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Practicing Food Solidarity: Garden Biodiversity, Culturally Important Foods, and Diets of Immigrant Farmworker Communities Accessing Emergency Food Pantries

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ABSTRACT

Farmworkers are often overlooked in emergency food system programs, both as the producers and as consumers who carry unique culture, knowledge, and skills (L.-A. Minkoff-Zern & Carney, 2015). This study clarifies the relationship between biodiversity of garden spaces, access to culturally preferred food plants, and the diet of those who utilize emergency food pantries in Immokalee, Florida using a nutrition functional diversity (NFD) metric. A mixed-method approach was used, with a group participatory ranking activity (PRA) and interviews that included a garden mapping exercise and a 24-hr recall (N = 58). Garden NFD scores were the independent variable and diet NFD scores were the dependent variable, as were Healthy Eating Index scores. Garden NFD scores did not predict either diet NFD or HEI (HEI) scores. Housing condition, gardening practices, species richness, Shannon Weaver Index, and HEI scores differed significantly by language groups. Garden NFD, diet NFD scores, and species evenness differed significantly by housing condition. Regardless of housing and language, participants had consistent access to micronutrients via sources outside of gardens.

Practicing Food Solidarity: Garden Biodiversity, Culturally Important Foods, and Diets of Immigrant Farmworker Communities Accessing Emergency Food Pantries

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This study seeks to clarify the relationship between biodiversity of garden spaces, access to culturally preferred food plants, and the diet of those who utilize emergency food pantries in Immokalee, Florida. Immokalee is an unincorporated community in Collier County, Florida, with a population of 26,000, approximately 46% of whom were born in countries outside of the United States, mostly Mexico, Haiti, Guatemala, or Cuba. Poverty rates in Immokalee are 43.9%, nearly three times the national average (Krier, 2021). Forty-seven percent of Collier County's agricultural employment resides in Immokalee. Florida produces 90% of the United States' winter tomatoes and 90% of Florida’s tomatoes are grown in Immokalee (Greenhouse, 2014). Much of Immokalee qualifies as a USDA food desert, and the limited purchasing power of community members is exacerbated by the reality that food costs approximately 25% more as compared to major grocery stores located in the more affluent outskirts of town (Burnette, 2017; Felke et al., 2016). In this context, we explore the ways that gardens and culturally important food plants are used by immigrant farmworkers for nutrition resiliency. In addressing these research questions, this project seeks to explore collaborative dietetic practices that can inform emergency food systems and public health policy.

Evaluation of the role of garden spaces and access to culturally important food plants is underprioritized in policy, emergency food systems, and in nutrition research. In Minkoff-Zern’s work focusing on migrant workers in California, within the context of social programs aimed to improve nutrition but that ultimately reinforce social exclusion, community and market gardens were tools developed and utilized by participants to address food insecurity for themselves (Minkoff-Zern and Carney, 2015). Farmworkers are often overlooked in emergency food system programs, both as the producers of food but also as consumers who carry unique culture, knowledge, and skills (L. A. Minkoff-Zern, 2014). Research aimed to recognize farmworker agency and both their culinary and agricultural expertise can contribute to programs designed to provide emergency food and support the health of marginalized communities.

To explore the relationship between agrobiodiversity, access, and diet, a mixed-method approach has been used. We facilitate participatory research activities, map plant species of home gardens, and conduct diet recall interviews. This study specifically explores the application of a nutrition functional diversity (NFD) metric. NFD is defined as the number of distinct species in a population that have unique functional traits (Jones, 2017). An NFD metric applies an ecological framework to assess a range of plant species, including interactions between species and their environment (Remans et al., 2011). NFD has the potential to identify both synergies and tradeoffs between agriculture and nutrition (DeClerck et al., 2011; Luckett et al., 2015). Here, and NFD metric is used to evaluate growing spaces of research participants, representing both species richness and the assemblage of either nutrients or nutritional functional groups that they provide to human consumers. An NFD framework has the potential to consider the food environment of a community and assist in understanding patterns of nutrition resiliency.

Focusing specifically on the NFD of growing spaces, access to culturally important food items, and dietary patterns of community members in Immokalee, Florida, contributes valuable insight to current literature pertaining to nutrition security and deepens contextual knowledge for those working with these populations. Considering this topic with the purpose of better understanding practices of nutrition resiliency amongst immigrant farmworker communities is not only consistent with broad competencies of cultural humility but works towards a more collaborative food emergency system and dietetic practice.

1.1 Nutrition Resiliency

This research project explores links between agroecological biodiversity and human nutrition in the context of farmworker community home gardens, requiring an interdisciplinary lens that draws upon anthropology, ecology, community development, and nutrition science. As such, this literature review is organized by the following themes: work examining the daily life and food patterns of migrant farmworkers in the United States, migration and diet, the role of gardens in food security, considerations for social justice, gaps between agriculture and human nutrition, neglected and underutilized plant species, and nutrition functional diversity.

This paper utilizes the term “nutrition resiliency” at several points throughout. Within the development sector, resilience is a term that refers to people’s or institutions’ capacity to cope with and recover from shock. Resiliency requires identifying vulnerabilities within a system to improve this capacity. The term nutrition resiliency is somewhat novel, and when used, often refers specifically to undernutrition or malnutrition (Gostelow et al., 2015). This term is aptly consistent with ecological resilience. Building on this definition, this research uses nutrition resilience to also draw upon literature pertaining to trauma informed health care. In Looms et al.’s work on trauma informed public health systems in San Francisco, they define trauma as a result of chronic sociocultural stressors such as racism, poverty, historical oppression, or marginalization (Loomis et al., 2019). These chronic stressors are akin to how Scheper-Hughes and Bourgois define violence, not just as acute or political, but also in the structural, symbolic, and everyday experiences of marginalized people (Scheper-Hughes & Bourgois, 2004). Many

Americans have experienced at least one form of trauma, also sometimes referred to as an adverse childhood experience (ACE). The effects of trauma can range from physical and mental, to social and spiritual (Loomis et al., 2019). Links between trauma to both metabolism and health are not entirely clear, but one such mediating pathway is described by the concept of allostatic load (McEwen, 1998). In Liu and Eischer Miller's review of the specific ACE of food insecurity and cardiovascular disease risk, they describe allostatic load as the chronic stress that causes wear and tear on psychological systems over time, and contribute to chronic disease risk both via metabolic pathways and lower cognitive bandwidth or resiliency (Liu & Eicher-Miller, 2021).

Farmworker communities, through multiple mechanisms of citizenship, migration, labor, stigmatization, and (in)access to food, healthcare, and adequate housing, experience trauma at high rates. Mikoff-Zern and Carney point out that this trauma can occur even as a result of the institutions intended to support them (L.-A. Minkoff-Zern & Carney, 2015). Medical anthropologist Seth Holmes' ethnographic work of Mexican farmworkers utilizes Bourgois and Scheper-Hughes's phrase of "everyday violence" to capture the commonplace and micro-interactional expressions of violence and humiliation of Triqui strawberry pickers (Holmes & Bourgois, 2013). In this context, nutrition resilience can be defined as the practices that people and communities adapt to address vulnerabilities or concerns pertaining to food provision, nourishment, and care, including how they may withstand the shock and adverse effects of food insecurity. This paper uses the term nutrition resiliency as a way by which to honor the creativity and ingenuity of participants, situate this research within trauma-informed practice, and promote dignity.

1.2 Contextualizing "Nutrition" in Immokalee

> *"The official contract pay for strawberry pickers is 14 cents per pound of strawberries. This means that pickers must bring in fifty-one pounds of deleafed strawberries every hour because the farm is required to pay Washington State minimum wage—$7.16 at the time. In order to meet this minimum, pickers take few or no breaks from 5:00 A.M. until the afternoon when that field is completed. Nonetheless, they are reprimanded by some crew bosses and called perros (dogs), burros, Oaxacos (a derogatory mispronunciation of "Oaxacans"). Many do not eat or drink anything before work so they do not have to take time to use the bathroom. They work as hard and fast as they can, arms flying in the air as they kneel in the dirt, picking and running with their buckets of berries to the checkers. (…) During my fieldwork, I picked once or twice a week and experienced gastritis, headaches, and knee, back and hip pain for days afterward. I wrote in my field note after picking, "It honestly felt like pure torture."*

Fresh Fruit, Broken Bodies: Migrant Farmworkers in the United States

Seth M. Holmes, PhD, MD

The context of diet patterns and nutrition security for farmworker communities in the United States is distinct from the broader population. In Teresa Mares' *Life on the Other Border: Farmworkers and Food Justice in Vermont*, she makes the point that while anthropologists have explored how Latinx communities navigate inequitable food access, including the impact of citizenship, and have also explored the lives of farmworkers in the United States, very little work has explicitly investigated the intersection of food insecurity and farmworkers (Mares, 2019a). Citing non anthropological studies, Mares highlights that food insecurity amongst farmworker communities is three to four times the national average (12.3% in 2016), and higher also than "Hispanic" (18.5% in 2016).

The USDA's Household Food Security Survey Module (HFSSM) is a commonly used metric to measure food insecurity at the household level. It includes a survey that can be reduced to two questions and categorizes food insecurity at four levels: food secure, and then food insecure at three levels of marginal, moderate, and severe. Studies cited within this literature review typically use the HFSSM tool. It is intended to capture not just reduced food intake but also anxiety and perceptions of quality. In Mares' chapter on measuring food insecurity within farmworker communities, she points out that this measure may not adequately capture domains of food security, particularly in an intercultural context. In her own work she found the measurement to be overly technocratic but suggested that it's use can still provide baseline comparisons and that researchers should build upon the tool with appropriate methodology. One missing domain might be the prevalence of mixed economies, including foraging, hunting, or exchange (Mares, 2019b). A food insecurity measurement was not included in our research methodology, for the purpose of dignity and limited interview time. Instead, research participants were recruited from within social networks connected to the food pantry. Still, understanding the purpose and limitations of HFSSM helps clarify literature and consider dynamics of food access in immigrant farmworker communities in the United States.

In Ip et al.'s (2015) longitudinal study surveying patterns of food insecurity amongst 248 farmworkers in North Carolina, they use a hidden Markov analysis to build on the HFSSM score.

They found that 51% of participants were food secure and remained that way over the course of the three-year study. Participants within the severe food insecure group were the most transient. The researchers found seasonal (versus migrant) work status, absence of immigration documents, and season to be the greatest predictors of food insecurity. This work suggests that food insecurity is not necessarily chronic and may occur in episodes, shaped by various conditions of farm work, including temporary seasonal work, low wages, and vulnerabilities related to legal documentation (Ip et al., 2015). The researchers also point out that those who experienced episodes of food insecurity also indicated higher concern for both quality of balanced meals and the quantity of food, reflecting some of the complex dynamics and long-lasting effects that link trauma and food insecurity experiences.

Researchers Smith and Cuesta also acknowledge the unique form of stress that food insecurity causes farmworkers. They suggest that farmworker families with young children have the greatest vulnerability to this stress (Smith & Cuesta, 2020). Their study involves thirty-two Head Start families from across the United States participating in the national Migrant and Seasonal Head Start Policy Council. The families involved helped design the study. The researchers utilize a food justice framework and include the HFSSM tool. Forty-four percent of participants reported being within the food secure group, higher than similar studies, though the researchers suggest that the participants' active involvement in the MSHS policy council may indicate a relative stability when compared to some of their farmworker peers. Participants were strongly interested in gardening, and 72% were interested in contributing to garden spaces at their local Head Start centers (Smith & Cuesta, 2020).

Though an older study, several researchers and authors cite Kresge and Eastman's (2010) food security study focusing on agricultural workers in the Salinas Valley. This report found that 66% of 97 survey participants experienced food insecurity. Thirty-nine percent participated in SNAP, 37% were already growing their own fruits and vegetables, and an overwhelming 71% were interested in growing their own fruits and vegetables (Kresge & Eastman, 2010). As a study funded by the National Institute of Food and Agriculture, these findings show potential avenues to better understand nutrition resiliency and recognize the knowledge and expertise of both farmworkers and other individuals accessing emergency food services. It is evident throughout the literature that the HFSSM survey instrument is used broadly for households experiencing food insecurity. While no instrument has been developed to specifically address its potential shortcomings in evaluating food insecurity for farmworker households, this survey demonstrates additional survey questions pertinent to farmworker communities in the United States that can be used build on the basic HFSSM metric.

Though limited in its scope, it is important to situate this research project in broader anthropological work on the lives and experiences of migrant farmworkers in the United States. Seth Holmes' *Fresh Fruit, Broken Bodies* illuminates contributing dynamics and implications of the allostatic load uniquely carried by farmworkers (Holmes, 2013a). Holmes provides a close and detailed picture that helps readers understand the connection between labor conditions, structural violence, and the health of farmworkers. Minkoff-Zern draws upon political ecology and feminist epistemology to understand the ways that farmworkers cope with injustice. When this project initially presented itself, I read Mikoff-Zern's work closely and learned a great deal from it. Both Mikoff-Zern and Holmes appropriately shed light upon the broader context of farm labor, including the initial dispossession of land due dynamics caused by international trade agreements such as NAFTA, violence, climate change, and commodity dumping (L.-A. Minkoff-Zern, 2012). This reality was referred to in conversation with my research partner in Immokalee, whose parents came to the United States as farmworkers (L. Vazquez Reyes, personal communication, May 13, 2022). Upon arrival to the United States, the myriad of both overt and covert barriers to accessing food ranged from food apartheid, the potential threat of US Immigration and Customs Enforcement (ICE), fear of being deemed a public charge by US Citizenship and Immigration Services, monolingual service providers, lack of transportation, and so on. While this research pursues collaborative dietetic practice to inform emergency food systems and public health policy, Minkoff-Zern rightly makes the point that the root cause of unequal access to healthy foods stems from low wages (L.-A. Minkoff-Zern, 2012). Nonprofit food pantries and community projects provide emergency food today and can continue to improve upon the services they provide but cannot and should not be the sole focus nor end solution to addressing food insecurity, health inequalities, or even issues of food justice such as access to preferred cultural foods and growing spaces.

1.3 Migration and Diet

Academic research pertaining to migration and dietary acculturation has focused largely on the following three themes: comparing diet and food environments pre- and post-migration, measuring the dietary acculturation process as it relates to food choices and nutrition outcomes, and the impact of food environments on immigrant household nutrition. Amongst the twenty-seven academic papers identified on this topic, only two involved intervention studies (Wieland et al., 2012, 2016). The remaining academic papers represent a variety of qualitative and mixed methods, as well as various cross-sectional approaches. Two literature reviews were also included (Stokes, 2017; Wang et al., 2016), one of which involved a meta-analysis (Wang et al., 2016).

Across studies, first-generation immigrant community members consistently prefer homemade food that is familiar to their pre-migration settings (Dawson-Hahn et al., 2019; Wieland et al., 2012). Culturally appropriate meals are marked by ingredients, particularly staple items and spices (Garnweidner et al., 2012). Food preparation method is another indicator of a culturally proper meal (Garnweidner et al., 2012; Gichunge et al., 2016). Access or lack of access to culturally-preferred food or food ingredients was a common theme discussed in several studies (Dawson-Hahn et al., 2019; Gichunge et al., 2016; Lawlis et al., 2018; Moffat et al., 2017; Patil et al., 2009; Rondinelli et al., 2011; Tiedje et al., 2014; Wang et al., 2016). Some dynamics that surround accessing culturally preferred food include religious dietary rules and concern around appropriate substitutions or proper adherence when including food ingredients from the post-migration food environment (Garnweidner et al., 2012; Lawlis et al., 2018). Lack of food ingredient freshness was another concern cited by participants from several studies (Dawson-Hahn et al., 2019; Moffat et al., 2017; Vue et al., 2011).

From the perspective of first-generation migrants, culturally appropriate food consistent with pre-migration settings was a significant part of identity and self-expression (Gichunge et al., 2016; Ramírez et al., 2018; Vue et al., 2011). Several studies made the connection between self-expressed culturally appropriate family diet and either healthy eating outcomes or other positive health outcomes. A cross sectional study that looked at an inventory of twenty-six traditional vegetables amongst African refugees in Australia found that the presence of traditional vegetables in these refugees households was significantly associated with a greater number of servings of vegetables consumed daily (Gichunge et al., 2016). A longitudinal study involving 763 African immigrants to the United States found that immigrants that reported lower dietary change over time also reported higher self-rated health status than those who reported moderate dietary change (Okafor et al., 2014). Research focusing on Hmong refugees in the United States found that households with a stronger orientation towards traditional food practices consistent with pre-resettlement settings also correlated with increased understanding of self-hunger cues amongst children (Wieland et al., 2012). It's important to note that the connections between food, culture, and health are often assessed by healthcare providers and researchers from a "Western" cultural perspective. In fact, cultural food ways may also be integrated into a wider pluralistic medicine scape for immigrant families as well (Jennings et al., 2015), representing broader cultural differences in understanding health and influencing immigrants' interaction with their healthcare providers (Kercood & Morita-Mullaney, 2015).

An important dynamic to note is the intergenerational dynamics and shift that may occur in an immigrant family's experience when it comes to dietary patterns. In the study mentioned above that looked at traditional African vegetables in Australian refugee households, the availability of the twenty-six vegetables inventoried was significantly associated with the age of participants. Children within these households often had a lower preference for these vegetables, though they were still served (Gichunge et al., 2016). A study that interviewed fifteen Hmong mothers with young children to understand perspectives on food culture and health found that while these mothers strongly valued traditional foods as a way to combat health issues, several other dynamics that surrounded the migration experience often placed these mothers in a difficult position in fulfilling this goal (Vue et al., 2011). In Wilson and Renzaho's qualitative study that focused specifically upon intergenerational differences in acculturation experiences and food beliefs, adolescents consistently felt they ate traditional foods daily and mostly ate at home, while parents felt their children ate mostly nontraditional foods and that the composition of meals had changed post-migration (Wilson & Renzaho, 2015).

The list of added constraints that play into dietary patterns and nutrition of immigrants extends far beyond just the relative cost of food in post-migration contexts. In Hmong mothers' effort to maintain traditional foodways for their children, busyness was cited as a common tension with which they struggled (Vue et al., 2011). The investment involved for many immigrant families to adjust to a new country and work towards economic self-sufficiency is comprised of a myriad of complex dynamics. Several studies cite poverty and unemployment as significant factors in food choices and accessing nutritious food, let alone fresh and culturally preferred food items (Burge & Dharod, 2018; Lawlis et al., 2018; Wang et al., 2016). Aside from a lack of access to both fresh and culturally-preferred food mentioned above, other dynamics mentioned in several studies include transportation issues and concerns regarding neighborhood safety, which not only impact dietary choices but physical activity as well (Dawson-Hahn et al., 2019; Lawlis et al., 2018).

Given the different pre- and post- migration food environments, as well as the various constraints that are a part of the migration transition and dietary acculturation experience, it is important to note that cultural food patterns and food identity are not stagnant, but dynamic and, in a sense, in conversation with changing food environments. While focusing on Mexican-American immigrants, Ramirez's description of immigrant diets as a hybrid of traditional foods and certain components of those foods that are available in the host country, is helpful (Ramírez et al., 2018). In an interview-based study with twenty-one immigrants in Norway, researchers found that while Norwegian food was seen as different and less tasty to participants, there was still interest in learning about new food preparation techniques so that immigrants could make appropriate choices for their families in various circumstances, with an overall goal of "food continuity," pointing towards potential healthful outcomes in the dietary acculturation process as well (Garnweidner et al., 2012). In Vue's study involving Hmong women, participants expressed an interest in learning effective ways to create harmony around the dinner table, suggesting potential for developing recipes that appropriately address the unique constraints these women felt (Vue et al., 2011).

While many studies focusing on dietary acculturation seem to conclude with a general suggestion of developing culturally-appropriate nutrition interventions, some provide concrete examples such as family-centered counseling, promotion of "healthy traditional meals" (Tiedje et al., 2014), and special consideration for social capital dynamics amongst target populations (Roche et al., 2015). The two intervention studies included in the literature identified for this topic, one of which was a randomized control trial, utilized participatory techniques for developing appropriate physical activity and nutrition programs for immigrant community members (Wieland et al., 2012, 2016). Both interventions seem to present examples of what developing culturally appropriate dietary resources might look like, and by virtue of this participatory approach, were able to address and mitigate constraints unique to the group participant's experiences, many of which have been discussed throughout this review.

An inconsistency that seems to emerge from the literature centers around best practices for measuring dietary acculturation. While many studies measure dietary acculturation as a significant factor in health outcomes, some studies use language acquisition and length of stay as a proxy for measuring acculturation (Dharod et al., 2013). While language acquisition or length of residence may influence an individual's sense of belonging or comfort in a new food environment (Kercood & Morita-Mullaney, 2015), it seems inappropriate as a way by which to consider dietary shifts and cultural identity and may even represent confounding variables. Specific scales used for measuring acculturation more broadly included the East Asia Acculturation Scale (Kercood & Morita-Mullaney, 2015) and the Psychological Acculturation Scale (Lowell et al., 2011). The only scale focused specifically on dietary acculturation was the Dietary Change Scale, which was used in Okafor's research to assess dietary change amongst different African immigrant groups as it relates to self-rated health (Okafor et al., 2014). Being that this is a somewhat emerging topic and that the majority of the literature to this point is ethnographic and interview-based, most studies instead coded and identified patterns around dietary acculturation after interviews were conducted (Vue et al., 2011; Wilson & Renzaho, 2015). Consideration needs to be made as to whether dietary acculturation is an appropriate measure by which to investigate household nutrition, or if access to and consumption of cultural food items is more accurate, as seen in the study focused on traditional vegetables amongst African refugees in Australia (Gichunge et al., 2016).

1.4 Gardens for Nutrition Security

While some studies reference agrarian backgrounds of immigrant community members (Burge & Dharod, 2018), no study specifically looks at the relationship between access to garden space and household dietary patterns as a tool for nutritional resiliency, or the capacity amongst participants to address their own dietary issues or concerns. The only study that considered garden spaces and nutrition for post-migration was again the study focusing on traditional vegetables amongst African refugees in Australia. In fact, this study found that access to these twenty-six vegetables was significantly associated not just with having a local supermarket but also with having a vegetable garden (Gichunge et al., 2015). As mentioned previously, much of the literature cites participants as preferring food similar to their pre-migration setting but encountering difficulty in accessing such food (Vue et al., 2011). In Minkoff-Zern's study focusing on migrant workers in California, in the context of social programs aimed to improve nutrition but ultimately reinforcing social exclusion, community and market gardens were tools developed and utilized by participants to address food insecurity for themselves (L.-A. Minkoff-Zern & Carney, 2015). While the purpose of this study is to understand the ways that garden biodiversity is used for nutrition security, it is important to note that garden spaces offer more than just food in an immigrant's transition to their new environment. Studies focusing on community garden spaces found that gardens also play a therapeutic role and promote a sense of both belonging and becoming (Ong et al., 2019).

Looking at the use of gardens within a broader, global context, there are several studies that consider child anthropometrics, agrobiodiversity, and diet diversity. The Academy of Nutrition and Dietetics, in partnership with the Mayan Health Alliance, recently conducted a six-month quasi-experimental feasibility study evaluating the effect of a garden intervention to accompany the standard-of-care nutrition-specific protocol for Mayan children in two different areas of Guatemala. This study provides appropriate structure and insight to the research questions for our study. They found higher length-for-age z-score, higher crop species count, and higher NFD scores for the garden intervention group as compared to the standard-of-care group. Findings related to improved child and maternal diet diversity, as well as decreased food insecurity were not significant (Guzmán-Abril et al., 2021). In Luna-González et al.'s cross sectional study of children in rural Guatemala, higher NFD, diet diversity, and food self-sufficiency correlated with species richness, but diet diversity scores did *not* correlate with child anthropometric status. Anthropometric status correlated with improved sanitary conditions and maternal education, instead (Luna-González & Sorensen, 2018). While gardens may serve a critical role in providing access to certain nutrients, the relationship between gardens, diet, and health status is evidently not clear. Literature published in the context of global food security and child nutrition have some overlapping themes with our study, though the context and specific considerations for immigrant farmworker communities are distinct.

1.5 Food Access and Social Justice

While not a primary focus of this research project, an underlying and important theme underpinning this work is the broader context of the human right to food. While hunger is sometimes understood as a temporary condition of caloric deficit, framing food access as a right acknowledges the ways that food insecurity is a failure of social systems. As such, food insecurity is an issue of social justice (Devine, 2016). Food as a human right emphasizes not just quantity, but also quality, cultural appropriateness, and dignity.

In Thompson, Thapa, and Whiteway's research around place-based food stories of the Wasagamack people, they highlight how the nutrition transition experienced by their community from the 1970s onward has been integrally linked with colonization, constituting an attack on their land and therefore on their food system itself (Thompson & Thapa, 2019). In this context, the promotion of local food species and biodiversity for improved agroecology and nutrition is a step towards seeking the leadership of communities that understand, utilize, and safeguard these foods. While farmworker communities included in this study have experienced a change of geography and foodshed, by way of migration, structural forces have contributed to this migration pattern and the opportunity to understand the culinary and agricultural knowledge of participants remains.

Work to integrate agroecology and nutrition requires a “just transition”’ approach, where equity is at the center. In Sumnar, Tarhan, and McMurty’s cross-sectional study looking at food procurement patterns of indigenous communities throughout Canada, the authors argue that a just transition framework is vision-led, unifying, and place-based. The authors explain that utilizing this framework inverts the segregated and prescriptive approach often utilized to understanding food and nutrition. Rather than focusing on monocrops that have led to the nutrition transition, the authors propose that researchers and advocates take a more nuanced approach to food systems assessments. They argue that individual food choices are often the product of government policies and marketing, and that a more place-based approach prioritizing the social well-being of individuals and communities would result in more a sustainable future for the global food system as a whole (Sumner et al., 2019). This “just transition” approach is aptly consistent with Hunter et al.’s suggestion that food-based dietary guidelines need to be linked to local foods and biocultural heritage (Hunter et al., 2019).

1.6 Gaps Between Agriculture and Nutrition

The Green Revolution was a set of research technology transfer initiatives that took place in Asia from 1950 to the late 1960s and is credited for preventing mass starvation (DeClerck et al., 2011). These research and policy efforts were directed towards cereal crops, specifically rice, wheat, and maize. This singular pursuit of increased agricultural outputs emphasized high carbohydrate food items with low levels of protein and minimal other nutrients necessary for human nutrition. During this time, hybrid dwarf varieties were developed via classical breeding methods, to direct more energy into the grain, as opposed to biomass. Hybrid varieties were more productive, and also required more optimal conditions, including increased use of fertilizer (S. R. Gliessman, 2014). More recently, “Golden Rice” was genetically engineered to be capable of biosynthesizing beta-carotene, a precursor to vitamin A (MASIPAG, 2001). Golden Rice is an example of a single micronutrient intervention, a bio-technology intervention with a narrow and specific focus that may fall short of considering resiliency more broadly . The promotion of species such as hybridized varieties of commodity and cereal crops such as rice, corn, and soy has been criticized for its potential to crossbreed and thus contaminate local seed varieties and ecosystems, as well as for increasing farmers’ dependence on markets by requiring that they purchase new seed each year, along with excessive fertilizer and pesticide application (Girard, 2016). In agricultural spaces, the priorities of reflected in these breeding efforts have been cited as responsible, at least in part, for a shift from more diversified cropping systems to simpler cereal-based systems (DeClerck et al., 2011). Monocropping resulted in lower diversity, not only on farms, but also in human diets. The cost of a more singular focus was in increased vulnerabilities in the global food system, particularly concerning sustainability, and resulted in both land degradation and long term human micronutrient deficiencies (Frison et al., 2006).

Increasing agrobiodiversity within food production, in contrast, is a way to promote resiliency within food systems, both for planetary and human health. Though beyond the scope of this paper, biodiversity is one of the thirteen principles of agroecology as outlined by the United Nations and Food and Agriculture Organization. Wezel et al. (2020) explain that agroecology is often presented in three ways: as a science, a set of practices, and a social movement. In all three contexts agroecology aims to understand the interlinkages between various ecological, agricultural, and social dynamics. Gliessman explains that diversity, within agroecology, is simultaneously a product, measure, and foundation of the full system (S. Gliessman, 2013; S. R. Gliessman, 2014).

The United Nations declared 2010 the International Year of Biodiversity (IYB) and the proceeding decade the “UN Decade on Biodiversity” in an effort to protect and safeguard the planet’s natural wealth and prevent biodiversity loss (Lutaladio et al., 2010). Policy makers and advocates promote the importance of agroecological biodiversity as a way to improve horticultural systems, protect the environment, facilitate food and nutrition security, and create sustainable livelihoods (DeClerck et al., 2011; Lutaladio et al., 2010; Toledo & Burlingame, 2006; Willett et al., 2019). In Frison et al.’s 2011 review of previous research pertaining to biodiversity and food systems, they cite several research studies that show the importance of biodiversity both within species and between species in agroecological spaces. The authors argue that biodiversity boosts productivity, enhances ecosystem functions, and promotes adaptability, thus reducing risk of crop failures in more high stress environments (Frison et al., 2011). Biodiversity, as a part of food production systems, is critical to protect global food structures to deliver essential services and benefits.

Even amid calls for advocacy and deeper understanding of these links, research between disciplines has remained segregated. Looking specifically at nutrition research, one must consider the historical context for the discipline. Modern nutrition science is young, dating perhaps to 1926 when the first vitamin, thiamine, was isolated and chemically defined (Mozaffarian et al., 2018). What ensued then was decades marked by vitamin discovery, research related to single-nutrient deficiency diseases, and food fortification efforts. Mozaffarian et al. explain that the emergence of nutrition science coincided with the Great Depression and World War II and was thus shaped by fears of food shortages, which were the impetus for minimal dietary guidelines being commissioned by the US government, the British Medical Association, the League of Nations. The first recommended dietary allowances (RDAs) were published in 1941 at the National Nutrition Conference on Defense and set a precedent for future research and policy work (Mozaffarian et al., 2018). This focus on single nutrient deficiencies is evidenced even in the Green Revolution era efforts, mentioned prior.

Nutrition research measures have therefore specifically relied on and been shaped by population dietary guidelines and recommended intakes. Accordingly, diets are typically assessed through recall methods or food frequency questionnaires that are then compared to broader dietary recommendations, with upper and lower limits. Diet data may also be categorized by food groups consistent with regionally-appropriate food-based dietary guidelines, or translated into diet quality scores (Remans et al., 2011; Wahlqvist, 2009). This research project utilizes one such diet quality score, the "Healthy Eating Index," which measures how diet compares to key recommendations from the Dietary Guidelines for Americans (DGAs) (Kennedy et al., 1995; Krebs-Smith et al., 2018). While these measurements are critical for contexts such as epidemiological application, or assessing deficiencies and toxicities, the approach has some shortfalls. From a sustainable foodshed perspective, whereby we consider the geographic areas that produce food for specific populations, the disconnect between individual diet and local geography is problematic. For one, these measures do not account for agroecological inputs and consequences and thus contribute to the disintegration that causes such high ecological costs. While dietary guidelines have been key to understanding diseases related to nutrient deficiencies, food recommendations segregated from local context also run the risk of being overly prescriptive and lacking important context. In this way they may potentially do harm to cultural foodways and overlook opportunities to understand nutrition resiliency.

It is within this context that the nutrition community has more recently begun to discuss the importance of sustainable diets, not only to benefit food production systems, but for human health as well. Research in this area has culminated in the EAT-Lancet Commission's meta-analysis report "Food in the Anthropocene," which posits healthy diets as inextricably linked to food production. As a response to the global nutrition transition, the EAT-Lancet Commission argues that healthy diets are composed of diverse plant-based foods, lower consumption of animal-sourced foods, unsaturated fats, and small amounts of grains. The authors suggest that an eating pattern consistent with these parameters may even avert 10.8-11.6 million deaths per year (Willett et al., 2019). While sustainable diets may be one way to integrate our understanding of biodiversity, agriculture, and human health, this approach is consistent with the historical nutrition interventions that emphasize responsibility on the individual consumer behavior. It remains a prescriptive and top-down in its approach.

1.7 Neglected and Underutilized Species

Between 1961 and 2009 diets have grown increasingly similar, with a 68.8% decrease in variation in food supply chains between different countries, and an overall shift towards wheat, rice, and maize (Hunter et al., 2019). To prevent the continued homogenization of global diets and promote resiliency, some researchers emphasize the importance of more data and greater understanding of what some refer to as "Neglected and Underutilized Species" (NUS) food plants. Hunter et al. explain that several adjectives have been used for such crops, including 'neglected,' 'orphan,' traditional,' 'local,' and 'minor.' Broadly speaking, the term NUS refers to plant species that have been marginalized specifically by specialized modern agriculture production systems (Hunter et al., 2019). In the context of this nutrition transition, it is important to recognize this terminology, and consider both by whom and for whom this language is used, including the positionality of both the researcher and this project. In working with NUS, policy and research should prioritize the leadership of communities that have generational knowledge and practices, both in cultivation and in food preparation, related to these plants. While the term NUS will be used in this paper, it is evident that these food plants are, in no way, underutilized or neglected by research participants, themselves. In contrast, as participants forage, grow, or consume herbs such as chipilín (*Crotalaria longirostrata*) or epazote (*Dysphania ambrosioides*), it is within government composition databases that these plants are not listed. Even on a global scale, the United Nations' recent State of the World's report on Biodiversity for Food and

Agriculture reported that 16% of the 91 reporting countries regularly incorporate wild foods into national diets (Egal, 2019).

In the context of the Green Revolution and proceeding bio-technological developments that focus on specific crops and nutrients discussed earlier, Welsh and Glenna (2006) argue that these priorities have been, in part, a result of private sector and commercial interests dominating research and development for hybrid and transgenic plant species. They suggest that when private corporations lead seed development, the focus will naturally be placed on commercial crops and profitable traits. Because of this dynamic, Welsh and Glenna argue that it is the role of public institutions and universities to prioritize the NUS plant species, and that withstand industry influence that fails to prioritize these minor crops and traits (Welsh & Glenna, 2006). Considering this argument to safeguard and protect NUS species for the public good is relevant when considering the implications for nutrition science and population health, and even illustrates a priority that serves as a potential bridge between disciplines.

In Beltrame et al.’s article on mainstreaming biodiversity, which provides case studies and analyses of national policies from Kenya, Sri Lanka, and Turkey as a part of a larger “Biodiversity for Food and Nutrition” project, the critical role of NUS in working towards the United Nation’s Sustainable Development Goals is underscored. However, the authors argue that this work depends not simply on interdisciplinary and cross-sector partnerships, but on improved food composition data of NUS species. When insufficient data for local species exists, Beltrame et al. found that markets and policy makers more easily replace traditional food items with commodity crops, promoting uniformity in regional food systems and increasing vulnerabilities (Beltrame et al., 2019). Hunter et al.’s paper focusing on opportunities and barriers to promoting NUS for improved diets and nutrition, involving case studies in Brazil, Kenya, Sri Lanka, and Turkey, points out that while food composition of these species is under-researched, nutrition content has often been found to be superior to those species that currently dominate food systems (Hunter et al., 2019). Preceding this work, Burlingham et al. also called for improved food composition data, particularly between and within plant species and with a special emphasis on NUS food plants. This sort of research, the authors argue, promotes not only conservation and biodiversity but also food and nutrition security (Burlingame et al., 2009). Frison refers to this multidisciplinary and comparative framework with a specific emphasis on traditional foods as a "holistic foods-based approach" (Frison et al., 2006).

In an earlier meta-analysis based on case studies that focus on the role of traditional foods in healthy diets, Emile A. Frison and a team from the International Genetic Plant Resources Institute made a strong appeal for partnerships between research centers, national agricultural research systems, universities, and community-based organizations in order to develop an evidence base that links biodiversity, nutrition, and health (Frison et al., 2006). Consistent with this appeal, Herforth et al. argues that developing an integrated framework between the three domains of nutrition quality, environmental sustainability, and economic viability requires several areas of research, including improved measurements, modelling across disciplines, and drawing attention to inequities among different population groups as they relate to these domains (Herforth et al., 2014).

1.8 Nutrition Functional Diversity

The question of how nutrition science might more effectively integrate biodiversity frameworks into community health measures remains, both for the purpose of broad-systems policy work but for on-the-ground community extension work as well. Research up to this point has primarily focused on diet diversity scores in order to capture food consumption patterns (Lutaladio et al., 2010). These scores are typically measured by categorizing diet intake data by food groups, which may themselves be regionally determined (Sibhatu et al., 2015). Interestingly, these scores are somewhat analogous to species richness measures mentioned below, which count the number of crops in a particular growing space (Di Falco et al., 2010). Baudron et al. provide an example of applications for such metrics in their assessment of 266 Oroma households in Ethiopia. This research considered diet diversity, food security, crop and livestock management, and forest use to develop a diet diversity gradient according to household proximity to forest spaces. Researchers in this study found that while home gardens explained increased household consumption of all food, garden diversity itself increased with proximity to the forest, largely due to improved water management systems in those geographies (Baudron et al., 2017). A diet diversity score, while informative, is limited as an assessment tool in that it fails to integrate agrobiodiversity and human diet. Hunter et al., meanwhile, focus on assessments aimed at incorporating and promoting NUS. They argue that nutrition science has generally considered dietary diversity only in terms of inter-species diversity and aggregated food composition data, which fails to capture agroecological, seasonal, and genetic differences (Hunter et al., 2019).

In the context of these shortfalls, a potential alternate metric that has emerged in research over the past decade is nutritional functional diversity (NFD) measures. Functional diversity (FD) is an ecological metric whose development is credited to Petchey and Gaston (2002). It uses a trait-based approach to quantify biodiversity in a way that does not give equal weight to species that fulfill redundant functions in an ecosystem (Petchey & Gaston, 2002). While several metrics to assess FD exist, the approach generally starts with a matrix of species traits that reflect the ecological contribution of each species to specific functions, within the overall context of measuring diversity in a broader ecosystem. DeClerck et al. is credited for applying this concept to nutrition and human health in a 2011 review of existing literature pertaining to ecological approaches to human nutrition. Paired with a case study from western Kenya, this paper argues that understanding the association between agricultural biodiversity and diet diversity is the nexus of human nutrition and ecology. While the authors do not explicitly use the term NFD, they essentially call for a metric that pursues a clear understanding of plant species' nutritional and ecological functions. The authors argue that metrics which consider numerous functions of species, by identifying and combining species assemblages to maximize functions, will provide a more holistic systems perspective and ensure that interventions are sustainable. In this way, the field of ecology and its study of interactions between species and their environment has the potential to identify both synergies and tradeoffs between agriculture and nutrition (DeClerck et al., 2011).

In Jones et al.'s 2017 systematic review and meta-analysis of emerging research focused specifically on agricultural biodiversity, diet diversity, and nutritional status, the authors include research work that focuses on the association between at least one indicator of agricultural biodiversity and at least one indicator pertaining to either diet quality, diversity, or nutritional status. The authors outline a total of twenty-three papers which were almost all cross-sectional in design aside from one longitudinal study. While all research studies included a distinct crop species count (referred to as "species richness"), one study further considered distinct varietal counts, and four studies also included a measure of species evenness—that is, a measurement of the relative population size of species present. Two studies included in this meta-analysis utilized an NFD measure as well. NFD is defined in this paper as the number of “distinct species in a population that have unique functional traits” (Jones, 2017). In the context of assessing agricultural biodiversity and diet, an NFD measure is used to indicate crop species that provide a unique combination of either nutrients or nutritional functional groups. Nineteen of the studies included in this review found a positive association between agricultural diversity and diet diversity, though the magnitude of this association was small in most cases (Jones, 2017). The authors of this analysis argue that the downstream health impacts of agricultural biodiversity are still largely unexplored.

An earlier example of such work is provided by Remans et al.’s (2011) study of assessing NFD of 170 different farms from Kenya, Uganda, and Malawi. In their project, they documented plant species on all plots of the 170 household sites, including home gardens. The researchers identified seventy-seven different species in this study, with twenty-seven species common across all three research countries. Species richness was found to be independent of landholding size and the number of edible species per farm varied significantly between villages. Remans et al. created a database of nutritional composition data, which was standardized and weighted via conversion to the Dietary Reference Intake (DRI) percentage for each nutrient provided by 100g of the consumable product. Four NFD scores were then calculated and included FDtotal, FDmacronutrients, FDminerals, and FDvitamins. In this study, the authors found that there was a strong correlation between FDtotal and species richness, but that FDtotal began to level off once about twenty-five edible species were present on the farm. That is, after about twenty-five plants, additional plant species contributed less to overall nutritional diversity. However, it is important to note that while there was a correlation between FDtotal and species richness, individual farms with the same number of species could, in fact, have very different NFD scores. The authors argue that NFD metrics can be used to identify variability in nutritional diversity between farms and villages and can be instrumental in identifying both nutritional vulnerabilities and redundancies of growing spaces (Remans et al., 2011). This study is an excellent example of applying NFD measures in research settings and illustrates opportunities for extension work.

A secondary analysis and cross-sectional study from Luckett et al. also looked at NFD in Malawi, though at a nation-wide level, including over 11,000 households. The purpose of this research project was to compare a food consumption module, a tool used by the World Bank to record diet data over the course of one week, to an NFD measurement, which was calculated using a food-nutrient matrix. Contributing to the broader conversation, this study considered NFD as it relates to market access, road access, household demographics, and across different seasons. The authors found that purchased food contributed more to household nutritional diversity than home-produced foods. However, NFD varied according to agroecological zones and the research suggested that for those households either further from markets or with less access to roads, home-produced foods contributed more significantly to NFD. Luckett et al. suggest that an NFD metric is sufficiently effective in identifying populations with low nutritional diversity and might be used to also identify determinants of dietary diversity. They suggest that the NFD might be used by policymakers to plan interventions that consider the roles of markets, agriculture extension, and home production to support more sustainable diets and food systems. The authors also aptly suggest that NFD is limited. Adequate nutrition also depends on an individual's nutrient requirements and metabolism, which cannot be captured by NFD. As such, they suggest it should be understood as a measure of availability rather than adequacy (Luckett et al., 2015).

Like these studies, a 2018 research project conducted by Luna-Gonzalez et al. focused specifically on NFD scores as they relate to health and anthropometric outcomes. The study included 154 children from rural Guatemala and considered household demographics, agricultural practices, and socio-economic status. Agricultural biodiversity was measured by crop species richness, livestock ownership, and an NFD measure in order to "quantify the functions provided to diet by the agrobiodiversity found in the participants' food systems" (Luna-González & Sorensen, 2018). Children's dietary assessments were conducted by 24-hour dietary recalls. Anthropometric measurements were assessed by height/length-for-age Z-score and weight-for-age Z-score, according to World Health Organization (WHO) guidelines. While higher NFD scores did not correlate with child anthropometrics, they were associated with higher nutrient availability for participants. While nutrient-rich plants were generally lacking in the children's diets, higher dietary diversity scores were associated with greater NFD. The authors suggest not only that nutrient variety and availability increased with greater species richness and NFD, but that this was especially true where wild edible plants were cultivated, as they were good sources of micronutrients. By utilizing an NFD metric the authors conclude that agrobiodiversity provides nutritional benefits and perhaps even helps mitigate the nutrition transition of households (Luna-González & Sorensen, 2018).

With almost a decade of developing research around NFD measurements, a foundation exists that substantiates its application for assessing agriculture biodiversity to support human nutrition. Utilizing an ecological framework such as FD allows researchers to build bridges between disciplines, assess agriculture and nutrition from an ecological systems approach, and in doing so contribute to a more resilient and sustainable global food system. Furthermore, NFD reflects a framework consistent with community management of foodsheds, and its application is best utilized when integrated with a just transition approach, or one that is led by smallholder agriculturalists, gardeners, and research participants, themselves. The literature outlined suggests that further exploration of NFD in other contexts. The aim of this research project is to apply an NFD metric to better understand the ways that garden spaces are used as tools for nutrition resiliency by immigrant farmworker community members in Immokalee, Florida.

2. METHODS

2.1 Population and Sampling Method

This research was done in partnership with Cultivate Abundance, a 501(c)3 nonprofit organization who mission is to mobilize appropriate resources to eliminate hunger and enable small-scale food production in vulnerable households and communities. Cultivate Abundance is a faith-based organization that practices food solidarity by increasing Immokalee community members' access to healthy foods by collecting and sharing fresh produce and by equipping landless households to grow supplementary foods in container gardens. The research purpose and methodology were submitted to the Institutional Review Board (IRB) at Syracuse University. The project was deemed to be exempt from IRB requirements as data collection was performed by Cultivate Abundance staff members, the research incentives for participation were provided by Cultivate Abundance, and all data were deidentified before secondary analysis. The researcher collaborated with Cultivate Abundance in designing the primary research questions, the methodology, and planning. The project was then led and facilitated by Cultivate Abundance, and the author was not involved in any primary data collection.

Cultivate Abundance facilitates a community garden plot behind Misión Peniel, a food pantry funded by the Peace River Presbytery and located at 208 Boston Avenue, in the center of Immokalee. Each Friday, Misión Peniel serves between 300 and 450 individuals through a food distribution. During 2021, Cultivate Abundance shared 42,000 pounds of produce, 125,795 servings, through these weekly distributions, prioritizing foods that are preferred by pantry goers and would be familiar to them from pre-migration settings. Local Immokalee community members provided 11% of this produce. Cultivate Abundance also partners with 22 gardens and purchases from area small farms throughout Southwest Florida.

To understand the relationships between garden biodiversity, cultural food preferences, and diet, two primary methods were used for this research (1) participatory ranking activities (PRA), and (2) interviews that include a 24-hour diet recall and a garden map exercise.

Participants were recruited by the research facilitators. Lupita Vazquez Reyes and Helen Midney both work for Cultivate Abundance and facilitated activities and interviews in Spanish. Frantzso Marcelin facilitated activities and interviews in Haitian Kreyòl. He is a contract worker for Partners in Health and the Coalition for Immokalee Workers. Participants were recruited by snowball technique. Individuals were first invited to the participatory ranking exercise by word of mouth via the Misión Peniel food pantry distribution day and those who are active in the Cultivate Abundance garden space behind Misión Peniel. Individuals that attended this activity were then also invited to participate in an individual interview. As individuals were interviewed, they recommended friends or neighbors to also be invited. To include more Haitian Kreyòl speakers, Frantzso also visited the weekly open-air market in Immokalee to recruit additional participants. Participants who attended the participatory ranking activity were given a $20 to the local Family Dollar, to thank them for their time and contribution to this activity. Individuals who participated in an interview were provided with a $15 gift card to Family Dollar.

The inclusion criteria for the PRA session were broad and restricted to any adult living in Immokalee. However, to focus on women, men were excluded from the interview portion of the project. In these immigrant households, women are often the ones to tend gardens and act as nutritional gatekeepers. Inclusion criteria for interview participants involves identifying as a woman and living in Immokalee, Florida. Any length of residence in the United States, occupation, migration status, or housing situation was included for interview participants. Exclusion criteria included either being a man or those under the age of 18.

The initial aim for this research project was to host a participatory activity with ten community members and conduct 30 individual interviews. In the end, 16 individuals participated in the ranking activity (11 Spanish speakers and 5 Haitian Kreyòl speakers). After the initial 30 interviews were complete, the Southwest Regional Planning Committee funded an additional 30 interviews, of which 28 were completed. In total, 58 interviews were conducted.

2.2 Stage 1: Participatory Ranking Activities

As consistent with the aim to prioritize the agency of research participants, and lay a foundation for the interviews, this project began with a “Participatory Ranking Activity” (PRA) session that seeks the input of participants.

The PRA session was facilitated by the Cultivate Abundance Program and Technical Director, Rick Burnette, with the help and support of Lupita Vazquez Reyes, Helen Mideny, and

Frantzso Marcelin, as mentioned above. The session took place over the course of one hour in the garden space, located behind the Misión Peniel food pantry. Participants were provided with snacks and refreshments and in addition to the Family Dollar gift card, a bundle of fruits and vegetables was also given, to thank them for their time. The purpose of the PRA session was to seek the perspective of research participants in defining and ranking food plants according to preference. Other topics outlined and ranked plants most difficult to access, and which plants were typically accessed via different outlets (pantry, purchase, garden, exchange, or foraging). According to the nature of the PRA structure, all results are semi-quantitative. Documentation of the PRA portion of this research project was done by photographs of the final PRA results. The protocol used for the PRA session is included in the Appendix A.

The participatory ranking activities include eight steps. The first step was a "piling" activity, where participants were asked to list all their preferred fruits or vegetables. This list excluded grains and dry pulse crops, for the purpose of identifying plants that would more or less likely to be accessible through garden spaces. Participants were then given a set of five sticky notes and invited to vote for those plants that were the most culturally important to them. The phrasing of this question, at the advice and guidance of the facilitators, was "as a ________ (Haitian, Guatemalan, or Mexican) person living in Immokalee, the most important food to me is ________." This activity is an example of a ranking activity, where, after piling a list, participants vote for items that are the most relevant or important for a given question. For PRA activity titled "(In)Access," participants were asked to vote again with sticky notes of a certain color, for plants that were the most difficult to access. In the preceding PRA activities, participants were asked to vote for food plants they were most likely to source from different methods, referencing the larger list created earlier. That is, which plants they most likely access through garden spaces, through a food pantry, by foraging, by purchasing at a store, or via exchange.

The groups of plants listed in the beginning and then through the subsequent ranking exercises were then used to create nutrition composition matrices, as outlined below. Each plant included in each ranking activity was a unique row in the matrix. The unique row was weighted by the relative number of votes that plant item was assigned, adjusted for the number of participants in each language group. Within the PRA portion of this research, the language groups were specified only by Haitian Kreyòl and Spanish, there was no language group in the PRA session that specifically differentiated individuals who also spoke an Indigenous language.

These lists were also used to create spider graphs of 400-gram samples of the different plant lists, based on Tong et al.'s meta-analysis evaluating fruit and vegetable consumption for a healthy heart (Gan et al., 2015). These graphs consider the ways that different food access points provide different micronutrients, and are compared to the US Food and Drug Administration's recommended intake.

2.3 Stage 2: Interviews

In total, 58 women were recruited to participate in individual interviews. Interviews were conducted in Spanish and in Haitian Kreyòl. All interviews begin by reading an oral consent (Appendix B) statement to research participants. If in agreement, the participants then completed a garden map interview (Appendix C) and a 24-hour dietary recall (Appendix D). Each registration was assigned a unique study participant ID number. This ID number was used for the 24-hour recall and NFD forms. Quantities of ingredients were estimated using a hand as reference, the diagram for which is included Appendix E. The garden map was used to create an

NFD plant nutrient matrix. The diet recall was used to assign an HEI score and to create a NFD diet nutrient matrix. Demographic data collected, at the guidance of Cultivate Abundance interviewers, included languages spoken, housing condition (trailer, house, rented room, and rent or own), age, and the number of years the participant has lived in the United States.

2.4 NFD Matrix

The PRA results, garden maps, and diet recall information were all used to create an NFD nutrient matrix that was then used to assign an NFD score to individual PRA activities, garden plots, and diet information, respectively. To determine functional diversity in ecology, a matrix of species traits that reflects the ecological contribution of each species is created. This method was developed by Petchey and Gatson (Petchey & Gaston, 2002). In the context NFD, the species traits refer to the nutrient content of food plants. As such, NFD reflects the nutrients *made available* for human consumption within each garden. It is important to note that NFD is a *relative* measure, where a higher score reflects a more diverse diet.

This research project follows the methodology outlined by Luckett et al., (2015) in "Application of the Nutrition Functional Diversity indicator to assess food system contributions to dietary diversity and sustainable diets of Malawian households." They outline four steps, the first of which was to create a food nutrient matrix (*Table 1*). A large matrix was created, with three subcomponents: (1) a composition matrix for all plants discussed in the PRA activities, (2) a composition matrix for the garden maps, and (3) a composition matrix for the 24-hour diet recall interviews. In these matrices, each row is a food item that was identified in the research interviews/activities, and each column is a nutrient. All nutrition composition data was reported per 100g of the item. By way of the PRA session, 83 food plants were listed and ranked. For this subcomponent, the relative presence of each plant species was weighted by the number of votes it received during the PRA session. Because five Haitian Kreyòl speakers and eleven Spanish speakers participated in the PRA session, the votes were standardized so that the language groups were equally represented. Through the home garden map portion of the 58 interviews, 98 plants species were identified. These plant species were weighted by the relative amount of space they took up on the garden map, which was represented by a grid. These weighted scores were also adjusted to represent the larger plots of those living in homes, versus the smaller plots of individuals living in trailers.

Consistent with the Luckett et al. (2015) methodology, the diet recall food items were listed, and then more processed foods were excluded, including items like alcohol, caffeine, salt, and food from restaurants (which were nominal). The rationale for this step is that these foods contribute little nutritional value to the individual's dietary intake. After this step, 160 individual items were included via the diet recall portion of the interviews. Food items in this subcomponent were weighted according to the amount consumed. When all three sections were compiled (PRA session, garden maps, and diet recalls), the final matrix from all three portions included 242 unique food items. Nutrition composition values came from ESHA Research Food Processor database (*Food Processor Nutrition Analysis Software*, 2022). Wherever possible, United States Department of Agriculture (USDA) National Nutrition Database for Standard Reference Legacy (SR Legacy) or Food and Nutrient Database for Dietary Studies (FNDDS) were used from within the ESHA database. Where plant composition data was not available, the United Nations International Network of Food Data Systems (INFOODS) was referenced, as well as Toensmeier et al.'s "Perennial Vegetables: A Neglected Resource of

Biodiversity, Carbon Sequestration, and Nutrition" (Toensmeier et al., 2020). The composition matrix included 34 nutrient values (*Table 1*), prioritizing macro and micronutrients of interest, and also those for which sufficient data was available. This table has been transposed for readability, but in the matrix created each plant or food entry was an individual row, and the columns included one for relative weighting (votes received in the PRA session, relative abundance in the garden, or amount consumed in the diet) and then subsequently the 34 nutrients. If a specific micronutrient was unavailable for a given plant entry, a zero was entered into that cell, essentially meaning that it would add no value to resulting dendrogram or the overall NFD score. Nutrient values were standardized by first dividing each value by RDA for an adult man, and then standardizing by creating a Z-score, reflecting how many standard deviations each % RDA value is above or below the mean.

The second step involved converting this nutrient matrix into a food-food distance matrix. In this new matrix, each row and column represent one of the plant species, and each cell represents the distance between one given species and another. This is calculated as Euclidean distance and is outlined in Luckett et al.'s methodology. The third step involved a cluster analysis of the distance matrix to group foods by nutrient similarities, and distances between and within clusters of foods. Group average method or unweighted pair group method was used. The final step was to calculate the distances of the horizontal lines, or branches, of the dendrogram. The potential NFD is calculated by summing the branch lengths of all the 242 plants within the full matrix (*Fig 1, Fig 2*). Each individual NFD is then calculated. The NFD score calculation is as follows: (individual household NFD)/(total potential NFD)x100 (Luckett et al., 2015). All scores were calculated using the FDiversity software (Casanoves et al., 2011).

Estimates and supplemental R script was also used (Colwell, 2013; Villéger et al., 2016).Home garden NFD scores were calculated. Individual NFD scores were calculated for the PRA activities, as for the individual diet recalls.

2.5 HEI Score

For the second portion of the individual interviews, participants responded to an in-person 24-hour diet recall with the trained interviewer from Cultivate Abundance. The decision to conduct a 24-recall, as opposed to a Food Frequency Questionnaire, was at the guidance of Cultivate Abundance facilitators. This recall method allowed for the interview to require a shorter amount of time and for the session to be more informal and relational.

The interviewers used hand measurements such as a fist or thumb as a reference to estimate portion sizes. If the participant referenced a home-cooked meal, they were asked to describe how the full dish was made. All diet recalls were entered into the ESHA Food Processor Database. Whenever possible, USDA SR Legacy or USDA FNDDS data was used. ESHA Food Processor reports were produced for the complete 24 recall, with 64 individual nutrients reported. ESHA MyPlate reports were also produced for each interviewee.

Individual Healthy eating Index (HEI) scores were used following the USDA's Center for Nutrition Policy and Promotion HEI-2015 components and scoring standards. The HEI score is comprised of thirteen individual sub-scores, nine of which are adequacy scores and four of which are moderation scores (*Table 2*) (Kennedy et al., 1995; Krebs-Smith et al., 2018; USDA Center for Nutrition Policy and Promotion, n.d.). The HEI score is out of 100 possible points.

2.6 Statistical Analysis

Data exploration began with descriptive statistics around key areas of interest, including the HEI scores, caloric intake, and NFD scores. HEI scores from the 58 interviews were normally distributed, so parametric analysis was used. Levene's Test was used to verify the assumption of equal variance. Chi-square goodness-of-fit was used to determine if foraging was a random behavior or not, and then chi-square for independence and logistic regressions were used to evaluate relationships between categorical variables, specifically language and housing, language and gardening, and language and foraging.

Two-way analysis of variance was used to evaluate the relationship between independent categorical variables with three or more categories, such as housing and language, and dependent continuous variables such as HEI score and NFD scores. A one-way analysis of variance was used similarly, but for categorical independent variables with two categories, as was the case with having a garden or not or participating in foraging or not. A three-way analysis of variance was then used to test a more complex model of looking at the effect of language, housing condition, and foraging on HEI scores. Where appropriate a post-hoc comparison using Tukey's HSD was also used.

Finally, both correlation and regression analyses were used to evaluate the relationship between continuous independent and dependent variables, specifically the relationship between garden NFD scores and diet scores, including HEI scores, sub-components of HEI scores, and diet NFD scores.

3. RESULTS

The average age of interview participant was 51 (± 15.25) and the median age was 52. The amount of time interview participants had lived in the United States ranged from 0.75 years to 65 years, the average was 17.89 (± 13.02), and the median was 14.5. Of the 58 women interviewed, 39 had a garden of some sort, whether it be plants in small containers or one individual who had a fruit orchard. Twenty-one individuals had participated in foraging within the last month. The average caloric intake 1,448 kcal (± 697.08) with a median 1,309 kcal, the average water intake was 1.3 liters (± 0.6) with a median of 1.2 liters, and the average sodium intake was 2,474 mg (± 2071) with a median of 1,987 mg. HEI scores ranged from 34.92 to 87.53. The average HEI score was 61.72 (± 12.27) and the median was 62.68, as compared to the US population average of 58 (USDA Center for Nutrition Policy and Promotion, n.d.) (*Table 3*).

3.1 Participatory Ranking Activities

NFD scores for individual ranking activities were calculated both for the full group (*Table 4*), and according to the separate language groups (*Table 5*). The plants listed as those difficult to access had the highest NFD score of 31.3, just above the 30.1 NFD score of plants individuals were able to access from the Misión Peniel food pantry. The lowest overall NFD score was from the ranking activity that listed plants that were foraged, which had an NFD score of 17.4.

The plant lists created from PRA activities were used to consider and compare key micronutrients they provide (*Fig 3*). The plants listed by participants as those most commonly gardened, foraged, and exchanged provided the highest levels of Vitamin-A-RAE, respectively. All provided between 180-200% of the daily recommended intake. These plant lists also provided higher levels of calcium, between 40-60% of the RDA recommended intake, in comparison to the plants accessed through the pantry and the store, which provided between 20-40%. Plants accessed through gardening and exchange provided relatively higher levels of Vitamin K, about 60% of the FDA recommended daily intake.

NFD scores were also assigned for the plants listed in the separate language groups (*Table 5*). In terms of where participants accessed plants, the Haitian Kreyòl speakers reported their highest NFD list as plants that were sourced by purchase at a store (19.77) and next those accessed through a pantry (17.89). The Spanish speakers had the highest NFD scores from plants they accessed through the pantry (20.28) and then those that they accessed by purchase at a store (19.42). The NFD scores of plants accessed for Spanish-speaking participants both through gardens and exchange were higher than the Haitian Kreyòl-speaking participants (19.61 versus 4.50, and then 17.73 versus 0.95, respectively). The Haitian Kreyòl speakers who participated in the PRA listed no foraged plants.

A one-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of language on average nutrient functional diversity scores. As outlined within the HEI section below, language may be understood as a proxy for the ways that culture shapes food patterns, preferences, and diet practices. There was a significant difference in overall effect of mean NFD scores for the two language groups ($F(2, 15) = 3.62$, $p = 0.05$). The Spanish-speaking group had a higher average functional diversity score and had far less variability (*Table 6*).

3.2 Language, Housing, Foraging, and Gardening Practices

A Chi Square for independence test was used to explore the relationship between language and foraging patterns (*Table 7*). Foraging was most common within the Haitian Kreyól language group, where 54.20% reported foraging, as compared to 27.8% of Spanish speakers and 37.9% of Spanish + Indigenous speakers. The chi-square test for independence indicated no significant association between language and foraging, X^2 (2, 58) = 4.612, p = 0.10. To build on this analysis, a direct logistic regression was performed to assess the impact of a housing and language on the likelihood that participants practiced foraging. The full model with the two predictors of language and housing was not statistically significant.

A Chi Square for independence test was used to explore the relationship between language and gardening (*Fig 4*, *Table 8*). Gardening was most common within the Spanish speakers, where 100% of participants gardened. In comparison, 93.8% of Spanish + Indigenous speakers gardened and 25% of the Haitian Kreyól speakers gardened. The chi-square test for independence indicated significant association between language and foraging, X^2 (2, 58) = 33.315, p = 0.00.

A Chi Square for independence test was then used to explore the relationship between language and housing condition (*Fig 5*, *Table 9*). Some housing data is missing as it was not reported during the beginning of data collection. Haitian Kreyòl speakers were the most likely to live in a rented room (81.8%). Both Spanish speakers and Spanish + Indigenous were the most likely to live in a house, at 62.5% and 50.5%, respectively. They were also more likely to live in a trailer, at 37.5% and 43.8%, respectively. The chi-square test for independence indicated significant association between language and housing, X^2 (4, 43) = 28.932, p = 0.00.

3.3 HEI Trends

HEI scores from the 58 interviews were normally distributed (*Fig 6*), so parametric analysis was used. Levene's Test was used to verify the assumption of equal variance. Average participant subscores were notably high for total vegetables consumption, total protein, refined grains. The mean score for vegetable intake was 3.93 (±1.56) out of 5.00 and the median was 5.00. Mean participant subscores for total protein consumption was 4.26 (±1.51) out of 5.00 and the median was 5.00. Mean participant subscores for refined grain consumption, a moderation subscore, was 8.66 (±2.63) out of 10.00 and the median was 10.00. In comparison, scores were lower for dairy, sodium, and whole fruit subscores were notably low. Mean participant subscores for total dairy consumption was 2.56 (±3.48) out of 5.00 and the median was 0.48. Mean participant subscores for total sodium consumption was 3.06 (±4.46) out of 10.00 and the median was 0.00. Lastly, mean participant subscores for whole fruit consumption was 1.60 (±2.33) out of 5.00 and the median was 0.00 (*Table 10*, *Fig 7*).

A T-test was conducted to explore the impact of having a garden on HEI scores, and there was not a statistically significant effect of having a garden ($F(1, 56) = 1.93$, $p = 0.17$). A two-way between-groups ANOVA was conducted to explore the impact of housing conditions on HEI scores. Participant housing conditions were divided into three groups: those that lived in a house, trailer, or a rented room. The was not a statistically significant effect of housing condition ($F(2, 40) = 1.41$, $p = 0.26$). There was not enough statistical power to explore the effect of renting versus owning on HEI scores, as so few participants were homeowners.

A two-way ANOVA between-groups was conducted to explore the impact of language on HEI scores (*Table 11*). Language was used here as a proxy to understand the ways that culture shapes food patterns and diet practices. Participants were categorized by three language groups, those that spoke Haitian Kreyòl, those that spoke Spanish exclusively, and those that spoke multiple languages, specifically Spanish + Indigenous language. Within the third language group, eight different indigenous languages were spoken. There was a significant difference in overall effect of mean HEI scores for the three language groups (F (2, 55) = 3.86, p = 0.03). Post-hoc comparisons using the Tukey HSD indicated that the mean HEI score for the Kreyòl speaking group (M = 56.59, SD = 10.32) differed significantly from the Spanish speaking group (M = 65.99, SD = 10.80). The Spanish + Indigenous language group (M = 64.06, SD = 14.16) did not differ significantly from either of these other groups (*Table 12*). This higher HEI score within the Spanish speaking group means that, on average, the Spanish speaking participants had a significantly higher diet quality than participants that spoke Haitian Kreyòl, as measured by the thirteen subscores outlined above in the methodology section.

A three-way between-groups ANOVA was used to evaluate the interaction between language groups, foraging behavior, and housing conditions (HEI = Forage * Housing * Language) (*Fig 8*, *Table 13*). The interaction effect between language, foraging, and housing was not statistically significant (F (1, 30) = 0.06, p = 0.82). There was statistically significant main effect for language (F (2, 30) = 4.48, p = 0.02) and for housing (F (2, 30) = 3.56, p = 0.04). There was a borderline significant effect of language and foraging (F (1, 30) = 3.77, p = 0.06). There was also a marginal, but not significant effect of foraging and housing condition on HEI (F (1, 30) = 3.49, p = 0.07). The main effect for foraging did not reach statistical significance (F (1, 30) = 0.03, p = 0.87).

A two-way between-groups ANOVA was used to evaluate the interaction between language and foraging behavior (HEI = Language * Forage) (*Fig 9*, *Table 14*). The interaction effect between language and foraging was not statistically significant (F (2, 52) = 2.56, p = 0.09). There was statistically significant main effect for language (F (2, 52) = 3.4, p = 0.04).

Finally, a two-way between groups ANOVA was conducted to explore the impact of language and housing condition on HEI (HEI = Language * Housing) (*Table 15*). In this test housing was a fixed factor and language was a random factor. This is due to the issue of access and economics. There was no significant difference in overall effect of mean HEI scores (F (3, 35) = 0.65, p = 0.59). There was a significant main effect of housing condition (F (2, 35) = 3.9, p = 0.05).

3.4 Nutrition Functional Diversity

Scatterplots were created to evaluate the relationships and trends around diet and NFD scores. All scores were created following Luckett et al.'s methodology, outlined above. Diet NFD scores were those that measured the NFD of the diet recalls, specifically, or what individuals consumed. Garden NFD scores were the NFD scores created using the same methodology, but reflecting the garden plots, or what plants were grown (and therefore *available* to) by participants.

The relationship between NFD measures and HEI total and subscores were explored with correlation analysis. The was no correlation between dietary NFD (independent variable) and total HEI score (dependent variable, r=-0.047, p=0.724, N=58. The vegetable HEI subscore exhibited truncated distribution with a bias toward the maximum score of 5. The relationship between the vegetable HEI subscore and dietary NFD was explored with both correlation (nonsignificant positive relationship; r=0.037, p=0.789, N=58) and logistic regression. For the logistic regression analysis, the HEI vegetable subscores were recoded dichotomously (scores

<2.5 = 0; scores higher than 2.5=1). NFD scores (diet and garden) as predictors did not improve the goodness of fit for the statical model of Vegetable HEI subscore = NFD (NFD diet X^2=0.204, df=1, p=0.652; NFD garden X^2=0.205, df=1, p=0.651). The correlation between garden NFD (independent variable) and total HEI score was also nonsignificant (r=-0.047, p=0.727, N=58). The relationship between both age and years lived in the US and garden NFD was very slightly negative. A regression analysis was performed to assess the impact of age and years in the US on garden NFD. The full model with two predictors of age and years in the US was not statistically significant.

A two-way between-groups ANOVA was conducted to explore the impact of housing on the raw dietary NFD scores (*Fig 10*, *Table 16*). Housing conditions were again divided into three groups (house, trailer, room). There was a significant difference in overall effect of mean diet NFD scores for the three housing groups (F (2, 40) = 4.28, p = 0.02). Post-hoc comparisons using the Tukey HSD indicated that the mean raw diet NFD score for those living in a house (M = 115.27, SD = 72.92) differed significantly from those that lived in a rented room (M = 189.98, SD = 63.63). Those that lived in a trailer (M = 125.89, SD = 61.42) did not differ significantly from either of these other groups (*Table 17*). A two-way between-groups ANOVA was also conduced to explore the impact of housing on raw garden NFD scores (*Fig 10*, *Table 18*). There was a significant difference in overall effect of mean garden NFD scores for the three housing groups (F (3, 39) = 9.29, p = 0.00). To build on this analysis, three separate two-way between-groups ANOVA were conducted to explore the impact of housing on species richness, Shannon Weaver, and species evenness measurements. There was no significant effect of species richness or Shannon Weaver between the three housing groups, but there was a significant effect on species evenness (F (2, 40) = 4.13), p = 0.02; *Table 19*). T tests were also conducted to explore the impact of renting versus owning a home on both diet and garden NFD scores (*Fig 11*). Mean garden NFD scores were higher for homeowners (M = 2.19, SD = 3.16) versus those who rented (M = 1.37, SD = 1.41), though these scores varied widely. The mean diet NFD scores were slightly higher for renters (M = 3.54, SD = 0.72) than homeowners (M = 3.23, SD = 0.57). Neither of these differences were statistically significant.

Following a similar pattern, two-way between-groups ANOVA tests were conducted to explore the impact of language on diet NFD and garden NFD scores (*Fig 12*). Neither of these relationships were significant. To build on this analysis, three separate two-way between-groups ANOVA were conducted to explore the impact of language on species richness, Shannon Weaver, and species evenness measurements. There was no significant effect of species evenness between the three language groups, but there was a significant effect on both species richness (F (3, 58) = 5.92, p = 0.00; *Table 20*) and the Shannon Weaver Index (F (3, 58) = 5.67, p = 0.00; *Table 21*).

Finally, T tests were also conducted to explore the impact of foraging on both diet NFD and HEI scores (*Fig 13, Fig 14*). The diet NFD and HEI scores were slightly higher for those who did not forage, as opposed to those who did, but these differences were not statistically significant.

4. DISCUSSION

This research project explored the relationship between agrobiodiversity and diet patterns. It specifically tested the hypothesis that increased biodiversity, reflected in the garden NFD scores, would impact dietary diversity, reflected both in HEI scores and diet NFD scores. The findings indicate no significant relationship between agrobiodiversity and diet. However, important themes emerge from the data to illuminate some of the nuanced context, providing direction for further work.

While not a primary purpose of this research project, it is possible that overall caloric intake and water intake of participants were low, as estimated by the 24-hour recall data. Salt intake was somewhat high. In reviewing the literature and in conversation with research partners, it is evident that the concept of nutrition resiliency extends beyond food justice and food access and into metabolism and healthcare as well. The physiological needs of farmworkers, due to a myriad of factors that would include labor conditions, differ from the broader population. It is also true that access to water in Immokalee is complicated, in part because of unfair housing practices (L. Vazquez-Reyes, personal communication, May 13, 2022). Questions around these specific topics were not included in this research methodology. These patterns may reflect issues of access. In the context of inaccess, low caloric intake could specifically reflect decisions that participants (women) made to prioritize nutritional needs of the broader household, including children. Further, they may also reflect strategies that participants use to best navigate their environment, consistent with the observation that Holmes makes in his book, that farmworkers did not eat or drink before work so as to avoid breaks (Holmes, 2013a). Similarly, the high salt intake could reflect dietary preferences for taste, but when considering the ways that nutrition resiliency extends to metabolism, higher salt intake would also promote fluid retention, which would be helpful in the hot Florida climate and in the fields as people work, particularly if they are also needing to avoid consuming water. While the specific methodology used from this project cannot elucidate these connections, conversations with research partners provided necessary insight into these dynamics. Considerations for nutrition resiliency even in the context of metabolic implications may help a dietitian or healthcare provider better understand the unique needs and strategies employed by the individuals for whom they are entrusted to care.

4.1 Social Determinants of Health

Language emerged as a main effect for HEI scores. While there was no significant difference in the effect of language on garden NFD scores or diet NFD scores, there was a significant impact on HEI scores. Language correlated with gardening patterns and housing status.

Different language communities in Immokalee have unequal access to land. Individuals who spoke Spanish were far more likely to garden; 100% of the Spanish-speaking interviewees participated in gardening, and 93.9% of the Spanish + Indigenous speakers gardened. For the Haitian Kreyòl speakers, only 25% of individuals gardened. The Haitian Kreyòl speakers were also far more likely to live in a rented room (81.8% of the Haitian Kreyòl speakers lived in a rented room, and 90% of those living in rented rooms were Haitian Kreyòl speakers). Spanish speakers were more likely to live in a house (62.% lived in houses, and of those living in houses, 52.6% were Spanish speakers). The Spanish + Indigenous speakers were most likely to live in a house and were also the most represented within the population living in trailers (50% of those living in trailers were from this language group).

Based on the presented results, it appears that gardening as a practice is more available to individuals with access to land, which is a privilege unequally distributed amongst the Immokalee community members utilizing the Misiòn Peniel food pantry. Where cultural foodways inform food preferences and patterns, social determinants of health (SDOH) shape the context in which those foodways are embodied and performed. Though allostatic load was referenced in the literature review, SDOH were not. Simply put, SDOH might also be understood as a gradient, where social position predicts better health outcomes (Marmot & Wilkinson, 2015; Peretz et al., 2020). While health behavior is a commonly understood factor influencing health outcomes, SDOH consider the causes that may influence environmental conditions that then, in turn, contribute to biological markers. When understood alongside allostatic load, SDOH link health policy to issues of labor, housing, food environment, transportation, access to healthcare, discrimination, and so forth. For individuals with more safe and secure housing, gardening was a more accessible practice, providing not just food but also exercise and potentially therapeutic outlets as well.

4.2 The Role of Foraging and Gaps in Data

In the participatory ranking activities, a group activity where community members collaborated to develop lists together, the Haitian Kreyòl-speaking participants did not list any plants they access through foraging. The Spanish-speaking participants listed a group of plants that represented 18% of the potential full NFD score from the PRA session. In contrast, during the interviews, the Haitian Kreyòl speakers were more likely to forage, with just over half (54.2%) having participated in foraging within the month prior to the interviews. In comparison, 27.8% of the Spanish speakers and 37.9% of the Spanish + Indigenous speakers reported foraging within the last month. This higher prevalence of foraging within the Haitian Kreyòl-speaking community was not statistically significant. For both Haitian Kreyòl speakers and Spanish + Indigenous speakers, those who foraged reported a slightly higher HEI score (*Fig 8*), and while the overall combined effect of the impact of foraging and language on HEI scores was not significant, language acted as a main effect in this model. While some of the larger patterns around foraging amongst Immokalee community members remain unclear, it is interesting to note the ways in which foraging can provide key micronutrients to the diet, specifically Vitamin A, Vitamin K, and Calcium (*Fig 3*). Foraging exemplified strategies for nutrition resiliency. Whether as a function of preference or culture, or as a strategy to navigate lack of access to land or food, participating in foraging increases micronutrients, including antioxidants and key minerals of concern.

The inconsistency in reporting foraging between the PRA activities and the interviews might be because foraging could carry a stigma that we had not anticipated or understood. When conducting interviews, Helen shared that a direct translation of "foraging" into Spanish did not make sense and could allude to the idea that the individual foraging was trespassing or stealing plants from someone else. To clarify the intention behind the interview question, Helen decided to share stories from her childhood of foraging as an example and ask if the participant had done anything similar (H. Midney, personal communication, July 13, 2022). While many of the participants that spoke Spanish (of both sub-groups) affirmed that they had foraged, it was still more likely that they had *not* foraged within the past month, in comparison to those who spoke Haitian Kreyòl.

When evaluating the foraged plants that participants shared during interviews, some of the issues around "Neglected and Underutilized Species," as discussed previously in the literature review, were relevant. Composition data for several plants and food items were unavailable through ESHA Food Processor. After researching available databases and manuscripts, several underutilized species were added to the analysis. The data available for these species, such as malanga root and leaves (*Xanthosoma sagittifolium*), was less complete than the plants that had USDA FNDDS or USDA SR Legacy composition data and only included five of the 34 nutrient values that were available in the USDA plant data. While still included, this meant that several micronutrient values could not be added to the overall NFD matrices and therefore not tabulated in the NFD scores. It was also necessary to use substitutions. For example, only the nutrient composition for dried products could be used for yierba santa (*Piper auritum*), marjoram (*Origanum majorana*), and tree chili (*Capsicum anuum "de Arbol"*). Lack of composition data also meant some plants were substituted with closely related species, such as Okinawa spinach (*Gynura* bicolor) instead of longevity spinach (*Gynura procumbens*), or Licuri (*Syagrus coronate*) instead of Queen palm (*Syagrus romanzoffiana*). Chilis were a food of importance, particularly for Spanish-speaking participants, but due to the lack of available composition data for subspecies, *Capsicum annuum* was often used to encompass the wide list of specific types. In the end, five plants could not be included in the matrix. Four of these plants were foraged and were often the leaves of plants commonly known: orange leaves (*Citrus x sinensis*), catnip leaves (*Nepeta cataria*), pigeon pea leaves (*Cajanus cajan*), and jatropha seeds (*Jatropha curcas*).

A plant that had to be excluded and that was both gardened and foraged was Haitian basket vine, or hoopvine (*Trichostigma octandrum*). As a perennial vegetable listed several times during the community PRA session, the absence of Haitian basket vine illustrates Beltrame et al.'s (2019) points well. Where composition data is missing, a plant is then unreported. One begins to see the downstream reality, where policy and markets are more likely to promote uniformity in regional food systems and in turn, increase vulnerability. Relying on generic composition data does not adequately reflect the reality of global foodways. As Burlingame et al. (2009) argue, composition data for species level and below is needed in order to make links between agroecology and nutrition, and to promote biodiversity. Within dietetics, the cost is overlooking a valuable source of nourishment, and an unfulfilled opportunity to build cultural humility and understand nutrition resiliency.

4.3 Differences Between NFD and HEI Scores

A primary objective of this study was to evaluate the potential application of an NFD score. Much of the literature where NFD scores has been used, to this point, does so in the context of smallholder agriculture. That is, participants who cultivate plants or care for livestock on landholdings of five acres are less. Smallholder farmers likely have some interaction with a market, but are also more likely to rely on their land for food (Sibhatu et al., 2015). It is important to note that exploring the application of an NFD score in a community such as Immokalee, Florida, is novel. Community members in Immokalee have access to food markets, and limited access to land. Both land and food access in Immokalee is significantly shaped by food apartheid, the term used by scholars and activists to describe the structural underpinnings of food inequity, including racialized inequalities (Joyner et al., 2022). What's more, individuals interviewed for this research project were likely to also utilize local food pantries. The Misiòn Peniel food pantry, like many food pantries in the United States, is supplied through food banking networks. Food that is channeled through pantries tends to reflect commodities distributed through The Emergency Food Assistance Program (TEFAP) and other donated goods, often with an emphasis on shelf stable options. One aspect that distinguishes Misiòn Peniel is its sourcing of fresh fruits and vegetables through Cultivate Abundance's work, food items that are also often familiar to home settings of pantry goers.

Both the overall diet NFD scores and the garden NFD scores of participants did not correlate with total HEI scores. In part, the lack of relationship between these variables may highlight the differences between these scores and what they intend to measure. The HEI score is made up of thirteen sub-scores. Only 20% of the total score was directly impacted by consumption of produce. Specifically, total vegetables (five points), greens and beans (five points), total fruit (five points), and whole fruit (five points); twenty points out of the complete score of one hundred (*Table 2*). Other components of the HEI score include subscores such as dairy, whole grains, saturated fats, and sodium. These components of the HEI score would be strongly impacted by other types of food, food they are accessing either through the pantry, the store, or exchange. In comparison, the NFD scores are measured by thirty-four nutrients, including, calories, some macronutrients, and several micronutrients. It appears that overall, HEI scores of participants were shaped by other factors aside from the plants they consume. In fact, HEI scores may capture some realities of food apartheid and SDOH, including the day-to-day life of a food insecure individual sourcing food.

The garden NFD scores best reflect what micronutrients were made *available* to the individuals that used them. The housing condition of individuals significantly impacted these garden NFD scores. Individuals with space had gardens available to them, with increased access to sources of these micronutrients. Unpacking the relationship between garden NFD and other variables is less clear, perhaps in part that garden NFD scores varied widely in all categories, which can be noted on the bar graphs that show garden NFD scores by housing, home ownership status, and language (*Fig 10, 11, and 12*). It is interesting to note that vegetable HEI scores had a slight negative relationship with garden NFD scores, indicating that produce from other sources than the garden may be influencing the vegetable consumption patterns of participants.

The analysis for housing conditions and both diet and garden NFD was done with the raw functional diversity scores. When these analyses were done as a ratio of complete scores, the differences were not significant. Additional work needs to be done to evaluate the use and application of the NFD scores in this project. An NFD score is unique in the ways that it can evaluate biodiversity as it relates to the functional traits within a population, in this case, the nutrient values of plants. While the differences in NFD scores by language were not significant, there was a significant difference with other biodiversity measures, specifically species richness and the Shannon Weaver Index. Perhaps species count, particularly in the context of small home garden spaces such as those in Immokalee, is more appropriate and sufficient to indicate nutrient availability.

Taken together, it appears that all participants had access to diverse and consistent source of plant nutrients from other means than just gardens. In fact, the individuals that rented rooms who therefore had limited access to land, still reported the highest diet NFD scores. This may, in part, reflect the produce that is made available to them through Cultivate Abundance's programs, along with other sources. While gardening was more common amongst those who had more space, and this resulted in higher garden NFD scores, that garden NFD score did not necessarily translate into dietary practices.

4.4 Strengths and Weaknesses

Strengths of this study include the application of an NFD score both within the US and in the specific context of Immokalee, Florida, where immigrant farmworker community members carry both agricultural and food knowledge from their pre-migration settings as they navigate a new food environment and access emergency food resources. In doing so, this study has helped clarify some of the differences and applications of HEI scores versus NFD scores, including strengths and limitations of each. It considers ways that SDOH, specifically access to housing, may shape either or both of those scores. This study also models potential application of PRA approaches in dietetics and food pantry projects and provides considerations for the ways that a framework for nutrition resiliency is both trauma informed and can promote dignity.

As an initial study, the methodology was limited by several factors. A diet recall method was chosen in collaboration with research partners but limited some of the generalizability and strength of these findings. Initially, the project intended to use a food frequency questionnaire validated for Hispanic populations. Cultivate Abundance decided to use a 24-hour recall method because it took less time to collect and therefore posed less of a burden on research participants. The downside to this method was that it can only provide insight into the dietary intake of one day, which may or may not be representative of a participant's diet, more broadly. The recall method also requires accurate recollection and representation from participants, and naturally includes some error in how food is reported. A longitudinal study over the course of one year, by collecting more than one 24-hour recall over a period of time, would provide stronger insight. As Ip et al. (2015) point out, the value of collecting data at multiple points in one year might be especially true for farmworkers, where food insecurity is strongly impacted by work status and seasonality. This was a cross sectional study of participants who already participate in the Misiòn Peniel food pantry, and therefore had weekly access to fresh, local, and culturally appropriate food plants. Similar studies that evaluated gardens in an international context did so in a smallholder agriculture setting and used an experimental design with a garden intervention. Participants in this study had access to stores and food pantries with limited access to land, and findings indicated they were accessing plants and micronutrients through other sources outside of the garden. To clarify some of the relationships between biodiversity and diet in this context, a quasi-experimental or longitudinal design would have been incredibly valuable. Other factors that limited this study were resource constraints. Due to time and capacity, the interviews were conducted in a way to reduce the burden of time on both the research partner and the participants. Methodology included a mapping activity rather than a garden walk, which may have impacted some of the ways that garden NFD scores were measured. The researchers also decidedly did not include a food insecurity measure, which may have provided additional insight.

4.5 Next Steps

Time constraints limited the ability for this research project to explore additional metrics that may provide valuable insight into the relationship between garden agrobiodiversity and diet diversity. Next steps for this data set include the following (1) using a simple diet diversity metric such as the minimum diet diversity score for women (MDD-W) to evaluate diet recall information. This metric includes ten subscores, five of which may be directly impacted by garden diversity (grains, roots and tubers, dark leafy greens and vegetables, other vitamin A-rich fruits and vegetables, other vegetables, and other fruits). (2) Looking at the presence of the "culturally preferred vegetables" listed within the PRA session and determine relationship to both eating scores, age of the participant, and presence of a garden, consistent with Gichunge et al.'s (2016) methodology looking at the impact of 26 traditional vegetables on the diets of African refugees in Australia (3) Explore more work with diversity metrics, particularly within garden and foraging practices. (4) Evaluate saturation points as it relates to species richness and garden NFD scores. (5) Pursue opportunities and funding to conduct composition analysis for key plants of interest like hoopvine (*Trichostigma octandrum*).

At a local level there will be opportunities to foster continued conversation as to applications for this work. Uneven access to land and growing spaces is an issue of concern for Immokalee residents (L. Vazquez Reyes, personal communication, May 13, 2022) that can be underscored and supported with this work. Considering ways that access to preferred food items can be supported and increased, particularly those that are listed as difficult to access, is another key action point. Highlighting plants of interest and considering community cooking events is an additional opportunity that may be of interest. These action points will be shaped by research partners in collaboration with their community and are yet to be determined.

At a policy level, opportunities to connect this research include active participation in the Academy of Nutrition and Dietetics Farm Bill Task Force. The task force is meeting this fall to prepare a draft statement for submission. This research and accompanying literature review will be used for advocacy for language around SDOH to be included within that report, advocacy for the wellbeing and livelihoods of works across the supply chain (specifically farmworkers), funding for specialty crops, particularly within the TEFAP program, and funding for small scale agricultural projects within marginalized communities to build and retain capital in the local economy.

5. CONCLUSION

This study sought to clarify the relationship between biodiversity of garden spaces, access to culturally preferred food plants, and the diet of those who utilize emergency food pantries in Immokalee, Florida. Some patterns emerged around uneven access to housing and gardening in Immokalee. In the context of food apartheid, issues of labor and citizenship, and other social determinants of health, community members in Immokalee, Florida may make choices around food procurement and consumption for a myriad of reasons. With an average HEI score slightly higher than the national average, participants in this study evidently carry strategies for nutrition resiliency. Individuals living in rented rooms had the highest diet NFD scores. Foraging added key micronutrients to diet. Several food items consumed by participants were not included in the USDA composition database.

The research question that shaped this project was brought to Immokalee from an outsider perspective on several levels, including geographically, culturally, and linguistically. The question was specifically and narrowly applied, and the lack of correlation between agrobiodiversity and diet warrants further reflection. What people desire to eat effects what is grown, and what is grown shapes what people eat, but perhaps these links are not clear, and maybe the motivations behind food culture and garden spaces are not meant to be linear. In "*Not yet at the table: The absence of food culture and tradition in agroecology literature*," the authors argue that academic work around agroecology typically mentions cultural dynamics in passing, and with the assumption that the promotion of agroecology will naturally result in unspecified healthy, diversified, and community-driven food choices, but little critical work has been done to explore these connections (Morgan & Trubek, 2020). Perhaps understanding the links between gardens and diet require a deeper knowledge and conversations around foodways that are embodied in kitchen spaces, including the structural dynamics that surround those places. Food culture will always be complex, forever changing, and shaped by a myriad of factors. Decisions made around food may also be rooted in relationships, social capital, dignity, preference, therapeutic elements, harm reduction, identity, and so on. This research reflects only a small part of those complexities, informs additional questions, and illuminates the need for cultural humility in seeking further answers. There are opportunities at hand to learn from the culture and strategies for nutrition resiliency that farmworkers carry with them. In doing so, dietitians and healthcare professionals may improve care, and be better equipped to improve upstream issues that shape health outcomes within the communities they work.

TABLES

Table 1: Composition Matrix Example

Nutrient	Cassava (*Manihot esculenta)* Leaves	Recommended Dietary Allowances
Cals (kcal)	93.00	2200.00
Prot (g)	7.60	110.00
Carb (g)	17.00	275.00
TotFib (g)	7.90	30.8
Fat (g)	1.10	75.00
Chol (mg)	0.00	300.00
Water (g)	72.10	3700.00
Vit A-RAE (mcg)	287.00	900.00
BetaCaro (mcg)	3440.00	6000.00
Vit B1 (mg)	0.25	1.20
Vit B2 (mg)	0.46	1.30
Vit B3 (mg)	2.40	16.00
Vit B6 (mg)	0.48	1.30
Vit C (mg)	33.00	90.00
Vit E-a-Toco (mg)	0.42	15.00
Folate (mcg)	120.00	400.00
Vit K (mcg)	0.00	120.00
Panto (mg)	0.00	5.00
Calc (mg)	0.00	1000.00
Chrom (mcg)	0.00	35.00
Copp (mg)	0.16	0.90
Iodine (mcg)	0.00	150.00
Iron (mg)	0.00	8.00
Magn (mg)	73.00	420.00
Mang (mg)	0.00	2.30
Moly (mcg)	0.00	45.00
Phos (mg)	145.00	700.00
Pot (mg)	711.00	3400.00
Sel (mcg)	0.00	55.00
Sod (mg)	6.00	1500.00
Zinc (mg)	1.29	11.00
Omega3 (g)	0.35	1.60
Omega6 (g)	0.17	17.00
Chln (mg)	0.00	550.00

Table 2: HEI-2015[1] Components and Scoring Standards

(USDA Center for Nutrition Policy and Promotion, n.d.)

Component	Max Points	Standard for Max Score	Standard for Min Score of Zero
Adequacy			
Total Fruits[2]	5	≥0.8 cup equivalent per 1,000 kcal	No Fruit
Whole Fruits[3]	5	≥0.4 cup equivalent per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equivalent per 1,000 kcal	No Vegetables
Greens and Beans[4]	5	≥0.2 cup equivalent per 1,000 kcal	No Dark-Green Vegetables or Legumes
Whole Grains	10	≥1.5 cup equivalent per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equivalent per 1,000 kcal	No Dairy
Total Protein Foods[4]	5	≥2.5 cup equivalent per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[4,6]	5	≥0.8 cup equivalent per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acid[7]	10	(PUFAs + MUFAs)/SFAs ≥ 2.5	(PUFAs + MUFAs)/SFAs ≤ 1.2
Moderation			
Refined Grains	10	≤1.8 ounce equivalent per 1,000 kcal	≥4.3 ounce equivalent per 1,000 kcal
Sodium	10	≤1.1 grams per 1,000 kcal	≥2.0 grams per 1,000 kcal
Added Sugars	10	≤6.5% of energy	≥26% of energy
Saturated Fats	10	≤8% of energy	≥16% of energy

[1]*Intake between the minimum and maximum standards are scored proportionately.*
[2]*Includes 100% fruit juice.*
[3]*Includes all forms except juice.*
[4]*Includes legumes (beans and peas).*
[5]*Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.*
[6]*Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).*
[7]*Ratio of poly- and mono-unsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).*

Table 3: Descriptive Statistics

Variable	Observations	Mean	Median	STDV	Min	Max
Age	42	50.88	52.00	15.25	26.00	76.00
Years in the US	42	17.89	14.50	13.02	0.75	65.00
HEI Score	58	61.72	62.68	12.27	34.92	87.53
Caloric Intake (kcal)	58	1447.77	1308.88	697.08	301.84	4121.14
Water (g)	58	1300.00	1199.36	611.92	300.32	3864.03
Sodium (mg)	58	2473.63	1986.63	2070.75	336.09	11549.10
Diet NFD Score	58	8.32%	8.75	4.43	0.32	17.22
Garden NFD Score	58	2.62%	2.76	1.340	0.10	5.42

Table 4: NFD of PRA

	Raw Functional Diversity Score	NFD % All PLA Plants (83)	NFD % Diet Recall Plants (160)	NFD % All Plants in Data Set (241)
All plants from diet recalls (160)	1798.18		100.00	
All PLA Plants (83)	546.18	100.00	30.37	0.27
Culturally Preferred	162.86	29.80	9.06	0.08
Access	171.02	31.30	9.51	0.08
Garden	113.88	20.90	6.33	0.06
Pantry	164.64	30.10	9.16	0.08
Forage	95.19	17.40	5.29	0.05
Store	158.36	29.00	8.81	0.08
Exchange	100.12	18.30	5.57	0.05
All Plants in Dataset (241)	203618.24			100.00

Table 5: NFD of PRA, by Language

Language		Raw Functional Diversity Score	NFD % All Plants used within a Language	NFD % All PLA Plants (83)	NFD % All Diet Recall Plants (160)	NFD % All Plants in dataset (242)
Haitian Kreyòl	All Plants	394.64	100.00	72.25	21.95	0.19
	Culturally Preferred	88.29	22.37	16.17	4.91	4.91
	Access	89.16	22.59	16.32	4.96	4.96
	Garden	24.56	6.22	4.50	1.37	1.37
	Pantry	97.73	24.76	17.89	5.43	5.43
	Store	107.98	27.36	19.77	6.00	6.00
	Exchange	5.20	1.32	0.95	0.29	0.29
Spanish	All Plants	244.72	100.00	44.81	13.61	13.61
	Culturally Preferred	113.67	46.45	20.81	6.32	6.32
	Access	96.89	39.59	17.74	5.39	5.39
	Garden	107.13	43.78	19.61	5.96	5.96
	Pantry	110.74	45.25	20.28	6.16	6.16
	Forage	96.00	39.23	17.58	5.34	5.34
	Store	106.07	43.34	19.42	5.90	5.90
	Exchange	96.85	39.58	17.73	5.39	5.39

Table 6: PRA NFD and Language ANOVA

Language	Mean PRA NFD Score	STDV
Haitian Kreyòl	115.37	129.20
Spanish	121.51	50.24

	Df	Sum of Sq	Mean Sq	F value	Pr(>F)
Language	2	666170.22	333085.11	3.62	*0.05*
Residuals	15	1378408.9	91893.93		

*Table 7: Language * Foraging Chi Square for Independence*

			Forage		Total
			No	Yes	
Language	Haitian Kreyòl	Count	11	13	24
		% within Language	45.8%	54.2%	100.0%
		% within Forage	30.6%	59.1%	41.4%
		% of Total	19.0%	22.4%	41.4%
	Spanish	Count	13	5	18
		% within Language	72.2%	27.8%	100.0%
		% within Forage	36.1%	22.7%	31.0%
		% of Total	22.4%	8.6%	31.0%
	Spanish + Indigenous	Count	12	4	16
		% within Language	75.0%	25.0%	100.0%
		% within Forage	33.3%	18.2%	27.6%
		% of Total	20.7%	6.9%	27.6%
Total		Count	36	22	58
		% within Language	62.1%	37.9%	100.0%
		% within Forage	100.0%	100.0%	100.0%
		% of Total	62.1%	37.9%	100.0%

	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	4.612[a]	2	.10
Likelihood Ratio	4.623	2	.10
Linear-by-Linear Association	3.819	1	.05
N of Valid Cases	58		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.

*Table 8: Language * Garden Chi Square for Independence*

			Garden		Total
			No	Yes	
Language	Haitian Krèyol	Count	18	6	24
		% within Language	75.0%	25.0%	100.0%
		% within Garden	94.7%	15.4%	41.4%
		% of Total	31.0%	10.3%	41.4%
	Spanish	Count	0	18	18
		% within Language	0.0%	100.0%	100.0%
		% within Garden	0.0%	46.2%	31.0%
		% of Total	0.0%	31.0%	31.0%
	Spanish + Indigenous	Count	1	15	16
		% within Language	6.3%	93.8%	100.0%
		% within Garden	5.3%	38.5%	27.6%
		% of Total	1.7%	25.9%	27.6%
Total		Count	19	39	58
		% within Language	32.8%	67.2%	100.0%
		% within Garden	100.0%	100.0%	100.0%
		% of Total	32.8%	67.2%	100.0%

	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	33.315[a]	2	0.00
Likelihood Ratio	38.891	2	0.00
Linear-by-Linear Association	23.716	1	0.00
N of Valid Cases	58		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.24.

*Table 9: Language * Housing Chi Square for Independence*

			Housing			Total
			House	Trailer	Rented Room	
Language	Haitian Kreyòl	Count	1	1	9	11
		% within Language Code	9.1%	9.1%	81.8%	100.0%
		% within Housing Code	5.3%	7.1%	90.0%	25.6%
		% of Total	2.3%	2.3%	20.9%	25.6%
	Spanish	Count	10	6	0	16
		% within Language Code	62.5%	37.5%	0.0%	100.0%
		% within Housing Code	52.6%	42.9%	0.0%	37.2%
		% of Total	23.3%	14.0%	0.0%	37.2%
	Spanish + Indigenous	Count	8	7	1	16
		% within Language Code	50.0%	43.8%	6.3%	100.0%
		% within Housing Code	42.1%	50.0%	10.0%	37.2%
		% of Total	18.6%	16.3%	2.3%	37.2%
Total		Count	19	14	10	43
		% within Language Code	44.2%	32.6%	23.3%	100.0%
		% within Housing Code	100.0%	100.0%	100.0%	100.0%
		% of Total	44.2%	32.6%	23.3%	100.0%

	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	28.932[a]	4	0.00
Likelihood Ratio	29.047	4	0.00
Linear-by-Linear Association	11.415	1	0.00
N of Valid Cases	43		

a. 5 cells (55.6%) have expected count less than 5. The minimum expected count is 2.56.

Table 10: HEI Score Descriptives

	Mean	Standard Error	Median	Mode	STDV	Sample Variance	Kurtosis	Skewness	Sum
Adequacy:									
Total Fruits	2.17	0.30	0.76	0.00	2.30	5.31	-1.87	0.22	125.99
Whole Fruits	1.60	0.31	0.00	0.00	2.33	5.42	-1.41	0.79	93.03
Total Vegetables	3.94	0.20	5.00	5.00	1.56	3.34	-0.05	-1.18	228.648486
Greens and Beans	2.32	0.33	0.00	0.00	2.51	6.29	-2.05	0.14	134.55
Whole Grains	4.13	0.61	0.00	0.00	4.63	21.47	-1.81	0.35	239.30
Dairy	2.56	0.46	0.48	0.00	3.48	12.10	-0.02	1.18	148.42
Total Protein Foods	4.26	0.20	5.00	5.00	1.51	2.29	3.17	-2.08	246.80
Seafood and Plant Proteins	2.18	0.32	0.00	0.00	2.47	6.12	-1.98	0.26	126.67
Fatty Acids	6.69	0.43	7.05	10.00	3.26	10.64	-0.67	-0.63	387.89
Moderation:									
Refined Grains	8.66	0.35	10.00	10.00	2.63	6.94	3.63	-2.11	502.01
Sodium	3.06	0.59	0.00	0.00	4.46	19.87	-1.25	0.84	177.74
Added Sugars	7.84	0.43	10.00	10.00	3.28	10.77	0.40	-1.34	454.94
Saturated Fats	8.05	0.41	10.00	10.00	3.15	9.93	1.34	-1.61	466.91
Total HEI Score:	61.72	1.61	62.68	#N/A	12.27	150.60	-0.32	-0.02	3579.71

Table 11: Language and HEI Scores ANOVA

Language	Mean	N	STDV
Haitian Kreyòl	56.59	24	10.32
Spanish	65.99	18	10.80
Spanish + Indigenous	64.06	16	14.16
Total	61.57	58	12.20

		Sum of Sq	df	Mean Sq	F	Sig.
HEI SCORE * Language	Between Groups	1045.10	2	522.55	3.86	0.03
	Within Groups	7438.60	55	135.25		
	Total	8483.71	57			

Table 12: Language and HEI Post Hoc

			Mean Difference	Standard Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Haitian Kreyòl	Spanish	*-9.40**	3.63	*0.03*	-18.13	-0.66
		Spanish + Indigenous	-7.47	3.75	0.12	-16.51	1.58
	Spanish	Haitian Kreyòl	*9.40**	3.63	*0.03*	0.66	18.13
		Spanish + Indigenous	1.93	4.00	0.88	-7.69	11.56
	Spanish + Indigenous	Haitian Kreyòl	7.47	3.75	0.12	-1.58	16.51
		Spanish	-1.93	4.00	0.88	-11.56	7.69
LSD	Haitian Kreyòl	Spanish	*-9.40**	3.63	*0.01*	-16.66	-2.13
		Spanish + Indigenous	-7.47	3.75	0.05	-14.99	0.06
	Spanish	Haitian Kreyòl	*9.40**	3.63	*0.01*	2.13	16.66
		3	1.93	4.00	0.63	-6.08	9.94
	Spanish + Indigenous	Haitian Kreyòl	7.47	3.75	0.05	-0.06	14.99
		Spanish	-1.93	4.00	0.63	-9.94	6.08

*. The mean difference is significant at the 0.05 level.

*Table 13: HEI = Forage * Housing * Language ANOVA*

Source	Type III Sum of Sq	df	Mean Sq	F	Sig.	Partial Eta Squared
Corrected Model	2598.876[a]	12	216.57	1.62	0.14	0.39
Intercept	87468.80	1	87468.80	656.14	0.00	0.96
Language	1193.23	2	596.62	4.48	0.02	0.23
Forage	3.88	1	3.88	0.03	0.87	0.00
Housing	949.83	2	474.91	3.56	0.04	0.19
Language * Forage	*503.19*	*1*	*503.19*	*3.77*	0.06	0.11
Language * Housing	309.69	2	154.85	1.16	0.33	0.07
Forage * Housing	465.12	1	465.12	3.49	0.07	0.10
Language * Forage * Housing	7.40	1	7.40	0.06	0.82	0.00
Error	3999.26	30	133.31			
Total	175548.95	43				
Corrected Total	6598.13	42				

a. R Squared = .394 (Adjusted R Squared = .151)

*Table 14: HEI = Language * Forage ANVOA*

Source	Type III Sum of Squares	df	Mean Sq	F	Sig.	Partial Eta Squared
Corrected Model	1730.559[a]	5	346.11	2.67	0.03	0.20
Intercept	177501.77	1	177501.77	1366.78	0.00	0.96
Language	883.29	2	441.64	3.40	0.04	0.12
Forage	5.10	1	5.10	0.04	0.84	0.00
Language * Forage	664.96	2	332.48	2.56	0.09	0.09
Error	6753.15	52	129.87			
Total	228347.77	58				
Corrected Total	8483.71	57				

a. R Squared = .204 (Adjusted R Squared = .127)

*Table 15: HEI = Language * Housing ANOVA*

Source		Type III Sum of Squares	df	Mean Sq	F	Sig.
Intercept	Hypothesis	75185.033	1	75185.033	217.950	0.00
	Error	892.436	2.587	344.964[a]		
HouseCode	Hypothesis	873.594	2	436.797	3.850	0.05
	Error	1357.417	11.966	113.440[b]		
LanguageCode	Hypothesis	828.874	2	414.437	4.544	0.14
	Error	250.342	2.745	91.196[c]		
HouseCode * LanguageCode	Hypothesis	277.932	3	92.644	0.650	0.59
	Error	4990.934	35	142.598[d]		

a. .731 MS(LanguageCode) - .072 MS(HouseCode * LanguageCode) + .341 MS(Error)
b. .584 MS(HouseCode * LanguageCode) + .416 MS(Error)
c. 1.029 MS(HouseCode * LanguageCode) - .029 MS(Error)
d. MS(Error)

Table 16: Housing and Diet Raw NFD ANOVA

	N	Mean	STDV	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
House	19	115.27	72.92	16.73	80.13	150.42	5.77	241.56
Trailer	14	125.89	61.42	16.42	90.42	161.35	17.01	214.47
Rented Room	10	189.98	63.63	20.12	144.46	235.49	69.78	279.70
Total	43	136.10	72.36	11.034	113.83	158.37	5.77	279.70

	Sum of Sq	df	Mean Sq	F	Sig.
Between Groups	38726.56	2	19363.28	4.28	0.02
Within Groups	181190.69	40	4529.77		
Total	219917.25	42			

Table 17: Housing and Diet Raw NFD Post Hoc

Tukey HSD						
Housing Condition		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
House	Trailer	-10.61	23.71	0.90	-68.31	47.09
	Rented Room	-74.70*	26.29	0.02	-138.70	-10.70
Trailer	House	10.61	23.71	0.90	-47.09	68.31
	Rented Room	-64.09	27.87	0.07	-131.91	3.73
Trailer	House	74.70*	26.29	0.02	10.70	138.70
	Trailer	64.09	27.87	0.07	-3.73	131.91

*. The mean difference is significant at the 0.05 level.

Table 18: Housing and Garden Raw NFD ANOVA

Housing	Mean	STDEV
House	131.81	155.58
Trailer	121.84	174.05
Rented Room	49.47	159.58

	Df	Sum Of Sq	Mean Sq	F value	Pr(>F)
Housing	3	741686.86	247228.95	9.29	0.00
Residuals	39	1038068.6	26617.14		

Table 19: Housing and Species Evenness ANOVA

Housing	Count	Sum	Average	Variance		
House	19	15.89	0.84	0.01		
Trailer	14	10.84	0.77	0.02		
Rented Room	10	7.28	0.73	0.01		
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.08	2	0.04	4.13	0.02	3.23
Within Groups	0.40	40	0.01			
Total	0.48	42				

Table 20: Language and Species Richness ANOVA

	Df	Sum of Sq	Mean Sq	F value	Pr(>F)
Language	3	48448.15	16149.38	5.92	0.00
Residuals	58	158267.3	2728.75		

Table 21: Language and Shannon Weaver Index ANOVA

	Df	Sum Of Sq	Mean Sq	F value	Pr(>F)
Language	3	11.41	3.80	5.67	0.00
Residuals	58	38.93	0.67		

FIGURES

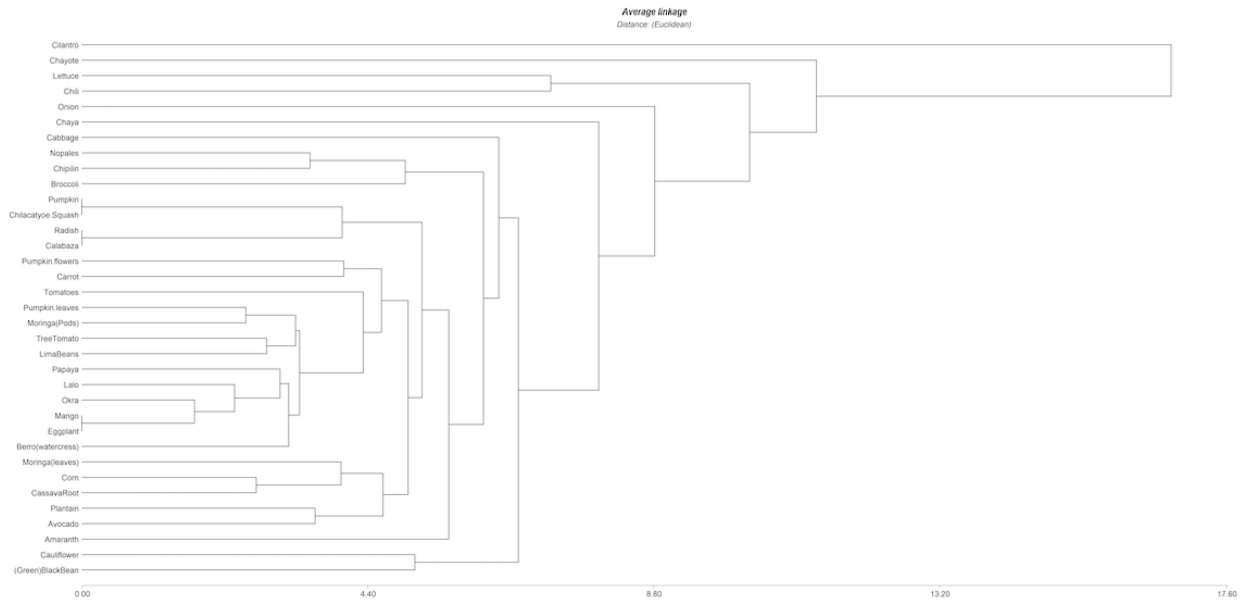


Figure 1: Complete List of Plant Species Dendrogram Example

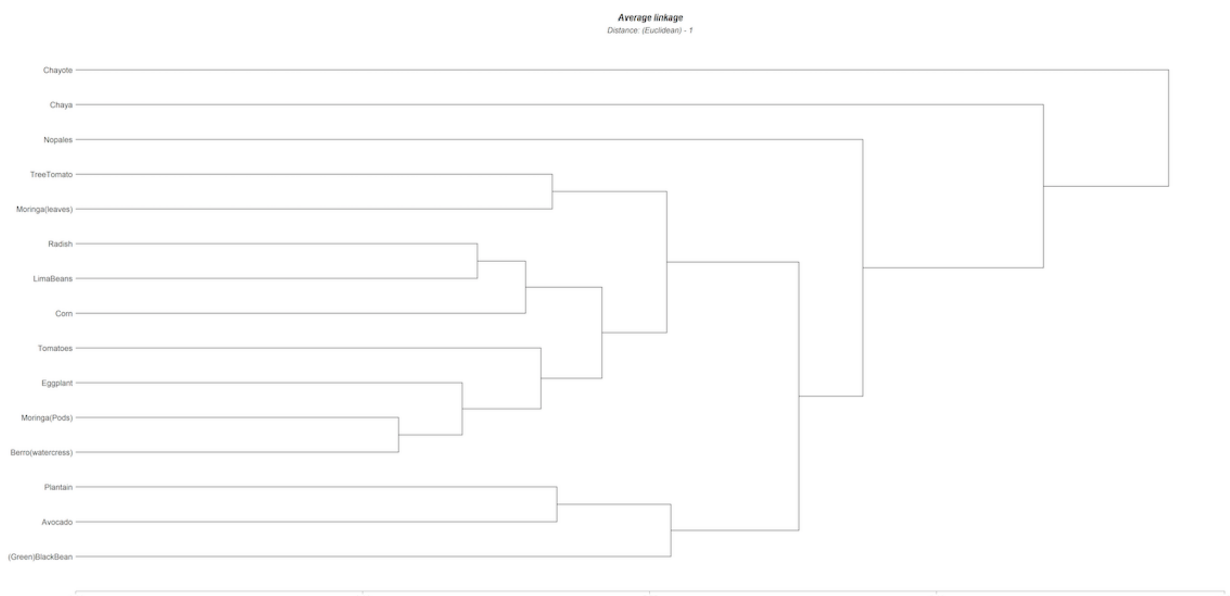


Figure 2: Plants Listed in One PRA Activity Dendrogram Example

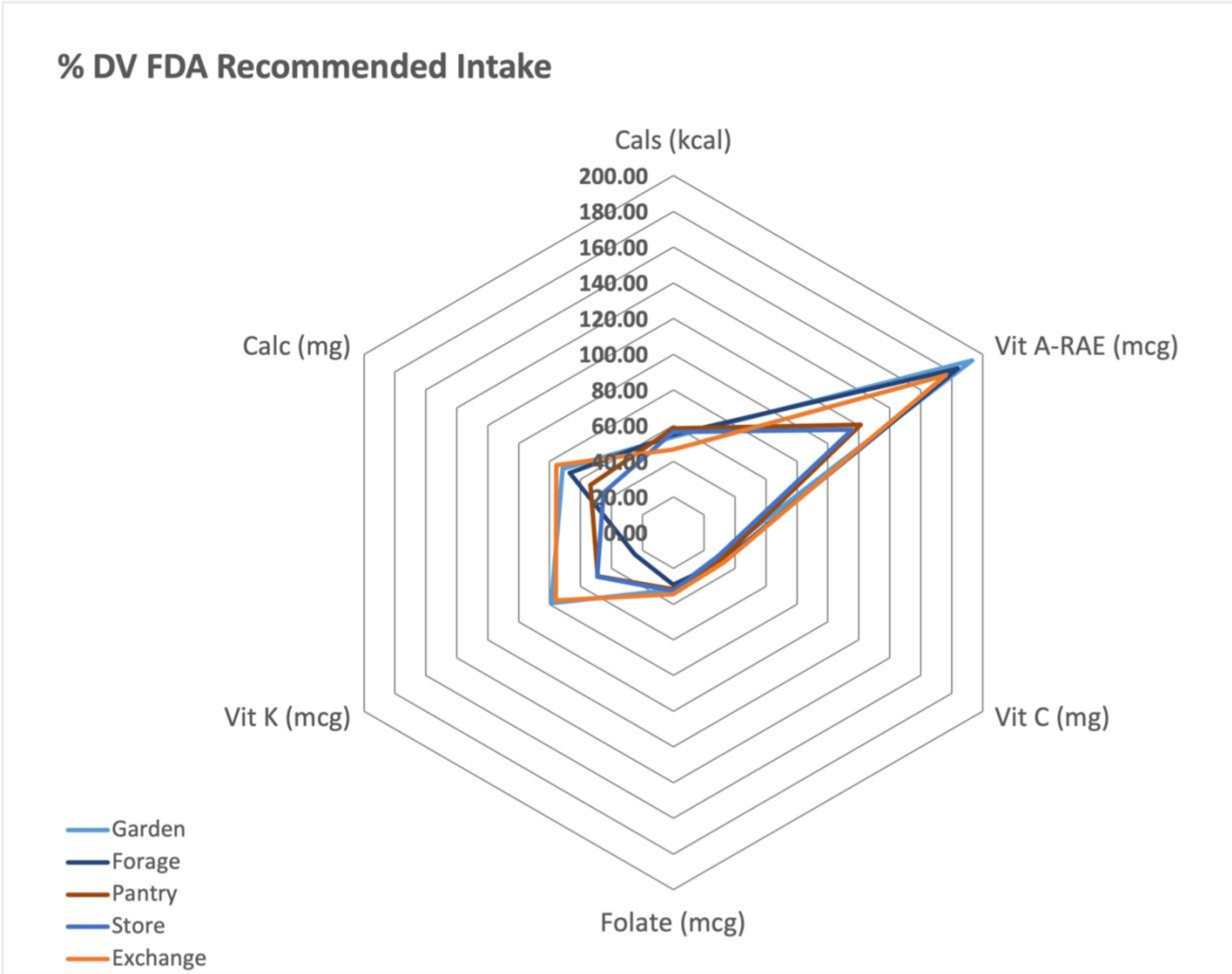


Figure 3: Micronutrients from 400g of Plants Accessed Through Gardens, Foraging, Pantry, Store, and Exchange, as Compared to FDA Recommended Intake

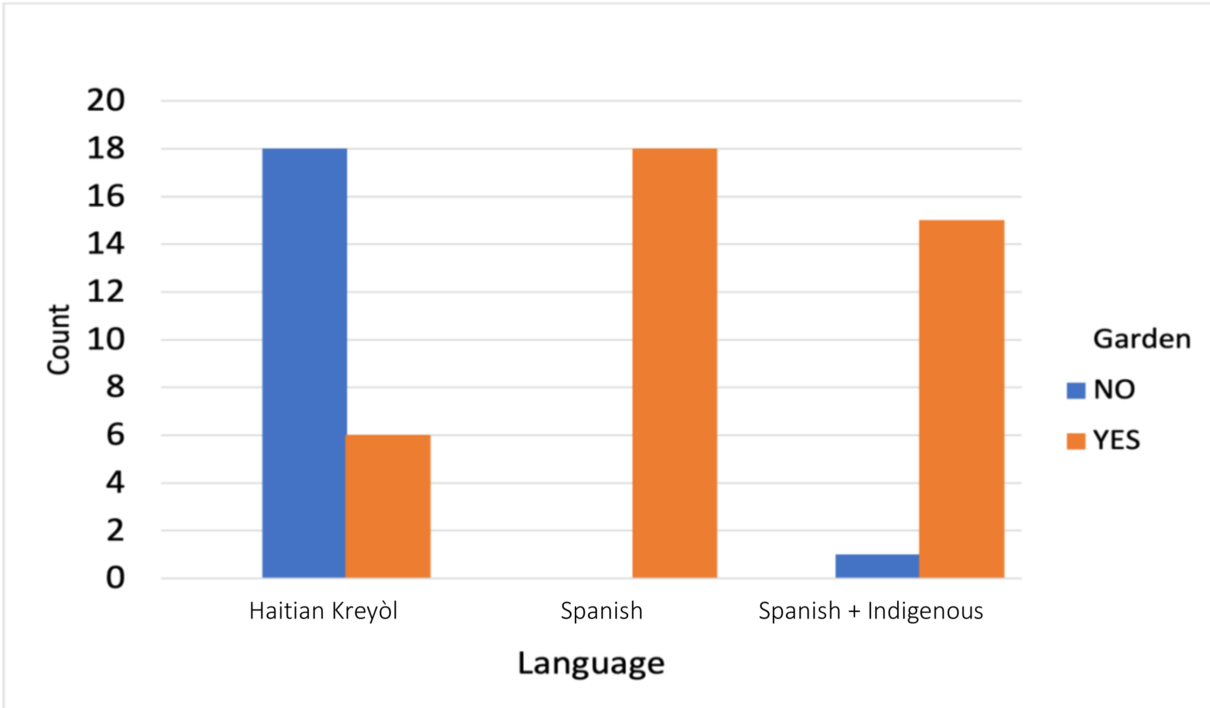


Figure 4: Gardening Practices by Language

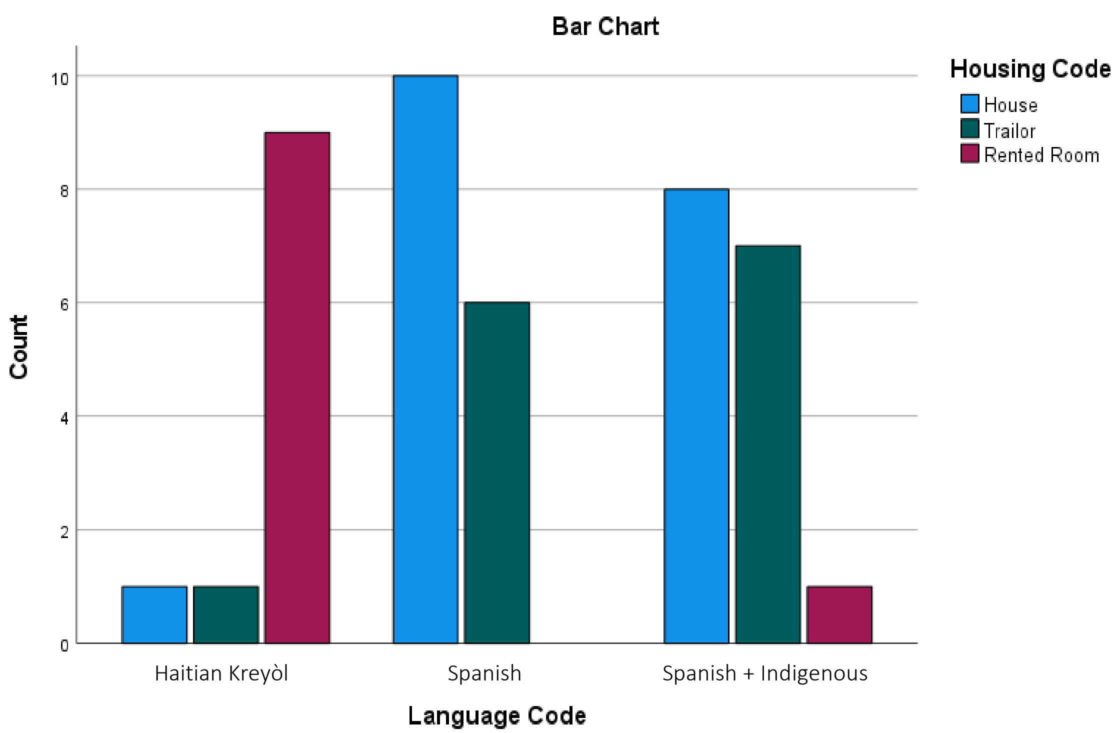


Figure 5: Housing Condition by Language

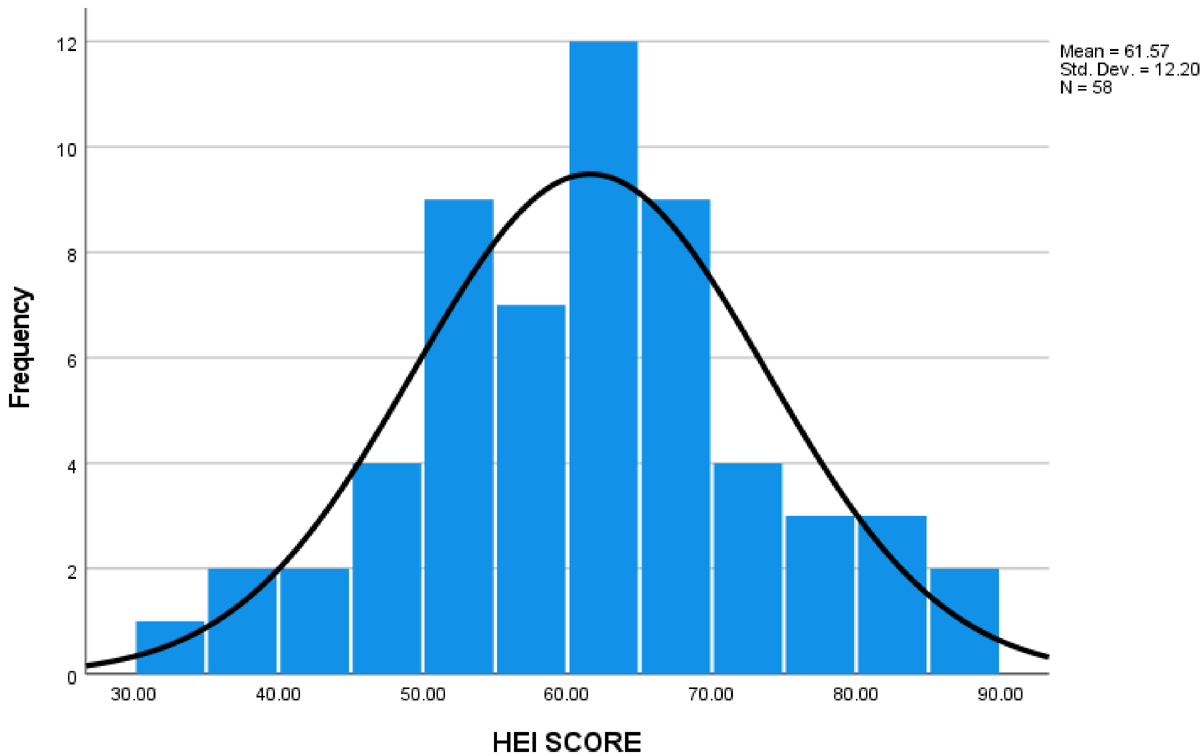


Figure 6: Participant HEI Score

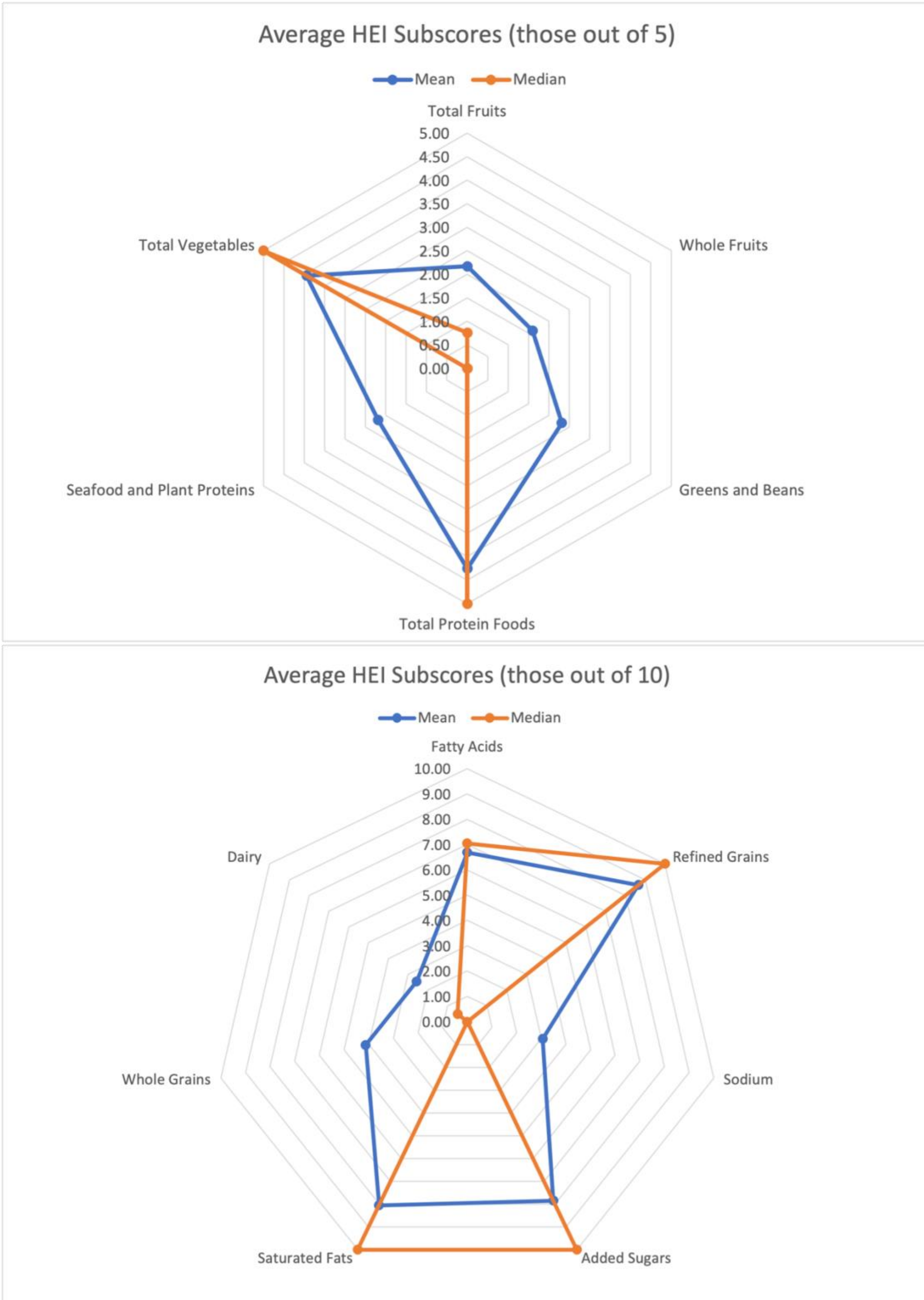


Figure 7: Average Participant HEI Subscores

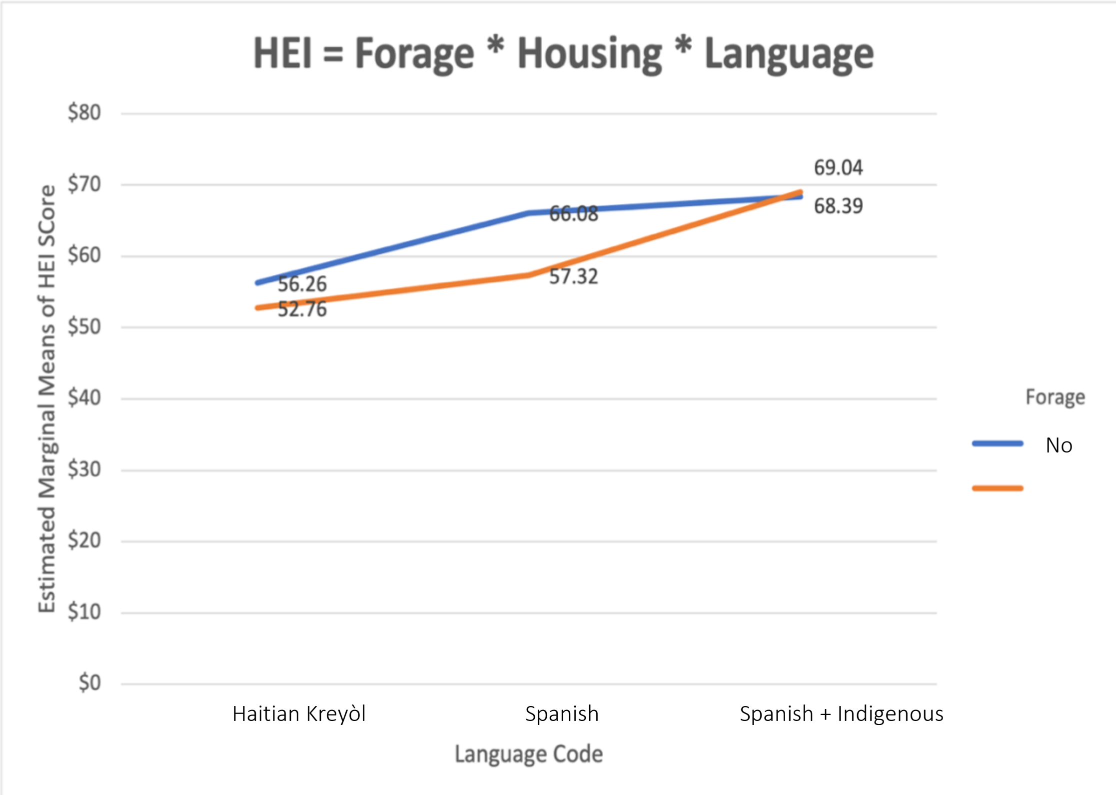


Figure 8: Impact of Language, Foraging, and Housing on HEI

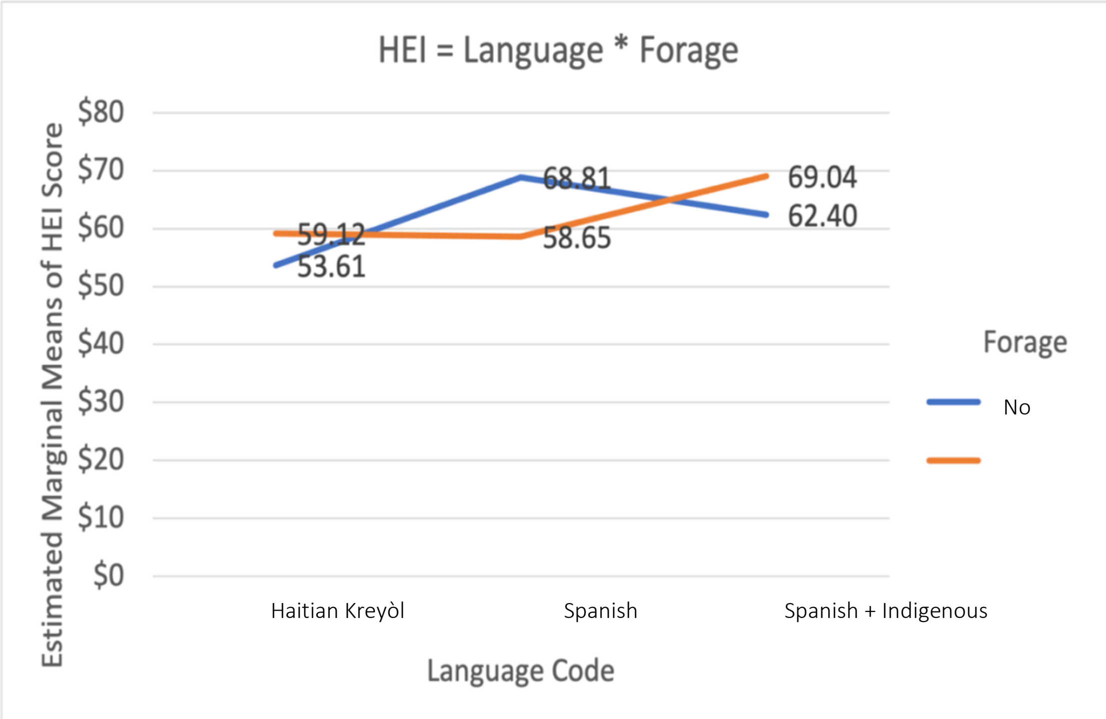


Figure 9: Impact of Language and Foraging on HEI

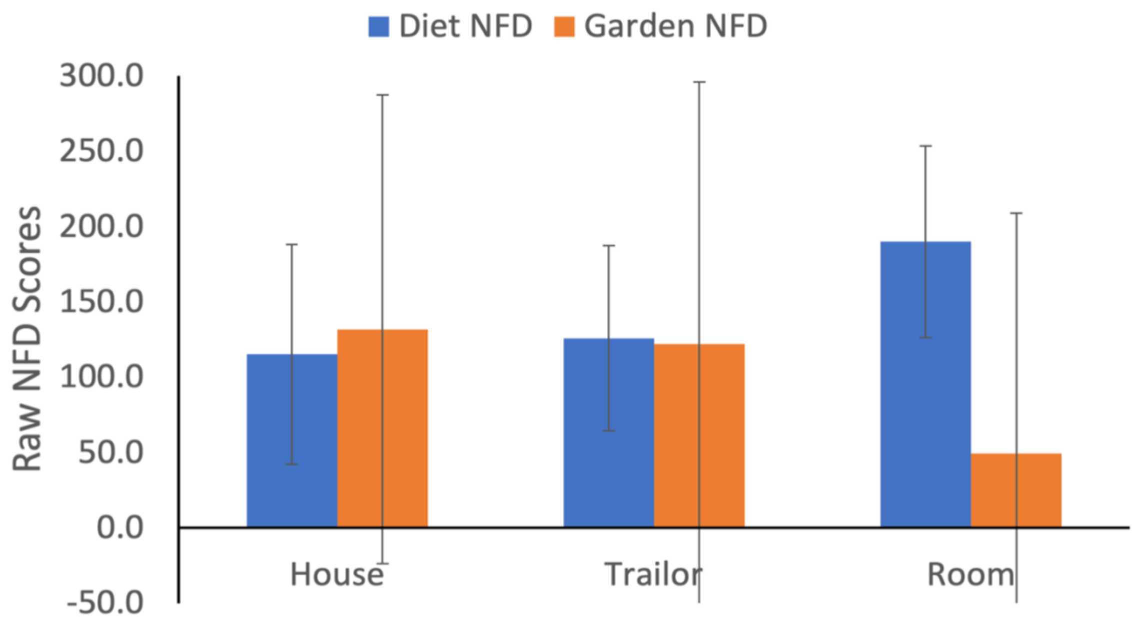


Figure 10:Garden NFD and Diet NFD by Housing

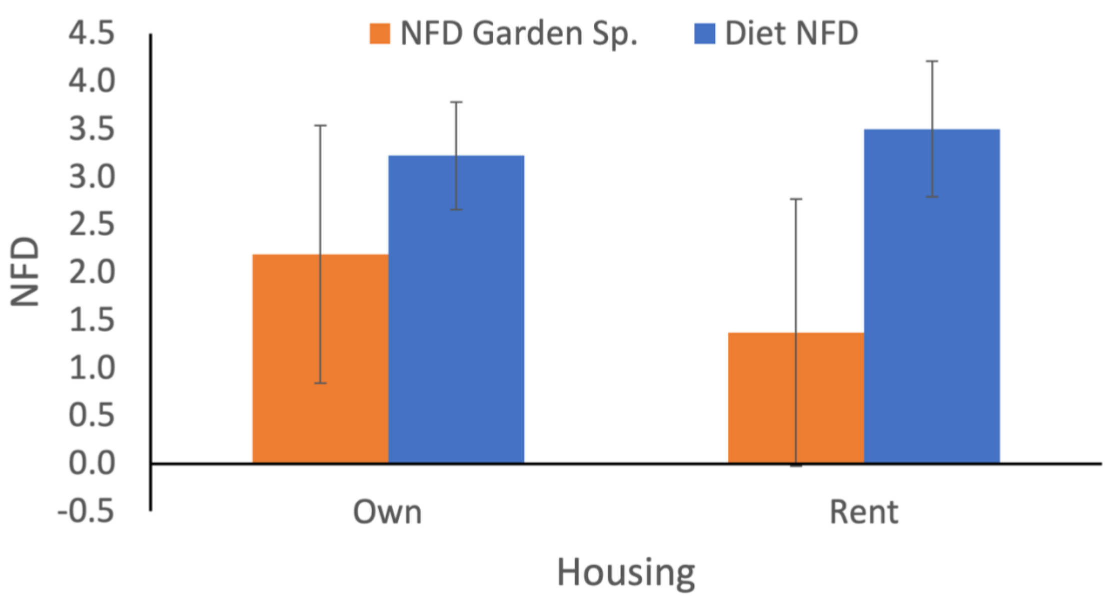


Figure 11: Garden NFD and Diet NFD by Homeowner and Rental Status

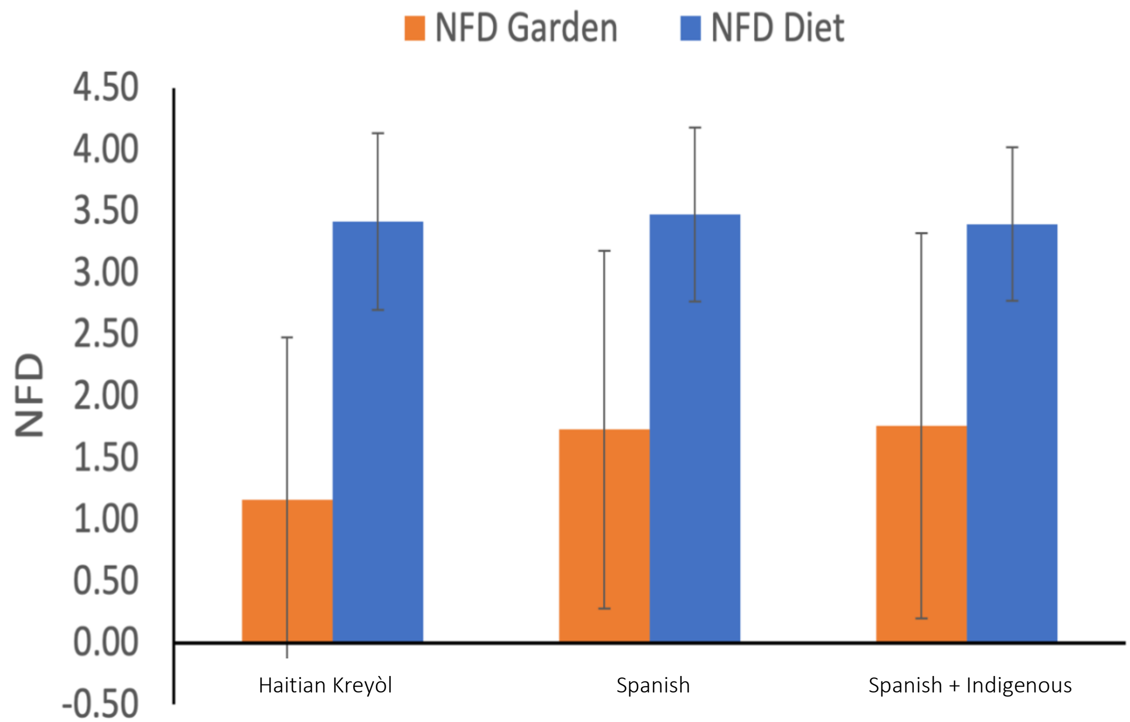


Figure 12: Garden NFD and Diet NFD by Language

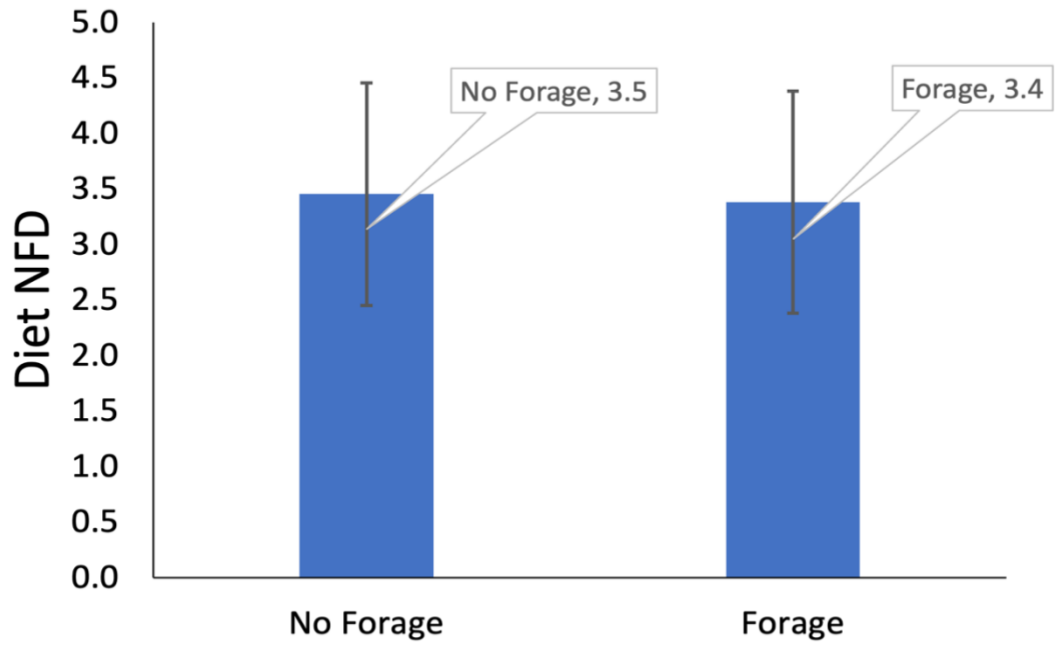


Figure 13: Diet NFD by Foraging Practices

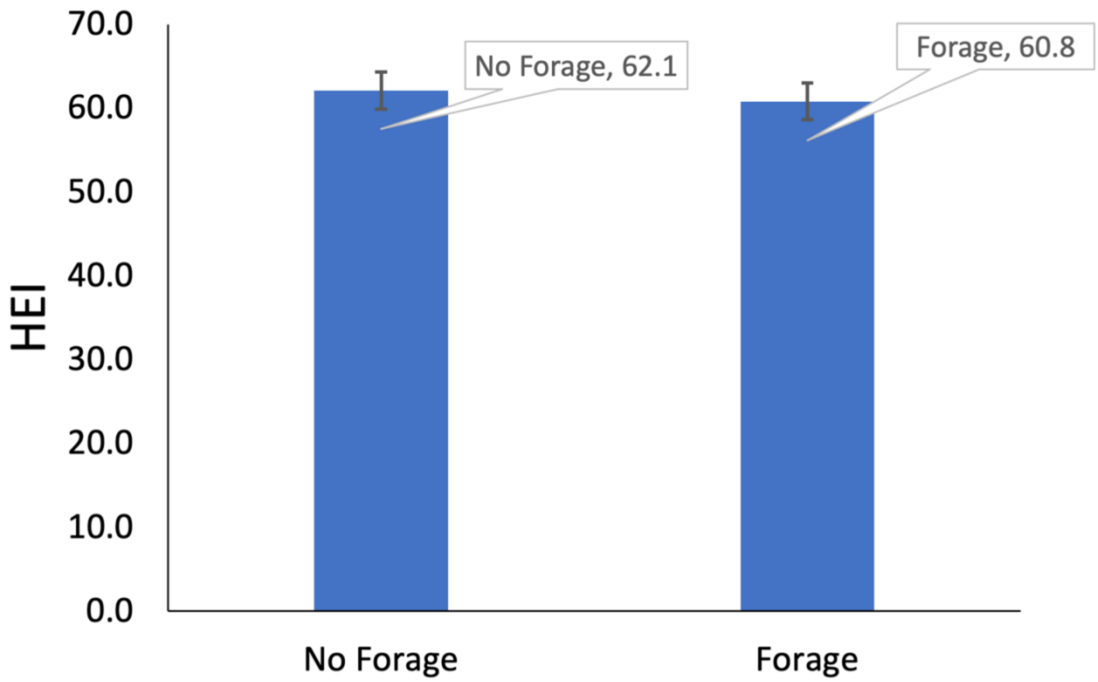


Figure 14: HEI Scores by Foraging Practice

APPENDIX A: PRA OUTLINE

Participatory Ranking Activity: a mixed-method approach in which a group of knowledgeable participants are guided through a series of questions and topics to generate rich, contextual data. This data can be counted, ranked, and compared both across or within groups.

Participatory ranking activities build of the larger context of participatory rural appraisal techniques. In this research project they are being utilized to provide input from *Cultivate Abundance* garden participants to identify and prioritize food preferences, as well as barriers to growing food.

Time Required: 1 hour

Roles:

- Mentor (Rick): The individual responsible for guiding the conversation. This person should be able to anticipate the group, know how to ask questions, and will ask open-ended questions for the group to respond. They will also help summarize and reflect the results from the activities.
- Interpreters/Facilitators: Lupita, Frantzso, Helen
- Note taker (Rebecca): The individual responsible for documenting activity. This person should take written notes throughout the process. They should also take photographs of the facilitation, particularly the final ranking results for each topic discussed.

Supplies:

- Set of images of potential plants that will be discussed, both those grown in the Cultivate Abundance and those Rick & Lupita highlight as potentially important
- Blank pieces of paper to include new food plants that are added by participants
- Large markers that are easy to see/read when responses are written on paper
- Dot stickers in at least two different colors (for the different questions, i-vii), precut into strips of three. In each question, a participant will receive three stickers to "vote" on their preferred answers.
- Camera/cell phone to document responses.

Outline:

1. Intros: (Lupita & Frantzso explain purpose) (5 mins)
2. Preferred vegetables: Everyone creates a personal list and then shares (10/15 mins)
3. For each of the following, everyone can vote for three, rank as a group
    a. As a Haitian/Mexican/etc person, which one is the most important to you, or which one can you not live without? (10 mins)
    b. Which are more challenging to get? (5 mins)
    c. Access:
        i. Which can be accessed through a garden (5 mins)
        ii. Which can be accessed through food pantry (5 mins)
        iii. Which can be foraged (5 mins)
        iv. Which can be purchased (5 mins)
        v. Access through exchange (5 mins)

SCRIPT:

Introduction: Today we will discuss food, food we like to grow, and food that is important to us. I will provide some topics for us to talk about. There is no right or wrong answer to these questions. Please share from your experiences and stories. You are welcome to speak out at any point that you want.

So that everyone has time to speak I will allow for pauses. We want this to be a safe place where everyone feels comfortable and to give time for people to share. Please be respectful of other people around you.

Instructions: With each topic I present we will begin by asking a question. An example couple be "As a _______ what food is most important to you?"

1. Collect ("Pile"):
    Pair: First, we will take time to reflect alone, then sharing with the person next to you, and then sharing as a whole group.

    Share: Together we will make a list of all the possible answers. We will take turns sharing our ideas. Each person will speak, and we will put all of the responses in the center.

    You can give as many answers as you want. There are no right or wrong answers. As you share your answers feel free to share stories if you want.

Group: Next, we will take time to group answers. If some answers are similar/the same, we will put them in one group. We will chat about the responses and if we have any other ideas or reflections. All of the answers will then be on a table/on the floor in the middle of our group to look at.

2. Rank:
   Then we will rank the answers. For each question we talk about, everyone will be given a set of stickers. With these stickers you can "vote" to the answers that are the most important, or least important (depending on the question).

   After everyone has had time to vote we will talk about the results together. The facilitator will then put the answers in the order of most popular to least popular. The facilitator will share these results with the group. Which answers were the most popular? Which were the least popular? Why?

   For many of the topics discussed we will rank with different questions. We will go through the process of talking about these questions separately, voting with different colored stickers (for example: which are the most important culturally, which are medicinal, or which are hardest to access). We will also talk about each vegetable and if you can access it through a garden, the food pantry, or from the store.

3. Discuss:
   Individuals will be given the chance to talk about why they voted the way they did. They will be asked if any of the results were surprising to them, if they agree or disagree, or what they think.

APPENDIX B: CONSTENT STATEMENT

Introduction: The purpose of this statement is to give you information about this research project and to give you the chance to decide if you want to participate, or not. You can take as much time as you want to decide and ask any questions. You can also ask questions during the interview or even after.

Purpose of Research: The purpose of this research study is to understand the ways that gardens and access to culturally important food affect the diet of community members in Immokalee, FL.

How Interview Works: You will be asked to share about the food you eat by answering a series of questions about what you eat, generally. There are several questions, it will take about 30 minutes to complete. To guess how much, I'll show you pictures of different amounts.

Potential Risks: Sometimes talking about food is uncomfortable for people, so I want to make sure you are comfortable with answering these questions. If this is uncomfortable for you, please feel free to let me know.

Potential Benefits: Some benefits that might come with participating is the chance to share about your food and culture. This information will be used to teach people working in food pantries and at food banks about your food and the value of green spaces and resources for gardens in our community. We will also give you at $15 gift card to the Family Dollar for your participation today, to say thank you.

Privacy: All the information you provided today will be safe and private. The form I fill out about your diet does *not* have your name on it and only your participant ID.

Your rights:

- Participating in this interview is your choice, completely voluntary
- Participating or not participating does not, in any way, affect your relationship with Misión Peniel or Cultivate Abundance
- You can skip or not answer any questions for any reason
- You can withdraw from the interview at any time without penalty

Questions:

If you have any questions now, during, or after you can contact Lupita Vazquez at ____________.

Conclusion:

- Do you have any questions now?
- Are you 18 years of age or older?
- How can I give you a copy of this script?

Participants give consent by signing registration form next to name and contact phone numbers.

APPENDIX C: GARDEN NFD INTERVIEW

Nutrition Functional Diversity Data Sheet: This study explores the application of nutrition functional diversity (NFD) metric to evaluate the role between ecological diversity of growing spaces and its impact on human dietary diversity. An NFD metric draws upon the field of ecology. NFD can be defined as the number of distinct species in a population that have unique functional traits. The NFD measure will measure growing spaces of research participants, representing both the number of crop species diversity and the combination of either nutrients or nutritional functional groups that they provide to human consumers. This data collection sheet is for participants to share what they are growing around their homes, and the relative abundance of those plants.

Time: 10 minutes

Questions:

(1) Do you grow any plants where you live for you and your family to eat? (Yes/No)
Note: If yes, proceed to #2. If no, proceed to #4.

(2) Can you list *all* of the plants that you have growing right now?

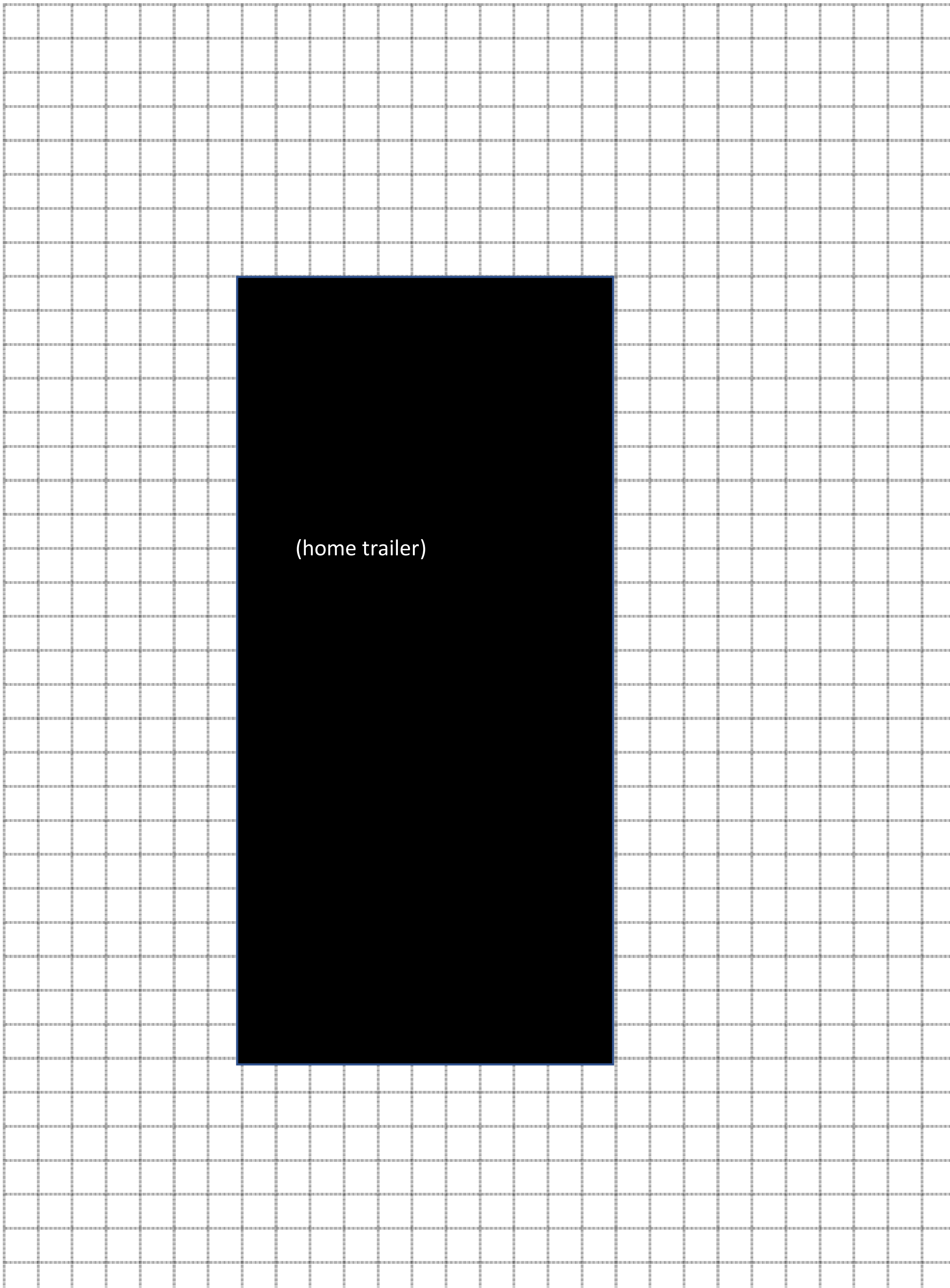
(3) If this piece of paper was the area that you grow plants in, even if it's in pots or in the ground, can you tell me about how much space ________ takes up? You can say it takes up half the space, or if you want you can use a marker to draw/fill in about how much space it takes up. There is no perfect or right way to answer this question, it can just be a guess.

(Have a blank piece of the large grid paper ready (below). The box in the paper represents the trailers that participants live in, in Immokalee, for reference. Have some different color markers or colored pencils available to color in parts of the grid paper to show relative abundance. Help to label the name of the plant if appropriate. Do this for each and every plant listed. After collecting this piece of paper, write the unique ID of the interviewee at the top/back of this paper for record.)

(4) Do you ever collect plants that you see on the side of the road or growing in empty lots, to take home and eat? (Yes/No)

(5) Can you name any of the plants that you collected in the past month?

ID: ____________________________   Space of Garden: __________________



APPENDIX D: 24 HR RECALL SHEET

Respondent ID ____________________________ Date _________________ Interviewer ___________________________

Please recall everything you had to eat or drink yesterday, from the time you woke up until you woke up this morning.

Pass 1 & 2: Quick list & meal gap

Pass 3: Probe for details for each food/beverage consumed, amount, prep method

Pass 4: Did you eat any snack foods, fruits, vegs, cheese, water, coffee, tea?

Amount	Dish Name	Preparation Method	Ingredients	Time	Place

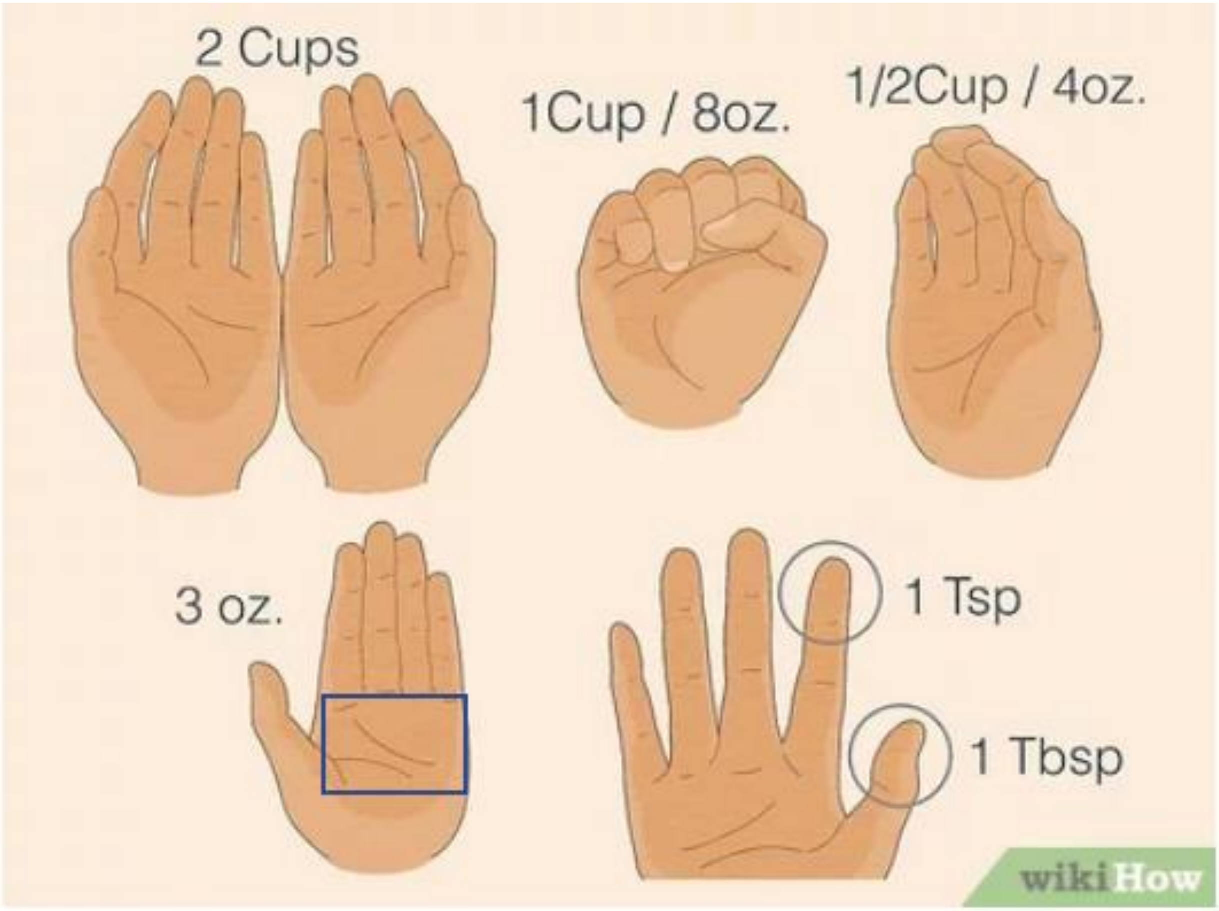
Pass 5: Read back detailed list of foods/beverages consumed to verify. Make any corrections.

Summary question: Was the amount of food you ate yesterday more than usual, usual, or less than usual? ____ More ____ Usual ____ Less

Demographics:

Age: _____________ Language(s): ________________ Home/Living Situation: _____________________ Years in US: ______________

APPENDIX E: PORTION SIZES



REFERENCES

Baudron, F., Duriaux Chavarría, J. Y., Remans, R., Yang, K., & Sunderland, T. (2017). Indirect contributions of forests to dietary diversity in Southern Ethiopia. *Ecology and Society*, *22*(2). https://doi.org/10.5751/ES-09267-220228

Beltrame, D., Gee, E., Guner, B., O. Lauridsen, N., Samarasinghe, W. L. G., W. Wasike, V., Hunter, D., & Borelli, T. (2019). Mainstreaming Biodiversity for Food and Nutrition into Policies and Practices: Methodologies and Lessons Learned from Four Countries. *Anadolu Ege Tarımsal Araştırma Enstitüsü Dergisi*, 25–38. https://doi.org/10.18615/anadolu.568795

Burge, C., & Dharod, J. M. (2018). What Are the Nutrition Education Needs of Refugees: Assessment of Food Choices, Shopping and Spending Practices of South-Asian Refugees in the USA. *Journal of International Migration and Integration*, *19*(3), 555–564. https://doi.org/10.1007/s12134-018-0565-1

Burlingame, B., Charrondiere, R., & Mouille, B. (2009). Food composition is fundamental to the cross-cutting initiative on biodiversity for food and nutrition. *Journal of Food Composition and Analysis*, *22*(5), 361–365. https://doi.org/10.1016/j.jfca.2009.05.003

Burnette, R. (2017). *Responding to Food Insecurity in Immokalee*. https://www.cultivateabundance.org/post/2017/09/29/responding-to-food-insecurity-in-immokalee

Casanoves, F., Pla, L., Di Rienzo, J. A., & Díaz, S. (2011). FDiversity: A software package for the integrated analysis of functional diversity. *Methods in Ecology and Evolution*, *2*(3), 233–237. https://doi.org/10.1111/j.2041-210X.2010.00082.x

Colwell, R. K. (2013). *EstimateS: Statistical estimation of species richness and shared species from samples*.

Dawson-Hahn, E., Koceja, L., Stein, E., Farmer, B., Grow, H. M., Saelens, B. E., Mendoza, J., & Pak-Gorstein, S. (2019). Perspectives of Caregivers on the Effects of Migration on the Nutrition, Health and Physical Activity of their Young Children: A Qualitative Study with Immigrant and Refugee Families. *Journal of Immigrant and Minority Health*, *0123456789*. https://doi.org/10.1007/s10903-019-00905-6

DeClerck, F. A. J., Jessica, F., Cheryl, P., & Roseline, R. (2011). Ecological approaches to human nutrition. *Food and Nutrition Bulletin*, *32*(1 SUPPL.). https://doi.org/10.1177/15648265110321s106

Devine, H. K. (2016). *Student Note: Vermont Food Access and the "Right to Food": Using the HUman Right to Food to Address Hunger in Vermont*. *1*, 0–24.

Dharod, J. M., Croom, J. E., & Sady, C. G. (2013). Food Insecurity: Its Relationship to Dietary Intake and Body Weight among Somali Refugee Women in the United States. *Journal of Nutrition Education and Behavior*, *45*(1), 47–53. https://doi.org/10.1016/j.jneb.2012.03.006

Di Falco, S., Bezabih, M., & Yesuf, M. (2010). Seeds for livelihood: Crop biodiversity and food production in Ethiopia. *Ecological Economics*, *69*(8), 1695–1702. https://doi.org/10.1016/j.ecolecon.2010.03.024

Egal, F. (2019). Review of The State of Food Security and Nutrition in the World, 2019. In *World Nutrition* (Vol. 10, Issue 3). https://doi.org/10.26596/wn.201910395-97

Felke, T., Want, L., Zhang, C., Knezevic, L., Mann, M., & Meyers, K. (2016). *Mapping Food Access in Immokalee, FL*.

Food Processor Nutrition Analysis Software. (2022). ESHA Research. https://esha.com/products/food-processor/

Frison, E. A., Cherfas, J., & Hodgkin, T. (2011). Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability*, *3*(1), 238–253. https://doi.org/10.3390/su3010238

Frison, E. A., Smith, I. F., Johns, T., Cherfas, J., & Eyzaguirre, P. B. (2006). Agricultural biodiversity, nutrition, and health: Making a difference to hunger and nutrition in the developing world. *Food and Nutrition Bulletin*, *27*(2), 167–179. https://doi.org/10.1177/156482650602700208

Gan, Y., Tong, X., Li, L., Cao, S., Yin, X., Gao, C., Herath, C., Li, W., Jin, Z., Chen, Y., & Lu, Z. (2015). Consumption of fruit and vegetable and risk of coronary heart disease: a meta-analysis of prospective cohort studies. *International Journal of Cardiology*, *183*, 129–137. https://doi.org/10.1016/j.ijcard.2015.01.077

Garnweidner, L. M., Terragni, L., Pettersen, K. S., & Mosdøl, A. (2012). Perceptions of the Host Country's Food Culture among Female Immigrants from Africa and Asia: Aspects Relevant for Cultural Sensitivity in Nutrition Communication. *Journal of Nutrition Education and Behavior*, *44*(4), 335–342. https://doi.org/10.1016/j.jneb.2011.08.005

Gichunge, C., Harris, N., Tubei, S., Somerset, S., & Lee, P. (2015). Relationship Between Food Insecurity, Social Support, and Vegetable Intake Among Resettled African Refugees in

Queensland, Australia. *Journal of Hunger and Environmental Nutrition*, *10*(3), 379–389. https://doi.org/10.1080/19320248.2014.929544

Gichunge, C., Somerset, S., & Harris, N. (2016). Using a household food inventory to assess the availability of traditional vegetables among resettled African refugees. *International Journal of Environmental Research and Public Health*, *13*(1). https://doi.org/10.3390/ijerph13010137

Girard, N. (2016). *Minority and indigenous women ' s right to culture : identity , gender and opportunities for empowerment*.

Gliessman, S. (2013). Agroecology: Growing the roots of resistance. *Agroecology and Sustainable Food Systems*, *37*(1), 19–31. https://doi.org/10.1080/10440046.2012.736927

Gliessman, S. R. (2014). *Agroecology : The Ecology of Sustainable Food Systems, Third Edition*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/syracuse-ebooks/detail.action?docID=1852938

Gostelow, L., Desplats, G., Shoham, J., Dolan, C., & Hailey, P. (2015). *Nutrition and Resilience: A Scoping Study*.

Greenhouse, S. (2014, April 24). In Florida Tomato Fields, a Penny Buys Progress. *New York Times*. https://www.nytimes.com/2014/04/25/business/in-florida-tomato-fields-a-penny-buys-progress.html

Guzmán-Abril, A., Alajajian, S., Rohloff, P., Proaño, G. V., Brewer, J., & Jimenez, E. Y. (2021). Academy of Nutrition and Dietetics Nutrition Research Network: A Home Garden

Intervention Improves Child Length-for-Age Z-Score and Household-Level Crop Count and Nutritional Functional Diversity in Rural Guatemala. *Journal of the Academy of Nutrition and Dietetics*. https://doi.org/10.1016/j.jand.2021.04.002

Herforth, A., Frongillo, E. A., Sassi, F., Mclean, M. S., Arabi, M., Tirado, C., Remans, R., Mantilla, G., Thomson, M., & Pingali, P. (2014). Toward an integrated approach to nutritional quality, environmental sustainability, and economic viability: Research and measurement gaps. *Annals of the New York Academy of Sciences*, *1332*(1), 1–21. https://doi.org/10.1111/nyas.12552

Holmes, S. (2013a). *Fresh Fruit, Borken Bodies: Migrant Farmworkesr int he United States*. University of California Press.

Holmes, S. (2013b). “How the Poor Suffer”: Embodying the Violence Continuum. In *Fresh Fruit, Broken Bodies: Migrant Farmworkers in the United States* (1st ed., pp. 88–110). University of California Press. http://www.jstor.org/stable/10.1525/j.ctt7zw45x.9

Hunter, D., Borelli, T., Beltrame, D. M. O., Oliveira, C. N. S., Coradin, L., Wasike, V. W., Wasilwa, L., Mwai, J., Manjella, A., Samarasinghe, G. W. L., Madhujith, T., Nadeeshani, H. V. H., Tan, A., Ay, S. T., Güzelsoy, N., Lauridsen, N., Gee, E., & Tartanac, F. (2019). The potential of neglected and underutilized species for improving diets and nutrition. *Planta*, *250*(3), 709–729. https://doi.org/10.1007/s00425-019-03169-4

Ip, E. H., Saldana, S., Arcury, T. A., Grzywacz, J. G., Trejo, G., & Quandt, S. A. (2015). Profiles of food security for US farmworker households and factors related to dynamic of change. *American Journal of Public Health*, *105*(10), e42–e47.

https://doi.org/10.2105/AJPH.2015.302752

Jennings, H. M., Merrell, J., Thompson, J. L., & Heinrich, M. (2015). Food or medicine? the food-medicine interface in households in Sylhet. *Journal of Ethnopharmacology*, *167*, 97–104. https://doi.org/10.1016/j.jep.2014.09.011

Jones, A. D. (2017). Critical review of the emerging research evidence on agricultural biodiversity, diet diversity, and nutritional status in low- and middle-income countries. *Nutrition Reviews*, *75*(10), 769–782. https://doi.org/10.1093/nutrit/nux040

Joyner, L., Yagüe, B., Cachelin, A., & Rose, J. (2022). Farms and gardens everywhere but not a bite to eat? A critical geographic approach to food apartheid in Salt Lake City. *Journal of Agriculture, Food Systems, and Community Development*, *11*(2), 1–22. https://doi.org/10.5304/jafscd.2022.112.013

Kennedy, E., Ohls, J., Carlson, S., & Fleming, K. (1995). The Healthy Eating Index: Design and Applications. *Journal of the American Dietetic Association*, *95*(10), 1103–1108. https://doi.org/10.1016/S0002-8223(95)00300-2

Kercood, S., & Morita-Mullaney, T. (2015). Health Perceptions and Practices of Burmese Refugee Families: A Participatory Mixed Method Study. *Journal of Southeast Asian American Education and Advancement*, *10*(1). https://doi.org/10.7771/2153-8999.1124

Krebs-Smith, S. M., Pannucci, T. E., Subar, A. F., Kirkpatrick, S. I., Lerman, J. L., Tooze, J. A., Wilson, M. M., & Reedy, J. (2018). Update of the Healthy Eating Index: HEI-2015. *Journal of the Academy of Nutrition and Dietetics*, *118*(9), 1591–1602.

https://doi.org/10.1016/j.jand.2018.05.021

Kresge, L., & Eastman, C. (2010). *Increasing Food Security Among Agricultural Workers in Californias Salinas Valley*.

Krier, R. (2021). *Immokalee Economic Overview*. https://doi.org/10.1515/9783035622805-181

Lawlis, T., Islam, W., & Upton, P. (2018). Achieving the four dimensions of food security for resettled refugees in Australia: A systematic review. *Nutrition and Dietetics*, *75*(2), 182–192. https://doi.org/10.1111/1747-0080.12402

Liu, Y., & Eicher-Miller, H. A. (2021). Food Insecurity and Cardiovascular Disease Risk. *Current Atherosclerosis Reports*, *23*(6), 14–19. https://doi.org/10.1007/s11883-021-00923-6

Loomis, B., Epstein, K., Dauria, E. F., & Dolce, L. (2019). Implementing a Trauma-Informed Public Health System in San Francisco, California. *Health Education and Behavior*, *46*(2), 251–259. https://doi.org/10.1177/1090198118806942

Lowell, W., Peterman, J. N., Silka, L., Bermudez, O. I., Wilde, P. E., & Rogers, B. L. (2011). Acculturation, Education, Nutrition Education, and Household Composition Are Related to Dietary Practices among Cambodian Refugee Women. *Yjada*, *111*(9), 1369–1374. https://doi.org/10.1016/j.jada.2011.06.005

Luckett, B. G., DeClerck, F. A. J., Fanzo, J., Mundorf, A. R., & Rose, D. (2015). Application of the Nutrition Functional Diversity indicator to assess food system contributions to dietary diversity and sustainable diets of Malawian households. *Public Health Nutrition*, *18*(13), 2479–2487. https://doi.org/10.1017/S136898001500169X

Luna-González, D. V., & Sorensen, M. (2018). Higher agrobiodiversity is associated with improved dietary diversity, but not child anthropometric status, of mayan achí people of Guatemala. *Proceedings of the International Astronomical Union*, *21*(11), 2128–2141. https://doi.org/10.1017/S1368980018000617

Lutaladio, N. B., Burlingame, B., & Crews, J. (2010). Horticulture, biodiversity and nutrition. *Journal of Food Composition and Analysis*, *23*(6), 481–485. https://doi.org/10.1016/j.jfca.2010.08.001

Mares, T. M. (2019a). Feeding the Nation But Not Being Fed. In *Life on the Other Border: Farmworkers and Food Justice in Vermont*. University of California Press.

Mares, T. M. (2019b). Measuring the Immeasurable ? Assessing Dairy Worker Food Insecurity with the (Quantitative) Tools at Hand. In *Life on the Other Border: Farmworkers and Food Justice in Vermont* (pp. 62–66). University of California Press.

Marmot, M., & Wilkinson, R. (2015). Social Determinants of Health. In *Oxford University Press* (Vol. 15, Issue 1). https://doi.org/10.1093/acprof

MASIPAG. (2001). *Grains of Delusion* (Issue February).

McEwen, B. S. (1998). Stress, adaptation, and disease. Allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *840*, 33–44. https://doi.org/10.1111/j.1749-6632.1998.tb09546.x

Minkoff-Zern, L.-A. (2012). *Migrations of Hunger and Knowledge: Food Insecurity and California's Indigenous Farmworkers* [University of California, Berkley].

http://dx.doi.org/10.1016/j.actamat.2015.12.003%0Ahttps://inis.iaea.org/collection/NCLCollectionStore/_Public/30/027/30027298.pdf?r=1&r=1%0Ahttp://dx.doi.org/10.1016/j.jmrt.2015.04.004

Minkoff-Zern, L.-A., & Carney, M. A. (2015). Latino Immigrants, "Dietary Health" and Social Exclusion. *Food, Culture, and Society*, *18*(3), 463–481.

Minkoff-Zern, L. A. (2014). Hunger amidst plenty: farmworker food insecurity and coping strategies in California. *Local Environment*, *19*(2), 204–219. https://doi.org/10.1080/13549839.2012.729568

Moffat, T., Mohammed, C., & Newbold, K. B. (2017). Cultural dimensions of food insecurity among immigrants and refugees. *Human Organization*, *76*(1), 15–27. https://doi.org/10.17730/0018-7259.76.1.15

Morgan, C. B., & Trubek, A. B. (2020). Not yet at the table: The absence of food culture and tradition in agroecology literature. *Elementa*, *8*(1). https://doi.org/10.1525/elementa.437

Mozaffarian, D., Rosenberg, I., & Uauy, R. (2018). History of modern nutrition science-implications for current research, dietary guidelines, and food policy. *BMJ (Online)*, *361*, 1–6. https://doi.org/10.1136/bmj.k2392

Okafor, M. T. C., Carter-Pokras, O. D., & Zhan, M. (2014). Greater Dietary Acculturation (Dietary Change) Is Associated With Poorer Current Self-Rated Health Among African Immigrant Adults. *Journal of Nutrition Education and Behavior*, *46*(4), 226–235. https://doi.org/10.1016/j.jneb.2013.11.015

Ong, M., Baker, A., Aguilar, A., & Stanley, M. (2019). The meanings attributed to community gardening: A qualitative study. *Health and Place*, *59*(August), 102190. https://doi.org/10.1016/j.healthplace.2019.102190

Patil, C. L., Hadley, C., & Nahayo, P. D. (2009). Unpacking dietary acculturation among New Americans: Results from formative research with African refugees. *Journal of Immigrant and Minority Health*, *11*(5), 342–358. https://doi.org/10.1007/s10903-008-9120-z

Peretz, P., Islam, N., & Matiz, L. A. (2020). Community Health Workers and Covid-19 - Addressing Social Determinants of Health in Times of Crisis and Beyond. *New England Journal of Medicine*, *108*(1), 1969–1973. nejm.org

Petchey, O. L., & Gaston, K. J. (2002). Functional diversity (FD), species richness and community composition. *Ecology Letters*, *5*(3), 402–411. https://doi.org/10.1046/j.1461-0248.2002.00339.x

Ramírez, A. S., Golash-Boza, T., Unger, J. B., & Baezconde-Garbanati, L. (2018). Questioning the Dietary Acculturation Paradox: A Mixed-Methods Study of the Relationship between Food and Ethnic Identity in a Group of Mexican-American Women. *Journal of the Academy of Nutrition and Dietetics*, *118*(3), 431–439. https://doi.org/10.1016/j.jand.2017.10.008

Remans, R., Flynn, D. F. B., DeClerck, F., Diru, W., Fanzo, J., Gaynor, K., Lambrecht, I., Mudiope, J., Mutuo, P. K., Nkhoma, P., Siriri, D., Sullivan, C., & Palm, C. A. (2011). Assessing nutritional diversity of cropping systems in African villages. *PLoS ONE*, *6*(6). https://doi.org/10.1371/journal.pone.0021235

Roche, A., Goto, K., Zhao, Y., & Wolff, C. (2015). Bonding and Bridging Social and Cultural Capitals: Perceived Factors Associated With Family Eating Practices Among Hmong, Latino, and White Mothers and Fathers. *Journal of Nutrition Education and Behavior*, *47*(6), 540-547.e1. https://doi.org/10.1016/j.jneb.2015.08.017

Rondinelli, A. J., Morris, M. D., Rodwell, T. C., Moser, K. S., Paida, P., Popper, S. T., & Brouwer, K. C. (2011). Under- and over-nutrition among refugees in San Diego County, California. *Journal of Immigrant and Minority Health*, *13*(1), 161–168. https://doi.org/10.1007/s10903-010-9353-5

Scheper-Hughes, N., & Bourgois, P. (2004). Introduction: Making Sense of Violence. *Violence in War and Peace: An Anthology*, *January 2004*, 1–32.

Sibhatu, K. T., Krishna, V. V., & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(34), 10657–10662. https://doi.org/10.1073/pnas.1510982112

Smith, J., & Cuesta, G. (2020). Hunger in the fields: Food insecurity and food access among farmworker families in Migrant and Seasonal Head Start. *Journal of Latinos and Education*, *19*(3), 246–257. https://doi.org/10.1080/15348431.2018.1500291

Stokes, H. (2017). *Conceptualizing and Measuring Food Security Among Resettled Refugees Living in the United States*`. 1–257.

Sumner, J., Tarhan, M., & McMurtry, J. (2019). Eating in Place: Mapping Alternative Food

Procurement in Canadian Indigenous Communities. *Journal of Agriculture, Food Systems, and Community Development*, *9*, 1–12. https://doi.org/10.5304/jafscd.2019.09b.016

Thompson, S., & Thapa, K. (2019). *Sacred harvest , sacred place : Traditional land uses and food in Wasagamack First Nation*. *9*.

Tiedje, K., Wieland, M. L., Meiers, S. J., Mohamed, A. A., Formea, C. M., Ridgeway, J. L., Asiedu, G. B., Boyum, G., Weis, J. A., Nigon, J. A., Patten, C. A., & Sia, I. G. (2014). A focus group study of healthy eating knowledge, practices, and barriers among adult and adolescent immigrants and refugees in the United States. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1). https://doi.org/10.1186/1479-5868-11-63

Toensmeier, E., Ferguson, R., & Mehra, M. (2020). Perennial vegetables: A neglected resource for biodiversity, carbon sequestration, and nutrition. *PLoS ONE*, *15*(7), 1–19. https://doi.org/10.1371/journal.pone.0234611

Toledo, Á., & Burlingame, B. (2006). Biodiversity and nutrition: A common path toward global food security and sustainable development. *Journal of Food Composition and Analysis*, *19*(6–7), 477–483. https://doi.org/10.1016/j.jfca.2006.05.001

USDA Center for Nutrition Policy and Promotion. (n.d.). *Healthy Eating Index*. Retrieved May 15, 2022, from https://www.fns.usda.gov/healthy-eating-index-hei

Villéger, S., Ramos Miranda, J., Hernánddez, D. F., & Mouillot, D. (2016). *Supplement 1. R script for computation of functional diversity and functional specialization indices*. Wiley. https://doi.org/https://doi.org/10.6084/m9.figshare.3515324.v1

Vue, W., Wolff, C., & Goto, K. (2011). Hmong food helps us remember who we are: Perspectives of food culture and health among hmong women with young children. *Journal of Nutrition Education and Behavior*, *43*(3), 199–204. https://doi.org/10.1016/j.jneb.2009.10.011

Wahlqvist, M. L. (2009). Connected Community and Household Food-Based Strategy (CCH-FBS): its importance for health, food safety, sustainability and security in diverse localities. *Ecology of Food and Nutrition*, *48*(6), 457–481. https://doi.org/10.1080/03670240903308596

Wang, Y., Min, J., Harris, K., Khuri, J., & Anderson, L. M. (2016). A Systematic Examination of Food Intake and Adaptation to the Food Environment by Refugees Settled in the United States. *Advances in Nutrition: An International Review Journal*, *7*(6), 1066–1079. https://doi.org/10.3945/an.115.011452

Welsh, R., & Glenna, L. (2006). Considering the role of the university in conducting research on agri-biotechnologies. *Social Studies of Science*, *36*(6), 929–942. https://doi.org/10.1177/0306312706060062

Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, *40*(6). https://doi.org/10.1007/s13593-020-00646-z

Wieland, M. L., Weis, J. A., Hanza, M. M. K., Meiers, S. J., Patten, C. A., Clark, M. M., Sloan, J. A., Novotny, P. J., Njeru, J. W., Abbenyi, A., Levine, J. A., Goodson, M., Porraz Capetillo, M. G. D., Osman, A., Hared, A., Nigon, J. A., & Sia, I. G. (2016). Healthy immigrant families:

Participatory development and baseline characteristics of a community-based physical activity and nutrition intervention. *Contemporary Clinical Trials*, *47*, 22–31. https://doi.org/10.1016/j.cct.2015.12.004

Wieland, M. L., Weis, J. A., Palmer, T., Goodson, M., Loth, S., Omer, F., Abbenyi, A., Krucker, K., Edens, K., & Sia, I. G. (2012). Physical Activity and Nutrition among Immigrant and Refugee Women: A Community-Based Participatory Research Approach. *Women's Health Issues*, *22*(2), e225–e232. https://doi.org/10.1016/j.whi.2011.10.002

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., … Murray, C. J. L. (2019). Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wilson, A., & Renzaho, A. (2015). Intergenerational differences in acculturation experiences, food beliefs and perceived health risks among refugees from the Horn of Africa in Melbourne, Australia. *Public Health Nutrition*, *18*(1), 176–188. https://doi.org/10.1017/S1368980013003467

CURRICULUM VITA

EDUCATION

SYRACUSE UNIVERSITY | AUGUST 2022-PRESENT	Dietetic Internship
SYRACUSE UNIVERSITY | SEPTEMBER 2019 – AUGUST 2022	M.S. Nutrition Science
ONONDAGA COMMUNITY COLLEGE | JANUARY 2017 - JUNE 2019	DPD Coursework
CALVIN COLLEGE | AUGUST 2006 - MAY 2010	B.A. Sociology and International Development Studies

PROFESSIONAL EXPERIENCE

FOOD DIGNITY INSTITUTE LEAD | FOOD DIGNITY | JANUARY 2021 – AUGUST 2022

- Write participatory activities on topics like screening for food insecurity in clinical settings, dignity in food pantry design, and asset mapping
- Illustrate for weekly RD-hosted podcast and for community stakeholder meetings

GRADUATE ASSISTANT | SYRACUSE UNIVERSITY | SEPTEMBER 2019 – MAY 2022

- Researched maternal diet and stress impact on birth outcomes, two accepted abstracts
- Authored ten mindful eating curriculum modules for research with preschool age children
- Graded NSD457 Research and Evaluation in Nutrition Science and NSD 225 Nutrition in Health

NUTRITION EDUCATOR | FOOD BANK OF CENTRAL NEW YORK | JUNE- SEPTEMBER 2019

- Taught weekly SNAP-Ed nutrition and cooking lessons at the Downtown Farmers Market

OFFICE MANAGER | ECHO ASIA IMPACT CENTER | JANUARY 2013 - DECEMBER 2016

- Led and supported ten staff members in a bilingual work environment
- Coordinated annual conferences for agriculture community development workers from Asia

COMMUNITY GARDEN INTERN | ECHO INTERNATIONAL | OCTOBER 2011 - DECEMBER 2012

- Consulted with and trained over forty school and community gardens in Southwest Florida
- Maintained a 600 square foot demonstration and teaching garden

PROGRAM COORDINATOR | HEART OF THE CITY | AUGUST 2010 - SEPTEMBER 2011

- Managed client applications for state-funded home repair environmental health programs
- Initiated and led a Community Feedback Project in the 14213 zip code for a Strategic Plan

OTHER RELEVANT EXPERIENCE

FARM BILL TASK FORCE MEMBER | ACADEMY OF NUTRITION & DIETETICS | JULY 2022 - PRESENT

GRASSROOTS ORGANIZER PUBLIC POLICY COMMITTEE | HUNGER AND ENVIRONMENTAL NUTRITION DIETETIC PRACTICE GROUP | OCTOBER 2020 - PRESENT

NETWORK ADVISORY MEMBER | CULTIVATE ABUNDANCE | JANUARY 2017 - PRESENT

BOARD SECRETARY | HOPE FOR ARIANG | JANUARY 2017 - PRESENT

BOARD MEMBER | ECHO INTERNATIONAL | JANUARY 2019 – JANUARY 2022

EDITING, WRITING, AND PRESENTING EXPERIENCE

LECTURER/PRESENTER

- Workshop Presenter, Food and Nutrition Conference and Expo (October 2022)
- Participatory Methods for Nutrition, Agriculture, Food, and Human Values Society (May 2022)
- NSD 225 (March 2020) and NSD 457, Syracuse University (November 2021)
- Accepted abstracts to International Congress of Dietetics (September 2020), NYS Academy of Nutrition and Dietetics Annual Meeting (April 2020), (canceled due to COVID-19)
- Conference presentations in Cambodia (2015), Indonesia (2015), Thailand (2014)

AUTHOR

- “Book review of Unsavory Truth by Marion Nestle,” Renewable Agriculture and Food Systems, Cambridge University Press (May 2020)
- "Green and Healthy Homes" grant application, awarded $830,000 from NYS Department of Housing & Community Renewal (August 2011)
- “Bonding and Bridging Activities of US Pentecostals,” published in Sociological Spectrum, Mid-South Sociological Association (April 2011)

CO-EDITOR

- Practical Nutrition Guide for Community Development Workers, ECHO Asia (2015)
- Asia Development Notes, over 2,000 subscribers in seven languages (2013-2016)