

# Household Food Insecurity Negatively Impacts Diet Diversity in the Vietnamese Mekong Delta: A Cross-Sectional Study

Asia Pacific Journal of Public Health  
2023, Vol. 35(4) 276–283

© 2023 APJPH

Article reuse guidelines:



sagepub.com/journals-permissions

DOI: 10.1177/10105395231166544

journals.sagepub.com/home/aph



Thuy Ngoc Vuong, PhD<sup>1,2</sup>, Chinh Van Dang, MD<sup>2</sup>, Paul Jagals, PhD<sup>3</sup>,  
Simon Toze, PhD<sup>4</sup>, Danielle Gallegos, PhD<sup>1,5,\*</sup> ,  
and Michelle Gatton, PhD<sup>6\*</sup> 

## Abstract

Healthy, diverse diets are vital for life. In low/middle-income countries, however, the focus is more on food quantity rather than diet quality. This study assessed household diet diversity (HDD) in the Vietnamese Mekong Delta and its associations with household food insecurity (HFI) and household food availability (HFA) controlling for socioeconomic factors. Primary food-preparers in 552 randomly selected households in two rural provinces were interviewed about socioeconomic factors, HDD, HFI, and HFA. More than 80% of households predominantly consumed energy-dense foods, whereas less than 20% consumed nutrient-dense foods. Lower HDD was associated with HFI, lower HFA, for the Khmer ethnic minority, and low livelihood capitals (landlessness, low expenditure, debt) and low utensil scores. The study highlighted the need to provide improved food and nutrition policies that increase availability and access to diverse and healthy foods as well as reduce poverty and increase incomes for at-risk rural and ethnic minority groups.

## Keywords

public health nutrition, social determinants of health, diet diversity, household food insecurity, household food availability, ethnic minorities, Vietnamese Mekong Delta

## What We Already Know

- Good nutrition, including the consumption of a variety of nutritious foods, results in improved health outcomes.
- A high proportion of people living in many low, lower-middle, and middle-income countries (LMICs) have diets that lack diversity, and thus lack essential nutrients for a healthy and active life.
- Studies in LMICs identified several associated factors of low diet diversity, such as socioeconomic status (including income, education, landlessness) and low agricultural diversity.

expenditure, debt, low utensil ownership) are likely driving low diet diversity in Vietnam.

## What This Article Adds

- Ethnic minority groups in Vietnam and other LMICs are more likely to consume energy-dense, nutrient-poor foods than their ethnic majority counterparts.
- Low livelihood capitals such as natural capital (landlessness) and financial capitals (low household food

<sup>1</sup>School of Exercise and Nutrition Sciences, Queensland University of Technology, Kelvin Grove, QLD, Australia

<sup>2</sup>Institute of Public Health in Ho Chi Minh City, Ho Chi Minh City, Vietnam

<sup>3</sup>Children's Health and Environment Program, Child Health Research Centre, The University of Queensland Centre for Children's Health Research, South Brisbane, QLD, Australia

<sup>4</sup>Urban Water Futures, The Gap, Brisbane, QLD, Australia

<sup>5</sup>Woolworths Centre for Childhood Nutrition Research, Faculty of Health, Queensland University of Technology, South Brisbane, QLD, Australia

<sup>6</sup>School of Public Health and Social Work, Queensland University of Technology, Kelvin Grove, QLD, Australia

\*Danielle Gallegos and Michelle Gatton are joint senior authors of this article.

## Corresponding Author:

Thuy Ngoc Vuong, Institute of Public Health in Ho Chi Minh City, 159 Hung Phu Street, Ward 8, District 8, Ho Chi Minh City 70000, Vietnam.  
Email: vuongngochuy27@gmail.com

- Low household food availability and household food insecurity were associated with compromised diet diversity independent of socioeconomic factors.

## Introduction

Healthy, diverse diets are beneficial for people, including strengthening the immune system, contributing to optimal growth and cognitive development, protecting against chronic conditions, and supporting emotional wellbeing.<sup>1,2</sup> Diet quality is, therefore, central to nutrition policies globally. Diet quality comprises four main dimensions: nutrient adequacy, food variety (or diversity), proportionality (distribution across food groups), and food safety (safe microbiologically and from contamination).<sup>3,4</sup> Notably, diet diversity is considered a good proxy for diet quality.<sup>5</sup>

Monotonous staple-based diets lacking in diversity are very prevalent in low, lower-middle, and middle-income countries (LMICs).<sup>5</sup> Many LMICs have principally focused on producing larger quantities of staple foods as a national food security strategy, which potentially detracts from efforts to improve the overall quality and diversity of food.<sup>5</sup> This may in part explain why availability and access to healthy, diverse diets are typically limited in LMICs.<sup>5</sup>

Determinants of low diet diversity are multiple and closely linked. Most at-risk are disadvantaged households living in rural or remote areas, those with low incomes, and households headed by women and/or householders with lower education attainment.<sup>6</sup> Other risk factors impacting attaining a healthy diverse diet include household food insecurity (HFI) and households owning fewer livelihood capitals (eg, low access to cultivatable land).<sup>7-9</sup> Agricultural diversification (ie, less reliance on monoculture farming) also contributes to diversified diets through both subsistence- and income-generating activities.<sup>7</sup> At-risk subpopulations tend to consume predominantly starchy staples with inadequate intake of fruits, vegetables, and animal-source foods, compared with urban, wealthier, and more educated communities.<sup>6,7</sup>

Prior studies in LMICs have also associated reduced diet diversity with a lack of food storage facilities, preparation equipment, lack of clean water, reduced access to potable water sources, and lack of electricity.<sup>10,11</sup> In contrast, access to credit, homestead gardens, and livestock rearing have been positively associated with increased diet diversity,<sup>9,10,12</sup> as has increased women's empowerment, women's control over resources, and their nutritional knowledge.<sup>9,10</sup> None of the prior studies in LMICs appear to have examined the compounded impact of HFI and household food availability (HFA) on reduced diet diversity.

Vietnam, as an LMIC, is undergoing rapid economic development, as well as experiencing a nutrition transition characterized by shifts in dietary patterns. These shifts include increased consumption of meats, fats, sugar, and ultra-processed foods combined with reduced consumption of fresh vegetables, fruits, and legumes/nuts/seeds. All the

shifts reduce the diversity of healthy foods in daily diets.<sup>6,13</sup> This nutrition transition—during phases of urbanization and rapid economic growth—is also characterized by the co-occurrence of multiple types of malnutrition (stunting/wasting, obesity, and micronutrient deficiencies) and increased noncommunicable diseases, making diet diversity a key determinant of health in populations in LMICs.<sup>13,14</sup> Few studies have investigated household diet diversity (HDD) and the factors impacting HDD in LMICs, particularly in Asia. A better understanding of diet diversity patterns of these populations and associated determinants in Asia is important to design and implement appropriate intervention policies to improve diet quality, and thus contribute to improved health of the population.

Thus, this study was conducted to examine HDD in rural households in the Vietnamese Mekong Delta (VMD) and associated determinants. Our study evaluated and compared HDD of rural households in the northern and southern regions of the VMD. In addition, we also examined associations between HDD, HFI, and HFA.

## Methods

### Study Setting

Multistage sampling and interviewer-administered household surveys were used in one province (Dong Thap) in the northern region and one province (Tra Vinh) in the southern region, which were randomly selected. For each province, three communes within each of two rural districts were randomly selected. Forty-six households were then further randomly selected for face-to-face interview from one randomly chosen hamlet within each commune. In total, 552 randomly selected households from 12 hamlets were included, with the primary food-preparer (PFP) being interviewed in each household. The PFP is the adult responsible for buying foods and preparing meals for the household. Households were excluded if they had a special celebration on the previous day, which may have impacted diet quality.

### Sample Size Calculation

Data reported in this article were a part of the larger study on HFI and associations with health in the two rural regions of the VMD.<sup>15</sup> The sample size of 552 households was calculated to ensure that the prevalence of HFI could be estimated with a 95% confidence interval and error no larger than 5%, with 80% power. The initial estimate of prevalence was 0.4<sup>14</sup> with a cluster weighting of 1.5. The actual prevalence of HFI in the previous month within these 552 households was 34.4%.<sup>15</sup>

### Measuring Tools and Data Collection

Data were electronically collected in May and June 2018 on tablets using Key Survey™ (WorldApp, 2018). This period

of time is post-harvest season, and thus linked to higher potential HFI rates in rural areas. Trained fieldworkers interviewed each PFP in their homes using our study instrument developed from validated tools<sup>16-18</sup> with variations to suit local conditions. The questions were translated into Vietnamese and back-translated to English to ensure proficiency of language use.

Our study instrument consisted of four components: (1) socioeconomic information (ethnicity, income, education, employment, household assets, debt), agricultural land ownership, the experience of economic shocks over the previous year, and ownership of kitchen utensils; (2) HDD (on the previous day); (3) HFI; and (4) HFA (over the previous month). Before commencing the main study, the instrument was piloted in a test-retest study in a hamlet in the Tien Giang province. The results were discussed individually below in the corresponding test section. These households were not included in the main study to avoid any biases.

### Household Diet Diversity

Household diet diversity was quantified using the HDD score (HDDS) tallying the number of different food groups that households consumed on the previous day as described by Coates et al.<sup>16</sup> Data were collected for 16 predescribed food groups and then aggregated into 12 groups based on established protocols.<sup>17</sup> The HDDS ranged from 0 to 12, with higher scores indicating higher diet diversity. No reliability statistics were calculated for the HDDS in the test-retest study as we expected substantial variability in the foods consumed each day by individual households.

### Household Food Insecurity

Household food insecurity was assessed using the Household Food Insecurity Assessment Scale (HFIAS), with scores ranging from 0 to 27.<sup>16</sup> For analysis, the HFIAS score was categorized into two groups: food-secure (0-1) and food-insecure ( $\geq 2$ ) as described by Coates et al.<sup>16</sup> The reliability of HFIAS in the initial test-retest study was excellent, with intraclass correlation coefficient (ICC) of 0.97 (95% CI [0.79, 0.97]).

### Household Food Availability

Household food availability was surveyed using items included in the Home Food Environment Survey (HFES), commonly used in other LMICs.<sup>18</sup> The HFES asks, "In the last month, did your household have (specific food group)?" On a five-point scale, the corresponding scores ranged from 0 (never) to 4 (always).<sup>18</sup> These food groups were the same as those used in the HDDS. An HFA score (0-12) was calculated in the same way as the HDDS, where higher scores indicated greater availability of food in the house. The reliability of HFES in the test-retest study was good, with ICC of 0.90 (95% CI [0.74, 0.96]).

### Statistical Analyses

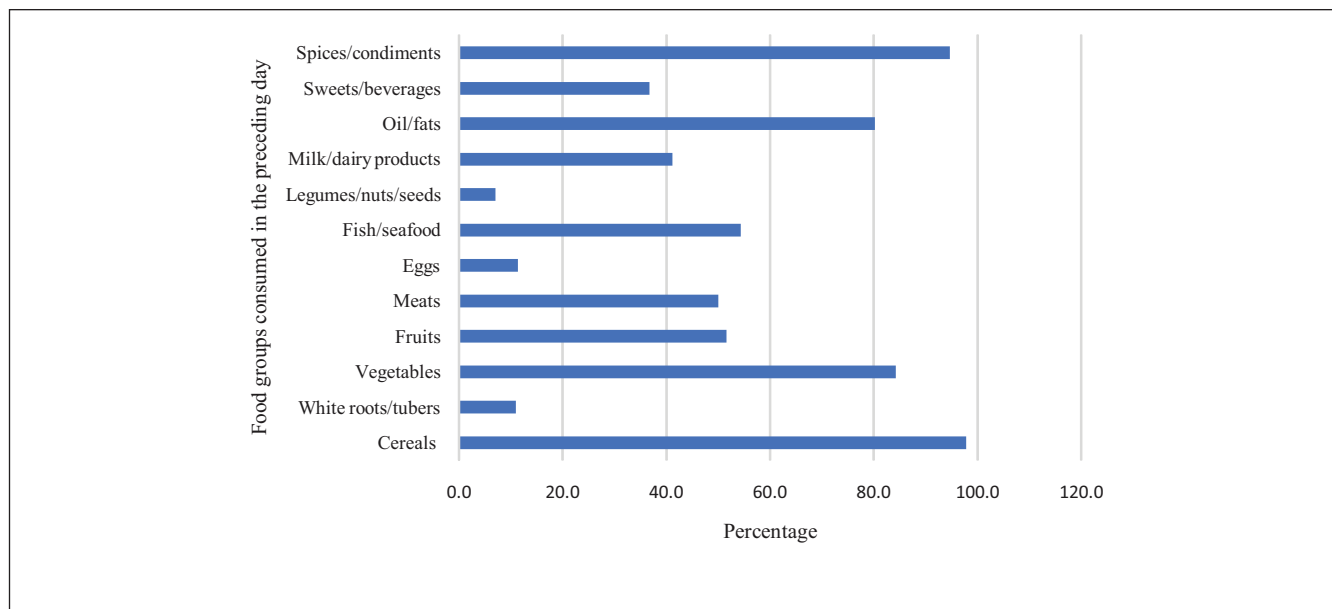
Data were analyzed using Stata 12.0 (StatCorp Version 12). A general linear model was used to examine differences in the HDDS between population groups. Variations in the consumption of each food group between study groups and HFI status (food-secure vs food-insecure) were examined using binary logistic regression. Linear regression was used to test the association between HDDS and HFA score. Variance inflation factors were confirmed to be below five for all multivariable models. Covariates included in the linear regression models were selected based on their significant association with the dependent variables in bivariate analyses or what had been reported in the literature. Odds ratios (OR) and 95% CIs are presented for the effect sizes, with statistical significance at  $p < .05$ . This study is reported using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies (Supplementary Material 1)

### Results

The majority of the PFP were women (82%), aged 18 to 64 years (84%), had an individual education level lower than ninth grade (85%), and predominantly lived in families consisting of married couples with children (74%). The two primary income sources were daily paid wages (34%) and farming (42%), while 24% of participants classified themselves as unemployed. Over half of the households (58%) indicated they engaged in agricultural activities. There were two ethnic groups identified in the study population: the Kinh (majority, 80%) and the Khmer (minority, 20%). There was only one Khmer household in the northern province (NP) sample, compared with 108 in the southern province (SP) sample. For the study, three population groups were therefore defined: NP Kinh, SP Kinh, and Khmer.

On average, households owned 3.3 (SD = 1.5) of the six nominated kitchen utensils, with the most common being electric rice cookers (91%), gas stoves (86%), and refrigerators (64%). Fewer households owned a kettle (45%), a food blender (41%), or a pressure cooker (6%). Differences in utensil ownership were observed between population groups, particularly for larger equipment. Khmer had significantly lower ownership of a refrigerator (27%) compared with NP Kinh (77%) and SP Kinh (67%) ( $p < .0001$ ). Sixty percent of Khmer households owned a gas stove, which was significantly lower than the NP and SP Kinh households ( $>90%$ ,  $p < .0001$ ).

Approximately 34% of the surveyed households were classified as food-insecure in the last month,<sup>15</sup> and each household had an average of 10 food groups available over the same time period (median: 11, interquartile range: 9-12). Most households "always" or "often" had cereals, spices/condiments, oils/fats, fish, and vegetables available. The percentage of households that always/often had organ meats



**Figure 1.** Percentage of households consuming nominated food groups in the preceding day in southern and northern rural provinces in the Vietnamese Mekong Delta.

(e.g., liver, kidney), seafood, legumes/nuts/seeds, and white roots/tubers was low, at 4.7%, 14.7%, 25.5%, and 26.6%, respectively.

In terms of HDD, an average household consumed six food groups (based on the previous day) (median: 6, interquartile range: 5-7). Most had consumed cereals, spices/condiments, vegetables, and oils/fats, whereas less than 20% of households ate nutrient-dense foods such as white roots/tubers, eggs, and legumes/nuts/seeds (Figure 1). Although 84% of households consumed vegetables on the previous day, only 17% consumed vitamin A-rich vegetables, such as leafy greens.

Multivariable statistical analyses of HDDS showed that Khmer households and households that were landless (lacked natural capital), had monthly household expenditures less than 3 million VND (US \$128), had debts (lacked financial capital), or a low utensil score had significantly lower HDDS ( $p < .05$ , Table 1).

The difference in HDDS between population groups was due to Khmer households being less likely than their Kinh counterparts to consume nutrient-dense foods such as vegetables ( $p = .002$ ; OR = 0.4; 95% CI [0.2, 0.8]), fruits ( $p < .0001$ ; OR = 0.5; 95% CI [0.3, 0.9]), and milk/dairy products ( $p < .0001$ ; OR = 0.5; 95% CI [0.3, 0.8]) (Table 2). In a similarly adjusted model, food-insecure households also had higher odds of not consuming fruits, vitamin A-rich vegetables, and meats compared with their food-secure counterparts (Table 2,  $p < .0001$ ).

There was a positive association between HDDS and HFA score ( $r = 0.56$ , 95% CI [0.50, 0.62],  $P < .001$ ). This remained after adjusting for potential confounders, with the HDDS

increasing by an average of 0.4 points (95% CI [0.3, 0.5];  $P < .01$ ) for each additional food group that was available in the household. Having no household debt and a higher utensil score was also associated with higher HDDS (Table 3).

The two main reasons reported for “never” or “rarely” having certain food groups available in the house were lack of money and disliking the food (Supplementary Material 2). The most nominated reason for milk/dairy products not being available was because members of the household did not like them. White tubers/roots, seafood, and fruits were unavailable in the house primarily due to a lack of money. For six food groups, Kinh households were more likely to nominate dislike of the foods, whereas Khmer were more likely to nominate lack of money.

## Discussion

This study is the first to investigate HDD in the VMD, revealing that diet diversity is relatively low in the two rural study provinces, especially for the Khmer ethnic minority group. The foods consumed tended to be predominantly energy-dense (mainly rice and edible oils/fats), rather than nutrient-dense (vegetables and fruits, legumes/nuts/seeds, and eggs). Based on the foods consumed on the previous day, the low percentage of rural households in the VMD ate nutrient-dense foods, such as vegetables and fruits rich in vitamin A (16.7% and 34.6%), fish/seafood (54.3%), and meats (50%). This contrasts with urban and wealthier households in Vietnam who consume a more diverse diet with higher intake of animal protein.<sup>19</sup> This disparity between rural and urban households corresponds to findings in other LMICs.<sup>7,10</sup> The

**Table 1.** Socioeconomic Factors Associated With HDDS in the Vietnamese Mekong Delta (n = 552).

Socioeconomic factors	Estimated HDDS marginal mean difference	95% CI	p values
Population group <sup>a</sup>			
SP Kinh	ns	—	.224
Khmer	-0.5	[-0.9, -0.2]*	.003**
Land ownership <sup>b</sup>			
0.1-< 0.5 ha	ns	—	.842
Landless	-0.6*	[-1.1, -0.1]	.005**
Monthly household expenditure (VND) <sup>c</sup>			
3-<6 million (US \$129-256)	ns	—	.05
<3 million (US \$128)	-0.7*	[-1.2, -0.2]	<.0001**
Debts <sup>d</sup>			
Yes	-0.8*	[-0.5, -1.1]	<.0001**
Utensil score <sup>e</sup>	0.2*	[0.04, 0.3]	<.0001**

Variables included in the model: population group, education, monthly household income and expenditure, land ownership, keeping at least half of own produce for domestic use, savings, debts, ability to access market for purchasing food, and asset and utensil scores.

Abbreviations: HDDS, household diet diversity score; NP, northern province; Ref, reference; SP, southern province; VND, Vietnamese dong.

<sup>a</sup>Ref: NP Kinh.

<sup>b</sup>Ref: 0.5 ha and above.

<sup>c</sup>Ref: 6 million VND (US \$257) and above.

<sup>d</sup>Ref: No.

<sup>e</sup>Utensil score was created by counting the number of six commonly owned utensils in Vietnam (pressure cooker, rice cooker, blender, fridge, kettle, and gas stove) (General Statistics Office of Vietnam, 2016).

\*Only significant differences are indicated.

\*\*Significant at  $p < .01$ .

**Table 2.** Household food consumption on the preceding day by population group and HFI.

Consumption of food group on the preceding day (ref = yes)	Population group					HFI category		Adjusted OR <sup>a</sup> [95% CI]
	NP Kinh <sup>(ref)</sup>	SP Kinh	Khmer	SP vs NP Kinh	Khmer vs NP Kinh	Food secure <sup>(ref)</sup>	Food insecure	
Cereals	271 (98.5)	162 (96.4)	107 (98.2)	ns	ns	358 (98.9)	182 (95.8)	ns
White roots/tubers	38 (13.8)	15 (8.9)	8 (7.3)	ns	ns	49 (12.5)	12 (6.3)	ns
Vegetables <sup>b</sup>	242 (88.0)	144 (85.7)	79 (72.5)	ns	0.5 [0.2, 0.8]	314 (86.7)	151 (79.5)	ns
Vitamin A-rich vegetables	60 (21.8)	24 (14.3)	8 (7.3)	ns	0.4 [0.2, 0.8]	72 (19.9)	20 (10.5)	ns
Fruits <sup>c</sup>	166 (60.4)	82 (48.8)	37 (33.9)	0.6 [0.4, 0.9]	0.5 (0.3, 0.9)	216 (59.7)	69 (36.3)	2.5 [1.6, 3.9]
Vitamin A-rich fruits	137 (49.8)	37 (22.0)	17 (15.6)	0.3 [0.2, 0.4]	0.3 [0.1, 0.5]	146 (40.3)	45 (23.7)	ns
Meats <sup>d</sup>	143 (52.0)	92 (54.7)	41 (37.6)	ns	ns	215 (59.4)	61 (32.1)	2.0 [1.4-3.4]
Eggs	30 (10.9)	22 (13.1)	11 (10.1)	ns	ns	47 (13.0)	16 (8.4)	ns
Fish/seafood	150 (54.5)	98 (58.3)	52 (47.7)	ns	ns	194 (53.6)	106 (55.8)	ns
Legumes/nuts/seeds	23 (8.4)	8 (4.7)	8 (7.3)	ns	ns	33 (9.1)	6 (3.2)	ns
Milk/dairy products	130 (47.3)	71 (42.3)	26 (23.8)	ns	0.3 [0.5, 0.8]	164 (45.3)	63 (33.2)	ns
Oil/fats	233 (84.7)	126 (75.0)	84 (77.1)	0.5 [0.3, 0.9]	ns	292 (80.7)	151 (79.5)	ns
Sweets/beverages	108 (39.3)	65 (38.7)	30 (27.5)	ns	ns	160 (44.2)	43 (22.6)	2.3 [1.1, 4.8]
Spices/condiments	263 (95.6)	162 (96.4)	97 (89.0)	ns	ns	343 (94.7)	179 (94.2)	ns

Abbreviations: HFI, household food insecurity; NP, northern province; OR, odds ratio; ref, reference; SP, southern province; vs, versus.

<sup>a</sup>Adjusted for education, household income sufficiency, land ownership, and HFI or population group (depending on model).

<sup>b</sup>Vegetables include vitamin A-rich vegetables, green leafy vegetables, and other vegetables.

<sup>c</sup>Meats include flesh meats and organ meats.

<sup>d</sup>Fruits include vitamin A-rich fruits and other fruits.

**Table 3.** Multivariable associations between household diet diversity and household food availability.

	Difference in estimated marginal mean HDDS [95% CI]	p value
Food availability score	0.4 [0.3, 0.5]	<.0001**
Land ownership (ref: 0.5 ha and above)		
0.1-< 0.5 ha	ns	.853
Landless	-0.3 [-0.7, -0.03]	.013*
Debts (ref: Yes)		
No	0.6 [0.3, 0.8]	<.0001**
Utensil score	0.1 [0.05, 0.2]	<.0001**

Abbreviations: HDDS, household diet diversity score; ref, reference; ns, nonsignificant.

Only significant differences are indicated.

\*Significant at  $p < .05$ .

\*\*Significant at  $p < .01$ .

Variables included in the model to predict HDDS: household food availability score, population group, household income sufficiency, household debts, land ownership, utensil score, and total monthly household expenditure.

lack of diverse and nutritious diets in many rural households in the VMD could partially explain the prevalent and persistent maternal and child undernutrition (stunting and wasting) and micronutrient deficiencies previously reported in rural and ethnic minority groups.<sup>19</sup>

Along with the differences in HDD between the study area and the overall Vietnamese population, our study also revealed differences in HDD between the Khmer minority and Kinh majority ethnic groups. Khmer households predominantly consumed energy-dense foods such as cereals and oils/fats as well as significantly lower consumption of vegetables and fruits, especially those rich in vitamin A and milk/dairy products. This pattern agrees with a previous study which reported that minority ethnic groups in other parts of Vietnam ate less meats and fish.<sup>19</sup> The higher level of disadvantage among ethnic minority groups in Vietnam in terms of lower livelihood capitals such as financial capitals (income) and natural capitals (land ownership) and capabilities (lower agricultural skills and practices), along with limited access to basic services such as water, sanitation, other settlement infrastructure, education, and health, may also be contributing to this food and nutrition inequity.<sup>20</sup> In addition, ethnic minority households have been reported to lack finances to diversify into high-yielding nonfarm activities and thus had lower financial returns, had less access to credit, and lacked the knowledge or skills to diversify income-generating activities.<sup>21-24</sup> These facts correlate with the findings of this study that the Khmer ethnic minority consumed less nutritionally diverse food than the Kinh majority. However, the ethnic differences in HDD and the consumption of many nutrient-dense food groups remained after adjusting for income sufficiency, education, and HFI. This suggests additional reasons for lower diet diversity, such as lack of culturally preferred foods, and different cultural beliefs and behaviors.<sup>6</sup>

This study has shown that food-insecure households had reduced diet diversity, independent of the population group, education, household income sufficiency, and land ownership, which is consistent with other studies conducted in LMICs.<sup>9,25,26</sup> Food security has six dimensions (availability,

access, utilization, agency, stability, and sustainability), and research has consistently found that diet quality or diversity is associated with the food access dimension.<sup>9,10</sup> However, the findings of this study suggest that other dimensions, such as availability and utilization, also play an important role. Our findings corroborate previous research which indicate that HFA is positively associated with healthier dietary patterns, especially higher consumption of fruits and vegetables even when food preferences for these nutrient-dense foods are low.<sup>27</sup> Globally, successful policies and interventions have improved HDD through enhancing food security and food availability. For example, homestead food production programs that support women in poor households through improving their education and nutrition knowledge, enhancing their resources, and control over resources (such as livelihood capitals and agricultural inputs) assist them growing their own nutritious foods.<sup>12</sup> Such programs are amenable to adaptation at the local level and could be implemented in Vietnam and other LMICs.<sup>28,29</sup> Re-establishment of the vegetation-aquaculture-animal husbandry system in the direct vicinity of the home may be another appropriate program for deployment in the VMD to improve both quantity and quality of rural household diets.<sup>29</sup>

In addition to household food security and HFA, low livelihood capitals particularly associated with financial and natural capitals were significantly associated with reduced diet diversity. Our study's findings are consistent with previous work in LMICs suggesting that households not owning cultivable land and having a lower monthly food expenditure were at higher risk of reduced healthy diet diversity.<sup>5,6,10</sup> Our study also indicates that the level of household debt could impact the access dimension of food security, and therefore diet diversity.

Our study builds on previous studies of the association between kitchen utensil ownership and HDD, showing that households owning fewer utensils also had lower diet diversity than those owning more kitchen items. Ownership of more kitchen utensils implies that households are wealthier, and thus have more money to purchase diverse foods.

However, in our study, the association between diet diversity and kitchen utensil ownership remained after controlling for economic factors. We suggest having fewer kitchen utensils impacts the utilization dimension of food security, thus potentially limiting the ability to easily convert foods into meals. The lack of major equipment, such as refrigerators, may also affect decisions regarding the types of foods to purchase, specifically avoiding perishable foods.

The interpretation of the results of this study should consider a number of limitations. First, this study used a customized HDD tool measuring diet diversity on the previous day, meaning day-to-day or seasonal variations in food consumption were not captured. Second, while the study controlled for many factors when examining the associations with diet diversity, unmeasured confounders, such as prior knowledge of nutrition, crop diversity, and livestock ownership, remained. Finally, the cross-sectional design of this study does not allow for interpreting the causal associations between HDD and explanatory variables. Despite these limitations, the results provide insight into the importance of focusing on diet diversity in the context of household food security.

## Conclusion

This study shows that HDD, HFA, and overall household food security are compromised for many rural households in the VMD. The findings revealed an inequitable food and nutrition status between population groups, with the Khmer minority more likely to be food-insecure, have less access to and availability of nutrient-dense foods, and have a higher consumption of energy-dense, nutrient-poor foods. The structural and cultural factors leading to this difference remain needing to be addressed most probably through addressing the current inequitable access to important food groups, thus aiding a progression toward more diverse and nutritious diets. Further robust studies are also warranted to provide causational results that can inform and direct more effective interventions for improving inequitable food and nutrition between population groups.

## Acknowledgments

We acknowledge support from local commune staff and participants in the study areas. We are also grateful to the staff of the Institute of Public Health (IPH), Vietnam for their assistance in data collection.

## Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This

study had financial support from the QUT Institute of Health and Biomedical Innovation and the Ho Chi Minh City Institute of Public Health to fund the research assistants who collected the data. Chinh Van Dang received salary from Ho Chi Minh City Institute of Public Health. Danielle Gallegos is currently supported by a grant from the Queensland Children's Hospital Foundation through a philanthropic donation from Woolworths. The Foundation and Woolworths did not provide any funding for this research, and neither organization had any role in the design, collection, analysis, or interpretation of the data or in the writing of the manuscript. There are no restrictions on the sharing of data and materials. Data for this study are available from QUT Research Data Finder ([https://doi.org/10.25912/RDF\\_1636522923750](https://doi.org/10.25912/RDF_1636522923750)).

## ORCID iDs

Danielle Gallegos  <https://orcid.org/0000-0001-5901-1909>

Michelle Gatton  <https://orcid.org/0000-0003-1188-609X>

## Supplemental Material

Supplemental material for this article is available online.

## References

1. Narcisse MR, Felix HC, Long CR, English ES, Bailey MM, McElfish PA. Food insecurity and depression among low-income adults in the USA: does diet diversity play a role? Findings from the 2013–2014 National Health and Nutrition Examination Survey. *Public Health Nutr.* 2021;24(7):1877–1888. doi:10.1017/S1368980020004644
2. McDonald CM, McLean J, Kroeun H, Talukder A, Lynd LD, Green TJ. Correlates of household food insecurity and low dietary diversity in rural Cambodia. *Asia Pac J Clin Nutr.* 2015;24(4):720–730.
3. Vadiveloo M, Dixon LB, Mijanovich T, Elbel B, Parekh N. Development and evaluation of the US Healthy Food Diversity index. *Br J Nutr.* 2014;112(9):1562–1574. doi:10.1017/S0007114514002049
4. Global Panel on Agriculture Food Systems for Nutrition. Food systems and diets: facing the challenges of the 21st century. 2016. Accessed 23 December, 2016. <https://www.glopan.org/sites/default/files/Downloads/Foresight%20Report.pdf>
5. Ruel MT, Harris J, Cunningham K. Diet quality in developing countries. In: Preedy V, Hunter LA, Patel V, eds. *Diet Quality Nutrition and Health*. Humana Press; 2013:239–261.
6. Mayén AL, Marques-Vidal P, Paccaud F, Bovet P, Stringhini S. Socioeconomic determinants of dietary patterns in low- and middle-income countries: a systematic review. *Am J Clin Nutr.* 2014;100(6):1520–1531. doi:10.3945/ajcn.114.089029
7. Jones AD. Critical review of the emerging research evidence on agricultural biodiversity, diet diversity, and nutritional status in low- and middle-income countries. *Nutr Rev.* 2017;75(10):769–782. doi:10.1093/nutrit/nux040
8. Larson JB, Castellanos P, Jensen L. Gender, household food security, and dietary diversity in western Honduras. *Global Food Sec.* 2019;20:170–179. doi:<https://doi.org/10.1016/j.gfs.2019.01.005>
9. Pautz E, Batal M, Philizaire Y, Blanchet R, Sanou D. Determinants of diet quality among rural households in

- an intervention zone of Grande Anse, Haiti. *Food Secur.* 2016;8(6):1123-1134. doi:10.1007/s12571-016-0615-5
10. Mbwana HA, Kinabo J, Lambert C, Biesalski HK. Determinants of household dietary practices in rural Tanzania: implications for nutrition interventions. *Cogent Food Agric.* 2016;2(1):1224046. doi:10.1080/23311932.2016.1224046
  11. Huluka AT, Wondimagegnhu BA. Determinants of household dietary diversity in the Yayo biosphere reserve of Ethiopia: an empirical analysis using sustainable livelihood framework. *Cogent Food Agric.* 2019;5(1):1690829. doi:10.1080/23311932.2019.1690829
  12. Rammohan A, Pritchard B, Dibley M. Home gardens as a predictor of enhanced dietary diversity and food security in rural Myanmar. *BMC Public Health.* 2019;19(1):1145. doi:10.1186/s12889-019-7440-7
  13. Ronto R, Wu JH, Singh GM. The global nutrition transition: trends, disease burdens and policy interventions. *Public Health Nutr.* 2018;21(12):2267-2270. doi:10.1017/S1368980018000423
  14. Ali D, Saha KK, Nguyen PH, et al. Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. *J Nutr.* 2013;143(12):2015-2021. doi:10.3945/jn.113.175182
  15. Vuong TN, Van Dang C, Toze S, Jagals P, Gattton M, Gallegos D. Household food insecurity in regions of the Vietnamese Mekong Delta: prevalence and risk factors. *J Hunger Environ Nutr.* 2022;2022:2090883. doi:10.1080/19320248.2022.2090883
  16. Coates J, Swindle A, Bilinsky P. *Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide, Version 3.* 2007. Accessed 18 August, 2016. [https://www.fantaproject.org/sites/default/files/resources/HFIAS\\_ENG\\_v3\\_Aug07.pdf](https://www.fantaproject.org/sites/default/files/resources/HFIAS_ENG_v3_Aug07.pdf)
  17. Kennedy G, Ballard T, Dop MC. Guidelines for measuring household and individual dietary diversity 2011. Accessed 23 December, 2016. [http://www.fao.org/fileadmin/user\\_upload/wa\\_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf](http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf)
  18. Soares ALG, França GVAD, Gonçalves H. Household food availability in Pelotas, Brazil: an approach to assess the obesogenic environment. *Revista Nutrição.* 2014;27:193-203.
  19. Huong TT, Thomas-Agnan C, Simioni M. Relations between socio-economic factors and nutritional diet in Vietnam from 2004 to 2014: new insights using compositional data analysis. *Stat Med Res.* 2019;288:2305-2325.
  20. Imai KS, Gaiha R, Kang W. Poverty, inequality and ethnic minorities in Vietnam. *Int Rev Appl Econ.* 2011;25(3):249-282. doi:10.1080/02692171.2010.483471
  21. Vu LH. Estimation and analysis of food demand patterns in Vietnam. *Economies.* 2020;8(1):11.
  22. Bui AT, Nguyen CV, Pham TP. Poverty among ethnic minorities: the transition process, inequality and economic growth. *Appl Econ.* 2017;49(31):3114-3128. doi:10.1080/00036846.2016.1254341
  23. Linh TN, Long HT, Chi LV, Tam LT, Lebailly P. Access to rural credit markets in developing countries, the case of Vietnam: a literature review. *Sustainability.* 2019;11(5):1468.
  24. Kyeyune V, Turner S. Yielding to high yields? Critiquing food security definitions and policy implications for ethnic minority livelihoods in upland Vietnam. *Geoforum.* 2016;71:33-43. doi:10.1016/j.geoforum.2016.03.001
  25. Singhal S, Beck U. Ethnic disadvantage evidence using panel data. In: Tapp F, ed. *Growth, Structural Transformation, and Rural Change in Vietnam: A Rising Dragon on the Move.* Oxford University Press; 2017:21-50.
  26. Shariff ZM, Sulaiman N, Jalil RA, et al. Food insecurity and the metabolic syndrome among women from low income communities in Malaysia. *Asia Pac J Clin Nutr.* 2014;23(1):138-147.
  27. Lwin MO, Malik S, Lau J. Association between food availability and young people's fruits and vegetables consumption: understanding the mediation role of the theory of planned behaviour. *Public Health Nutr.* 2020;23(12):2155-2164.
  28. Pham VP, Nguyen HH, Tran XC. *Community-Based Model for Improving Child Nutrition Status—A Success Story in Yen Bai.* Hanoi. 2016. Accessed 7 January, 2022. [https://vietnam.savethechildren.net/sites/vietnam.savethechildren.net/files/library/Community\\_based\\_nutrition\\_0.pdf](https://vietnam.savethechildren.net/sites/vietnam.savethechildren.net/files/library/Community_based_nutrition_0.pdf)
  29. Hopfe T. Programs to improve production and consumption of animal source foods and malnutrition in Vietnam. *J Nutr.* 2003;133(11 suppl 2):4006S-4009S. doi:10.1093/jn/133.11.4006S