

Reliability of a Household Food Waste Self-Assessment Tool

by

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A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Science

Approved April 2022 by the
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May 2022

ABSTRACT

Food waste is gaining considerable attention from researchers in terms of its sources, its causes, and its potential effects on the environment, economy, and population health. To date, few instruments exist that allow researchers to measure food waste at the household level in reliable ways. This study aimed to assess the reliability of a newly developed self-assessment tool to measure household food waste, among participants living in Mexico. The survey tool consisted of 11 items which ask participants (N = 22) to estimate the amount of food per category that generally gets thrown away instead of eaten in the average week. Two tests of reliability were conducted, including Cronbach's Alpha for test-retest reliability, and Intra-class Correlation for internal reliability. Results varied across food categories evaluated by individual items. Items related to fresh fruit and bread products did not show reliability when testing for internal reliability or test-retest reliability. Fresh vegetables, meat and poultry products, meat alternative products, fish and seafood products, leftovers, and shelf stable foods were shown to be reliable when testing Cronbach's alpha and ICC. However, dairy products, eggs and frozen foods were inconclusive when testing for reliability. The study suggests future testing with larger sample sizes should be conducted to demonstrate reliability of the food waste self-assessment tool.

TABLE OF CONTENTS

	Page
LIST OF TABLES	iv
LIST OF FIGURES.....	v
CHAPTER	
1 INTRODUCTION.....	1
Introduction.....	1
Definition of Terms.....	4
Delimitations and Limitations.....	4
2 REVIEW OF LITERATURE.....	6
Introduction.....	6
Food Waste in Households	7
Food Waste Demographics	8
Food Waste in Restaurants.....	9
Food Waste and the Environment.....	10
Food Waste and the Economy.....	11
Food Waste Globally	12
Food Waste and Health.....	15
National Food Waste Reduction Strategies.....	16
Food Waste Reduction Planning in Homes.....	18
Food Waste Measurement Strategies	20
Food Waste Measurement Testing in Schools	22

CHAPTER	Page
Food Waste Study Purpose/Conclusion	23
3 METHODS	25
Participants	25
Study Design.....	25
Protocol Procedure.....	25
Statistical Analyses	27
4 RESULTS	28
5 DISCUSSION	34
6 CONCLUSION	41
REFERENCES.....	32
 APPENDIX	
A QUESTIONNAIRE QUESTIONS.....	48
B QUESTIONNAIRE QUESTIONS TRANSLATED TO ENGLISH.....	51
C IRB APPLICATION.....	52
D IRB MODIFICATION	57

LIST OF TABLES

Table		Page
1.	Participant Demographics	30
2.	Intra-class Correlation Results by Food Category.....	32
3.	Cronbach's Alpha Results by Food Category	33

LIST OF FIGURES

Figure	Page
1. Food Waste Breakdown of Supply Chain by Region	14
2. EPA's Food Recovery Hierarchy for Reducing Food Waste	18

CHAPTER 1

INTRODUCTION

In the United States, it is estimated that between 30 to 40% of all food in the U.S. supply chain is wasted.^{1,2} Given the scale of the problem, and its relation to public health, environmental, and economic outcomes for individuals and the country alike, food waste has captured the interest of policy makers, community organizations, and researchers alike.³ This is important in the context of a consumer economy such as that in the U.S., because while food waste comes from all levels of the food supply chain, the largest proportion of food waste comes from the retail and consumer levels.^{4,5}

Aside from the losses of various precious resources used to grow food such as water, fertilizers and pesticides, considerable climate change emissions are of major concern.⁶ Landfills have generated between 14-18% of the U.S.'s methane gas emissions and food waste is the biggest contributor towards it.^{7,8} Methane is one of the leading gases contributing to climate change because of its high density and ability to trap heat in the atmosphere like a blanket.⁹ Methane is not the only gas that contributes to global warming, however. Carbon dioxide is also a greenhouse gas that is emitted in the production, transportation and handling of food.⁶ It is therefore important to understand the repercussions of climate change because of its impact on society.

Many of these key impacts have direct effects on public health. Extreme weather, resulting from climate change, as well as wildfires, decreased air quality, and possible disease transmitted through insects, contaminated food and water can negatively impact the health of the population.¹⁰ Increased deaths related to extreme weather conditions and

a positive association between infectious disease and climate change have also been reported.¹¹ Additionally, climate change hinders food security because of its effect on water quality, increased drought, and harm to ocean ecosystems.¹⁰ Food insecurity can lead to negative health outcomes in children such as oral health problems, increased risk for asthma, exacerbating chronic illnesses, and mental health challenges.¹¹ Food insecurity can also affect the elder population health with increased risk for diabetes, cardiovascular health problems, and mental health challenges.¹¹

Food waste affects the economy as well. It accounts for an average of \$165.5 billion loss per year.¹² In 2019, it accounted for a \$285 billion loss.¹³ All levels of the food production chain are affected economically, from farms, losing an average of \$14 billion, to consumers, losing an average of \$158 billion.¹³ The USDA states that on average \$370 could be saved per person annually by reducing food waste.⁷ Additionally, the USDA states that trash pickup is less expensive in some areas when there is less food in the bin and that some trash pickups will lower prices if food is separated from trash and sent to be composted.⁷ Finally, the Business Case for Reducing Food Loss and Waste found that 99% of the 1200 business sites from 17 countries (including food manufacturing, food retail, hospitality and food service) had a positive return on investment after reducing their food waste.¹⁴

There have been a variety of programs and attempts to reduce food waste including the ReFED's (a national non-profit organization that is dedicated to reducing food loss and waste) "Roadmap to 2030: Reducing U.S. Food Waste by 50%", the EPA's Food Recovery Challenge, and the USDA and EPA's U.S. Food Loss and Waste 2030

Champion program.^{13,15} ReFED estimates that with policy changes, innovation and engagement with a \$40 billion budget, food waste can be reduced by 45 million tons, saving \$73 billion in net financial benefit, 4 tons of water, and 75 million metric tons of greenhouse gases.¹³ It could also increase availability of food by 4 billion meals, and create 51,000 jobs over 10 years.¹³ Some examples of the changes needed to accomplish the plan are optimizing harvests, enhancing product distributions, refining product management, and maximize recycling.¹³ The EPA's recovery challenge incentivized United States businesses with a competition to gain EPA recognition by reducing food waste in their operations using a variety of strategies and goals.¹⁶ The EPA has since discontinued the program but is developing a new program that encompasses the advancements that have been made over the last 3 decades.¹⁷ The USDA and EPA's Food Loss and Waste 2030 Champions also seeks to reduce food waste by targeting large corporations. By joining this program, the corporations commit to reducing their food waste in their operations by 50% by the year 2030.¹⁸ They created a food recovery hierarchy to provide a visualization to corporations about preferred routes to reduce food waste. The hierarchy presents "source reduction" as its highest or most effective strategy to reduce food waste. This is then followed by feeding hungry people, feeding animals, allocations to industrial uses, composting and incineration/landfill respectively.^{8,15} However, while the EPA also has resources available for consumers on their website about how individual households can reduce their food waste (including making a shopping list, keeping track of what foods are already in the house to avoid buying more,

planning meals, and purchasing imperfect product), much less attention has been focused on the issue at the household level.¹⁹

While the EPA and USDA are dedicated to reducing the food loss and waste around the country, neither has a baseline to estimate food loss and waste.¹⁵ The USDA claims that if a data collection tool that can reliably and accurately assess food waste is developed, this would represent a major boon for research in this area.¹⁵

As there is not a widely used tool currently in existence that can reliably assess food waste produced in households, this study aimed to assess the reliability of a self-assessment tool of food waste across food categories, to be initially evaluated using a convenience sample of Mexican households that had participated in previous studies of our lab. This approach represented a critical first step for exploring a new way to assess and estimate food waste in households. In creating a tool that may be reliable, researchers can go on to validate such a tool and begin to measure how much food the average person wastes and, in turn, government agencies such as the USDA and EPA can take the necessary steps to address reduction, on a national or even global scale.

Definition of terms:

Reliability: The consistency or repeatability of measures used in a study/experiment

Test re-test reliability: The assessment of the consistency of a score 2 or more times over a period of time

Internal reliability: A measure of how well items in a set relate to a topic

Delimitations and limitations:

Delimitations: One delimitation in this study is the geographical area selected for participants in the study. All participants are from Mexico which may not be representative of the food waste behaviors of those in the United States.

Additionally, the food waste self-assessment did not have open-ended responses which limits participants choices one of the available options. The options may not always completely align with the participants food practices and can cause inaccuracies in reporting.

Limitations: Some limitations that occurred in this study were that the participants self-assessed their food practices. They may be likely to rate themselves in a light that they *think* will make them look like they produce less food waste, even when is it discouraged to do so. Another limitation of this study is that only those who volunteered to participate were selected for the study as randomization could not be achieved.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Food waste is an issue gaining considerable attention in academic literature. Because food waste, including its sources; potential health, economic, and environmental impacts; and mitigation strategies, are still not entirely defined, studies are now being published exploring these and other topics. Federal entities are also taking notice: the Environmental Protection Agency (EPA) recently posted its first ever call for proposals regarding research focused on consumer food waste reduction.²⁰

Food waste is the number-one category of material that ends up in municipal landfills.²¹ Food is lost in a variety of ways throughout the food production chain, from the growing phase all the way through the consumer phase. In relation to food production, considerable resources are dedicated to growing food at the industrial scale, including water and fertilizers. With the estimated loss of one-quarter or more of the food produced globally, it is estimated that 24% of total water, 23% of total land, and 23% of global fertilizer is wasted.²² Additionally, food is wasted through agricultural overproduction. Producers harvest more food than demand due to overfishing, spillage during harvest, and illness of animals.²¹ Food waste also happens during processing and handling phases. Foods that are prepackaged, for instance, foods that are canned or smoked, trimming of meats, vegetables, fruits, etc. produce a significant amount of food waste due to the scrapping of anything that is not considered suitable.²¹ Also, in the industrial setting, extra pieces of food that are considered “scrap” that could be

potentially used for other purposes, such as ingredients in other products, are often thrown away.²¹ The final stages of the food production chain are the distribution and consumer stages. Industrialized and developed countries that are considered high income countries, particularly those in North America, Oceania, and Europe waste more food at the consumer level compared to developing countries, or those considered to be low-income countries, such as Sub-Saharan Africa and South/Southeast Asia.²¹ Though developing countries and developed countries waste food at different stages, they both waste between 630-670 million tons of food per year.²³

Food waste in households

About one-third, or roughly 31%, of all food waste comes from the retail and consumer levels in the U.S.^{15,24,25} This equates to about 1.3 billion tons of food per year.²¹ There are many variables that go into the amount of food wasted at the consumer level. For instance, the income level, empathy level, and the behaviors and attitudes that relate to food waste have a great impact on the amount of food waste a household can produce.²⁶ Households that have a higher income level are suggested to have more food waste because of their “disposable” income.²⁶ This information comes from a study done that surveyed U.S consumers about their food-related behaviors.²⁶ The survey consisted of a variety of questions that fit within 3 principal components. The components included what families thought they would lose if they reduced their food waste, the guilt that was associated with food waste and whether the household felt that they could do more to reduce their food waste. Some of the statements that participants rated included “throwing food away after its package date prevents food illness” and “food past its

package date has a significant decrease in quality”^{.26} Researchers conducted a multivariate regression analysis; results showed that those with higher income levels were more likely to have the highest score with regards to questions pertaining to the benefits lost by reducing food waste.^{.26}

Household income is not the only factor influencing food waste, however. Perceived effects of food waste also influence the behaviors associated with food waste. Fifty-nine point three percent of respondents in the survey agreed with the statement that some food waste is necessary to ensure food quality.^{.26} Further, more than half of survey respondents strongly agreed that throwing food away past the package date reduced the risk of foodborne illness.^{.26} In high income households, uneaten food being tossed was linked with more perceived benefits such as reducing the risk of foodborne illness.^{.26} However, even as households reported a high level of food waste across demographics, they similarly reported high levels of guilt attached to the behavior. Seventy-seven percent of respondents answered that they feel guilty for throwing food away.^{.26} Despite this, 51.2% responded that it would be difficult to further reduce food waste within their home.^{.26}

Food waste and demographics

Food waste likely occurs in every household in every country. However, specific variables, like socioeconomic status, accessibility to food, the type of diet, and number of household members all factor into how much food waste is produced. A study conducted by Machate assessed the influence of household demographics on food waste.^{.27} Results from a meta-analysis found that older adults, those aged 65 and older

wasted less food than younger adults.²⁷ The study also concluded that higher income households waste less food than lower income households.²⁷ Employment and education level were also assessed. Those employed or self-employed wasted the least amount of food and those who were unemployed (students, retired, housewives) produced the most waste.²⁷ The study suggested three scenarios that had potential influences on the results. The suggested scenarios were that the person who prepares the food creates the most food waste, the person who spends the most time in the house wastes the most food, and the person/people who are not in charge of making the food purchases waste the most food.²⁷ The final category assessed in the study was education level. No correlation between food waste and education level was determined.²⁷ The study then concluded that there would need to be more studies with larger sample sizes to confirm the results.²⁷

Type of diet followed may also play an important role in how much food waste a house can produce. Fruits and vegetables represent the largest proportion of avoidable food waste, contributing to about 65% of all avoidable food waste. This is then followed by breads and cereals (25%), meat and fish (6%), milk, cheese and eggs (2%), fats and sugars (1%), and other (1%).²⁸

Food waste in restaurants

Food waste at the consumer level does not come solely from households. Restaurant also show significant amounts of food waste. A survey created to assess food waste in restaurants revealed that 34% of restaurants do not measure the amount of food waste that they produce.²⁹ Additionally, the most common method of disposing of food in restaurants is giving it to employees, noted among 72% of respondents.²⁹ Suggestions for

restaurants to reduce their food waste recommended by the study included donation to homeless shelters, food pantries, or other means to reduce food insecurity to vulnerable populations.²⁹ However, due to potential liability donation can cause, 75% of survey respondents stated that they do not donate food because of those concerns.²⁹ Finally, at least 14% of the restaurants surveyed disposed of their food waste to landfills.²⁹ It has been suggested that methods for measuring food waste be further researched and that restaurants take more action to reduce their food waste.²⁹

Food waste and the environment

One concern of food waste is its effect on the environment. Understanding the root cause of global warming has been an area of interest to researchers for decades. Greenhouse gasses are one of many contributions to global warming and can be produced from food waste. For example, in developing countries, such as Mexico and Brazil, enforcement from the local and government officials to participate in recycling programs or separate municipal waste from food waste is limited, and therefore, greenhouse gasses are emitted in the landfills from that lack of separation.²³ The greenhouse gasses in landfills create a blanket effect over the earth keeping the warmth from the sun under it, resulting in an increase in the earth's temperature, which contributes to global warming.³⁰ In fact, the EPA reported that in 2021, 170 million MTCO₂e greenhouse gas emissions came from food waste.³¹ This number does not include the greenhouse gasses, primarily methane, that came from landfills.³¹ That number is equivalent to the amount of CO₂ produced from about 42 coal-fired power powerplants.³¹

Food waste also affects the environment because of the resources used in food production. Nitrogen fertilizer, for example, is the biggest investment of energy in producing the food because it uses so little of the nitrogen to grow and expels more into the atmosphere as greenhouse gasses.³² Phosphorous fertilizers can be problematic in different ways, causing harm to marine life if lost into the aquatic environment.³³ The circulation of nitrogen in the atmosphere can have negative effects in a variety of ways including damage to marine systems and freshwater ecosystems, as phosphorous can promote the growth of toxic algal to the environment which can affect human health.³³ Unfortunately, higher quality diets that are rich in fresh fruits and vegetables can result in more wasted irrigation and pesticides required of them.³³ Another environmental concern due to food waste is the amount of wasted cropland used to promote food growth. Land use is predicted to be a large contributing factor because of the estimated land and resources it takes to produce the amount of food that is wasted.³⁴

Food waste and the economy

Food waste significantly affects the economy as well. Food waste in the United States accounts for about a \$161.5 billion loss per year.³⁵ Farmers are especially affected economically by food waste because of the unsellable produce. Some foods are harvested “cosmetically challenged” and will result in being thrown away unless they are composted.³⁶ Farmers also often overproduce crops due to uncertainty of demand, which results in extra crops remaining in the field or going unsold.³⁷ Consumers also contribute to a money loss to retailers because consumers will likely not buy produce that is seen as “flawed”, such as being misshapen or bruised, even if the product is still edible.³⁷ Finally,

consumers lose money by overbuying food and allowing it to spoil before consuming or throwing away food that is still safe for human consumption, but the “best by” or “sell by” dates on them have passed.²¹

A 16-year analysis study conducted by Conrad using the National Health and Nutrition Examination Survey (NHANES), the USDA Center for Nutrition Policy and Promotion (CNPP), the USDA Loss-adjusted Food Availability data series (LAFA), the Food Commodity Intake Database (FCID), and the National Household Food Acquisition and Purchase Survey (FoodAPS) to estimate total food waste and cost revealed that the average cost of food waste per capita per day was between \$7.65 and \$7.88.³⁸ It was estimated that over one-quarter of consumer daily budget is spent per day on wasted food, approximately \$3.50.³⁸ The cost per capita per year on wasted food is estimated to be \$1300.³⁸

Food waste globally

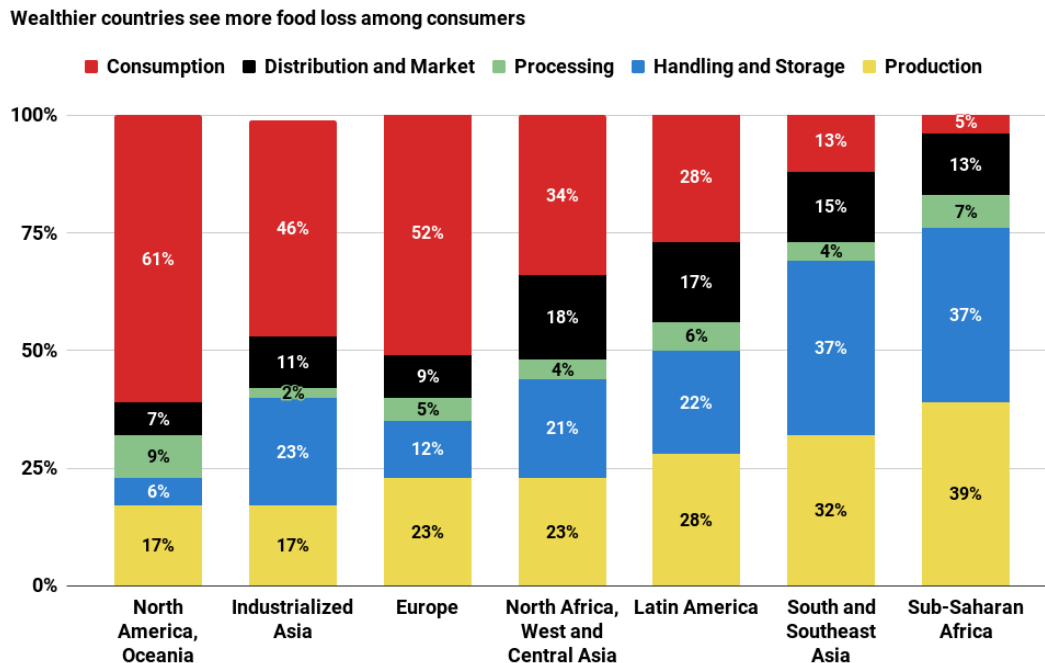
Though many efforts to reduce food waste exist in the United States, it is not the only country that produces food waste at any level. Both developing countries and industrialized countries produce food waste. Developing countries generally face bigger challenges in food waste management than developed countries because of the lack of separation in waste such as recycling.²³ Additionally, developing countries do not have the education programs to teach about separating waste or the funding to improve their food waste reduction strategies.²³ Despite differences in food waste reduction strategies, a study revealed that developed countries and developing countries produce approximately the same amount food waste. In countries occupying Europe and North America, food

waste per capita was about 95-115kg/year where in Sub-Saharan Africa and South/Southeast Asia, countries food waste per capita was about 6-11kg/year.^{21,23} However, with the total population in the 49 recognized developed countries being about 1.2 billion combined, and the population in the 137 developing countries being about 6 billion combined, there is little difference in the estimated total food waste, amounting to about 670 million tons compared to about 630 million tons respectively.²³ Additionally, developing countries tend to produce more food waste per capita from the production to retailing phases than developed countries, further balancing the amount of food waste produced between them.²¹ The main differences that occur between developing countries and developed countries in terms of food waste have to do with income level, population size and public participation in food waste management.²³ There is a definitive correlation between income level and food waste, however, it differs between the types of country and food waste reduction policy. In developed countries, as income increases, the amount of food waste produced decreases when a “zero waste” policy is in place.²³ But in developed countries that lack a “zero waste” plan, increasing income is related to food waste increases.²³ Developing countries show a similar result as developed countries without a “zero waste” policy: as income increases, food waste also increases.²³

Food is lost at all levels of the food chain and the amount produced at each level varies by categorization of the continent. In an analysis of food wasted at different levels of the food supply chain between continents, it was determined that areas of the world populated by more industrialized countries (such as those in North America/Oceania

(grouped as one), Industrialized Asia, Europe, and North Africa/West and Central Asia (grouped as one)) produce more food waste at the consumer level/distribution and marketing level.³⁹ In all four categorized locations, the consumer and distribution and marketing level of the supply chain make up more than 50% of the food wasted in said regions, at 68%, 57%, 61%, and 52% respectively.³⁹ For developing regions, such as Latin America, South/Southeast Asia, and Sub-Saharan Africa, most food waste occurs at the production and handling/storage phases resulting in about 50%, 69%, and 76% of total food waste, respectively.³⁹ A breakdown of percentage of food lost during the food supply chain by region can be seen in Figure 1.

Figure 1. Food waste breakdown of supply chain by region.³⁹ Image adapted from Lipinski, B. et al. 2013. “Reducing Food Loss and Waste.” Working Paper, Installment 2 of Creating a Sustainable Food Future. Washington, DC: World Resources Institute.



Food waste and health

Food waste is also related to population health. Fruit, vegetables, and combined fruit and vegetable dishes are the highest wasted food category at 38% of total wasted food.³³ Fruits and vegetables are high in essential nutrients and one study assessed the nutrient content of wasted food. This study determined that over 800 kcal per person per day was wasted, approximately 29% of total daily recommended intake.³³ Additionally, the study determined that carotenoids were the highest wasted nutrient, at 31% of total nutrients wasted, followed by vitamin D at 25%.³³ The study, however, refrained from interpreting the diet quality as increasing if the wasted food was eaten because it is possible that overconsumption, increased intake of sodium, saturated fat, and added sugar, which are known to increase disease risk, can also be a possible outcome.³³ The study also assessed diet quality and its association with food waste. The study determined that higher quality diets resulted in more food waste. On the contrary, food insecurity may also play a role with food waste and health. The more a family is food insecure, the more likely they are to acquire chronic diseases, but they are also less likely to produce food waste, according to one study.^{27,40} Those who are food insecure tend to have limited access to healthy food options.⁴¹ Fruits and vegetables, a food category that produces a high volume of food waste, are essential for preventing chronic disease and are linked to improving health when intake of them increases.^{21,42} However, a separate study revealed that lower income families produce more food waste than higher income families.²⁷ To address food waste, promoting a healthy diet, and food insecure families, a health

promotion program, Brighter Bites, was implemented in Texas.⁴⁰ The program provided families each week with 2 bags of produce at no cost.⁴⁰ It addressed food waste at the production and retail level by using produce donated by local retailers, farmers, growers, and food banks.⁴⁰ It also provided nutrition education in schools to children and provided families with recipes and tips on how to prepare the food that came in the bags.⁴⁰ The program also provided families with nutrition handbooks that outlined proper food handling, food storage, menu planning, grocery shopping tips, and healthy recipes.⁴⁰ A study that assessed the effectiveness of Brighter Bites from 2013-2016 revealed that 83% of parents reported a general increase in fruit and vegetable intake in their children. It also reported that across the three years parents saved between \$29.80 to \$30 each week on groceries.⁴⁰ The parents last reported on the survey that parents were using about 90% of the fruit provided and 85% of the vegetables provided each week.⁴⁰

National food waste reduction strategies

Knowing the impact food waste has on the environment, economy, and population health, government agencies have started to implement food waste reduction strategies in attempt to mitigate those effects. The United States Department of Agriculture's (USDA) plan "Winning on Reducing Food Waste Initiative" is one of those plans.⁴³ The EPA, USDA, and Food and Drug Administration (FDA) coordinated to create a plan to reduce food loss and waste throughout the country.⁴³ Their goal is to increase education on the potential impacts of reducing food waste and leverage government resources more effectively to implement strategic methods to reduce food waste.⁴³

Another attempt to address food waste came from the EPA called the Food Recovery Challenge.¹⁶ This plan challenged businesses and organizations to reduce their waste in their daily operations in exchange for recognition from the EPA each year to the organization or business that reduced the most.¹⁶ The EPA took the initiative to create a visual (Figure 2) to show the most important reduction strategies from most preferred to least preferred based on the potential benefits those actions would produce.⁴⁴ There are 6 strategies in the pyramid including, from most preferred to least preferred: Source Reduction, Feed Hungry People, Feed Animals, Industrial Uses, Composting, and Landfill/Incineration.⁴⁴

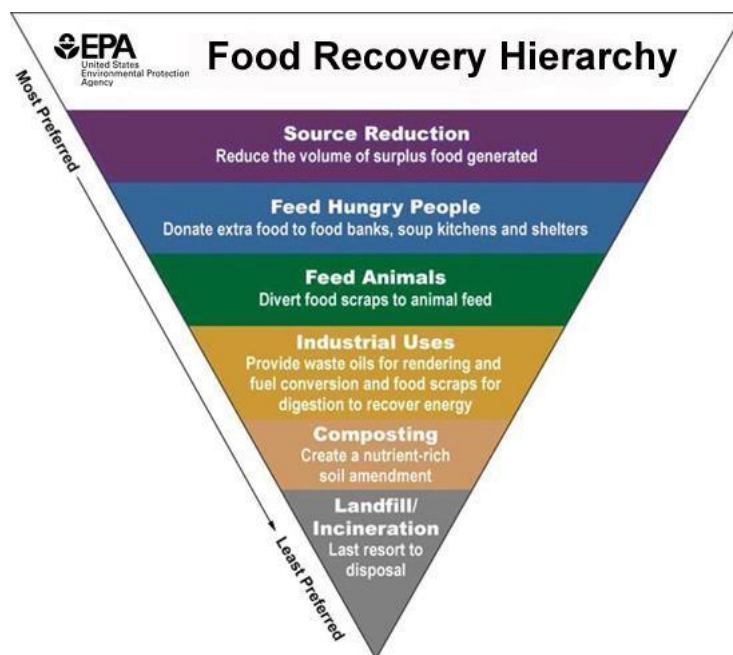
The National Resources Defense Council's (NRDC) "Save The Food" campaign also aims to reduce food waste. There are a variety of resources for consumers to use to reduce their food waste at home on their website. Some of these resources include storage and planning tips and creative methods to include foods on the verge of spoiling into new recipes.⁴⁵ Additionally, the NRDC advocates for sensible food date labeling and promotes food rescue in restaurants and recycling of food scraps.⁴⁶

The USDA and EPA have another plan to reduce food waste called the U.S. Food Loss and Waste 2030 Champions.¹⁸ This plan targets large businesses and organizations and challenges them to commit to reducing their food waste and loss by 50% by the year of 2030.¹⁸ Some of these businesses include large corporations such as Amazon, Kellogg's, Sodexo, Wendy's, Walmart, Walt Disney World, PepsiCo, Hilton and more.¹⁸

Feeding America is yet another organization that aims to address food waste. Feeding America "rescues" food by working with participating retailers, manufacturers,

and farmers and collects food that would otherwise be thrown away.⁴⁷ In 2021, Feeding America rescued 4.7 billion pounds of groceries that were originally going to be thrown away, despite its safety for human consumption.⁴⁷ The food rescued goes directly towards supporting the 38 million Americans facing hunger.⁴⁷

Figure 2. EPA’s Food Recovery Hierarchy for reducing food waste. Adapted from <https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy>



Food waste reduction planning in homes

Consumer behaviors have also been assessed to prevent food waste. The USDA, EPA and FDA have taken steps to address consumer behavior by dedicating sections of their databases towards reducing waste in the home.^{19,48,49} The EPA provides planning and shopping tips including double checking the pantry to ensure food is not double bought, buying from bulk bins to avoid having to purchase more of an item that will not

be eaten or used, and purchasing imperfect produce to avoid letting it go to waste.¹⁹ The EPA also encourages consumers to reduce their food waste by informing them of the potential benefits reducing waste would do for them. This includes describing how reducing their food waste will reduce their environmental impact and save them money.¹⁹ Guilt, a component of the Qi and Roe study, plays an important role in reducing food waste. In that study, 77.2% either agreed or strongly agreed they experienced the feeling of guilt associated with throwing away food.²⁶ Survey results also showed that females were more likely to agree with statements of guilt towards food waste. As a result, authors suggested that the most influenceable population to target to promote reduction in food waste are women who are more environmentally concerned.²⁶

Other categories that the EPA addresses for consumers includes storage tips and cooking and preparation tips.¹⁹ These categories include how to properly store different types of food at their desired temperature and humidity level, what foods to keep away from each other to avoid premature spoilage, how to make foods last longer that are on the verge of spoilage, such as pickling, and encouraging consumers to learn the difference in the date labels “best by”, “sell by” and “use by”.¹⁹ The USDA and EPA have similar resources including infographics, videos, and pages with tips to reduce food waste. The FDA provides refrigerator tips to consumers such as encouraging them to check the temperature of their refrigerator to ensure foods are being kept at the right temperature, cleaning spills right away to avoid bacterial contamination, and avoiding “over packing” the refrigerator to allow cool air to circulate and maintain foods temperature.⁵⁰ These tips also help maintain food safety while preventing early spoilage.

The USDA encourages consumers to compost instead of throwing compostable food away and the USDA's MyPlate provides consumers with helpful shopping tips such as buying a variety of fresh and frozen food to avoid spoilage, eating before going grocery shopping, and making a plan for meals of the week to avoid buying and not using food.⁴⁹

An exploratory study conducted in Taiwan revealed four prevention strategies that resulted in decreased household food waste.⁵¹ The methods included planned purchase schedules, skills to keep the food fresh for longer, understanding family preferences and leftovers management, and sharing additional food and co-procurement and cooking.⁵¹ These methods addressed four motivators of reducing food waste.⁵¹ The motivators included convenient shopping environment, health concerns, social-cultural values and social norms, and food expenditure.⁵¹

Food waste measurement strategies

Important to the growing area of food waste research are tools for reliable measurement of waste in the home. However, only a handful of studies have included development of these types of tools. A study conducted in Swiss households determined a correlation between a novel food waste questionnaire (FWQ) and a food waste diary (FWD).⁵² This study had the participants take an online survey consisting of questions related to the participants food waste behaviors, including the type of food eaten and amount wasted by themselves and by other members of their family.⁵² It relied on the participants ability to accurately remember those behaviors and the frequency of them.⁵² The participants were then asked if they wanted to continue to participate in the FWD portion for a monetary incentive.⁵² The FWD was a method used to determine the

objective amount of food wasted in the participants, what the reason for the disposal of food was, and how it was disposed.⁵² This was done by the participants weighing their food waste and reporting the measures stated above for twenty-one days.⁵² The study aimed to assess if the two measures were correlated and determine if psychological predictors for the two measures were the same.⁵² The results of the correlational and regression analyses revealed that the food waste per person per week in the FWQ and FWD were significantly positively correlated with one another and shared similar patterns in their predictors.⁵² Another study, conducted in Italy, also measured the correlation between a questionnaire and food waste diary.⁵³ This study had two stages. In stage one, participants measured their food waste after each meal, they were recommended to use a kitchen scale or other means such as a spoon or glass, and recorded it in a diary over the period of one week.⁵³ The type of food (canned, fresh, frozen) and the method of disposal (trash, fed to pets, composted), along with the product being thrown away and the cause of the wasted food was also recorded in the diary.⁵³ The participants also had to check off a box indicating if the food was edible or inedible.⁵³ The next stage of the study involved a Computer Assisted Web Interview (CAWI) questionnaire that was made up of 23 questions to assess the food waste behaviors, including the shopping, preparing, and managing of food and leftovers, feelings towards food waste, motivators for food waste reduction strategies, and their estimation for their food waste.⁵³ This questionnaire was only delivered once.⁵³ This study had a large sample size of 388 families sampled, with variety in number of household members.⁵³ The study concluded after using non-parametric testing and a

multivariate analysis that there was a high amount of bias when comparing the questionnaire and diary, and the questionnaire should not be used to assess the quantity of food waste a household produces.⁵³ Additionally, this study advised for further studies to be conducted, with changes in the questioning.⁵³

Food waste measurement testing in schools

Some assessment tools that have been used in studies, such as one in a National School Lunch Program study which included methods like visual estimation, photography, direct weighing, and a combination of all three were not determined to be accurate or reliable and results were varied.⁵⁴ Two additional studies done in school cafeterias - one in an elementary school and another done in 4 middle and 5 high schools - also addressed reliability in tools to assess food waste.^{55,56} The study at the elementary school measured the reliability of visualization techniques including the quarter waste method, the half waste method and the photograph method.⁵⁶ The quarter waste method is a method of assessing how much food has been left on a tray after a student discards it. The researcher in the study would look at how much food was left on the tray or pick up any container that was not able to be visually assessed, such as a milk carton, and determine how much of each food item was left, by classifying each individual item as none, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, or all.⁵⁶ A second researcher then did the same thing, and then the tray was passed to the final two researchers to weigh each individual food item.⁵⁶ The half waste method is the same concept, however instead of using quarter increments, the half waste visualization method uses none, $\frac{1}{2}$, or all to record each item left on the tray.⁵⁶ The photography method included taking a photograph of the tray, then researchers would

estimate how much food waste was left on the tray by 0.10 increments (none, 0.10, 0.20...to all wasted).⁵⁶ Inter-rater reliability and inter-method reliability were tested against the methods.⁵⁶ Of the three methods, the quarter waste method was the most reliable measure of both inter-rater reliability and inter-method reliability at 0.95 and 0.90 respectively.⁵⁶ Following not far behind was the half waste method at 0.88 and 0.83 and finally with low reliability, the photograph method at 0.57 and 0.48.⁵⁶ This study deemed the quarter waste method and the half waste method reliable measuring tools to estimate food waste in schools.⁵⁶ The study conducted in the middle and high schools also tested inter-rater reliability on the quarter waste method using the k statistic to assess inter-rater reliability and found that the percentage of perfect agreement or almost perfect agreement was 87%, where $k > 60\%$ indicated strong reliability.⁵⁵ They deemed the quarter waste method a reliable tool in assessing food waste.⁵⁵ The methods that were assessed for reliability have the potential to be extremely useful in research and for the initiation of food waste prevention tools. However, these studies were conducted in schools. The gap in literature still lies in testing the reliability of food waste self-assessment tools for household food waste. As described by Sakaguchi et al., “the current tools for assessing food waste are highly complex or lack accuracy.”²⁹

Food waste study purpose/conclusion

Food waste is an ongoing world problem that has effects on the environment, the economy and population health. Although attempts have been made to reduce food waste, there is still a lack of methods to assess food waste at the household level. This study's purpose was to design and test the reliability of a self-assessment tool intended to

measure food waste, to be pilot-tested among Mexican households. This information is critical for formulating a new way to assess and estimate food waste in households, as strong methods are currently lacking. By creating a tool that is reliable, researchers can go on to validate such tools and begin to measure how much food the average person wastes and, in turn, can take the necessary steps to address reduction, on a national or even global scale.

CHAPTER 3

METHODS

Participants

The participants in this study were recruited from previous research conducted in Mexico where twenty-four participants voluntarily gave their permission to be contacted for future studies. The participants were also recruited in Mexico using Facebook ads, using the snowball technique to reach them. Using a priori power analysis using an alpha level of 0.05 and an intra-class correlation of 0.50, it was determined that a sample size of 92 with two observations per participant would provide a power of 0.95. A 20% dropout rate was assumed and a final sample size of 115 participants was determined to be sufficient for this study. Inclusion criteria comprised the following: adults over the age of 18 and who have resided in Mexico for at least 1 year, who were responsible for food-related decisions in their household, who were fluent in Spanish as the survey was distributed in Spanish, and had access to the internet.

Study Design

This reliability study included a quantitative self-assessment in which participants completed an 11-item food waste self-assessment at two time-points separated by a 14-day waiting period. The study was designed to determine test-retest reliability.

Protocol procedure

IRB approval was granted through ASU's IRB prior to conducting this study (See Appendices C and D). Participants were recruited to participate in the study through their contact information in Qualtrics. These contact data were collected as a part of a previous

study in which participants gave permission to be contacted for future studies.

Participants were incentivized with a \$5 gift card for completing both surveys. Before they began, participants were asked to complete an informed consent form, and asked a series of demographic information questions that included income, number of family members in the home, if there were any minors in the home, and if they worked. The online questionnaire the participants completed contained a series of questions about the composition of their household food waste (e.g. fruits, vegetables, and other food categories); see appendix A for Spanish, B for English. The participants were sent a survey to complete via email. After the survey was completed, a second survey was sent 14 days later to be completed once again.

The survey questions were developed by members of the Radical Simplicity Lab team, Dr. Christopher Wharton, Maricarmen Vizcaino, and Bryanna Leone. The Radical Simplicity Lab team met weekly to develop the survey questions including the type of question (close-ended), the food categories and how they were separated, and question verbiage. Maricarmen, a member of the Radical Simplicity Lab team translated the questions from the English version to the Spanish version. She also worked on another Mexico study and therefore had known what dialect to translate the survey into. The survey had participants rate, on a Likert scale from 1-6, their food waste behaviors with regard to specific food categories where 1 = almost none, 2 = very little, 3 = moderate amount, 4 = a good deal, 5 = a great deal, and 6 = I never buy these foods. Food categories included fresh fruits, fresh vegetables, dairy products, meat and poultry products, eggs, meat alternative products, fish and seafood products, bread products,

leftovers, shelf stable foods, and frozen foods. Cronbach's alpha and a two-way mixed single rater absolute agreement intra-class correlation test were performed to determine survey test-retest reliability and internal reliability respectively. ICC results are recorded as single measures. The final question of the survey was a sliding visual scale that asked about the percentage of household food waste on a scale from 0 to 100%. The scale was developed by members of the same team and was previously analyzed in a separate study. It was used in this study because of its strong correlation with objectively measured food waste in prior research.

Statistical Analyses

Two tests were done to analyze survey responses. The first test conducted was a two-way mixed, single-rater, absolute agreement model for intra-class correlation. This is also known as test-retest reliability and shows how closely responses from individual participants across both surveys related to one another over time. The second test analysis was Cronbach's alpha. This test examined the internal reliability of survey items. In other words, this test was conducted to assess how well each survey item related to the overall concept of food waste. Analyses were conducted in the Statistical Package for Social Sciences, version 28.0.1.1 (14).

CHAPTER 4

RESULTS

A total of thirty-three participants agreed to take part in the study. This included 24 participants from the previous study and 9 participants from the Facebook ad. A total of 22 participants completed the study in its entirety and were included in the results. The number of participants recruited was significantly smaller than the estimated need of sufficient participants for this study. Because this study was voluntary, the sampling pool was small. One participant did not complete demographic information. Majority of participants (73%) reported that they lived with their family, while 9% reported living just with their spouse and another 9% living by themselves. Fifty-nine percent of respondents stated that they live with a minor. Household size consisted of 9% 1-person, 27% 2-person, 14% 3-person, 18% 4-person, 9% 5-person, 14% 6-person, and 5% 7-person. Approximately 59% of respondents reported working full time, 27% of respondents reported working part-time, and 9% reported that they do not work. Approximately 5% of respondents have an income less than \$5,000 Pesos (less than \$252.96 USD), 14% have an income between \$5,000-\$9,999 Pesos (\$252.96-\$505.86 USD), 18% between \$10,000-\$19,999 Pesos (\$505.92-\$1,011.78 USD), 14% between \$20,000-\$29,999 Pesos (\$1,011.83-\$1,517.69 USD), 14% between \$30,000-\$39,999 Pesos (\$1,517.75-\$2,023.61 USD), 14% between \$40,000-\$49,000 Pesos (\$2,023.66-\$2,529.52 USD), 5% between \$50,000-\$59,000 Pesos (\$2,529.58-\$3,035.44 USD) and 5% of participants income is greater than \$60,000 Pesos (greater than \$3,035.49 USD). A breakdown of participant demographics can be seen in Table 1. Two tests were

performed to determine the reliability of the food waste self-assessment tool. Intra-class Correlation for internal reliability and Cronbach's Alpha for test-retest reliability. Fresh vegetables, Meat and Poultry Products, Meat Alternative Products, Fish and Seafood Products, Leftovers and Shelf Stable Foods yielded ICC values above the lowest threshold for moderate reliability (ICC = 0.5). Conversely, Fresh Fruit, Dairy Products, Eggs, Bread Products, and Frozen Foods did not meet the minimum threshold for moderate reliability. Frozen Foods yielded an unusual result of a negative value of -0.004 when calculating ICC values. When testing Cronbach's Alpha, Fresh Vegetables, Meat and Poultry Products, Fish and Seafood Products, Leftovers, and Shelf Stable Foods yielded test results of $\alpha > 0.70$ where anything greater than 0.70 is an accepted value of reliability. Fresh Fruit, Dairy Products, Eggs, Meat Alternative Products, Bread Products, and Frozen Foods did not yield test results that surpassed the 0.70 threshold for acceptable reliability. Frozen Food also yielded a negative value for Cronbach's Alpha, with a result of -0.008. Tables 2 and 3 show ICC results and Cronbach's alpha for all food categories and their respective yielded results.

Table 1. Participant Demographics

	Number of Participants	Percent of Participants
Overall	21	95%
Lives with:		
<i>Self</i>	2	9%
<i>Partner/Spouse</i>	2	9%
<i>Family (Partner/Spouse, Children)</i>	16	73%
<i>Did not answer</i>	1	5%
Work		
<i>Full Time</i>	13	59%
<i>Part time</i>	6	27%
<i>Unemployed</i>	2	9%
Income (converted to USD)		
<i>Less than \$252.96</i>	1	5%
<i>Between \$252.96-\$505.86</i>	3	14%
<i>Between \$505.92-\$1,011.78</i>	4	18%
<i>Between \$1,011.83-\$1,517.69</i>	3	14%
<i>Between \$1,517.75-\$2,023.61</i>	3	14%

<i>Between \$2,023.66-\$2,529.52</i>	3	14%
<i>Between \$2,529.58-\$3,035.44</i>	1	5%
<i>Greater than \$3,035.49</i>	1	5%
<i>Did not answer</i>	2	9%
Live with minors		
<i>Yes</i>	13	59%
<i>No</i>	8	36%
Number of household members (including self)		
<i>One</i>	2	9%
<i>Two</i>	6	27%
<i>Three</i>	3	14%
<i>Four</i>	4	18%
<i>Five</i>	2	9%
<i>Six</i>	3	14%
<i>Seven</i>	1	5%

Table 2. Intra-class Correlation Results by Food Category.

Food Category	ICC Value	95% CI	p-Value	Survey One		Survey Two	
				Mean	Range	Mean	Range
Fresh Fruit	0.468	0.057, 0.740	0.014*	1.71	1-3	1.67	1-3
Fresh Vegetables	0.540	0.178, 0.777	0.003*	1.86	1-4	2.1	1-3
Dairy Products	0.168	-0.286, 0.551	0.233	1.33	1-2	1.33	1-2
Meat and Poultry Products	1.000	0.999, 1.000	<0.001*	1.52	1-6	1.57	1-6
Eggs	0.261	-0.159, 0.606	0.112	1.14	1-2	1.29	1-2
Meat Alternative Products	0.509	0.113, 0.763	0.008*	2.95	1-6	2.95	1-6
Fish and Seafood Products	0.855	0.686, 0.937	<0.001*	1.48	1-6	1.57	1-6
Bread Products	0.475	0.065, 0.745	0.013*	1.43	1-3	1.43	1-2
Leftovers	0.590	0.240, 0.806	0.002*	1.86	1-4	1.76	1-3
Shelf Stable Foods	0.549	0.172, 0.785	0.001*	1.14	1-2	1.38	1-3
Frozen Foods	-0.004	-0.386, 0.397	0.507	1.19	1-2	1.90	1-6

* = statistically significant value

Table 3. Cronbach's Alpha Results by Food Category

Subscale	No. items	Cronbach's Alpha (α)
Fresh Fruit	2	0.627
Fresh Vegetables	2	0.710
Dairy Products	2	0.279
Meat and Poultry Products	2	1.000
Eggs	2	0.418
Meat Alternative Products	2	0.666
Fish and Seafood Products	2	0.920
Bread Products	2	0.633
Leftovers	2	0.742
Shelf Stable Foods	2	0.751
Frozen Foods	2	-0.008

CHAPTER 5

DISCUSSION

The results revealed a mix of strong and less strong reliability scores when testing for ICC. Six out of the eleven categories tested in this survey resulted in ICC scores >0.5 , all of which were statistically significant values. The statistically significant values mean the results produced were unlikely to be attributable to any accident or coincidence, but that they were associated exclusively with the survey questions. The results indicated that the survey questions regarding fresh vegetables, meat and poultry products, meat alternative products, fish and seafood products, leftovers, and shelf stable foods were reliable or consistent from one survey to the next. This means that they have the potential to be used in future studies. Five survey items did not have ICC scores >0.5 , however not all of them were statistically significant. Fresh fruit and bread were the only two survey items that had an ICC value <0.5 that were also statistically significant. The other survey items, including those focused on dairy products, eggs, and frozen foods had ICC values <0.5 . These items were also not statistically significant and as such no conclusions could be drawn about their intra-class correlation reliability. It can be concluded that fresh fruit and bread are not reliable measures when testing for test-retest reliability as responses varied too much between surveys due to their statistical significance. In testing Cronbach's alpha, results demonstrated a mix of reliability scores regarding internal consistency. Fresh vegetables, meat and poultry products, fish and seafood products, leftovers, and shelf stable foods had internal consistency scores of $\alpha > 0.70$ demonstrating acceptable reliability between survey items. This suggests the possibility

that these items may be a reliable combination of questions to explore household food waste. The categories fresh fruit, dairy products, eggs, meal alternative products, bread products and frozen foods resulted in a score of $\alpha < 0.70$ which indicated a poor relationship to other survey items, and therefore, poor internal reliability. These survey items showed that they are not closely related to one other and should not be used together to measure food waste. There was one instance where the results revealed both negative alpha and ICC values. This was for frozen foods. Some survey responses regarding frozen foods increased from week 1 to week 2 and some decreased. A possible explanation for the negative value could be from the inability to accurately determine frozen food waste given that frozen food can possibly be stored for months before it is consumed. This study's results will be useful in creating a more reliable tool to measure food waste, as this one had inconsistent results between categories.

This study differed from others because of its exclusiveness of testing a singular self-assessment survey tool for reliability. Reliability tests for tools to measure food waste are limited. Amicarelli et al. stated that during a critical review when searching for food waste measurement strategies, only 58 matched the search criteria, and noted that there was a large lack of research done in regards to standardized methodologies for measuring food waste.⁵⁷

Giordano et al.'s study, "Are questionnaires a reliable method to measure food waste? A pilot study on Italian households" assessed responses of a food waste questionnaire and a food waste diary and compared it against collected, weighed and registered food waste.⁵⁸ The 3-step study, conducted over a 1-week period, had

participants record two types of estimation strategies for their household food waste in a diary, answer two questionnaires, and audit for food waste.⁵⁸ The participants first answered a questionnaire pertaining to food waste behaviors such as purchasing, storing and cooking foods, the perception of food waste and its effect of the household and the self-perceived quantity of food waste.⁵⁸ They then completed a day's worth of estimation each day using the WRAPS and FUSHION methods of food waste estimation for one week.⁵⁸ The food was collected by participants and put out on the curb after 8pm, where a researcher would come do an audit or audits at during the week.⁵⁹ A second questionnaire was then distributed to participants after they collected their food waste to assess whether the diary correctly adjusted the participants perception of their food waste.⁵⁹ The study used a Mann-Whitney U test to test the comparison of the questionnaire against the diary, the questionnaire against the collection analysis, and diary against the collection analysis.⁵⁸ Results revealed that the lowest estimates of food waste came from the questionnaire, the highest estimates came from the food analysis, and the diary fell in the middle closer to the food waste analysis.⁵⁸ The study found that the questionnaires were not a reliable method to measure food waste, and that food waste diaries and collection analyses may be reliable but that more studies needed to be conducted with a larger sample size to obtain better accuracy.⁵⁸ However, the study did suggest that questionnaires and diaries could be reliable tools to assess food waste behaviors qualitatively.⁵⁸ The pilot study differed from this study in the fact that the questionnaire tool that was used was open-ended and during the study, participants were instructed to

measure, report and collect objective food waste and that there were multiple steps that the participants had to follow.

The Elimelech et al. study tested validity tools similar to those used in this study.⁶⁰ Two objective measurements, a physical waste survey and a food expenditure survey, and a self-assessment questionnaire were analyzed in this study.⁶⁰ This study tested the validity of Likert scale type questions regarding food categories, a sliding scale type question, and a monetary open-ended question asking how much the participant thought the household would save by avoiding food waste, against food waste collected for one week, and receipts from purchases from the previous 2 weeks.⁶⁰ The results concluded that self-assessments might not be a valid tool to measure household food waste because of its significant underestimation when it came to food waste estimation, proportion and monetary loss.⁶⁰ The main difference between this study and the Elimelech et al. study was that the Elimelech et al. study tested the questionnaire only for validity, whereas this study tested the self-assessment for reliability. The survey questions, although also Likert scale, varied in food category. In the Elimelech et al. study, dairy and eggs were classified as one category as were fish, meat, and poultry.⁶⁰ In this study, however, those categories were separated from one another for a better chance of reliability and inclusion of those who may be, for example, pescatarian. The Elimelech et al. survey also assessed monetary loss and participants perception of their monetary loss through the self-assessment whereas in this survey, money was not addressed.⁶⁰

Other food diaries tested to measure household food waste came from the Richter et al. study and the Quested et al. study. In Richter et al. and Quested et al., food diaries

were used to determine food waste behavior and validity of food waste diaries, respectively.^{61,62} The Richter et al. study followed participants over the course of several months. The participants only had to fill out their diary for one week in those months and were required to record what they had in their home at the start of the diary.⁶¹ They then were required to list all food products bought and all food products wasted and why.⁶¹ The food waste diaries were shown to have a strong correlation with food waste behavior, and were found to be occasionally linked to particular behaviors, such as insufficient planning of meals.⁶¹ Food waste diaries have also often been used to test their validity against objectively measuring the waste. In a comparative study by Quedsted et al., five studies that assessed the validity of food waste diaries were analyzed.⁶² The study determined that food waste diaries were shown to significantly underestimate the amount of food waste actually collected.⁶² However, there seemed to be a degree of consistency with the food waste diaries underestimating food waste and the question remained if there could be a tool developed with a scaling factor to estimate food waste.⁶² This study aimed to address that question by using a Likert scale type question to estimate food waste.

With the perceived limited success of tools to measure household food waste reliably and accurately, given the results of the studies listed above, the intent of the study conducted was to develop a reliable measurement tool to measure household food waste with ease to the participant. The goal for the questionnaire in the study was to be successful in testing for reliability. Future studies would then have the opportunity to test for validation, and if successful, would then make the questionnaire a simple tool to measure household food waste with no participant burden. This questionnaire failed to

succeed in being a fully reliable tool, with only some portions being potentially reliable, however, there was less burden that was inflicted on the participant than there would be had the participant been objectively measuring their food waste like some other studies had done. The study can now be used as a guide for a more successful measurement tool to assess household food waste and continue to strengthen literature in developing a reliable and valid tool.

As with all studies, this research suffered from some limitations. Because of the small sample size due to recruiting difficulties, results may not be reflective of any general population. Further, results only provided a first glimpse of the potential reliability of this new survey tool. Another limitation of the study was that data collection occurred among Spanish-speaking participants living in Mexico. Food choices, cultures, and food rules vary across cultures and therefore food waste issues that may be prevalent in Mexico may not be as prevalent in the United States, and vice versa. The same is seen, for example, in research comparing dietary patterns of different cultures, such as that conducted in a study comparing the diets of São Paulo, Brazil and Minneapolis.⁶³ Similarly, food insecurity is also likely to play a role in food purchasing and usage in households, which could affect food waste issues and which was not assessed in the current study. A study conducted in Saudi Arabia found that the more food insecurity existed in households, the more uncooked food waste was produced.⁶⁴ Because food insecurity specifically was not assessed, it is unclear whether reliability of the measure in this study would be similar among those suffering from food insecurity. Finally, this study included a convenience sample of participants who were already involved in prior

research with the laboratory conducting this study. Taken together, results of this study, couched in its limitations, suggest that further research must be done to develop a broader understanding of reliability for this survey tool.

CHAPTER 6

CONCLUSION

This study aimed to test the reliability of a food waste self-assessment tool. Findings revealed that some portions of the survey were potentially reliable, while others were potentially not reliable or impossible to determine in the context of the current study. More research should be done to further test food waste self-assessment tools for reliability. Developing tools such as this one that are found to be just as or more reliable and can be tested for validity, can aid researchers in better understanding the nuances of food waste at the household level. Further, reliable and valid tools to measure food waste can be employed in interventions designed to minimize the effects food waste has on the environment, economy, and population health by giving researchers and more insight on how to address food waste behaviors. Some aspects of this study, such as those that yielded statistically significant results, may be used in future research to test reliability, but when considering food products such as fresh fruit, dairy, eggs, bread, and frozen foods, new or different tools or items may be needed.

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APPENDIX A

QUESTIONNAIRE QUESTIONS EACH PARTICIPANT ANSWERED TWICE, 14-DAYS APART.

Q1. Pensando en las frutas frescas que usted compra en promedio por semana, ¿cuanto estima usted que se tirará en lugar de consumirse?

Q2. Pensando en los vegetales frescos que usted compra en promedio por semana, ¿cuanto estima usted que se tirará en lugar de consumirse?

Q3. Pensando en los productos lácteos que usted compra en promedio por semana (por ejemplo: leche, yogurt, queso, nieve, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q4. Pensando en los productos de carne y ave que usted compra en promedio por semana (por ejemplo: carne molida, chuletas, carnes frías, pollo, nuggets de pollo, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q5. Pensando en los huevos que usted compra en promedio por semana, ¿cuanto estima usted que se tirará en lugar de consumirse?

Q6. Pensando en productos alternativos a la carne que usted compra en promedio por semana (por ejemplo: hamburguesas vegetarianas, tofu, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q7. Pensando en los pescados y mariscos que usted compra en promedio por semana (por ejemplo: filetes de pescado, camarones frescos, pescado entero fresco, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q8. Pensando en productos de harina y de maíz que usted compra en promedio por semana (por ejemplo: pan de caja, pan blanco, tortillas, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q9. Pensando en las sobras de comida que usted genera en una semana promedio (por ejemplo, sobras del desayuno o la cena, comida traída de fuera), ¿cuanto estima usted que se tirará en lugar de consumirse después?

Q10. Pensando en los alimentos no perecederos que usted compra en una semana promedio (por ejemplo: productos empaquetados como las pastas, salsas, mantequillas de cacahuete o avellana, aceites, harinas, cereales, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

Q11. Pensando en las comidas congeladas que usted compra en una semana promedio (por ejemplo: vegetales congelados, carnes congeladas, comidas preparadas congeladas, etc.), ¿cuanto estima usted que se tirará en lugar de consumirse?

- 1 = casi nada
- 2 = muy poco
- 3 = una cantidad moderada
- 4 = bastante
- 5 = mucho
- 6 = Nunca compro este tipo de comida

Visual analogue scale

¿Mueva el indicador de abajo para estimar que porcentaje de comida se desperdicia en su casa en una semana promedio?

APPENDIX B

QUESTIONNAIRE QUESTIONS EACH PARTICIPANT ANSWERED TWICE, 14-DAYS APART TRANSLATED TO ENGLISH.

Q1. Thinking of the fresh fruits you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q2. Thinking of the fresh vegetables you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q3. Thinking of dairy products (for example: milk, yogurt, cheese, ice cream) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q4. Thinking of meat and poultry products (for example: ground beef, steak, hot dogs, cold cuts, chicken, chicken nuggets, etc.) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q5. Thinking of the eggs you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q6. Thinking of meat alternative products (for example: veggie burgers, tofu, etc.) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q7. Thinking of fish and seafood products (for example: filets and other fresh fish) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q8. Thinking of bread products (for example: sliced bread, muffins, bagels, tortillas) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q9. Thinking of the leftovers from meals (either prepared in the home or brought home from restaurants), how much ends up getting thrown away instead of being eaten later on? (option added: I never keep leftovers)

Q10. Thinking of shelf-stable foods (for example: packaged pantry items such as pastas, sauces, nut butters, oils, flour, cereals, snack foods, etc.) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

Q11. Thinking of frozen foods (for example: frozen vegetables, meats, frozen dinners, etc.) you buy in an average week, how much would you estimate gets thrown away instead of being eaten?

(All questions above answered in a Likert-type scale where 1= almost none, 2 = very little, 3 = a moderate amount, 4 = a good deal, 5 = a great deal, 6 = I never buy these foods.)

Drag the indicator below to estimate what percentage of food that could have been eaten in your home gets thrown away instead in a regular week?



APPENDIX C
IRB APPLICATION

SOCIAL BEHAVIORAL INSTRUCTIONS AND TEMPLATE

NUMBER	DATE	PAGE
HRP-503a	4/13/2022	1 of 3

Instructions and Notes:

- Depending on the nature of what you are doing, some sections may not be applicable to your research. If so, mark as "NA".
- When you write a protocol, keep an electronic copy. You will need a copy if it is necessary to make changes.

1 Protocol Title

Reliability measure of a food waste self-assessment.

2 Background and Objectives

Provide the scientific or scholarly background for, rationale for, and significance of the research based on the existing literature and how will it add to existing knowledge.

- Describe the purpose of the study.
- Describe any relevant preliminary data or case studies.
- Describe any past studies that are in conjunction to this study.

Approximately one third of the food that is produced worldwide is wasted accounting to 1.3 billion tons per year. This represents a loss of resources – water, land – and generation of greenhouse gas emissions in vain at the global level, and a loss of income at the household level. Families may also miss opportunities for a more varied and nutritious diet when food is continually wasted. Nonetheless, the literature on household food waste is very limited especially in the US. Specifically, there is no validated measurement tool to reliably determine objective amount of household food waste. The purpose of this study is to evaluate the validity and reliability of an existing food waste self-assessment.

3 Data Use

Describe how the data will be used. Examples include:

- Dissertation, Thesis, Undergraduate honors project
- Publication/journal article, conferences/presentations
- Results released to agency or organization
- Results released to participants/parents
- Results released to employer or school
- Other (describe)

Data will be used to assess the reliability and validity of a food waste self-assessment that will be used in future studies on food waste prevention. The results of this study may also be used in reports, presentations, and/or publications. The data will also be used in a master's thesis.

4 Inclusion and Exclusion Criteria

Describe the criteria that define who will be included or excluded in your final study sample. If you are conducting data analysis only describe what is included in the dataset you propose to use.

Indicate specifically whether you will target or exclude each of the following special populations:

- Minors (individuals who are under the age of 18)
- Adults who are unable to consent
- Pregnant women
- Prisoners
- Native Americans
- Undocumented individuals

Adults older than 18 years of age that have been residing in the US for at least one year and who are responsible for food-related decisions in their households will be eligible to participate. In addition, participants must be fluent in the English language and have a device capable of video recording. Participants will not be restricted by household type or size.

5 Number of Participants

Indicate the total number of participants to be recruited and enrolled: **90**

6 Recruitment Methods

- Describe who will be doing the recruitment of participants.
- Describe when, where, and how potential participants will be identified and recruited.
- Describe and attach materials that will be used to recruit participants (attach documents or recruitment script with the application).

SOCIAL BEHAVIORAL INSTRUCTIONS AND TEMPLATE

NUMBER	DATE	PAGE
HRP-503a	4/13/2022	2 of 3

Recruitment will be conducted in collaboration with Walton Sustainability Solutions Service through social media (i.e. Facebook) through online ads. See attachment.

7 Procedures Involved

Describe all research procedures being performed, who will facilitate the procedures, and when they will be performed. Describe procedures including:

- The duration of time participants will spend in each research activity.
- The period or span of time for the collection of data, and any long term follow up.
- Surveys or questionnaires that will be administered (Attach all surveys, interview questions, scripts, data collection forms, and instructions for participants to the online application).
- Interventions and sessions (Attach supplemental materials to the online application).
- Lab procedures and tests and related instructions to participants.
- Video or audio recordings of participants.
- Previously collected data sets that that will be analyzed and identify the data source (Attach data use agreement(s) to the online application).

Participants will take part in a 3-week study that consists of a week-long collection of food waste, two online surveys, and a 14-day rest period. Participants in the study will weigh their food waste daily for one week, from Monday to Sunday (5 minutes/day). They will use a device of their own to upload images of their collection to the email that will be provided to them in their written instructions on how to complete the study. They will also complete two one-time online food waste-self assessments (3-5 minutes). The total expected time required for participation in this study is approximately 40 minutes. Participants will receive all materials (food waste buckets and scale) through the mail.

8 Compensation or Credit

- Describe the amount and timing of any compensation or credit to participants.
- Identify the source of the funds to compensate participants
- Justify that the amount given to participants is reasonable.
- If participants are receiving course credit for participating in research, alternative assignments need to be put in place to avoid coercion.

Participants will be compensated with a \$50 egift card/participant for a 3-week study and will also have a chance at winning one of 10 additional \$100 egift cards that will be awarded at random for participating. The total will cost \$5,500.

9 Risk to Participants

List the reasonably foreseeable risks, discomforts, or inconveniences related to participation in the research. Consider physical, psychological, social, legal, and economic risks.

Participants may find the collection of food waste an inconvenience as it will take time away from the day. The self-assessment does not ask about sensitive information.

10 Potential Benefits to Participants

Realistically describe the potential benefits that individual participants may experience from taking part in the research. Indicate if there is no direct benefit. Do not include benefits to society or others.

Participants may obtain an insight into their current level of food waste at home and their perceptions on the topic of food waste.

SOCIAL BEHAVIORAL INSTRUCTIONS AND TEMPLATE		
NUMBER	DATE	PAGE
HRP-503a	4/13/2022	3 of 3

11 Privacy and Confidentiality

Describe the steps that will be taken to protect subjects' privacy interests. "Privacy interest" refers to a person's desire to place limits on with whom they interact or to whom they provide personal information. Click here for additional guidance on [ASU Data Storage Guidelines](#).

Describe the following measures to ensure the confidentiality of data:

- Who will have access to the data?
- Where and how data will be stored (e.g. ASU secure server, ASU cloud storage, filing cabinets, etc.)?
- How long the data will be stored?
- Describe the steps that will be taken to secure the data during storage, use, and transmission. (e.g., training, authorization of access, password protection, encryption, physical controls, certificates of confidentiality, and separation of identifiers and data, etc.).
- If applicable, how will audio or video recordings will be managed and secured. Add the duration of time these recordings will be kept.
- If applicable, how will the consent, assent, and/or parental permission forms be secured. These forms should separate from the rest of the study data. Add the duration of time these forms will be kept.
- If applicable, describe how data will be linked or tracked (e.g. masterlist, contact list, reproducible participant ID, randomized ID, etc.).

If your study has previously collected data sets, describe who will be responsible for data security and monitoring.

No personal information will be collected (e.g. name, any contact information) to protect confidentiality. Responses will be anonymized by indicating in the Qualtrics settings to not record any personal information. Data collected in Qualtrics will be transferred into a password-protected master file. Each participant will be assigned a unique code (e.g.S01,S02,...S0n). All collected data will be stored in the ASU dropbox. Only authorized research personnel listed on this IRB application will have access to the data. Research personnel will only access data from password-protected computers. Data will be retained up to five years. After that, electronic files will be deleted from all storage sites including back-up drives.

12 Consent Process

Describe the process and procedures process you will use to obtain consent. Include a description of:

- Who will be responsible for consenting participants?
- Where will the consent process take place?
- How will consent be obtained?
- If participants who do not speak English will be enrolled, describe the process to ensure that the oral and/or written information provided to those participants will be in that language. Indicate the language that will be used by those obtaining consent. Translated consent forms should be submitted after the English is approved.

The consent process will be obtained online through Qualtrics prior to the collection of any data. Interested volunteers will complete a short online anonymous eligibility questionnaire through Qualtrics and if eligible potential participants will be redirected to an informed consent form. Potential participants will be asked to click "Next" and proceed to the next page in the survey if they consent to participate.

13 Training

Provide the date(s) the members of the research team have completed the CITI training for human participants. This training must be taken within the last 4 years. Additional information can be found at: [Training](#).

Christopher Wharton, PhD – Jan 2017
Maricarmen Vizcaino, PhD – Aug 2017
Bryanna Leone – Oct 2020
Kelly Cosgrove – Aug 2020

APPENDIX D
IRB MODIFICATION



APPROVAL: MODIFICATION

[Christopher Wharton](#)
[CHS: Health Solutions, College of](#)
602/496-1727
Christopher.Wharton@asu.edu

Dear [Christopher Wharton](#):

On 2/23/2021 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	An exploratory model to explain household food waste among Mexico adults.
Investigator:	Christopher Wharton
IRB ID:	STUDY00013020
Funding:	Name: ASU: Global KAITEKI Center, The, Funding Source ID: FPID00019651
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Updated additional food waste questions, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Maricarmen Vizcaino
Maricarmen Vizcaino
Kelly Cosgrove
Bryanna Leone
Christopher Wharton