural food supply system towards modern processing-based food supply system. These changes in the Nepalese diet are triggered by income and urbanization. In addition, the trade liberalization has made processed foods, edible oil and sugar easily available at supermarkets and fast-food outlets, which are more likely to be accessed by individuals who are more affluent and more food secure (38). Therefore, in Nepal, it is possible that the inverse association between food insecurity and cardiometabolic factors could be the result of the much more sedentary lifestyle of educated, wealthy and urban-dwelling people.

Limitations and Strengths

Limitations:

There are some limitations to this analysis. As mentioned earlier, we used a cross-sectional study design, and therefore cannot make causal inferences from our findings. Additionally, the data we used to define food insecurity in this study were self-reported, which could lack precision due to recall bias.

Furthermore, our study only considered two cardiovascular risk factors since only those were available in the dataset we used. Future studies should consider the relationship between head of household sex and food insecurity as related to diabetes and dyslipidemia.

Strengths:

Strengths of our study include a relatively large sample size which allowed to increase the precision of our findings in narrowing the error margin. The study also had objective measures of blood pressure and BMI.

Furthermore, our study was done in a on a nationally representative sample of Nepal, making the study results generalizable to the Nepali population. Lastly, the DHS used standard and valid tools for data collection reducing the probability of measurement error compared to other cross-sectional studies done in Nepal.

Conclusion and Recommendations

Cardiometabolic risk factors are a significant public health threat because of their association with adverse health outcomes, such as overweight/obesity, hypertension, diabetes, dyslipidemia, stroke, and cancer.

In Nepal, the typical diet is shifting away from agricultural staple-based foods to modern processed foods with higher total energy, total fat, and sugar which may increase cardio-metabolic risk (38).

Conversely to findings from previous literature, we found that being food secure increases cardiometabolic risks (having higher BMI and prevalence of hypertension) than being food insecure in Nepal. People living in households headed by males were

more likely to be food-secure than those who living in households headed by females. One reason for these outcomes are that Nepal is in the phase of the nutrition transition where a rise in income leads to increased fat and sugar consumption as well as a decrease in labor based physical activity (38).

Future studies should assess additional cardio-metabolic risks such as diabetes and dyslipidemia to better estimate the potential impact of household head gender in the relationship between cardiometabolic risk and food insecurity.

References

1. S. M. Household Food Security in the United States, 2009. EER-108, U.S. Dept. of Agriculture, Econ. Res. Serv. November 2010. Advances in Nutrition. 2011.
2. EDS M. Association between food insecurity and cardiometabolic risk in adults and the elderly: A systematic review. J Glob Health. 2020.
3. S B. cardiovascular disease trends in Nepal - An analysis of global burden of disease data 2017. Int J Cardiol Heart Vasc. 2020.
4. FAO. The state of food security and nutrition in the world 2022. 2022.
5. CW L. Very low food security predicts obesity predominantly in California Hispanic men and women. Public health nutrition 2012;15:2228–36.
6. KENDALL A. Relationship of Hunger and Food Insecurity to Food Availability and Consumption. , 96(10), . . Journal of the American Dietetic Association. 1996:1019-24.
7. HK S. Food insecurity is associated with chronic disease among low-income NHANES participants. J Nutr. 2010.
8. Jayachandran S. The Roots of Gender Inequality in Developing Countries. Annual Review of Economics 2015;7:1:63-88.
9. LS A. Does the female-headed household suffer more than the male-headed from Covid-19 impact on food security? Evidence from Ethiopia. J Agric Food Res 2023;12:100563. .
10. FAO.
11. B S-R. Impact of Health and Social Factors on the Cardiometabolic Risk in People with Food Insecurity: A Systematic Review. International Journal of Environmental Research and Public Health. 2022;19(21):14447.
12. FAO. The state of food security and nutrition in the world in 2022. 2023.
13. SA B. Trends in food insecurity for adults with cardiometabolic disease in the United States: 2005-2012. . PLoS One 2017;12(6).
14. Santos MP. Determinants of food insecurity among households with children in Villa el Salvador, Lima, Peru: the role of gender and employment, a cross-sectional study. BMC Public Health 2022;22 717

15. R. L. The use, misuse and overuse of the 'low-income and middle-income countries' category. BMJ Glob Health. 2022;7(6).
16. NM J. Gender differences in the prevalence of household food insecurity: a systematic review and meta-analysis. Public Health Nutr 2017. 2017;20(5):902-16.
17. A C. Cardiometabolic Risk Working Group (Canadian). Managing cardiometabolic risk in primary care: summary of the 2011 consensus statement. Can Fam Physician. 2012;58(4):389-93.
18. Sattar N. Improving prevention strategies for cardiometabolic disease. Nat Med 2020;26:320–5.
19. Miranda JJ. Understanding the rise of cardiometabolic diseases in low- and middle-income countries. Nat Med 2019(25):1667–79.
20. Gyawali B. The burden and correlates of multiple cardiometabolic risk factors in a semi-urban population of Nepal: a community-based cross-sectional study. Sci Rep. 2019(9):15382.
21. Council NHR. Nepal Burden of Disease 2019: A Country Report Based on the 2019 Global Burden of Disease Study. 2021.
22. Organization WH. Tackling NCDs: 'best buys' and other recommended interventions for the prevention and control of noncommunicable diseases. 2017.
23. Cucalon G. Food insecurity as a risk factor for obesity: A review. Frontiers in Nutrition. 2022;9:1012734.
24. Negesse A. The impact of being of the female gender for household head on the prevalence of food insecurity in Ethiopia: a systematic-review and meta-analysis. Public Health Rev. 2020(41):15.
25. Nwaka ID. Gender of the family head and food insecurity in urban and rural Nigeria. African Journal of Economic and Management Studies. 2020;11(3):381-402. .
26. Yoosefi Lebni J. Challenges and opportunities confronting female-headed households in Iran: a qualitative study. BMC Women's Health. 2020(20):183
27. Y V. Health related quality of life in the female-headed households. Int J Epidemiol Res. 2015;2(4):178–83.
28. Ashagidigbi WM. Gender and occupation of household head as major determinants of malnutrition among children in Nigeria. Scientific African. 2022(16):e01159.
29. Rana K. Trends in the Prevalence of Overweight and Obesity and Associated Socioeconomic and Household Environmental Factors among Women in Nepal: Findings from the Nepal Demographic and Health Surveys. Obesities 2021. 2021(1):113-35.
30. C S. Prevalence of Underweight, Overweight, and Obesity in Adults in Bhaktapur, Nepal in 2015-2017. Front Nutr. 2020(7):567164.
31. RR D. Trends in the Prevalence, Awareness, Treatment, and Control of Hypertension in Nepal between 2000 and 2025: A Systematic Review and Meta-Analysis. Int J Hypertens. 2021;2021:6610649.
32. Y H. Prevalence of hypertension and prehypertension in Nepal: a systematic review and meta-analysis. Glob Health Res Policy. 2019(4):11.
33. Dong L. Food Insecurity, Sleep, and Cardiometabolic Risks in Urban American Indian/Alaska Native Youth. Sleep Health. 2023;9(1):4-10.

34. Shariff ZM. Food insecurity and the metabolic syndrome among women from low-income communities in Malaysia. Asia Pac J Clin Nutr 2014;23((1)):138-47
35. D. R. Household food insecurity and overweight status in young school children: results from the Early Childhood Longitudinal Study. Pediatrics,. Pediatrics. 2006;117((2)):464-73.
36. Grammatikopoulou MG. Food security and adherence to the Mediterranean diet: An interplay of socio-demographic characteristics The Mediterranean Diet. 2020((Second Edition)):79-87.
37. Baker P. Processed foods and the nutrition transition: evidence from Asia. Obesity Reviews. 2014;15((7)):564-77.
38. YP S. Where is Nepal in the nutrition transition? Asia Pac J Clin Nutr. 2017;26((2)):358-67.