

Assessment of consumers' knowledge, attitudes, awareness, and beliefs of food handling
and beef safety handling behaviors

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ABSTRACT – SCIENTIFIC

Consumers desire tender, juicy, and flavorful cuts of beef. Mechanical tenderization (MT) and enhancement methods applied to lower valued beef cuts can improve tenderness, flavor or juiciness, increasing desirability for the consumer. However, these processes can introduce pathogens that may be present on the exterior of the meat into the sterile interior. This process renders an 'intact' product 'non-intact' and requires altered cooking methods to ensure safety. The primary pathogens of concern for beef products are Shiga-toxin producing *Escherichia coli* (STEC). STEC are associated with approximately 265,000 illnesses and 3,600 hospitalizations annually. Since 2006, there have been 6 STEC outbreaks in the United States and 18 cases in Canada attributed to MT beef (MTB). The pathogen has also been implicated in 136 non-intact beef-related recalls. Due to the potential food safety hazards associated with MTB, mandatory labeling of these products was mandated in 2015 to inform consumers on how to safely handle the product. While this is a good step to inform consumers, it is unclear how familiar they are with the terms associated with these processes. Consumer's knowledge, beliefs, attitudes, awareness, and behaviors related to MTBs is quite limited. This study uses an exploratory

sequential mixed-methods design, to assess consumer knowledge of MTB. Qualitative focus groups conducted throughout urban and rural North Carolina and Virginia found that although participants purchased MTBs, they were unaware of the process, did not prepare MTBs properly, wanted to know more about the process, and wanted applicable risk messages. A nationwide survey developed from the focus group findings found that demographic differences were associated with knowledge of; and how participants interact with MTBs. How demographics influence consumer's beef safety knowledge, practices, and risky behaviors was further explored. Demographic characteristics were highly correlated with consumers' behaviors surrounding beef storage, refrigerator temperature knowledge, defrosting behaviors, meat washing, and meat preparation behaviors. Collectively, the mixed methods research design provided insight into specific demographic characteristics related to consumer attitudes, beliefs, and behaviors surrounding beef safety. This data will help inform the development of well-crafted, culturally, and socially relevant risk messaging that may promote safe handling behaviors.

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ABSTRACT – PUBLIC

In the United States, every year, the Center for Disease Control estimates that 48M people are sickened, 128,000 people are hospitalized, and 3,000 people die from foodborne illnesses. The most common illnesses arise from *Salmonella*, *Norovirus*, *Campylobacter*, *Escherichia coli* [*E. coli*], *Listeria*, and *Clostridium perfringens*; these bacteria and viruses have been on the news as being associated with flour recalls, cantaloupe, eggs, cheeses, berries, and even at restaurants like Chipotle! The bacteria of concern in this study is *E. coli*. Most *E. coli* is not pathogenic, and extremely common in the environment; living in mammalian (e.g.: humans, cows, sheep, insects, etc.) gut and within the environment (e.g.: in the soil). However, there are some pathogenic variants, like Shiga-toxin producing *E. coli* [STEC] that have been associated with 265,000 annual illnesses and deaths. The main reservoirs of many pathogenic *E. coli* are within the intestines of ruminant mammals, including cattle. If mishandled, feces can contaminate and cause human illness as a result of improper handling and preparation. The contamination can occur through meat, water, and fecal-oral routes; often, improperly cooking and handling beef products can lead to illness. In the U.S., there have been 27 multi-state STEC associated food outbreaks. While

the U.S. beef industry is the largest in the world, five multi-state outbreaks were related to *E. coli* O157:H7 contamination in ground beef products. Additionally, between 2005 – 2018, 136 of 171 recalls were due to STEC-contaminated beef products. Non-intact beef products (e.g. ground beef) are the most commonly recalled types of beef products. Consumers purchase beef products on extrinsic (i.e. price, weight, cut) and intrinsic (i.e. color, fat, safety) factors with a desire for tenderness, juiciness, and flavor. Tenderization processes (e.g. mechanical tenderization) or other enhancement processes (e.g. marinades) can increase tenderness on lower-value cuts but may introduce pathogens from the exterior to the sterile interior. To prevent illness, it is necessary to prepare beef products to the recommended USDA-specified temperature using a thermometer to check. Up until this point, consumer knowledge of and behaviors towards mechanically tenderized beef products [MTBs] and other enhanced beef products had not been characterized. This study uses an exploratory sequential mixed-methods study design (qualitative study guides quantitative study) to assess consumer knowledge of MTBs, enhanced beef products, and food safety / beef safety handling behaviors. Focus groups conducted throughout urban and rural North Carolina and Virginia found that although participants purchased MTBs, they were unaware of the process, did not prepare them properly, wanted to know more about MTBs, and requested different ways of obtaining information. A nationwide survey developed from the focus group findings found that demographic differences were associated with knowledge of and interaction with MTBs and enhanced beef products. However, people were still generally unaware of MTBs, despite a recent 2016 labeling mandate for all MTBs. The Theory of Planned Behavior was used to further explore reported consumer's food safety knowledge, practices, and risky behaviors in the kitchen.

Demographic characteristics were highly correlated with consumers' behaviors of beef storage, refrigerator temperature knowledge, defrosting behaviors, meat washing, and meat preparation behaviors. Collectively, the mixed methods research design provided insight into specific demographic characteristics related to consumer attitudes, beliefs, and behaviors surrounding beef safety. Additional research, alternative non-didactic strategies, and collaborations within health and public services is necessary to accommodate for specific demographics, cultures, and social groups. Well-crafted, culturally, and socially relevant targeted risk messaging must be developed to increase awareness and promote ease-of-access.

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Table of Contents

<i>ABSTRACT – SCIENTIFIC</i>	<i>ii</i>
<i>ABSTRACT – PUBLIC</i>	<i>iv</i>
<i>Acknowledgements</i>	<i>vii</i>
<i>Table of Contents</i>	<i>xiii</i>
<i>List of Figures</i>	<i>xvi</i>
Chapter 2	<i>xvi</i>
Chapter 3	<i>xvi</i>
Chapter 4	<i>xvi</i>
Chapter 5	<i>xvi</i>
<i>List of Tables</i>	<i>xviii</i>
Chapter 2	<i>xviii</i>
Chapter 3	<i>xviii</i>
Chapter 4	<i>xviii</i>
Chapter 5	<i>xix</i>
<i>Preface / Attributions</i>	<i>xx</i>
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE REVIEW	6
Escherichia coli	6
Basics of Escherichia coli.....	6
Escherichia coli Virulence and Illness through Shiga-Toxins	6
Basics of STECs	7
Escherichia coli in Foodborne Illnesses	8
Beef Industry	10
The United States’ Beef Industry	10
Meat production	11
Cuts of Beef.....	13
Mechanically Tenderized Beef & Consumers.....	14
Beef Handling Safety	20
Consumer Preferences of Beef Products	21
Consumer Education and Knowledge	22
Consumer Food Safety	22
Consumer Perceptions of Risk	24
Labeling.....	26
Research Design	29
Mixed Methods Research Design.....	29

Focus Groups.....	31
Survey Design	32
Theory of Planned Behavior and Locus of Control	33
REFERENCES.....	34
CHAPTER 3.....	53
ABSTRACT.....	54
INTRODUCTION	55
MATERIALS AND METHODS	58
3.1 Recruitment	58
3.2 Procedure and materials	59
3.3 Data analysis.....	60
RESULTS	61
1: Participants’ previous exposure to Tenderized Beef Products	61
2: MTB Label	61
3: Future Purchasing Behavior	64
4: Locus of Control.....	65
5: Interventions.....	66
DISCUSSION	68
1: Participants’ previous exposures to tenderized beef products	68
2: MTB Label	69
3: Future Purchasing Decisions	70
4: Locus of Control.....	72
5: Interventions.....	72
CONCLUSION	75
ACKNOWLEDGEMENTS	76
REFERENCES.....	77
CHAPTER 4.....	94
ABSTRACT.....	95
INTRODUCTION	97
MATERIALS AND METHODS	100
4.1 – Nationwide Survey	100
4.2 –Nationwide Survey Participant Recruitment	100
4.3 – Nationwide Survey Data Analyses	101
4.4 – Survey Limitations	101
RESULTS	103
1: Purchasing Behaviors of Enhanced Beef Products	103
2: Attitudes Toward Mechanically Tenderized Beef Products	104
3: Awareness of Mechanical Tenderization Label and Safe Handling Instructions Label	104
4: Self-Enhancement Behaviors at Home	105
5: Preparation of Enhanced Beef Products	106
DISCUSSION	108
1: Purchase of Enhanced Beef Products	108
2: Attitudes Towards Mechanically Tenderized Beef Products	109
3: Awareness of the Mechanical Tenderization Label	110
4: Self-Enhancement Behaviors at Home	112
5: Preparation of Enhanced and Mechanically Tenderized Beef Products	113

CONCLUSION	116
ACKNOWLEDGEMENTS	118
REFERENCES.....	119
CHAPTER 5.....	141
ABSTRACT.....	142
INTRODUCTION	144
MATERIALS AND METHODS	146
2.1 – Phase 1: Focus Groups	146
2.2 – Phase 2: Nationwide Survey.....	147
RESULTS	148
5.1 – Storage of Beef Products	148
Part 5.2: Preparation of Beef Products	151
Part 5.3: Locus of Control	159
DISCUSSION	161
Storage Behaviors.....	161
Refrigerator Temperatures	161
Storage on the Top Shelf.....	162
Preparation Behaviors	164
CONCLUSION	175
STUDY LIMITATIONS	178
ACKNOWLEDGEMENTS	179
REFERENCES.....	180
CHAPTER 6: CONCLUSION.....	207
APPENDIX A.....	211
Appendix A1: Recruitment poster for focus group sessions	211
Appendix A2: Attached pull-off tab and flyer for recruitment posters (Appendix 1A).	212
Appendix A3: Semi-structure focus group interview questions on mechanically tenderized beef and safe handling practices.....	213
APPENDIX B.....	217
Appendix B1: Demographic Questions	217
Appendix B2: Demographic characteristics of survey participants in a study of consumer beliefs, knowledge, attitudes, and behaviors regarding mechanically tenderized beef products and enhanced beef products.	223
Appendix B3: Survey Questions related to enhanced beef products and MTBs.	225
APPENDIX C.....	230

List of Figures

Chapter 2

Figure 2. 1: Pros and cons of various survey methodologies	52
---	----

Chapter 3

Figure 3. 1: Mechanically tenderized beef [MTB] label shown to participants	81
--	----

Chapter 4

Figure 4. 1: Examples of mechanically tenderized label designation format (FSIS, 2016) (a) Example MTB label from a Federal establishment with all required information; (b) Example MTB with solution label from a Federal establishment with all required information; (c) Example of principal display for MTB produced at a retail store	122
Figure 4. 2: Percentage of respondents that self-reported purchasing cubed (n=158) and marinated (n=83) beef products based on income level and marinated beef products based on age (n=83)	125

Chapter 5

Figure 5. 1: Theory of Planned Behavior	186
Figure 5. 2: Respondents' (n=500) storage of beef in refrigerator only by demographic factors.....	189
Figure 5. 3: Participant's (n=500) self-reported storage of beef on refrigerator top shelf within each group of demographic factors.....	190
Figure 5. 4: Respondent's (n=500) knowledge of refrigerator temperature based on gender and educational level.....	192
Figure 5. 5: Respondent's self-reported duration of defrosting beef products on counter (n=171) within Hispanic/Latino populations and within educational groups.....	195
Figure 5. 6: Respondent's self-reported washing of beef products (n=223) within ethnicity/race and by location	197
Figure 5. 7: Respondents' methods of washing beef products (n=223) within gender, Hispanic/Latino populations, and ethnicity/race.....	198
Figure 5. 8: Percentage of respondent's reasons for washing beef products by gender (n=195).....	199
Figure 5. 9: Median attitudes of properties (color, texture, juices, smell, time, and temperature) as indicators of doneness. (1=Agree; 2=Somewhat Agree; 3=Neither Agree nor Disagree; 4=Somewhat Disagree; 5=Disagree).....	201

Figure 5. 10: Frequency of behaviors of properties (color, texture, juices, smell, time, and temperature) used as indicators of doneness. (1=Agree; 2=Somewhat Agree; 3=Neither Agree nor Disagree; 4=Somewhat Disagree; 5=Disagree)..... 202

Figure 5. 11: Correlation of Behavior vs Attitude regarding doneness via Spearman correlation coefficient 203

List of Tables

Chapter 2

Table 2. 1: Estimated annual number of hospitalizations and deaths by pathogenic <i>Escherichia coli</i> until 2011 (Scallan et al., 2011)	42
Table 2. 2: Shiga-toxin producing <i>Escherichia coli</i> outbreaks in the United States (2006 – May 2018)	43
Table 2. 3: USDA and FDA STEC-related recalls (2005 – May 2018)	45

Chapter 3

Table 3. 1: Summary of selection criteria for focus group locations in study on mechanically tenderized beef products (non-intact beef products)	82
Table 3. 2: Demographic characteristics of focus groups participants and selected focus group participants in a study of consumer beliefs, knowledge, attitudes, and behaviors regarding mechanically tenderized beef products and enhanced beef products	83
Table 3. 3: Content analysis results of focus group participants on mechanically tenderized beef products [MTB]	85
Table 3. 4: Content analysis of focus group participants on interventions for mechanically tenderized beef products	91

Chapter 4

Table 4. 1: Number of respondents (n=500) who purchase enhanced beef products	123
Table 4. 2: Number of respondents who indicated purchasing mechanically tenderized beef products and also purchasing other enhanced beef products	124
Table 4. 3: Attitudes and feelings of Hispanic/Latino (n=89) and cubed steak purchasers (n=158) towards mechanically tenderized beef products	126
Table 4. 4: Number of respondents that self-report purchasing MTBs (n=52) and are aware of the MTB label	127
Table 4. 5: Number of respondents' self-reported awareness of SHI label and MTB labels	128
Table 4. 6: Number of respondents' self-reported awareness of the mechanically tenderized beef (MTB) label and the safe handling instructions (SHI) label	129
Table 4. 7: Number of respondents that self-report marinating or tenderizing beef products prior to preparation.....	130
Table 4. 8: Number of respondents who self-reported tenderizing or marinating beef products prior to preparation based on purchase cubed beef and marinated beef products	131
Table 4. 9: Participants' (n=176) self-reported self-tenderization methods	132

Table 4. 10: Number of participants who self-report mechanical tenderization of beef products (n=176) prior to preparation within ethnicity.....	133
Table 4. 11: Number of respondents that self-report mechanically tenderizing beef products prior to preparation based on self-reported location	134
Table 4. 12: Number of respondents (n=148) who marinate beef products to tenderize prior to preparation by age	135
Table 4. 13: Number of respondents by ethnicity/race that self-report using texture and smell as indicators of doneness.....	136
Table 4. 14: Number of respondents self-reported using time as an indicator of doneness within age group	137
Table 4. 15: Self-reported preparation of mechanically tenderized beef products to >160F for purchasers (n=44) of MTB products	138
Table 4. 16: Number of respondents that use a thermometer to measure internal temperature (n=81) to check for doneness of tenderized beef products based on location	139
Table 4. 17: Frequency of self-reported cooking of tenderized beef products to $\geq 160^{\circ}\text{F}$ by income bracket.....	140

Chapter 5

Table 5. 1: Elapsed time of respondents (n=500) putting away groceries from the store	187
Table 5. 2: Location where respondents (n=500) store beef products in their home prior to preparation	188
Table 5. 3: Participants self-reported (n=500) perceived coldness of refrigerator	191
Table 5. 4: Participant's awareness of refrigerator temperature using an indicator by income.....	193
Table 5. 5: Location where respondents (n=500) defrosted beef products in their home prior to preparation	194
Table 5. 6: Methods and reasons for washing meats	196
Table 5. 7: Participant's (n=500) self-reported preparation methods of beef products .	200
Table 5. 8: Participants owning of food thermometer	204
Table 5. 9: Behaviors and attitudes of food thermometer owners (n=310) to use food thermometer in determining internal temperature of beef product.....	205

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Wesley Wallner is most recently an undergraduate from Virginia Tech in the Department of Human Nutrition, Food, and Exercise. He has been instrumental in the progress and direction of this research; he was a co-moderator for many focus group. He is a co-author on Chapter 3.

CHAPTER 1: INTRODUCTION

Gram-negative *Escherichia coli* (*E. coli*) are ubiquitous and generally innocuous bacteria commonly found residing commensally in the normal gut microflora of animals and humans, and within the environment (CDC, 2018; Montville & Matthews, 2008). Pathogenic variants of *E. coli*, such as Shiga-toxin producing *Escherichia coli* [STEC], have been associated with at least 265,000 foodborne and waterborne infections annually, and even death. The most commonly known STEC is *E. coli* O157:H7 (CDC, 2018). A STEC infection can range from mild abdominal discomfort to severe illness with bloody diarrhea. Up to 10% of individuals diagnosed with a STEC infection will develop a life-threatening secondary condition of hemolytic uremic syndrome (HUS) and/or thrombotic thrombocytopenic purpura (TTP) with lifelong sequela (CDC, 2018; Noris & Remuzzi, 2005). A conservative global estimate has quantified that STEC-related foodborne disease causes 2,801,000 acute illnesses, annually, resulting in 3,890 cases of HUS and 230 fatalities (Majowicz et al., 2012). The main reservoirs of many STECs are healthy cattle and other ruminant mammals' intestines (WHO, 2018; Noris & Remuzzi, 2005). Transmission of the pathogen can occur through consumption of contaminated foods (meats or produce), water, fecal-oral cross contamination, and quite often, through undercooked meats (WHO, 2018).

Between 2006 – 2018, there have been 27 multi-state STEC-associated outbreaks in meat/poultry, produce, and RTE foods; five (5) of these outbreaks were related to *E. coli* O157:H7 contaminated ground beef products (USDA-FSIS, 2018). Although non-O157:H7 ruminant-associated outbreaks are not common in the United States, internationally, there have been at least eight (8) non-O157 STEC-associated and confirmed ruminant outbreaks (Bollinger, 2004; USDA-FSIS 2018). Additionally, between 2005 – 2018, 136 of 171 recalls have been related to Shiga-

toxin producing *E. coli* contamination in beef products. Although non-intact ground beef is the most commonly recalled product in the United States, other types of beef products (i.e.: tenderized, boneless, roasts, etc.) have also been recalled.

As the largest segment of United States agriculture, the meat and poultry industries are estimated to produce over 92.9 billion pounds of meat and poultry, generating ~6% (\$1.02T) of the U.S. GDP (USDA, 2016; Dunham, 2016). The U.S. beef cattle industry is also the largest in the world, producing 41.5B pounds of beef a year between a million beef producers (NAMI, 2017; USDA, 2016).

When purchasing beef products for consumption, consumers utilize a variety of perceived extrinsic (price, origin, qualifier) and intrinsic (e.g. color, fat content, etc) cues to determine purchasing decisions (Grunert, 2005; Troy & Kerry, 2010). Perceived quality of beef products are important as there is a preference for the desired characteristics of tenderness, juiciness, and flavor. To improve the palatability of lower-valued beef cuts value-added processes are applied to intact beef cuts. Such processes can include but are not limited to: comminution (i.e.: ground, chopped, or minced), mechanical tenderization, marinade tenderization, injection (with marinade or enzymes), or vacuum tumbling. The output is an enhanced product that is rendered non-intact. Intact cuts are microbiologically different than non-intact cuts as the interior of an intact meat cut is considered “sterile” because it can not be exposed to pathogen contamination. However, a non-intact cut is one in which muscle fibers have been disturbed allowing pathogens (like *E. coli*) on the surface to contaminate the interior of the meat, thus, causing a potential food safety hazard if product is not properly prepared (USDA-FSIS, 2015).

Since 2006, the Center for Disease Control [CDC] has reported six STEC-associated outbreaks attributed to MTBs prepared at home and in restaurants. As of 2012, an additional 18

STEC-associated cases have also been reported in Canada. (USDA-FSIS, 2015). STEC was implicated in 136 non-intact beef-related recalls (FDA, 2018; USDA, 2018). About 2.7B pounds (11%) of all beef products are mechanically tenderized [MTB] and rendered non-intact. The 2017 Food Code defines the term “mechanically tenderized” as “manipulating meat with deep penetration by processes which may be referred to as ‘blade tenderizing’, ‘jacquarding’, ‘pinning’, ‘needling’ or using blades, pins, needles or any mechanical device”. This process increases tenderness, a purchasing factor that while desired by consumers, may increase the risk of pathogen introduction from the exterior of intact beef cuts into the interior of the beef muscle and beef product (FSIS, 2015; FDA, 2017). Due to the potential food safety hazards associated with MTBs, mandatory labeling of such products was enacted in 2015 to provide “sufficient information to ensure that these products are cooked safely” (FSIS, 2013). While the process of mechanical tenderization is not new, unlike with ground beef, chicken, or other meat/poultry products, research regarding consumer’s knowledge, beliefs, attitudes, awareness, and behaviors related to MTBs is quite limited.

To better understand consumer’s attitudes, behaviors, and knowledge regarding MTBs, it is also necessary to qualify, quantify, and explore consumer food safety knowledge and practices – along with risky behaviors – through the theoretical frameworks of The Theory of Planned Behavior [TPB] and the Socio-ecological Model. Proposed by Ajzen in 1988, TPB seeks to understand people’s behavior using the constructs of attitude, subjective norm, and perceived behavior control (Ajzen, 1988; Armitage & Christian, 2004). This theory is frequently applied to consumer food safety to not only better understand attitudes and behaviors regarding consumer’s interactions with food; but, to further elaborate and discuss intervention methodologies as it relates

to consumers' social identities, socio-cultural contexts in the socio-ecological model (Young & Waddell, 2016; Byrd-Bredbenner et al., 2013).

Through a pragmatist epistemology, this research project was conducted through a Sequential Exploratory Mixed Methods Research Design [MMRD]; a qualitative [QUAL] component preceded a quantitative [QUANT] component. The QUAL component “explore[d] the dimensionality of a phenomenon” – in this case, food safety attitudes and behaviors around beef through focus groups. Results obtained from QUAL focus group component was used as an exploratory function to guide the development of a nationwide survey (Bergman, 2011). Through sequential design MMRD, findings can be cross-validated and complement one another. Theoretically, MMRD should combine the strengths of open-ended and close-ended data sets to better “understand research problems”; as such, mixed methods epistemology tends towards pragmatism which “focuses on the consequences of research, on the primary importance of the question asked and use[s] multiple methods of data collection to inform the problems under study” (Watkins & Gioia, 2015; Caswell). As such, both deductive and inductive logics will be used.

Specific Objectives:

- (1) To assess consumer knowledge and awareness of MTBs through an exploratory sequential mixed-method design: (a) focus groups to collect qualitative data, followed by (b) nationwide consumer knowledge surveys to collect quantitative data.
- (2) To assess and define consumer knowledge, awareness, attitudes, and behaviors related to food safety and beef safety through an exploratory sequential mixed-methods study design.

Hypothesis:

Ho: Consumers are handling beef products correctly.

HA: Consumers are not handling beef products correctly.

Ho1: Consumers are aware of MTB products (and processes).

HA1: Consumers are not aware of MTB products (and processes).

Ho2: Consumers handle MTB products correctly.

HA2: Consumers do not handle MTB products correctly.

Ho3: Consumers practice correct food safety behaviors in the kitchen.

HA3: Consumers do not practice correct food safety behaviors in the kitchen.

CHAPTER 2: LITERATURE REVIEW

Escherichia coli

Basics of Escherichia coli

Gram-negative *Escherichia coli* (*E. coli*) are ubiquitous and generally innocuous bacteria commonly found residing commensally in the normal gut microflora of animals and humans, and within the environment (CDC, 2018; Montville & Matthews, 2008). Pathogenic variants of *E. coli* have been associated with foodborne and waterborne illnesses, and even death (CDC, 2018).

E. coli are rod-shaped, non-spore forming, facultatively anaerobic bacteria that grow optimally at 37°C. *Escherichia coli* are serotyped and identified by their functional surface antigens: O (somatic), H (flagellar), and K (capsule) antigens (Montville & Matthews, 2008). The specific O:H antigens are the identifiers for pathogenic strains attributed to diarrhea; the O-antigen represents the serogroup, while the H-antigen identifies the serotype. At least “167 O antigens, 53 H antigens, and 74 K antigens” have been identified (Montville & Matthews, 2008).

Escherichia coli Virulence and Illness through Shiga-Toxins

There are at least seven pathotypes of diarrheagenic *E. coli*: Shiga toxin producing *E. coli* [STEC], enterotoxigenic *E. coli*, enteropathogenic *E. coli*, enteroaggregative *E. coli*, enteroinvasive *E. coli*, diffusely adherent *E. coli*, and uropathogenic *E. coli*. STEC is the pathotype primarily associated with foodborne illnesses; STEC has also been referred to as verocytotoxin-producing *E. coli* (VTEC) or enterohemorrhagic *E. coli* (EHEC) (CDC, 2018). Most pathogenic organisms have easily distinguishable mechanisms, the mechanisms of *E. coli* pathogenesis are

quite similar to the pathogenesis mechanisms of not only its own pathotypes, but also other pathogens like *Shigella*, *Salmonella*, etc. (Donnenberg, 2013).

An *E. coli* or STEC-specific infection can range from mild abdominal discomfort to severe illness. The incubation period is approximately 3 – 4 days; however, onset can occur in as few as one day, or as many as ten days. Illness typically starts as a mild abdominal ache and intensifies into severe stomach cramps, bloody diarrhea, and vomiting, coupled with mild fevers (CDC, 2018). Patients will usually recover within a week; however, up to 10% of individuals diagnosed with a STEC infection will develop a life-threatening secondary condition of hemolytic uremic syndrome (HUS) and/or thrombotic thrombocytopenic purpura (TTP) (CDC, 2018; Noris & Remuzzi, 2005).

Basics of STECs

There are seven STEC serovars most commonly associated with foodborne illness. The CDC (2018) estimates at least 265,000 STEC-associated infections occur annually. *E. coli* O157:H7 is the most commonly known serovar, accounting for 36% of STEC-associated infections yearly. The other six, non-O157 STEC serogroups are associated with 64% of STEC infections yearly (CDC, 2018) and include O26, O45, O103, O111, O121, and O145. Although many of these serogroups may not cause as extreme an illness as O157, a few are more virulent (CDC, 2018).

According to the World Health Organization, the main reservoir of many STECs is healthy cattle and other ruminant mammals' intestines (WHO, 2018; Noris & Remuzzi, 2005). Transmission of the pathogen can occur through consumption of contaminated foods, fecal-oral

cross contamination, and quite often, through undercooked meats. Produce outbreaks associated with O157:H7 and other STEC serotypes have been linked to cross-contamination from the soil, transport, or even irrigated water (WHO, 2018). Infections have been known to occur through contaminated water. Thusly, all foods should be well cooked or irradiated, preventative measures against cross-contamination should be put in place, and other food safety practices must be instilled.

Escherichia coli in Foodborne Illnesses

Foodborne illness outbreaks cost the American public upwards of \$15.5B (Hoffmann et al., 2015). According to the United States Center for Disease Control [CDC], about 265,000 STEC infections occur annually from an estimated 3.6 million bacterial foodborne outbreaks in the U.S. In the United States, all STECs are actively tracked via FoodNet (Scallan et al., 2011). Globally, Majowicz et al. (2014) conservatively estimate that 2,801,000 acute illnesses resulting in 3,890 cases of HUS are from STEC-related foodborne disease, and 230 fatalities yearly are attributed to STECs with the majority occurring in individuals younger than 4 or older than 60 years old (Majowicz et al., 2014). As with most foodborne diseases, estimated numbers are lower than reality because ill individuals may not seek medical attention. For every illness reported, Scallan et al., (2011) estimates that at least 26.1 cases were not (Table 2.1).

E. coli O157:H7 serovar has received the most attention for its notoriety. Gould et al. (2013) and Scallan et al. (2011) estimated that O157:H7 causes an estimated 96,000 illnesses, 3,200 hospitalizations, and 31 deaths a year, while non-O157 STECs were the sources of twice as many illnesses in the United States. Illnesses caused by STECs are most frequent in the summer months (Dewsbury et al., 2015; Brooks et al., 2005; Slutsker et al., 1997). From 2003 – 2012, there

were a confirmed 391 outbreaks of O157:H7 with over 4,900 illnesses, about 1,300 hospitalizations, 300 HUS cases, and 34 deaths. Forty percent of outbreaks were linked to restaurants, delis, or banquets and 33% of outbreaks were linked to home food preparation.

As of 2000, any presence of STECs mandated reporting. Since 2009, in addition to O157:H7 tracking, non-O157 STEC related infections are identified and tracked. As of June 2012, all STEC Big 7 found in food products have been considered adulterants by FSIS. Indeed, routine testing of raw beef is mandated. Prevention and intervention methods will be discussed further in this literature review. Due to an increasingly more inter-connected food system STEC and other *E. coli* related outbreaks are not only multi-state outbreaks but can also be cross-country (Table 2.2). Additionally, cross-country outbreaks from food either imported into the United States or from travelers who've consumed contaminated foods in other countries and returned home with an infection have increased. As of 2012, internationally, there have been at least eight (8) confirmed non-O157 STEC outbreaks from ruminant meat consumption. In 2010, O26 contaminated ground beef sickened three individuals (Bollinger, 2004; FSIS 2012).

Notable outbreaks in other parts of the world include: Canada in 2000 where five individuals died and 27 were hospitalized from drinking O157:H7 contaminated water, or the 2011 *E. coli* O104:H4 multi-national outbreak from consumption of contaminated sprouts in Germany which sickened at least 4,000 individuals in 16 countries and resulted in an unprecedented number of HUS-related complications (CDC, 2013; Bayer et al, 2014). In addition to human foods, STECs have been detected in the semi-moist environments of pet foods (Nemser et al., 2014; Powell, 2014).

Between 2006 – 2018, 27 multi-state STEC-associated outbreaks occurred in meat/poultry, produce, and RTE foods; five (5) of these outbreaks were related to O157:H7 contaminated ground beef products (FSIS, 2018) (Table 2.2). While non-O157:H7 outbreaks from ruminants are not common in the United States, internationally, at least 8 non-O157 STEC outbreaks from ruminants have been confirmed (Bollinger, 2004; USDA-FSIS, 2018). Between 2005 – 2018, 136 of 171 recalls have been related to beef products. Shiga-toxin producing *E. coli* contamination has resulted in 136 beef-related recalls (Table 2.3). Ground beef is the most commonly recalled product in the United States; however, other types of beef products (i.e.: tenderized, boneless, etc.) have also been associated with recalls.

Both the CDC and WHO have put out notices for preventing STEC and EHEC infections. Measures to prevent contamination should be observed at all points in the food system from production to preparation. From both the retail and consumer perspective proper food safety practices are paramount to ensuring a safe product for consumption. Hands should always be washed thoroughly, meats should be cooked thoroughly, raw milk and unpasteurized products should be avoided, recreationally-used water imbuelement should also be avoided, and safety measures should be taken to prevent cross-contamination of food and food areas (CDC, 2018).

Beef Industry

The United States' Beef Industry

The meat and poultry industry are the largest segment of United States [US] agriculture, producing over 93B combined pounds, yearly and generating \$1.02T (~6% GDP) for the U.S. economy (USDA, 2016; Dunham, 2016). As the largest global beef cattle industry, the US beef

cattle industry produced 41.5B pounds of beef in 2016. (USDA, 2016; NAMI, 2017). USDA-FSIS reports inspecting about 33M cattle a year (USDA-FSIS, 2018). USDA-FSIS estimates each American consumes an average of 56 pound/year. Texas, Nebraska, Kansas, California, and Oklahoma are the top cattle producing states (ConsumerReports, 2015; BeefUSA, 2018). In addition to providing the United States beef needs, up to 5.6 billion pounds of beef are exported to countries like Canada, Japan, Mexico, South Korea, and Hong Kong with this number increasing yearly. The U.S. imports beef primarily from Canada, Australia, and New Zealand (USDA-ERS, 2018).

Thirty one percent of farms in the U.S. are classified as beef cattle farms (more than other types of farms. The top three beef packing operations in the U.S. are Tyson Foods, Inc., JBS Beef Co., and Cargill Meat Solutions (BeefUSA, 2018). Beef produced in or exported from the U.S. is desirable for being grain-fed along with its higher-quality cuts. Imported beef is usually considered of lower-value and produced from grass-fed herds are typically made into ground beef or other processed meats (USDA-ERS, 2018).

Meat production

All meats produced for human and animal consumption in the United States undergo mandatory inspection and a voluntary evaluative-grading process through the United States Department of Agriculture [USDA]. Inspection, by FSIS is mandatory to ensure that meat products are “safe, wholesome and correctly labeled and packaged” (USDA-FSIS, 2014). The processing plants are also inspected to ascertain sanitation, and inspected meats are stamped with an official federal seal of approval (USDA-FSIS, 2014). Additionally, if the meat is packaged at the inspection facility, the inspection label will also include the plant where the meat originated.

However, if meat is further trimmed and repackaged at retail, the seal may no longer be evident to the consumer (USDA-FSIS, 2014).

Meat inspection falls under the preview of the Poultry Products Inspection Act, and the Federal Meat Inspection Act. Typically, inspection occurs on two levels: the Federal Inspection program, and State Inspection programs. The Federal Inspection program inspects meat and poultry shipped across state borders or imported from other countries. For meats sold within the state of production, FSIS allows State inspection programs who themselves must be held to the same standards as the federal level inspection program, to conduct the inspections. FSIS works closely with USDA, State inspection programs, FDA, and EPA to assure the safety of the U.S. meat and poultry supply (USDA-FSIS, 2014).

Another type of inspection includes voluntary beef grading, which is conducted by a USDA Federal grader. This grading accounts for both (a) quality, and (b) yield. Developed in 1916, the *United States Standards for Grades of Carcass Beef* was developed to maintain uniformity and transparency for the meat industry and inspection agencies (USDA-AMS, 2016). Of most interest to consumers and retailers is quality grading which provides a descriptive difference between meats based on flavor, tenderness, and juiciness. Quality is determined by the “marbling [of meat], color, and maturity (USDA-FSIS, 2014). Maturity of the beef carcass prior to slaughter directly effects quality by measuring tenderness of product; younger cattle have more tender meat than older cattle (Tatum, 2011). Maturity is observed by looking at bone, cartilage ossification, and the ribeye muscle (Tatum, 2011). Marbling is the dispersion of intramuscular fat within the lean meat (i.e.: ribeye) and is paramount towards grading as higher marbling is attributed with increased tenderness, juiciness, and flavor (Tatum, 2011).

There are eight (8) grades available for beef. The preferred cuts of meat enjoyed by consumers are, in order of decreasing grade: Prime, Choice, and Select grades. Prime grade is the highest quality beef produced from young, well-fed beef cattle which are well marbled. While Choice grade beef has less marbling, it still has some good sensory characteristics and mouthfeel. Select Grade beef is quite uniformly lean with little marbling; as a result, it is less juicy and less flavorful than either higher grades, but still desired by consumers. This meat is oftentimes marinated before cooking to bring out tenderness and flavor. Finally, there are Standard, Commercial, and Utility, Cutter, and Canner graded beef. The latter graded beef products are commonly ground for ground beef and other processed meat products like hot dogs or pet food (USDA-FSIS, 2014).

Cuts of Beef

When domesticated cattle are slaughtered for food, their carcass is cut into primal cuts, which are then further divided into sub-primal cuts. Four basic major (primal) cuts are sold at retail: chuck, loin, rib, and round (USDA-FSIS, 2018). Nomenclature of beef products from these four basic cuts can vary by store and region that may cause confusion to consumers. Cuts of meat are differentiated by their ratios of muscle tissue (muscle fiber tenderness) and connective tissue (background tenderness), the latter which “connects” the former together (Maddock, 2008; Tatum, 2011). Formed by collagen and elastin, “[t]he amount of connective tissue determines the tenderness of the meat” and its concentration is determined by type of muscle use. While collagen breaks down into gelatin when cooked, elastin remains tough and undesirable. Cuts like the chuck (shoulder), brisket, and shank cuts tend to be tougher due to having more connective tissue. Some of the cuts are then ground down to become ground beef, pickled to make pastrami, etc. Tenderness

is a highly desired quality of beef, aging meat, and tenderization methods have been developed to soften the meat for consumer marketability, palate, and satisfaction, usually using cheaper, less tender cuts of meats (Maddock, 2008; Tatum, 2011)

Mechanically Tenderized Beef & Consumers

To achieve the desired characteristics and enhance palatability, lower-valued cuts of beef can be enhanced to increase desirability through value-added processes to create an enhanced product such as: comminution (i.e.: ground, chopped, or minced), mechanical tenderization (through blade, needle, mechanical, or cubing), marinade tenderization, injection (with marinade or enzymes) (USDA-FSIS 2015). The 2017 Food Code defines the term “mechanically tenderized” as “manipulating meat with deep penetration by processes which may be referred to as ‘blade tenderizing’, ‘jacquarding’, ‘pinning’, ‘needling’ or using blades, pins, needles or any mechanical device” (cite) thereby increasing tenderness, a purchasing factor that while desired by consumers may increase the risk of pathogen introduction from the exterior of intact beef cuts into the interior of the beef muscle and beef product (USDA-FSIS, 2015). USDA-FSIS reports mechanical tenderization happens in 2.7 billion pounds (11%?) of beef, accounting for more than 6.2B servings of roasts or steaks (USDA-FSIS, 2016).

These mechanical tenderization processes have the potential to introduce pathogens present on the exterior of intact beef cuts to the interior of the beef muscle and into the beef product. Two common tenderization methods recognized by AMI, “mechanical tenderization” and “tenderization with marinades”. Tenderization methods can be done separately or combined to obtain the ideal tenderness. Other less commonly used forms of tenderization including aging meat, using “proteolytic enzymes, electrical stimulation, [and] flaking/forming” (Yoon, 2011). Mechanical tenderization involves inserting sharp blades or needles into the meat to break apart

connective tissue and muscle fibers. The resulting product is also referred to as, “non-intact” meat in which the muscle fibers are no longer intact. Marinade tenderization involves marinating meat cuts with solution and flavoring injections via hollow needles or massaged/coated in a solution within a machine. The resulting products are referred to as, “enhanced” beef products. After tenderization, the beef becomes a value-added product. Mechanically tenderized beef [MTB] is then sold to foodservices or supermarkets that may further process the cuts.

The injection marinades are usually done through a chemical tenderization process using organic acid (acetic, citric, lactic) injections or other chemicals like calcium ascorbate, calcium chloride, and calcium lactate (Yoon, 2011). These chemicals, used in high concentration, have the tendency to attribute off-flavors; therefore, Scanga et al. (2000) has suggested combining marinades with other flavoring/seasoning agents. Yoon et al., reported that *E. coli* O157:H7 destruction during thermal cooking was augmented by “organic acid-containing treatments”; however, simply having a chemical tenderization process has no effect on increasing thermal sensitivity and destruction of *E. coli* O157:H7 (Yoon et al., 2011; Yoon et al., 2009).

While some mechanically tenderized beef products [MTBs] visually appear tenderized (i.e.: cubed steaks), other MTBs may resemble intact cuts. As such, there is concern that consumers will treat the latter-type of MTBs similarly to intact cuts and underprepare them, thus potentially rendering the product unsafe.

The Center for Disease Control has reported six outbreaks of Shiga-toxin producing *Escherichia coli* O157:H7 [STEC] since 2006 attributed to MTBs prepared at home and in restaurants. Since 2012, an additional 18 cases of STEC-associated outbreaks have been reported in Canada (USDA-FSIS, 2015). STEC was implicated in 136 non-intact beef-related recalls (FDA, 2018; USDA, 2018). Responding to the outbreaks and recalls, the Canadian Food Inspection

Agency announced mandatory labeling of MTBs as of August 2014. Despite meat industry precautions to minimize processing risk and due to previous outbreaks, both Canada and the United States have implemented mandatory labeling requirements for all MTBs. In the U.S., mandatory labeling compliance went into effect May 2016.

MTBs must be labeled as “Mechanically Tenderized Beef” to inform and aid consumers and retailers to handle the product differently to ensure safety (USDA-FSIS, 2015). Recommended cooking temperatures are also included in the new label. The effectiveness of labels to promote food safety is not well documented; in fact, the American Meat Institute (AMI) was concerned that the addition of terminologies like “mechanically tenderized” or “blade tenderized” to a label would not only not inform consumers; but, would incite fear and rejection of the product due to inexperience and lack of interaction with the term. Arguments in favor of labeling assert that because MTBs appear very similar to regular intact meats, the lack of information may lead the consumer to undercook and serve potentially contaminated foods. Additionally, “without clear labeling, food retailers and consumers do not have the information necessary to prepare these products safely”

The Federal Meat Inspection Act [FMIA] states that meat product labels “must be truthful and not misleading”; the information disclosed must accurately convey to the consumer what it is they are buying without misbranding or adulteration (USDA-FSIS, 2013). Since 1994 and prior to May 2016, the only label required on meat products was the “Safe Handling Instructions” label, which is always included on all raw or not fully cooked packages of meat and poultry (USDA-FSIS, 2014). FSIS continues to advise food safety in four easy-to-follow steps: Clean, Separate, Cook, and Chill.

Beef that has undergone the marinade process is required to have a label depicting the concentration and ingredients of the marinade. A cumulative study demonstrated that at least 10% of surface microflora on beef can be carried into the deeper tissue upon mechanical tenderization; however, this number is dependent on the “stage of growth of the spoilage flora” (Youssef et al., 2014).

Prior to March 2015, labels for mechanically tenderized meat were voluntary; however, mandated labeling for *all* mechanically tenderized products must be in place by March 2016. Current regulations require that any tenderized and non-intact meats would, in addition to the product name, also contain a descriptive designation, “and an accurate description of the beef component” with the print of words to be in the same style, size, and visible coloration as the product name. The proposed legislation would also require the addition of validated cooking instruction in conjunction with the already required “Safe Handling Instructions” (USDA-FSIS, 2015). Validated cooking instructions for establishments (i.e.: processors, distributors, etc.) would include, at a minimum: (a) “method of cooking”; (b) minimal internal temperature of product to destroy pathogen; (c) holding time and temperature to achieve pathogen destruction; and (d) necessity to use thermometer (FSIS, 2013). The use of thermometers with regards to consumer behavior will be discussed further, later. The information could be obtained either from previously conducted and proven research if similarities of their MTB (i.e.: cut of beef, tenderization method, thickness, cooking method, and desired time / temperature end) was similar to previous research.

The new labeling legislation applies to all beef products intended for “household consumers, hotels, restaurants[,] and similar institutions” (USDA-FSIS, 2015). Despite opposition from the meat industry, USDA-FSIS conceded that, “without clear labeling, food retailers and consumers do not have the information necessary to prepare these products safely” (USDA- FSIS,

2015). The reasoning behind the mandated labeling requirement was that consumers and restaurants may have been unaware, and may even be misled by the lack of information, of a purchased MTB product, leading them to undercook and serve potentially contaminated foods. Consumers and restaurants appear to generally not have “sufficient information to ensure that these products are cooked safely” because no such information has ever been provided by FSIS; neither are they aware that cooking temperatures for intact versus non-intact products are different. Finally, due to the lack of clear distinction between intact beef and non-intact (blade- or needle-tenderized, or marinade/solution injected) MTB products, it is also likely that consumers are unaware of any differences in frozen products, many of which will appear quite similar to intact products. As such, they will also be unaware of the potential risks associated (USDA-FSIS, 2013). This designation would not be applicable to other methods of tenderization which change the overall appearance of the product (i.e. cubing or pounding). The final USDA-FSIS label designation (9 CFR 317.2 (d)(3)) must include: (1) a descriptive designation (i.e. “mechanically tenderized”, “blade tenderized”, or “needled tenderized”) accompanied by an accurate description of the beef component in the product name; (2) within close proximity of one another without intervening texts or graphics; (3) with all descriptive words in the same style, color, on a single-color contrasting background; (4) allowing for upper and lower cases with the smallest letter at least 1/3 the size of the largest letter; and (5) validated cooking instructions including cooking method, specified minimum internal temperature, hold time and temperature prior to consumption to ensure inactivation of potential pathogens, and internal temperature measurement by thermometer (see Figure 4.1 for example).

In 2017, the U.S. Food Code defined the “mechanically tenderized” as “manipulating meat with deep penetration by processes which may be referred to as ‘blade tenderizing’, ‘jacquarding’,

‘pinning’, ‘needling’ or using blades, pins, needles, or any mechanical device” (FDA, 2017). The labeling rule does not cover cubed or pounded beef products which are visually obvious as being non-intact, corned beef, raw or partially cooked beef products <1/8” thick, nor products that will be fully cooked at an official establishment. Additionally, the rule does not cover vacuum-tumbled or injection marinated beef products, which, while not visually apparent, also undergo a process that may distribute bacteria into the interior.

The American Meat Institute was against this proposed legislation, stating the above reason of a low “food safety risk” not “warrant[ing] the proposed labeling”. They propose that if there is to be a labeling scheme, it should focus on “providing useful information to the consumer that can add an additional margin of safety” while also being conspicuous without having to be in the product name (AMI, 2013). Consumers who had consumed MTB products reported ordering their steaks “rare” or “medium-rare”. There is concern that despite the labeling requirement, there is a high probability that the risks associated with non-intact beef may still not be understood.

Meanwhile, the USDA-FSIS’ final 2014 rule (implemented May 2016) required that all raw or partially cooked mechanically (blade or needle) tenderized beefs products, along with marinade or solution enhanced products be labeled with their respective processes unless product would be cooked completely or receive another lethality treatment. The labeling rule is not applicable to those products that have been pounded or cubed (due to the visual obviousness of the process), products that are enzyme formed, nor products that have been vacuum tumbled (with or without marinade or enhancement solutions).

Although the recommended temperature of 145°F – for intact beef products – would be enough to destroy pathogens on the outside, demonstrated the increased likelihood of introducing pathogens (esp. *E. coli*) into the beef product through needle- or blade- tenderization methods led

to an imperative to cook the entire non-intact steak to higher temperatures or to hold the 145F temperature for longer so that the heat may transfer inside (Luchansky et al., 2008; USDA-FSIS, 2015).

Beef Handling Safety

Between 11-28 percent of people in the United States consume undercooked or raw ground beef. Between 2009-2013, 35% of all outbreaks were linked to consumption of undercooked beef contaminated with *E. coli* O157:H7, compared with 23% from *Salmonella*, or 20% from *Clostridium perfringens* in other products.

Proper handling and preparation of beef products is necessary to have a safe final product. USDA-FSIS recommends best practices for consumer handling of beef from the point of purchase (USDA-FSIS, 2018):

- Selecting one's meat product prior to "checking out" at the grocery store.
- Immediately storing beef in the refrigerator (40F).
- Defrosting in a refrigerator, in cold water, or in the microwave are the recommended best practices.
- Washing one's beef products is highly discouraged as it may aerosolize bacteria.
- Using a thermometer as the only reliable method of knowing product doneness; color and texture are not reliable indicators as color can change to a darker color before the internal temperature of a beef product has reached the safe temperature.
 - For intact cuts, 145F is a high enough temperature to inactivate any pathogens on the surface of a beef product.
 - For ground beef, 160F is the safe internal temperature for at-home preparation to decrease the risk of foodborne illness.

- FSIS recommends cooking MTBs to a safe internal temperature of 145F and allowed to rest for 3 minutes or to cook to 160F.

Consumer Preferences of Beef Products

Consumer purchase of beef products is strongly affected by their perception of the meat and beef industry (Troy & Kerry, 2010). When purchasing beef products, two types of contexts play consumer's decisions: an "everyday" context (consistent of purchasing, preparation, and consumption" and a "production" context (with a focus more on animal welfare, meat production, etc.) (Korzen & Lassen, 2010; Troy & Kerry, 2010). In terms of beef, consumers desire juicy, tender, and flavorful beef products; purchase of desired beef products is guided by a series of internal and external quality cues, forming the Total Food Quality Model, were developed to further elaborate and explain consumer's desire to purchase beef products (Troy & Kerry, 2010; Grunert et al., 2004). Extrinsic quality cues may include price, product presentation (packaging, appearance), brand, label, cut, and product origin – attributes that are tangible. Intrinsic quality cues would include attributes like color, fat, marbling, and presumed tenderness (Troy & Kerry, 2010; Grunert, 1997). If a consumer perceives a visually appealing product, they are more likely to attribute a great value to said beef product (Troy & Kerry, 2010; Steenkamp & Van Trijp, 1996).

Meat freshness is a desired characteristic of beef; if the product is perceived to be not fresh, consumers are unwilling to purchase the product unless it is discounted (Troy & Kerry, 2010). With freshness, consumers expect a certain concentration of fat and/or marbling to also be comparable to price and expected palatability (Troy & Kerry, 2010; Miller, 2002). Of consumption qualities, tenderness is the most important attribute (Troy & Kerry, 2010; Miller et al., 2001).

Price of food is important in food purchasing decisions; it can indicate both the perceived quality and also socio-economic availability of a product. For meat, some consumers will pay more for perceived tenderness of a beef product. On the other hand, for many, price and cost is the main determinant of purchase (Henchion et al., 2014; Realini et al., 2014). If monetary funds are available, consumers are also interested in spending more for specific brands, qualifiers (i.e. organic, hormone-free, and grass-fed, etc.).

Consumer Education and Knowledge

Consumer Food Safety

The Center for Disease Control [CDC], Food and Drug Administration [FDA], and World Health Organization [WHO] have promoted similar types of food safety controls to keeping food safe. The CDC promotes 4 Simple Steps: Clean, Separate, Cook, Chill (CDC, 2018). To build upon that, the WHO promotes the Five Keys to Safer Food: (1) keep clean; (2) separate raw and cooked foods; (3) clean thoroughly; (4) keep foods at safe temperatures; and (5) use safe water and raw materials (WHO, 2018). Both methods promote hygiene, proper cooking and preparation, prevention of cross-contamination, and use of safe foods through temperature control. From 2003 – 2012, 33% of outbreaks were linked to home food preparation (Slutsker et al., 1997; Brooks et al., 2005; Byrd-Bredbenner et al., 2013). Consumers often either underestimate the risks of at home food preparation or do not follow safe food-handling techniques resulting from optimism bias; 80% of consumers believe themselves to be knowledgeable of many food safety behaviors (Patil et al., 2005; Sivaramalingam, 2015; Redmond & Griffith, 2003). Since 1975, studies ranging from simple surveys and questionnaires, to interviews, to focus groups, and to observational studies

have been implemented to assess consumer food handling, (Redmond & Griffith, 2003). While much research has been done on the basics of food safety knowledge and behavior, only a few studies have been linked exclusively to beef. Although the use of thermometers is one of the greatest safeguards to beef safety, 51% of consumers do not consider thermometer use to be necessary. Similarly, Phang and Bruhn (2011) discovered that 65% of consumers did not know the proper cooking guidelines of ground beef. Ultimately, relying simply on self-reported data can be limited due to human tendencies to exaggerate good behaviors due to the social desirability bias (Phang & Bruhn, 2011; Milton & Mullan, 2010). As such, it is essential to incorporate a qualitative and quantitative approach to improve data collection through both survey data and observational data.

Recently, studies have also been conducted to understand the behaviors of under-represented and minority populations engaging in risky behaviors (Henley et al., 2012). Resulting from difficulties in communication, non-specific targeting, and also language barriers, under-represented populations and minority populations more frequently perform incorrect and/or risky food safety behaviors (Henley, 2013). However, when presented with salient and targeted messaging, non-White consumers do engage with the risk messages. Understanding sociocultural factors and the cultural relevancy of food attitudes and issues for various populations may allow for wider acceptance of risk information (Jacob et al., 2010). Yang et al. (2000) demonstrated that culturally and language-specific messages have been shown to improve label awareness and recognition. Additionally, one's location (urban versus rural) may greatly impact one's reception and practice of food safety behaviors. Due to isolation of communities and inaccessibility to resources and information, food safety and communicating food safety to rural consumers is not only necessary but difficult (Hartley, 2004; Hart et al., 2004).

Despite the difficulties in communicating correct food safety behaviors; it is necessary that messages discussing food safety behaviors are provided as both risk-benefit messages (and not skewed to only risks or only benefits). In addition, messaging and interventions should be provided in a timely, consistent, and multi-pronged approach (Jacob et al., 2010; Young & Weddell, 2016; van Dijk et al., 2012).

Consumer Perceptions of Risk

Consumer perception and knowledge of food safety risks are particularly skewed. Despite desiring pertinent and understandable information and communication, consumers oftentimes dismiss scientifically sound evidence in lieu of administering “emotions or feelings [...] as heuristics” (Loewenstien et al., 2001, Verbeke et al., 2007). Although the food system is at its safest and most transparent, today, consumers are increasingly wary and “uncertain” about the food supply (Verbeke et al., 2006). Further research into this phenomenon demonstrates underlying consumer behavioral fallacies and misunderstandings. According to Miles et al., (2001) and Fife-Schaw & Rowe (2000), consumers oftentimes perceive external risks beyond their control as having a far greater impact on their lives than those associated directly with their behavior. This may be due to a consumer’s need for control; in reality, the perceived risk is oftentimes inversely perceived compared to the actual risk. To the general consumer, risks at varying levels all portray the same level of risk. This is evidenced in beef products in the EU, in which due to concerns of Bovine Spongiform Encephalopathy, drug residues, or even antibiotic use, confidence in meats dropped dramatically in the 1990s as all concerns were perceived equally and negatively (Becker, 2000; Verbeke et al., 2007).

Perception filters contribute to the gaps, misalignments, and biases between scientists (industry; scientific knowledge) and consumer perception (Verbeke et al., 2007). The perception filter is affected by the nature of risk with the “individual psychological catalyst” and factors of risk perception, thusly defining the psychometric paradigm (Fischhoff et al., 1978; Verbeke et al., 2007). Additionally, Kasperson et al.’s (1988) “social amplification of risk” points out the contributions of “fright factors, panic elements, and societal triggers” strongly affected by inevitable risks or problems – in food safety – being a cause of mass hysteria and contributing to misinformation. Coupled with miscommunication and contradicting information provided by multiple parties, consumers are unable to maintain control, and are more likely to follow their emotional responses, than actual fact.

With regards to risk assessment, optimism bias contributes to engaging in risky behavior towards one’s own actions as being less risky when compared with others in the same demographic doing similar activities (Weinstein, 1980; Miles & Scaife, 2003). Even towards food safety on their own, consumers believe they are much better educated than their counterparts and also have more control of their risks and behaviors than they really do (Verbeke et al., 2007). On the other hand, “technology-related food risks” (e.g. GMO, pesticides, etc.) are considered quite harmful and dangerous, and regarded warily because the consumer has no control over that matter.

Even when information is readily available and resources are allocated for consumer education and awareness, consumers tend toward passivity and indifference unless provided with negative news which impacts consumer behavior quickly and positively (Verbeke & Ward, 2001; Verbeke et al., 2007). Indeed, this passivity and indifference has been dubbed the “rationally ignorant consumer hypothesis” which because information is not targeted correctly or meets the needs and interests of a certain group, it is thereby deemed “irrelevant or useless” (Verbeke et al.,

2007; McCluskey & Swinnen, 2004). Easily understandable codes of quality and certifications, however, easily drew interest. Providing over-arching general information directed towards the general public will be ignored. In the case of food safety and risk communication, Verbeke et al. determined that it is essential to develop focused information for specific segments of the population; consumers will move towards attitude and behavioral changes if the information is perceived to be directed specifically at them (Petty & Cacioppo, 1996; Verbeke et al., 2007). Verbeke et al. (2007) further suggests engaging the public to determine new and innovative methods of communication.

Fein et al. (2011) observed consumer behavior and risk perceptions from 1988 through 2010. Handling of food and perceptions of risk were affected differed by demographics. Consumer behavior and knowledge surveys applied over the years indicate that self-reported practices, while oftentimes positively reported as being followed, demonstrate a lack of good food safety behavior by consumers (Fein et al., 2011).

Labeling

Considered seminal in food industry communication, product labeling is increasingly used and seen to not only shape “consumers’ knowledge, purchasing patterns, and use practices”, but also a venue for manufacturers to display product offerings and shape “marketing practices” as it directly corresponds with “consumer demand in the marketplace” (Caswell & Mojduszka, 1996; Caswell, 1998). With a mix of voluntary *and* government policies, regulations, and interventions, labeling has become an imperative of the industry from production to consumer. Government intervention in labeling, however, is oftentimes criticized for its costliness; however, regulations in place to control “input standards, process standards, product performance standards, information

requirements, conditions of sale or service requirements and conditions of use requirements” prevent consumer deception and product failure (Caswell, 1998). Similarly, it is imperative that consumers have “sufficient information to protect themselves against unsafe products or unfair seller behavior” (Caswell & Mojduszka, 1996). The increasing demand by consumers for understandable information regarding the “health and nutritional aspects” of their food has created a conundrum in which consumers do not feel that they understand the product labels (Wandel, 1997; Glanz et al., 1989).

Current labeling regulation climate encourages basic impartment of information, mandatory disclosures to allow for consumers to make well informed decisions. As mentioned previously, nutritional labels and safe handling labels are mandated; labeling requirements for MTB products are being considered. With regards to food safety, labeling, and economics, consumers tend to make risk-based choices with regards to how much they are willing to pay for food depending on their perception of benefits; similarly, producers will only “supply food quality if it is profitable for them or if are required to do so” (Caswell & Mojduszka, 1996). Despite the benefits of labels, food labels for the market are limited by label space, “commercial free speech”, limited consumer usability of information (Caswell, 1998).

Food quality is oftentimes assessed through “experience attributes”, of which “food safety and nutritional characteristics” do contribute; however, even if a consumer were to become ill, oftentimes the consumer is unable to accurately identify the product causing the negative incidence. Furthermore, it can be argued that despite being informed or having a backing reputation, labels do not indicate food safety and nutrition that consumers would follow due to inability of consumers to form quality judgments.

Use of labels by consumers has been shown to be heavily demographic dependent by gender, education, age, and socio-economics. More educated women, prior to their mid-fifties, who are desire knowledge, are more likely to study labels. Yet, upon inspection, many who read labels find themselves even more confused after reading, oftentimes feeling “less satisfied” than those who hadn’t read any of the labels (Wandel, 1997). Generally, consumers are more content with the complete nutritional information provided by labels than they are with the indicated safety points. While this study referred to additives – and consumer thought of additives – the concerns can be expressed to “reflexive modernization of industrial society” brought about by the advent of the industrial society where food safety was put on the wayside in lieu of profit (Beck, 1992).

Food safety labeling falls into two categories: (a) voluntary differentiation of product’s safety levels about regulation set minimums, and (b) consumer education of safe-use practices for product. However, government mandated labeling tends to fall second to direct food safety regulations since the latter are easier to control and ensure consistency from the onset, and for fears that by relying on labeling, food industry will not be as incentivized to create a consistently safe product (Caswell, 1998). Theoretically, safe food handling practices are educational for consumers and food handlers on potential pathogenic hazard, product handling of a product and can result in risky behavior reduction, and allow for product differentiation; however, this becomes entirely dependent on the user to actually interact with the information.

MTB labeling falls under “labeling of process attributes” which in and of itself creates complex issues which could inevitably negatively (or positively) affect consumer purchases or perception of a product. While voluntary labeling has proved to be useful, a concern is that there are no actual advantages for a particular labeling (Caswell, 1998). Additionally, by labeling

process attributes, consumers can be misled into non-relevant information through their own perceptions.

Beef labeling, especially, has come to prominence with the onset of reflexive modernization. While both origin-labeling and traceability have risen to the height of consumer concern; in the U.S., as opposed to European countries, USDA food safety inspection certification is of utmost importance (Loureiro & Umberger, 2007). In other countries, having country-of-origin labeling, protected designation of origin, and protected geographical indication labels are all value-added benefits by ascertaining food quality credibility from whence the beef was derived and the process by which it was processed (Loureiro & Umberger, 2007). Only about 43% - 65% of consumers even know of there being a safe handling label (Ralston, 2002; Loureiro & Umberger, 2007).

Research Design

Mixed Methods Research Design

Mixed-methods research design has its roots in the field of evaluation (Creswell & Clark, 2018). At its core, it has evolved into “the combination of qualitative and quantitative approaches in the methodology of a study” (Tashakkori & Teddlie, 1998; Creswell & Clark, 2018). The purpose of this research design, regardless of paradigm or philosophy imbued at its core is to further understand and corroborate the breadth and depth of a research idea (Johnson et al., 2007; Creswell & Clark, 2018). Additionally, utilizing a mixed-methods research design can be considered epistemologically sound while allowing for paradigm plurality in its underlying

philosophy (Tashakkori & Teddlie, 2010). Further elaboration of mixed-methods research designs have solidified four core characteristics:

- (1) Collecting and analyzing qualitative and quantitative data specific to research questions and hypotheses
- (2) “Integrating the two forms of data and their results”
- (3) “Organizing these procedures into specific research designs that provide the logic and procedures for conducting the study”
- (4) “Framing procedures within theory and philosophy” (Tashakkori & Teddlie, 2010).

As it is used to produce a deeper understanding of a topic, mixed-methods research designs are used to expand on and/or complete previous results, define and explore a topic, or further explore initial exploratory results, compare different cases, involve participants, and develop/implement/evaluate a program. Based off of Greene, Caracelli, and Graham’s five proposed purposes for mixed-method evaluation designs (e.g. “triangulation, complementarity, development, initiation, and expansion”), this specific research project is used for development; but in the later aspects, this overall research project will become an expansion study (1989). Data collection will occur separately and sequentially. QUAL and QUANT data will be analyzed separately. They will later be incorporated once the vigor of results are established (Watkins & Gioia, 2015). Mixing of results will occur during data analysis as the QUAL data, once analyzed, will guide the analysis and development of the QUANT portion. Mixing will also occur at the point of data interpretation.

Sequential Exploratory Mixed Methods Research Design [MMRD] involves a qualitative [QUAL] component that will develop and inform a quantitative [quant] component (Greene et al., 1989; Creswell & Clarke, 2018). The QUAL component will “explore dimensionality of a

phenomenon”. Results obtained from QUAL component will enable/guide a quantitative aspect. A sequential exploratory mixed methods research design may be used when “the measurements and experimental activities are not available; the variable are unknown; there is no guiding framework or theory”; or there is a need to expand and further explore a quantitative aspect more specifically (Creswell & Clarke, 2018). Through sequential MMRD, findings can be cross-validated and complement one another. Theoretically, MMRD should combine the strengths of open-ended and close-ended data sets to better “understand research problems”; as such, mixed methods epistemology tends towards pragmatism which “focuses on the consequences of research, on the primary importance of the question asked and use[s] multiple methods of data collection to inform the problems under study” (Watkins & Gioia, 2015; Caswell & Clarke, 2018). On the other hand, exploratory MMRD leans more towards constructivist principles; but may shift later on to another philosophy.

Focus Groups

Focus groups, also known as, group depth interviews, are one of the oldest and most widely used research tools. With roots in behavioral sciences and research in war effects since the 1940s, then popularized by marketing research in the 1970s, focus groups have evolved from focusing on developing business growth to becoming a distinctive and important aspect of the qualitative and behavioral sciences fields. Focus groups are used to stimulate in-depth exploration of a topic that would otherwise be difficult to discuss on a one-on-one interview (Kreuger & Casey, 2014). Additionally, this approach to data collection allows for quick identification of similarities and differences between individuals with fairly instantaneous feedback and broken-down barriers. Focus groups also provide a higher degree of freedom in terms of responses; there are more options

and more ideas to discuss with the ability to address the “grand tour of questions: who, what, when, where, why, how”. Incidentally, focus group data cannot be and is not representative or generalizing of a larger population. It is only one instance and phenological; thus, in order to fully make sense of focus group results, it may be necessary to combine it with another study (Stewart et al., 2007).

Survey Design

There are various modes to implement surveys: single-mode or mixed-mode. Surveys can be conducted through a variety of mediums: (a) mail; (b) telephone – landline or cellular phone (call or text); (c) online (PC or cellular phone). The distribution of the survey – for acquiring respondents and for responses – can be the above mediums separately (single-mode) or interspersed (mixed-mode). There are pro and cons for all methods (see Figure 2.1). Additionally, in designing surveys, it is imperative to consider and minimize the four main types of errors: coverage errors; sampling error; nonresponse error; and measurement error – all of which affect the various mediums. Other issues to consider would be total survey error, sample frame (probability sampling), various information data, the ease of questionnaires, sensitivity of questions to question order variations and/or frequency scales, and general questionnaire design. As Dillman et al. (2014) notes, “questionnaire design needs to strike a balance between competing interests with the goal of keeping questionnaire length to a minimum in order to minimize respondents’ burden and avoid wasting their time collecting data that will never be used”.

Theory of Planned Behavior and Locus of Control

The strength of one's attitude is more closely tied and predictive of one's behavior, creating an attitude-behavior relationship. In fact, one's specific behavior has been shown to be more predictable of behavior if (a) a strong attitude is expressed; (b) attitude is "accessible in memory"; or (c) there is personal involvement (Armitage & Christian, 2004; Baron & Kenny, 1986; Conner & Sparks, 2002; Kokkinaki & Lunt, 1998; Thomsen et al., 1995; Kraus, 1995).

Proposed by Ajzen (1988), the Theory of Planned Behavior [TPB] has been frequently used to understand and predict consumers' food safety behaviors and responses to interventions. TPB builds off of Fishbein and Azjen's 1975 *theory of reasoned action*. TPB seeks to explain a person's behavior and possibly predict future behaviors through three determinants of intention: (a) attitude; (b) subjective norm; (c) perceived behavioral control (Figure 6.1). In this, not only is one's attitude able to predict behavior; additionally, perceived social pressures from one's circle would influence the outcome of a behavior. In addition, perceived behavior control [PBC] not only impacts behavioral intent; but, also can affect behavior, directly. If one perceives that they have the power to facilitate or inhibit a behavior, they will (or won't) do such a behavior (Armitage & Christian, 2004). PBC is similar to "Bandura's notion of self-efficacy" in which if someone believes "that a particular behavior is under their personal control" they are more likely to intend and to engage in the behavior and actually follow through with the behavior (Armitage & Christian, 2004; Bandura, 1997; Ajzen, 1994; Armitage & Conner, 2001). With regards to food safety, there are internal and external loci of control. External loci are things (i.e. situations, objects, etc.) which consumers are unable to control or are of outside of their influence. On the other hand, if consumers are empowered by perceived self-efficacy, they have a higher internal loci of control.

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Table 2. 1: Estimated annual number of hospitalizations and deaths by pathogenic *Escherichia coli* until 2011 (Scallan et al., 2011)

<i>E. coli</i> Pathogen	Illnesses	Hospitalizations	Hospitalization rate (%)	Deaths	Death rate (%)
O157:H7	96,534	2,138	46.2	20	0.5
non-O157:H7	168,698	271	12.8	0	0.3
ETEC, foodborne		12	0.8	0	0
non STEC and ETEC		8	0	0	0

Table 2. 2: Shiga-toxin producing *Escherichia coli* outbreaks in the United States (2006 – May 2018)

Year	Total Outbreaks	Outbreak Pathotype	Produce or Meat-Poultry or RTE	Outbreak Source ¹	Illnesses	HUS	Deaths	Hospitalizations
2006	1	O157:H7	Produce	Spinach	199	31	3	
2007	2	O157:H7	Meat*	Ground Beef	4	2	0	
			RTE	Pepperoni Pizza	21	4	0	
2008	1	O157:H7	Meat*	Ground Beef	49	1	0	
2009	3	O157:H7	Meat*	Ground Beef	17	2	0	
			RTE	Cookie Dough	26	5	2	
2010	3	O157:H7	Meat*	Ground Beef	72	10	0	
			RTE	Cheese	21	1	0	
2010	3	O145	Produce	Romaine Lettuce	38	1	0	
			Produce	Romaine Lettuce	26	3	0	
2011	4	O157:H7	Meat	Lebanon Bologna	58	3	0	
			RTE	In-shell Hazelnuts	14	0	0	
2011	4	O104:H4 ²	Produce	Sprouts	8	0	0	
			Produce	Spinach and Spring Mix	> 4,000	852	32	
2012	3	O157:H7	Produce	Spinach and Spring Mix	33	2	0	
			O26	Produce	Clover Sprouts	29	0	0
2012	3	O145	Other	Food	18	--	1	
			O157:H7	RTE	RTE Salads	33	2	0
2013	2	O121	RTE	Frozen Foods	35	2	0	9
			O157:H7	Meat*	Ground Beef	12	0	0
2014	2	O121	Produce	Raw Clover Sprouts	19	0	0	44%
			O26	Other	Unknown	60	0	0
2015		O157:H7	RTE	RTE Salad	19	2	0	5

¹ Multi-state outbreak. All outbreaks in this list, except for 2011 STEC O104:H4 infection have been identified as multi-state outbreaks.

²2011 *E.coli* O104:H4 produce outbreak traced back to sprouts originated in Germany. Six cases of STEC O104:H4 infections were confirmed in the United States.

* “Meat” indicated with an asterisk denotes beef-related outbreaks.

2016	O157	Produce	Alfalfa Sprouts	11	0	0	2
2017	O157:H7	Produce	Leafy Greens	25	2	1	9
2017	O157:H7	RTE	SoyNut Butter	32	9	0	26 (81%)
2018	O157:H7	Produce	Romaine Lettuce	98	10	0	46

Table 2. 3: USDA and FDA STEC-related recalls (2005 – May 2018)

Year	STEC or <i>E. coli</i> associated Recalls (Beef-Related)	Pathotype	Date	Product	Pounds recalled	Reported Recovered by Establishment
2018	Ongoing (1)	O157:H7	14-Apr-18	Romaine Lettuce	Undetermined	Undetermined
		O128	26-Mar-18	Fresh raw meals for dogs	4 lots (weight undetermined)	
		O157:H7	03-Mar-18	Ground Beef and Ground Pork Products	14,806	820
2017	14 (8)	Unspecified	20-Oct-17	Salad and Basil Products		
		O157:H7	13-Oct-17	Ground Beef Products	133	133
		O157:H7	04-Oct-17	Ground Beef Products	700	580
		Unspecified	08-Aug-17	Ice Cream		
		O26	07-Aug-17	Beef Products	1,290	13,917
		O157:H7	05-Jun-17	Ground Beef and Beef Primal Cut Products	22,832	5,309
		O121	31-May-17	Flour		
		Non O157	04-May-17	Beef, Veal, Pork Products	5,620	6,631
		O157:H7	27-Apr-17	Ground Beef Products	Undetermined	0
		O157:H7	24-Mar-17	Yogurt Peanut Crunch Bars		
		O103	19-Mar-17	Boneless Beef Products	79,461	250,872
		O157:H7	10-Mar-17	SoyNut Butter and granola products		
		O157:H7	07-Mar-17	SoyNut Butter		
		O103	02-Mar-17	Boneless Veal Products	40,680	0
2016	23 (12)	O26 O45	23-Dec-16	Veal Products	4,607	3,907
		O26	14-Oct-16	Non-intact Beef and Veal Products	2,349	395
		O157:H7	07-Oct-16	Ground Beef Patties and Steak	216,367	59,408

			Sandwich Products			
		O103	27-Sep-16	Boneless Beef Trim Products	2,100	12,355
		O157:H7	24-Sep-16	Beef, Veal, and Bison Products**	Undetermined	43,496
		Unspecified	09-Sep-16	Lamb Products	15	13
		O157:H7	08-Sep-16	Ground Beef Products	35	0
		O121	11-Aug-16	Dry Baking Mixes		
		STEC	08-Aug-16	Organic Cheeses	20,000	
		O157:H7	26-Jul-16	Ground Beef Products	2,606	0
		O157:H7	26-Jul-16	Intact and Non-Intact Beef Product	8,800	2,640
		O121 O26	25-Jul-16 (from May 2016)	Flour**		
		O121	13-Jul-16	Biscuit Mix		
		O121	12-Jul-16	Jalapeno Breader		
		O121	12-Jul-16	NRTE Chicken Products	5,850	8
		O121	11-Jul-16	Cake Mix		
		O121	09-Jul-16	Pancake Mix		
		O121	8-Jul-16	NRTE Beef & Poultry Products	44,850	5,644
		O121	17-Jun-16	Beer Bread Mix		
		O157:H7	14-Jun-16	Beef Products	3,586	150
		O157:H7	21-Apr-16	Frozen Ground Beef Patties	325	220
		O157:H7	25-Feb-16	Sprouts**		
		O157:H7	20-Jan-16	Ground Beef Products	410	325
		O157:H7	26-Nov-15	Celery Products in RTE Salad		
	11 (8)	EHEC	26-Oct-15	Granny Smith Apples	33 cases	
		O157:H7	01-Nov-15	Ground Beef Products	167,427	28,206
2015		Non-O157:H7	8-Sep-15	Ground Beef Products	20	20

		O157:H7, non- O157:H7	23-Jul-15	Veal Products	Undetermined	4,360
		O157:H7	03-Jul-15	Steak and Ground Beef Products	26,975	3,087
		O157:H7	04-Jun-15	Ground Elk Meat	1,640	
		O157:H7	03-Jun-15	Ground Beef Products	16,000	0
		O157:H7	18-May-15	Veal Trim	2,522	0
		O157:H7	27-Apr-15	Beef Products	1,029	0
		O157:H7	28-Jan-15	Boneless Beef Trim	1,620	9,970
		O103, O111, O121, O145, O26, O45	04-Feb-14	Beef Products	15,865	4,159
		O157:H7	19-May-14	Ground Beef Products	1,800,000	35,024
2014	6 (5)	O111:H8	28-Jul-14	Raw Goat Milk Cheese	Unspecified	Unspecified
		O157:H7	15-Aug-14	Ground Beef Products	368	0
		O157:H7	25-Sep-14	Beef Products	23,100	480
		O157:H7	22-Nov-14	Ground Beef Products	1,200	514
		O157:H7	15-Jan-13	Ground Beef Products	2,532	50
		Unknown	15-Jan-13	Artisan Cheeses		
		O157:H7	30-Jan-13	Veal Trimblings	1,260	942
		O121	28-Mar-13	Frozen Meal and Snack Products	10,500,000	0
		O157:H7	18-Jun-13	Ground Beef	22,737	5,090
2013	11 (7)	O157:H7	31-Jul-13	Ground Beef	50,100	49,136
		O157:H7, O145, O45	09-Aug-13	Boneless Veal	12,600	1,500
		O157:H7	12-Sep-13	Beef Tongue Roast Filet Products	690	60
		O157:H7	22-Oct-13	Ground Beef	Undetermined	604
		O157:H7	10-Nov-13	RTE Grilled Chicken Salads	181,620	112
			24-Mar-12	Ground Beef Patties	16,800	
2012	7 (5)	O157:H7	11-Apr-12	Ground and Tenderized Beef Products	2,057	
			14-Aug-12	Beef Products	38,200	
			19-Aug-12	Romaine Lettuce		

			22-Oct-12	Ground Beef Products	2,310
			22-Oct-12	Ground Beef Products	4,100
		Unknown	02-Nov-12	Spinach	
			05-Feb-11	Ground Beef Products	3,170
			08-Mar-11	Ground Beef Products	14,158
			22-Mar-11	Lebanon Bologna Products	23,000
			25-May-11	Ground Beef Products	500
			31-May-11	Ground Beef Products	900
			27-Jul-11	Beef Products	228,596
			09-Aug-11	Ground Beef Products	2,200
2011	16 (12)	O157:H7*	12-Aug-11	Ground Beef Products	60,424
			23-Sep-11	Frozen Fine Ground Beef Products	40,000
			27-Sep-11	Ground Beef Products	131,300
			30-Sep-11	Beef Products	80,000
			11-Oct-11	Ground Beef Products	377,775
			17-Oct-11	Bagged Salad Product	
			16-Dec-11	Ground Beef Products	40,948
			23-Dec-11	Fresh Spinach	
			11-Jan-10	Beef Products	2,574
			18-Jan-10	Beef Products	864,000
			02-Feb-10	Boneless Beef Products	14,000
			02-Mar-10	Beef Products	96,000
			21-Apr-10	Beef Trim Products	135,500
			15-May-10	Ground Beef Products	53,000
2010	12 (11)	O157:H7*	22-Jun-10	Ground Beef Products	3,700
			22-Jun-10	Ground Beef Products	35,000
			02-Jul-10	Ground and Tenderized Steak Bison Products	66,776
			06-Aug-10	Frozen Ground Beef Patties and	1,000,000

			Bulk Ground Beef Products		
			30-Dec-10	Organic Ground Beef Products	34,373
	O26		28-Aug-10	Ground Beef Products	8,500
			04-May-09	Ground Beef Products	4,663
			12-May-09	Ground Beef Products	375
			21-May-09	Ground Beef Products	95,898
			02-Jun-09	Ground Beef Products	39,973
			08-Jun-09	Beef Trim Products	75
			22-Jun-09	Ground Beef Products	6,152
			24-Jun-09	Beef Products	380,000
			12-Jul-09	Ground Beef Products	219
2009	16 (16)	O157:H7*	13-Aug-09	Ground Beef Products	3,516
			17-Aug-09	Ground Beef Products	128
			13-Oct-09	Ground Beef Products	925
			26-Oct-09	Ground Beef Patties	1,039
			31-Oct-09	Ground Beef Products	545,699
			17-Nov-09	Ground Beef Products	90
			21-Dec-09	Ground Beef Products	68
			24-Dec-09	Beef Products	248,000
			05-Jan-08	Beef Products	13,150
			12-Jan-08	Ground Beef Products	188,000
			08-May-08	Ground Beef Products	68,670
			16-May-08	Beef Products	Undetermined
			08-Jun-08	Ground Beef Products	13,275
2008	17 (17)	O157:H7*	25-Jun-08	Ground Beef Products	Undetermined
			30-Jun-08	Ground Beef Components	5,300,000
			23-Jul-08	Beef Cheek Products	1,560
			06-Aug-08	Frozen Ground Beef Products	153,630
			08-Aug-08	Beef Products	1,360,000

			11-Aug-08	Ground Beef Products	780
			08-Oct-08	Frozen Beef Trim	2,340
			08-Oct-08	Frozen Beef Trim	4,200
			08-Oct-08	Frozen Beef Trim	20,460
			10-Oct-08	Frozen Beef Trim	420
			16-Oct-08	Ground Beef Products	2,758
			24-Nov-08	Ground Beef Products	345
			29-Jan-07	Ground Beef Products	4,240
			02-Mar-07	Ground Beef	16,743
			20-Apr-07	Beef Products	259,230
			20-Apr-07	Frozen Ground Beef Products	107,943
			10-May-07	Beef Trim Products	117,500
			11-May-07	Beef Products	129,000
			03-Jun-07	Ground Beef Products	5,700,000
			08-Jun-07	Ground Beef Products	40,440
			21-Jul-07	Ground Beef Products	26,669
			25-Jul-07	Ground Beef and Buffalo Products	5,920
2007	22 (21)	O127:H7*	05-Sep-07	Ground Beef Products	884
			25-Sep-07	Ground Beef Products	21,700,000
			29-Sep-07	Ground Beef Products	65
			06-Oct-07	Frozen Ground Beef Patties	845,000
			13-Oct-07	Frozen Ground Beef Products	173,554
			13-Oct-07	Ground Beef Products	1,900
			24-Oct-07	Frozen Ground Beef Products	8,200
			27-Oct-07	Ground Beef Products	50
			01-Nov-07	Frozen Meat Pizza Products	3,300,000

			03-Nov-07	Ground Beef Products	1,084,384
			24-Nov-07	Ground Beef Products	95,927
			17-Dec-07	Hamburger Patties and Bulk Ground Beef	102
			05-May-06	Ground Beef Products	156,235
			17-Jul-06	Ground Beef	315
			31-Jul-06	Ground Beef	120
2006	8 (8)	O157:H7	04-Aug-06	Ground Beef Products	13,078
			05-Aug-06	Ground Beef	4,337
			18-Aug-06	Beef Products	909
			06-Oct-06	Ground Beef	5,226
			23-Oct-06	Ground Beef Products	1,680
			09-Jun-05	Frozen Ground Beef Products	63,850
			22-Aug-05	Frozen Ground Beef Patties	900,000
2005	5 (5)	O157:H7	23-Sep-05	Frozen Ground Beef Patties	184,000
			01-Nov-05	Frozen Ground Beef Patties	94,400
			03-Nov-05	Ground Beef	6,200

	Pros	Cons
Telephone (Landlines)	<p>97.6% of households have telephones (SSI, 2003)</p> <p>Uniform Interpretation: Conversational Interviewing techniques make sure respondents understand question</p> <p>Answers with higher variability</p> <p>RDD</p> <ul style="list-style-type: none"> Telephone: 94% --> data is more representative of US population (education, income, race/ethnicity, age) <ul style="list-style-type: none"> But with screening calls, this may not be the case. <p>Higher agreement/completion rates than cell phone (Brick et al., 2007)</p>	<p>Low response rates (increase non-response bias) People may hang up because they think telemarketer (Elvin, 2000; Remington, 1992)</p> <p>Decline in contact ability because less people use the landlines</p> <p>Decrease reporting b/c people don't think it's anonymous (Cooley et al., 2010)</p> <p>People don't want to pay immediate attention (Melymuka, 1997)</p> <p>Interviewer bias or "misbehavior"</p> <p>Social Desirability Response Impression Management Self-deceptive Enhancement</p> <p>22% of US households are not covered by landline RDD</p>
Telephone (Cell Phone)	<p>Increased Individuals with Cell Phones = theoretically, ^ RDD</p> <p>Same as above "Telephone (landlines)"</p> <p>Text messaging</p>	<p>Low response rate or Low Coverage Individuals may not actually reside in their area code Do not know limitations of cell phone usage / individuals</p> <p>Potential for under-coverage bias b/c RDD is mostly for landlines and excludes cell phones</p> <ul style="list-style-type: none"> US law forbids autodialing and leaving cell phone voice messages Cost issues Safety concerns Privacy issues when responding on cell phones Poor connections aren't actually too bad. <p>Lower refusal conversion rate (Brick et al., 2007)</p> <p>Higher refusal rate. (Brick et al., 2007)</p>
Web (PC / Online)	<p>Lower Acquisition Cost & Time</p> <p>Access to large number of pplz who would be able to participate</p> <p>May be more willing to give an answer b/c it can be assumed to be anonymous Providing of automatic or password protected access - semi-automatic = "higher response rates, completion rates, and less socially biased answers to sensitive Qs"</p> <p>Shorter, more interesting, enjoyable, confidential, and understandable; also more professional (Baker, 1992) Finish in one sitting</p> <p>Neutral or negative attitudinal evaluations; cognitive response styles (Roster et al., 2004)</p> <p>Free of interviewer bias and misbehavior; privacy --> increase completeness of reporting some behaviors (reduce response errors like social desirability and prestige?) (Cooley et al., 2000; Hair et al., 2003; Johnson et al., 2000)</p> <p>Consistency --> indicator of reliability (McDaniel and Gates, 2005; Braunsberger et al., 2007)</p> <p>Completion in 21% of time to do telephone surveys (less t)</p> <p>Lower social desirability response bias (compared to phone)</p> <p>Can control the UX to make friendly approach</p> <p>Combine with another mode to increase response</p> <p>Survey software (can also be con)</p> <p>Can have longer "fill in responses" than phone survey</p> <p>Many types of surveys: PDF fillable, email back, online survey to enter, etc.</p>	<p>Coverage Error (difference b/w target population and population actually used) can create <i>low response rate</i> (Couper, 2000) May NOT represent the population (Szolnoki & Hoffmann, 2013) People on web: Higher education w/ higher incomes Can't control speed of net and other variables. Digital Divide</p> <p>People may falsify demographic data (James, 2003) - you can account for this by having a specific panel of people</p> <p>Is there a representative sample of people that have internet access? (Roster, 2004, p360) Telephone - representative samples; internet surveys are restricted Need to ensure representativeness of sample. Would this be along the lines of the Census data?</p> <p>If <i>Email</i> technology: People may not open attachments Different target populations may or may not use (Shih & Fan, 2009)</p> <p>Recruiting individuals may be harder depending on method (email vs mail) Mail >> Web = higher response Email >> Web = lower response (perhaps surveys are lost in mail)</p> <p>Nonresponse rate Web surveys are 11% < other survey responses</p> <ul style="list-style-type: none"> Coverage Error (Couper, 2000) - not everyone has access to net Sampling Error (Couper, 2000) - not everyone who has access to net will have "equal chance to participant in the survey" <p>Survey fatigue High social anxiety individuals tend towards net leading towards responding to survey which would increase sampling error</p> <p>Non-coverage (lack of access) >>> Nonresponse (unwillingness to participate) in those over 50 years old. Lack of sampling frame - Sampling algorithm (like for RDD) can not be established for online surveys Tend towards opt-in Tend towards nonprobability sampling methodologies Respondents may not be inclined to complete the survey b/c what good it to ehm (gotta show them that)</p>
Mail	<p>Utilize USPS DSF to reach rural locations - Mail surveys important for rural locations due to decline response via telephone and non-coverage for internet (Dillman 2006)</p> <ul style="list-style-type: none"> Geocode addresses Respondents' proximities Stratify based on demographic compositions of geographic areas. Can collect data from cell-only households or individuals Considerably less than RDD landline surveys <12% less <p>Higher Response vs Email Survey (lost in spam?) Reasonable response rates (70%) w/ incentivize</p>	

Figure 2. 1: Pros and cons of various survey methodologies

CHAPTER 3

Research Paper

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Consumer awareness, attitudes, and how they handle mechanically tenderized and enhanced beef products

Author details

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ABSTRACT

In May 2016, labeling of non-intact mechanically tenderized beef products [MTBs] was mandated in the United States. This was due to the potential risk of pathogens (specifically Shiga-toxin producing *Escherichia coli* O157:H7) present on the beef surface being transferred to the inside of the meat. The lethality treatment for tenderized beef is different than intact meat. Without labeling, it can be difficult for the consumer to distinguish between intact and tenderized beef. The term mechanically tenderized may be a new processing term for consumers, therefore, the objective of this exploratory study was to identify and assess consumer knowledge, attitudes, and behaviors regarding MTBs. Thirty-two (32) focus groups were conducted in urban and rural counties of Virginia and North Carolina. All sessions were audio-taped and transcribed. Thirteen randomly selected focus groups were further analyzed for content through constant-comparison thematic analysis. Participants were aware of “cube steak”, a visually tenderized product purchased for its price, convenience, and palatability; however, awareness of other MTBs was limited. Other intrinsic and extrinsic properties (price, date) were initially more important to consumers for purchase and preparation than meat having been mechanically tenderized. While participants wanted to know about the MTB process and the specific designation through labels, other messaging methods (e.g.: in stores, through technology, with certifications, etc.) may be preferred. Consumers’ decisions to continue to purchase and prepare MTBs were affected by demographics and localities. Blade-, and mechanically- as opposed to needle-tenderized was preferred terminology for labels. This is the first survey to be done of American perception of MTBs; ultimately, it is necessary to understand national consumers’ awareness of MTB products and labels to enable and develop communication tools for new and current little-known risks.

INTRODUCTION

The meat and poultry industries are the largest segments of United States [US] agriculture, producing over 93B combined pounds, yearly, and generating \$1.02T (~6% GDP) for the U.S. economy (Dunham, 2016; USDA, 2016). As the largest global beef cattle industry, the U.S. beef cattle industry produced 41.5B pounds of beef in 2016. Additionally, to meet consumer consumption demands, beef is heavily imported and exported (USDA, 2016; NAMI, 2017).

To achieve desired beef characteristics (tenderness, juiciness, and flavor) and improved palatability, lower-valued beef cuts can be enhanced through value-added processes such as: comminution (i.e.: ground, chopped, or minced), mechanical tenderization, marinade tenderization, injection (with marinade or enzymes), or vacuum tumbling. These processes result in the output products being “non-intact” cuts of meat (Miller et al., 2001). The 2017 Food Code defines the term “mechanically tenderized” as “manipulating meat with deep penetration by processes which may be referred to as ‘blade tenderizing’, ‘jacquarding’, ‘pinning’, ‘needling’ or using blades, pins, needles or any mechanical device”, thereby increasing tenderness (FDA, 2017). These processes increase the risk of pathogen introduction from the exterior of intact beef cuts into the interior of the beef muscle and beef product (USDA-FSIS, 2015; FDA, 2017). USDA-FSIS reports mechanical tenderization happens in 2.7 billion pounds (11%) of beef annually (USDA-FSIS, 2016).

While some mechanically tenderized beef products [MTBs] visually appear tenderized (i.e.: cubed steaks), other MTBs may resemble intact cuts. Therefore, the consumer may have no way of knowing if the meats they have purchased has been mechanically tenderized. As such, there is concern that consumers will treat non-intact cuts similarly to intact cuts and underprepare them, potentially rendering the product unsafe.

The Center for Disease Control has reported six outbreaks of Shiga-toxin producing *Escherichia coli* O157:H7 [STEC] since 2006 attributed to MTBs prepared at home and in restaurants. Since 2012, an additional 18 cases of STEC-associated outbreaks have been reported in Canada (USDA-FSIS, 2015). Additionally, STEC-associated contamination has resulted in 136 non-intact beef-related recalls (FDA, 2018; USDA, 2018). At present, both the Canadian Food Inspection Agency and the United States Department of Agriculture – Food Safety and Inspection Service [USDA-FSIS] require mandatory labeling of MTBs. This requires that all raw or partially-cooked mechanically (blade or needle) tenderized beefs products, along with marinade or solution enhanced products be labeled with their respective processes unless product will be cooked completely or receive another lethality treatment. The labeling rule is not applicable to products that have been pounded or cubed (due to the visual obviousness of the process), enzyme formed, or vacuum tumbled (with or without marinade or enhancement solutions).

MTBs must be labeled as “Mechanically Tenderized Beef” (or a process-compatible name such as: “Blade Tenderized” or “Needle Tenderized”) to inform and aid consumers and retailers in product differentiation and safe handling procedures (including recommended thermometer-checked safe internal cooking temperatures: 145°F held for 3 minutes or 160°F (USDA-FSIS, 2015). Despite opposition from the meat industry, USDA-FSIS conceded that, “without clear labeling, food retailers and consumers do not have the information necessary to prepare these products safely” (USDA-FSIS, 2015).

The purpose of this study was to identify, define, explore, and assess consumer knowledge, awareness, attitudes, and behaviors regarding MTBs through focus groups. Focus groups were conducted instead of one-on-one interviews and surveys to allow discussion of open-ended topics, divert attention away from the interviewer, increase self-disclosure, create a natural discussion

environment, allow for emergence of ideas due to synergy not seen by an individual, and move towards a more phenomenological approach (Onwuegbuzie et al., 2009)

MATERIALS AND METHODS

The Virginia Tech Institutional Review Board approved the experimental protocol used in the present study (IRB #15-521).

3.1 Recruitment

Focus groups were conducted in both rural and urban locations across Virginia and North Carolina. Locations were randomly chosen based on population density of both County and City/Town as determined by the 2010 U.S. Census Bureau (urbanized areas > 50,000; rural < 50,000) (U.S. Census Bureau, 2015). Participants were recruited through a mixture of stratified random sampling, snowball sampling, and convenience sampling. Stratified random sampling was conducted through advertisements and recruitment materials to randomly recruit participants from pre-determined locations (Table 3.1). Following this approach, snowball sampling via word-of-mouth and recommendations from already recruited participants and researchers' networks (convenience sampling) were also conducted to recruit a larger number of participants. Recruitment materials (Appendix A1, A2) were distributed in counties via Extension personnel, and posted at randomly identified public or private locations (e.g.: libraries, coffee shops, meat markets, community boards in major retail supermarkets, local markets, Extension offices). These were also distributed through newspaper outlets (via newspaper ads or articles) both online and in-print and through online/social media recruitment campaigns.

Individuals interested in participating were instructed via recruitment materials to either fill out a brief online questionnaire or call to determine eligibility for the study. To be eligible, an individual must be over 18 years old, and be the primary food purchaser or meal preparer in the

household. Participants from the same geographic location were grouped together for the focus group session(s) based upon availability.

3.2 Procedure and materials

Each focus group was held at a local county Extension Office. During each session, two to three researchers were present: one moderator led the discussion, the other(s) took handwritten notes. All sessions were audio-recorded with two Olympus DS-30 digital audio-recorders (Olympus America, Inc., Center Valley, PA) and transcribed verbatim to ensure completeness of data. Each session lasted between one to two hours.

Nineteen semi-structured questions were asked to the group (Appendix 1C). This approach allowed for open-ended responses and further discussion around specific responses. Topics covered included: (a) beef purchasing behavior, (b) beef preparation behavior including storage and cooking times and temperatures, and perceived safety; (c) knowledge of tenderized beef (and intact versus non-intact products); and (d) labels and potential intervention methods. Socio-demographic characteristics were also gathered via written responses from participants to characterize groups based on urban and rural locations. Each participant received a \$30 retail grocery store incentive at the end of the focus group. Prior to data collection, the procedure was piloted on a group of university students to assess the questions for clarity and conciseness. The results from the pilot study were not included in the final results. Demographic information is presented in Table 3.2.

3.3 Data analysis

All notes taken during sessions were compared to the recorded audio and inserted at corresponding points in the verbatim-transcribed transcripts when necessary.

Due to time and research constraints, thirteen (three rural and nine urban) out of 35 completed focus groups were randomly selected for analysis based upon Kreuger & Casey's (2009) focus group parameters with focus participants ranging between 5 – 9 people. NVIVO11 Pro for Windows (QSR International; Victoria, Australia) was used for coding and data analysis. One person from the research team reviewed all the transcripts and developed an open coding system encompassing (a) interpretive; (b) inductive; and (c) constructivist approaches. To determine inter-coder reliability of the nominal data set, three randomly selected focus group transcripts were coded by a second researcher (Cohen's-kappa coefficient=0.92). Both researchers further developed focused themes. Constant comparison analysis was integrated to ensure comprehensive review of all data and emergent themes were combined.

Themes were also developed and analyzed via latent/interpretative, inductive, and constructionist approaches (Braun & Clarke, 2006). Transcriptions were analyzed using constant comparison analysis. Constant comparison analysis relies on a general inductive approach (Thomas, 2006). A deductive approach was also applied based upon previously developed topics. Constant comparison analysis was used to openly code small units of data into themes then sub-themes. This method is useful in comparing and contrasting units of data across various transcriptions. In such a way, it will allow for verification of developing themes while allowing new categories and themes to emerge. The data falls under the emergent-systematic focus group which both explores and verifies. Up to three levels of themes/categories were developed.

RESULTS

Analysis of focus groups revealed three categories and 12 main themes addressing factors from preparation behavior and purchasing behaviors for MTBs. Another five categories and 15 themes were identified for interventions desires.

1: Participants' previous exposure to Tenderized Beef Products

Participants in all focus groups were familiar with the process of tenderizing beef at home either mechanically or using a marinade. Methods of tenderization at home included using “cleavers”, “hammers”, “mallets”, “steak knife”, “forks” both wooden and metal, and even a “tea-cup plate”. One participant injected beef cuts with sodium phosphate. A mixture of marinades with “soy sauce”, “salt”, and acids or chemical tenderizers or dry seasonings to tenderize and soften beef or enhance “flavor” were reported as being used. There was also an associated tenderization with heat processing by “cooking [beef] low and slow”.

While discussing shopping behaviors, at least one participant per group mentioned having previously purchased or having familiarity with “Southern Fried Steak” or “country fried steak”, the colloquial term for “cubed steak”, a type of MTB product. Participants bought such products because they preferred the taste and ease-of-preparation of “Southern fried steaks” and “country fried steaks” over non-tenderized beef products.

2: MTB Label

Participants stressed the impact of “visual criteria” and price as greatly impacting meat purchasing decisions. Participants were shown a label (Figure 3.1) and asked to describe it. The

packaging date and sell-by dates, the cut (NY Boneless Strip Steak), price, size, and weight were the label components noticed first. Participants expressed concern at the closeness of the packing and sell-by dates, indicating that the product might not be as fresh. Country-of-origin, store, location, and contact information were also pointed out. Participants wished the fat content of product was listed. Participants in ten of thirteen focus groups, immediately recognized the temperature designation (160°F) of the label. Some recognized 160°F as “the safe temperature” and compared it to the proper temperature for cooking “eggs”; while others immediately disregarded a temperature of 160 as “overdone”, “too done”, and suggested that the buyer “might as well throw it away”.

2.1: Theme – Nomenclature of MTB Label

Generally, it was agreed upon that the label included the “minimum amount of information” desired by participants; in fact, many declared that “this is the most I’ve ever read on a meat label” and “one of the most honest labels out there”. In some focus groups, participants automatically noticed the “blade tenderization” terminology; in the majority of focus groups, participants were prompted to discuss the “blade tenderization” label. The terminologies “mechanical”, “blade tenderized”, or “needle tenderized” were ambiguous and confusing; some perceived the product as safer, while others could not initially visualize nor understand what the process was. “Blade tenderized” was preferred over “mechanical tenderization”. “Mechanical is not positive”, is “ambiguous” and sounded “manipulated”; whereas “blade tenderized” is “prettier”. However, “needle” tenderization was perceived as “scary” and a “real turnoff” (Table 3.3).

In most groups, although participants pointed out the designation of “blade tenderized”, many within the groups mentioned they “didn’t notice it” and/or “didn’t know what it meant”, leading to speculation of what the process entailed. Some guessed that blade tenderization meant using “paddles” or “a knife”, while others were able to determine that the product was “run through a machine [that] pokes holes”. Pork and chicken were mentioned as products that were often seen and purchased tenderized, more so than beef. Participants also mentioned that they were also confused by the terminology of “chicken fried steak” as it does refer to a non-intact beef product but used two different product designations in its name.

2.2: Themes – Transparency and Desire for Education of MTB Label

Participants felt that the label design was confusing and unclear. The wording and layout of the label was confusing; participants believed the labeling to be misleading and crowded. Participants felt that it should be made abundantly clear that there was a connection between the risk of *E. coli* infections and the tenderized product. Participants even recognized the potential contaminations risks that may arise in their own homes from self-tenderization; they wanted that knowledge to be made clear, too. When reading the label (Figure 3.1), participants read the two lines combined as one sentence, instead of reading the label designation as two separated sentences. As such, participants failed to recognize nor understand the label because “the safety stuff [“for your safety”, with temperatures] is kinda minimized [and] sandwiched in between [the most important thing with the giant bold print: Price, date, and type” (Figure 3.3).

3: Future Purchasing Behavior

Once moderators explained the MTB process, the majority of participants acknowledged that they may have previously and unknowingly purchased mechanically tenderized beef products (including cubed steaks). Participants in urban counties and in North Carolina focus groups were more aware of MTBs and realized that they had likely previously purchased “pre-tenderized” products. For those that had previously heard of tenderized products, many had experience and previous knowledge that “the butcher use[d] a machine” or “meat cutter” to process it.

North Carolina participants were more likely to continue to purchase MTBs due to recognition that “it’s just the way you cook it” that differentiates a non-intact product from an intact product (Table 3.3). Although Virginians purchased cubed steaks, participants were unaware of having seen or purchased MTBs. In some cases, participants did not initially make the connection that cubed steaks were MTBs until after the discussion. There was also confusion between “cubed cuts” (i.e.: beef cut into cubes used for stew) and “cubed steak” or “cubed beef”.

3.1: Themes – Perception and Attitudes towards MTBs Affecting Future Purchasing Behavior

Participants had both positive and negative feelings towards MTBs. Participants expressed a general dislike for the mechanical tenderization process. The potential risks involved with the mechanical tenderization process were acknowledged; with participants acknowledging that “you have to treat it [MTBs] more like ground beef [as the process] allowing [...] bacteria to get in”. Participants frequently described the process and product as “unnatural”, “gross”, “scary”, like a “wringer washer”, “gruesome”, “kill me roast”, and “poked”. Participants with a positive attitude towards purchasing MTBs were those that had previously purchased cubed and tenderized

products before or knew that they would self-tenderize at home. These participants recognized the inherent risks and internalized what they had learned from the focus group to being more careful with MTBs in the future. A few participants expressed concern with injection marinades and enhanced flavorings through injections; they would prefer to purchase mechanically tenderized products rather than injected products.

3.2: Themes – Preference, Impact of Price, and Preparation on Future Purchasing

Behavior

The same individuals who expressed concern at injection marinated products were also more likely to spend more money for a perceived higher quality intact cut. Participants who would not purchase tenderized products not only cited the potential risks; but, also preferred “intact steaks” due to preferring undercooked meats and disinterest in using a thermometer.

On the other hand, many low-income and mid-income participants would continue to purchase mechanically tenderized products because “price matters” (Table 3.3).

4: Locus of Control

Participants continued by discussing the amount of their perceived control over the safety of MTBs, the external locus of control and trust, and their own abilities for self-efficacy.

4.1 – Theme: Safety

Participants who declared that they would continue to purchase MTBs not only recognized that they would have to prepare the product differently; but, that they may need to purchase and use a thermometer. They felt that it was important to know if a product was

tenderized especially for immuno-compromised individuals or for others whom they would prepare food for. Recognition of the potential risks was a deterrent from purchasing the product; however, participants expressed that they would be more cognizant of labels henceforth.

4.2 – Theme: Self-Efficacy

Building off safety, self-efficacy is an expression of internal locus of control. Focus groups participants did want to be made aware of the process because it allowed them to be in control of the safety of their families while empowering them to make the choices they saw fit. Additionally, due to convenience, participants realized that while they would not purchase thermometers, they could be more aware of preparation behaviors.

4.3 – Theme: Trust

Both urban and rural focus group participants brought up factors of trust. Some urban participants expressed cynicism and skepticism of government and food safety notifications. On the other hand, other rural participants trusted government and food safety notifications but became worried that they had been deceived. All hoped that notices regarding the MTB process would be made clear. Many participants expressed that they were glad that the labeling mandate would be going into effect; however, participants also stated that while they would now notice labels, they were still unlikely to read or follow them.

5: Interventions

Five categories for improving information communication and 18 themes were identified as methods of increasing transparency and disseminating knowledge of MTBs (Table 3.4). Label

clarity was identified as a necessity with an emphasis on using pictograms or symbols to discuss the process. There is a distinct lack of knowledge with more information needed to convey the potential risks and describe the MTB process. The use of a separate sticker, delineating colors, and larger fonts were encouraged to draw attention. Participants also opted for easy-to-understand language with a clearer description and formatting. Interventions utilizing technology was encouraged to engage consumers. Younger participants recommended the use of QR codes that they could quickly scan while shopping. Additionally, for individuals of all ages, developing and designing an informative website was encouraged. Female participants and older participants also mentioned their frequent viewing of cooking shows; if chefs on cooking shows practiced and performed good behaviors, it would have a positive impact on viewers. Participants recommended in-store campaigns, signs at the counter, and cooking demonstrations to directly engage with consumers so as not to scare them away from purchasing MTBs. Urban and rural participants recommended creating separate sections for intact and non-intact beef products, similar to what is done for organic and conventional produce. Finally, participants across all focus groups discussed the importance of knowledge dissemination as a multi-prong approach through various outlets (via industry, government and academia). Additionally, it was recognized that there is a necessity to not only discuss *E. coli* and MTBs; but, to discuss overall food safety issues, more frequently.

DISCUSSION

Consumer behavior regarding beef products is shaped through their perceptions of beef in two contexts: “everyday context” and “production context” tied to various extrinsic (e.g.: price, origin, product) and intrinsic (physiological characteristics) quality cues (Korzen and Lassen, 2010; Troy & Kerry, 2010). Meat purchase is based largely on a number of specific aspects (i.e.: price, appearance, cut) which then affect perceived quality attributes of meat products (i.e.: tenderness, flavor, nutrition), reflecting participants’ desires of “just want[ing] the meat to taste good” (Grunert, 1997; Troy & Kerry, 2010).

1: Participants’ previous exposures to tenderized beef products

Tenderness is the most desired quality of meat (Miller et al., 2001; Troy & Kerry, 2010). At home, participants reported self-tenderizing their beef products with cleavers, mallets, and other tenderizers. Focus groups participants, most female, were more likely to make their own marinades than they were to purchase pre-marinated products, citing price, personal choice, and control as main reasons. Females generally placed greater emphasis on tender products, ease of preparation, and nutrition (Reicks et al., 2011). Additionally, preparation at home was linked to one’s self-efficacy and internal locus of control.

With food handling behaviors, consumers have a positive perception (attitude and belief) towards control of their own behavior (Povey et al., 2001; Font-i-Furnols & Guerrero, 2014). Frewer et al.(1994) determined that “lowest personal risk was associated with food poisoning from home produced food”. Although self-tenderizing was common, participants did not associate their own actions with any potential mishandling risks. Resulting from the locus of control of optimism bias – a cognitive bias in which a person believes themselves to be at a lower risk for experiencing

a negative event than others – consumers often underestimate the risks of at-home food preparation and do not follow safe food-handling techniques, despite 33% of foodborne outbreaks being linked to at-home food preparation (Slutsker et al., 1997; Brooks et al., 2005; Byrd-Bredbenner et al., 2013).

When prepared as country-fried steak, participants knew to treat the obviously manipulated and cubed product differently, likening it to “ground beef” in that it should be cooked to “well done”. This distinction further reinforces the precondition for not requiring MTB-designated labeling on cubed steaks. It is well documented that consumers don’t like to use thermometers to check the doneness of meat. This was a continued trend when discussing the doneness of cubed steaks; instead of thermometers, color and visual cues were the primary indicators of doneness. The visual appearance of steaks is not a reliable nor accurate indicator of microbial safety in which sufficient heat has been applied to tissues; the use of thermometers is the greatest safeguards to beef safety (Lyon et al., 2000; USDA-FSIS, 2013). Phang and Bruhn (2011) discovered that 65% of consumers did not know the proper cooking guidelines of ground beef and only about 16% of consumers actually used a thermometer in hamburger meat (Phang & Bruhn, 2011; Milton & Mullan, 2010).

2: MTB Label

In this study, focus group participants did not immediately recognize nor point out “blade tenderized” on the label. Rather, there were other characteristics of the label (i.e. price, dates) that consumers identified first. Indeed, extrinsic factors related to use-by dates, quality labels, and production/process information were quickly noticed and influence purchasing decision as participants automatically described the label based on date, cut, price, size, and weight (Grunert,

2006; Henchion et al., 2014 Henchion et al., 2017). Price and cost, as an extrinsic value, are greatly valued by participants and is often the primary indicator for purchasing beef (Realini et al., 2014; Acebron & Dopico, 2000; Grunert et al., 2004; Henchion et al., 2014; Reicks et al., 2011).

After explaining the possible risks of MTBs and recommended cooking temperatures to participants, some participants declared they would pay more attention and desired additional labeling. To encourage compliance, some participants noted that labeling should be changed from “recommended” to “required” with disclaimers. Participants felt there to be a disconnect in the warning on the label that “these two things are connected” based on wording and label layout (Table 3.3).

3: Future Purchasing Decisions

The American Meat Institute [AMI] had initially expressed concern of the labeling rule. They reasoned that the addition of terminologies like “mechanically tenderized” or “blade tenderized” to a label would not only not inform consumers; but, instead, would incite fear and rejection of the product due to inexperience and lack of interaction with the term (AMI, 2013). This turns out to not be true as focus group participants desired to know more; indeed, withholding information was associated with increased distrust and dislike of the specific industry.

Once the MTB process was explained, future purchasing decisions varied. There was not one specific group vocalizing willingness or unwillingness to purchase MTB in the future; half the participants would continue to purchase while the other half expressed displeasure at their product being handled more. A 2014 survey of Canadians living in British Columbia reported that 39% of participants would purchase MTBs while 51% would not (Heran & Sidhu, 2014). In the focus groups, some participants were disgusted that the product had “interference” and was “poked”,

preferring instead to self-tenderize and were “suspicious” of stores and companies for the “unnatural” process and possible *E. coli* contamination echoing the diminished trust of consumers in the meat system (Grunert, 2006). There are negative sentiments towards the beef industry due to perceived “excessive manipulation and lack of naturalness” in beef production and processing (Verbeke et al., 2010). Conversely, consumers do trust in the safety of beef products, despite not fully trusting specific aspects of the industry (Van Wezemael et al., 2010). Although distrust in consumers for the meat industry has decreased, contrary to AMI’s beliefs, Röhr et al. (2005) found that active communication of ethical and socially responsible initiatives is necessary to promote positive perception and encourage consumer trust.

For many individuals in the focus groups, purchasing behavior was dictated by socio-economic status (average income, education, etc.). Disadvantaged individuals in a lower income bracket or those relying upon government assistance were unable to be selective of their cuts due to fiscal and monetary concerns. Socio-economic status may have been a strong indicator of perception and cubed steak purchasing behavior. Income and education already strongly effect people’s purchase of varietal healthful and nutritious food items due to food-cost concerns (Turrell & Kavanagh, 2006; Turrell et al., 2009). Indeed, demographic differences are associated with different levels of risk perception (Yang et al., 2000) Regardless of locale, participants who had previously purchased would continue to purchase such products; others would continue to purchase due to price, quality, and specific desired preparation methods. For those that recognized they had previously purchased the product, price differential and ease of use was cited as the reason to continue purchasing such product.

4: Locus of Control

Upon further discussion of MTBs, participants quickly realized “the potential” for contamination, and expressed concerns about production and retail store “sanita[tion]”. Some participants felt they were less likely to purchase MTB products because the product was “processed” and “isn’t that good a cut of meat”. Despite an increased production of processed beef products, consumer fears have increased and trust has decreased with the proliferation of more processed food products (Grunert, 2006).

Predominantly, it is expected that participants would not only want to, but believe, they have more control over their own behaviors. Abbot et al. (2009) demonstrated that, the majority of participants felt that their locus of control for food safety behaviors was internally associated. As such, participants feel they can make the most educated choices if they are provided with all the information; whether or not they engage with the promoted behavior (Young & Waddell, 2016).

5: Interventions

A study in 2010 found that the majority of consumers notice that the safe handling labeling is present, but only 37% changed their preparation behavior in accordance with the safety guidelines. Socio-economic demographics greatly impacted one’s compliance and labeling affect could be thusly limited (Yang et al., 2000). Indeed, studies of the effects of nutrition labels on consumption behavior change has demonstrated there is little impact between nutrition labeling and consumer behavior, but its impacts were correlated with demographic differences (Crockett, 2018; Ollberding et al., 2011; Stran and Knol, 2013; Hess et al., 2012).

Layout, blocking, and font size were main concerns expressed about the current labels. Larger font sizes with highlighting were preferred over the current labeling style which was “hard to see”, even when expanded. Cognitive recognition and understanding must be conveyed by labels and instructions; indeed, fluent processing of not only instructions but labels, themselves, are affected by such parameters as typefaces, vocabulary used, etc. (Song & Schwarz, 2008; Alter & Oppenheim, 2008; Reber et al., 2004). Participants suggested that font size of cooking temperature should be larger and “non-threatening” to stress importance of proper handling, even utilizing a “temperature sticker” (Table 1). In a Canadian study exploring consumer acceptability and liking of differently phrased MTB labels, 80% of Canadian consumers agreed that the label instructions would be easy to understand, but less than 80% would follow the directions to flip the steak at least twice nor use the thermometer (Klassen & Gill, 2016).

In rural communities, reassurances that beef safety was linked to proper internal temperatures were stressed. Whereas, in North Carolina focus groups, participants stressed the importance of focusing on *E. coli* to “kill you” or the associated risks related to undercooking, improper temperature, and foodborne illness as opposed to focusing on the mechanical process. Social media, cooking shows, and other video formats with catch slogans were proposed for public service announcements and campaign ideas.

Recommended interventions are all in-line with discussions in other research not only with labels but risk messages. As Jacob et al. (2010) highlights, label ambiguity should be minimized through the use of clear languages and graphics. Additionally, a consistent message is needed for not just MTBs but even in discussing foodborne illness. Narratives and messages must be associative with the lifestyles and socio-cultural sensitivities of recipients. Targeting messages to at-risk populations or those currently undergoing a “health status” can also encourage behavior

change. It must also be accepted that although consumers are unlikely to change their behavior, they do want to be made aware of new information (Young & Waddell, 2016).

CONCLUSION

This study found that participants were aware of specific MTB products (e.g. cube steak) due to the obvious visual cues; however, they were not aware that mechanical tenderization was being done to other beef products. Although process-product designation labeling is important, its use in conveying information may be limited as it is not a primary desired extrinsic cue. Finally, while participants understood temperature guidelines, many variables including age, experience, locality determined the likelihood of (a) paying attention to the guidelines; (b) properly interacting with the guidelines; (c) exhibiting correct meat preparation behaviors for MTBs. Indeed, labeling is but one aspect of food safety educational programs “to inform consumers about proper food-handling and preparation practices to motivate persons” to shift behavior (Yang et al., 2000).

Prior to this study, no survey of American consumers’ awareness, knowledge, or understanding of mechanically tenderized beef products has been observed. Ultimately, it is necessary to consider what American consumers may know and/or understand of mechanically tenderized beef products post-labeling rule. In order to bring cognition and awareness to the mechanical tenderization process and other risk-messages, an “effective risk-benefit communication” must be developed alongside consumers to provide consumers with a balanced risk-benefit multi-pronged approach regarding food risks (EFSA, 2006, van Dijk et al., 2012).

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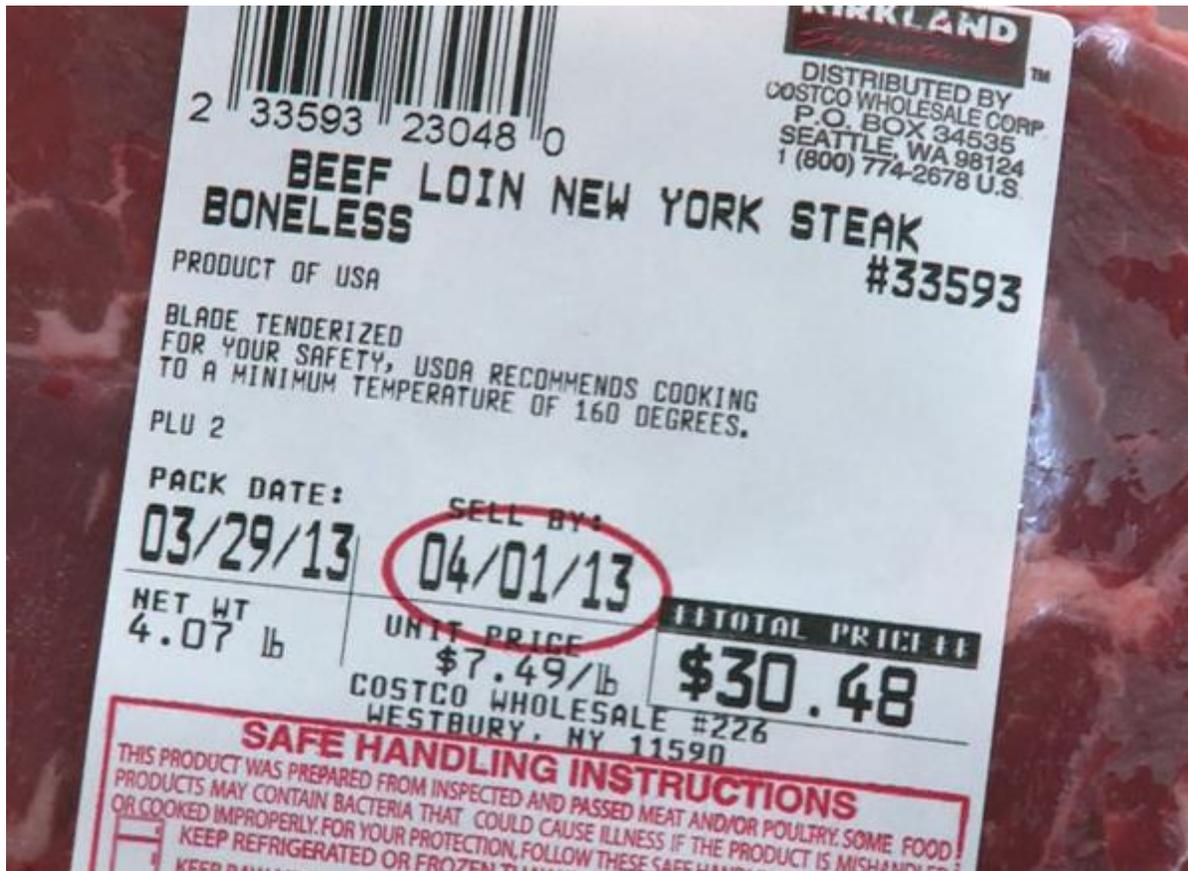


Figure 3. 1: Mechanically tenderized beef [MTB] label shown to participants

Table 3. 1: Summary of selection criteria for focus group locations in study on mechanically tenderized beef products (non-intact beef products)

	Virginia		North Carolina	
	County	Population ^a	County	Population ^a
Urban^b	Montgomery	1.04M	Wake	1.03M
	Suffolk City	88,161	Durham	267,587
	Henrico	325,155		
Rural	Henry	51,881		
	Orange	35,385		N/A ^c
	Culpeper	49,432		

^a Populations are based on 2015 estimated census data

^b Urban and Rural designations are based on specific cities of recruitment sites within the counties. Designations are determined by U.S. Office and Management and Budget (OMB) with population of metropolitan areas >50,000.

^c Due to time constraints, focus groups in rural North Carolina counties were not conducted.

Table 3. 2: Demographic characteristics of focus groups participants and selected focus group participants in a study of consumer beliefs, knowledge, attitudes, and behaviors regarding mechanically tenderized beef products and enhanced beef products

	Focus Groups		Selected Focus Groups	
	(n = 236)		(n = 91)	
	No.	% ^a	No.	%
Age				
18 - 24	19	8	7	8
25 - 29	25	11	8	9
30 - 34	25	11	10	11
35 - 39	24	10	13	14
40 - 44	25	11	11	12
45 - 49	22	9	8	9
50 - 54	27	11	9	10
55 - 59	29	12	10	11
60 - 64	15	6	3	3
65 - 69	15	6	8	9
>70	9	4	4	4
No Response	1	<1	0	0
Prefer not to answer	0	0	0	0
Gender				
Female	178	75	70	77
Male	57	24	21	23
No Response	1	<1	0	0
Ethnicity (mark all)^b				
Hispanic or Latino	10	4	3	3
Asian / Pacific Islander	9	4	1	1
Black or African American	85	36	30	33
White / Caucasian	133	56	56	62
Other	1	<1	0	0
No Response	2	1	1	1
Prefer not to answer	2	1	1	1
Total Household Income				
<\$10,000	12	5	5	5
\$10,000-\$19,999	16	7	6	7
\$20,000-\$29,999	27	11	13	14
	83			

\$30,000-\$39,999	22	9	8	9
\$40,000-\$49,999	27	11	9	10
\$50,000-\$74,999	60	25	21	23
\$75,000-\$150,000	38	16	15	16
>\$150,000	6	3	4	4
No Response	5	2	1	1
Prefer not to answer	23	10	9	10

Education Level

Grammar School	0	0	0	0
High School	23	10	9	10
Graduate or High School Equivalent				
Vocational/Technical School	15	6	9	10
Some College	46	19	19	21
Bachelor's degree	87	37	26	29
Master's degree	49	21	21	23
Doctoral degree	5	2	2	2
Professional degree	7	3	4	4
Other	3	1	1	1
No Response	1	<1	0	0
Prefer not to answer	0	0	0	0

Location (Census)

Urban	203	86	72	79
Rural	33	14	19	21

Location (Self-Identified)

Urban	68	29	24	26
Suburban	110	47	38	42
Rural	51	22	27	30
No Response	5	2	1	1
Prefer not to answer	2	<1	1	1

^a All percentages in this table have been rounded to the nearest whole integer

^b Each respondent could select multiple answer to this question, n=242 (all respondents), n=92 (selected participants)

Table 3. 3: Content analysis results of focus group participants on mechanically tenderized beef products [MTB]

Category	Theme	Example
MTB Label	Nomenclature	“I would rather it be mechanical without using the word “mechanical” would be better”
		“Instead of saying ‘blade tenderized’, explain a little bit what that means”
		“We know that blade tenderized is giving us a prettier image than mechanically”
		“I think using terms like mechanically rather than blade is important to make you think about it”
	Transparency	“I really value transparency [...] I want [retailers] to weigh in, in favor of something that can communicate an actual process rather than something that hides the actual process”
		“It needs to say it blatantly on the label”
	Desire for Education	“You need to make it plain that [foodborne illness or e.coli] is connected to the tenderizing”
		“Well, I think another key is making sure that you realize these two things are connected because they’re on a different lines, I didn’t even notice that those were connected in any way. I was just like, “Blade tenderized...ok that’s nice it’s tender” and then “oh, the USDA is yelling at us to cook our meat ‘til it’s well done again”. I didn’t realize that it was because it was blade tenderized that I now have to cook it to 160 degrees. Even if you just said something like – I’m sure the beef screamed bloody murder and lobby til the cows come home – if you said something like, “to minimize risk of e.coli” but you know, like it should way, “blade tenderized [colon]” so that you know that is’ related to the blade tenderized. But if you say, “to minimize risk of e.coli” people are going to pay attention to it as opposed to just “oh they want to cook our meat really welly done”. Because I don’t think people realize <i>why</i> they have to cook to well done. But if you say e. coli, people know e.coli is bad”
		“you wanna know it’s tenderized, cause like you said, it requires different cooking, and damnit, tell us”
		“Well, we’ve always heard that ground beef has to be cooked more thoroughly than an intact steak. The knowledge that mechanically tenderized steak is not an intact steak is not common knowledge. That’s what needs to be conveyed is that a steak that’s been

mechanically tenderized is not as safe as an intact steak...and I mean, how do you do that?"

"Maybe educational materials can't concentrate on blade tenderized or nothing, it's got to say, 'tenderized meat' because the same problem exists if we do it at home. So it's gotta be a broader topic"

"I think it's in education [...] buzzwords"

**Future
Purchasing
Behavior**

Positive Attitude

"I mean, I'll know what it means now, when I see it. But I don't think it will not make me not buy it."

"I don't know if it'll cause me to purchase this any differently because I'll usually end up tenderizing anyway; whether it's pounding or marinating, or something like that. I'll probably notice it; but I don't think it'll be any different than what I would buy"

"I will probably continue to purchase it. It's just that I would be much more careful about what kinds of meat I would purchase that have been tenderized."

"I would still purchase it. But I would make sure I would use a thermometer."

"Ya, I agree. I think that I'll notice it now; I don't know if it'll deter me or not, I'll just be more conscious about - at least making sure that the T is where it needs to be."

Negative Attitude

"I probably wouldn't buy it after hearing this, because I'm already kind of paranoid about that stuff anyways...so if I knew there was an increased risk with this, I would just get the intact piece."

"It says 'something' for your safety. For your safety, it says, 'blade tenderize for your safety' if it got something to do with for my safety, I'm not buying it. If they have anything in there about me, and they talking about me the safety, and I might not do the right thing for my safety, I'd rather leave that piece of meat alone."

"I'm going to continue to choose to avoid it. And I'm going to be more careful looking for blade tenderized."

"If you put an education program on TV – whether it's a food show or not – and start talking bout why blade tenderizing is being used...you gonna scare me to death. I don't want that meat"

	<p>“I’d rather be told that something has the potential to be a ‘kill me’ roast”</p> <p>"I don't know if I'd purchasing anything that said like [...] because I don't understand it, really. You explained it; but see, I hadn't knowed it before"</p>
Perception	<p>"Me as well [would prefer my beef not be tenderized]; but, if I knew up front it was, then I would take those extra precautions"</p> <p>"I think, you know, if I had that choice I guess I probably <i>would not</i> go for all that poking around. It just feels like it gives you more opportunity to mess up stuff. You added another step and whatever you are injecting in it, I don't know what you put in there. And so, it may not be something that works well with my system so I'm probably less likely to buy it. But, I mean, if it's a good sale, and what am I going to do with it?"</p> <p>"I'll definitely notice it from now on"</p>
	<p>"I don't know because sometimes we just grab stuff and we pick the price of stuff without looking at the rest of stuff. So I don't know."</p> <p>"Because when I picture blade tenderizing in my mind, it would be like knife blades this way [horizontal] running over it; not needles going down into it. That's just what I would picture in my mind. So, y'know, that would be different. So knowing that changes my thoughts about it a little bit. Because I feel like it would go further down in the meat. If there were bacteria there, it would go further down in the meat. Then it would, if there was something going over it rolling over it tenderizing it rather than going down into it."</p>
Price / Cost Impact	<p>"The price matters to me"</p> <p>"It has- if it was dollar for dollar and- no. But, I would be more aware of how I cook it if I do buy it that way. "</p> <p>"Ya, I mean...back to the original question, for me, if there is a small price difference – I am price conscious [...] but if it's not a huge difference, obviously I'll get the one that is better quality. If there's like a \$10 difference, we might have to chat a little. But uhm... if there's a small difference for a better quality, you better believe that I will shell out extra because I gotta think of my family that is eating it [also] I just think about the sanitary."</p>

	<p>“I would [continue to purchase]...depending on price. Like if we’re talking a \$10 difference, I mean, yeah, I would absolutely buy this because I would try to exactly remember what you said about how to flip it.”</p>
<p>Impact on Preparation</p>	<p>“I think it depends on my purpose. Like, if I know I’m putting it in a crockpot for 12 hrs., then it’s going to be cooked all the way through...pay less for it. But if it’s going to be something else that I did want to be pink in the middle, then I’ll pay a little bit more for the—I’ll make sure its intact.”</p>
	<p>"I think if it’s going in the crockpot, then it’s not problem. Save a little money there with some mechanically tenderized beef. I think it kinda depends on how you’re gonna use it, and how you’re gonna cook it”</p>
	<p>“It would depend on what I’m buying it for. For cubed steak, we’re only making cubed steak are chicken fried steak and so...there’s no pink left.”</p>
	<p>“I doubt it [it will not affect my decisions moving forward]. Like I said, I always do well done so it don’t really matter to me.”</p>
	<p>“It would definitely affect how I purchase it or how I prepare it. I would have to make sure to kill it all the way through.”</p>
<p>Preference</p>	<p>"I’m not usually interested in purchasing it, just because since you have to treat it like GB, it gets more cooked than I usually like to cook my steaks. And since I want to treat it like a steak, I know that safety-wise, I shouldn’t...so that would be why I usually wouldn’t buy them”</p>
	<p>“I also prefer the intact cut because I don't eat a lot of steak. Usually, I either do ground beef or food that you cook for like a really long time. So if I'm going to eat a steak...I mean, I do like the pink center. If it's going to taste like a steak, you don't want to ruin it by cooking is so much so I would rather just have the kind you could eat at the lower temperature.”</p>
	<p>"I never used tenderized beef... but for me, it’s not because like [anything because I do] I use a thermometer, so I’m not worried about the safety aspect for me. Because I don’t cook meat that often, you know? I feel like when something like that—when it is like adulterated, it—“</p>
	<p>"Probably not, actually. Just because when I do have a steak...like, I really do like the medium-rare flavor of it and so, for me, I would rather spend a little bit more money to ensure safety and also I like to eat less processed foods, also.”</p>

Locus of Control	Safety	<p>“Right, I may cook it longer, or if I get a thermometer, I’ll follow that guideline now, but before I wouldn’t notice that”</p> <p>"Would want to know if product is mechanically tenderized] Especially for the family members that like to eat it less than well-done.”</p> <p>“Now if I was going to buy steak to cook for someone else, I don’t think I would go for the mechanically tenderized”</p> <p>“I have heard and I would be tempted not to purchase it and it myself [b]ecause I see the potential of those [blades] not being cleaned as easily [and] as well as those on the blades on the knives”.</p> <p>“oh I would start reading labels more”</p>
	Self-efficacy	<p>“But if it’s labeled like this, it gives me the choice...so I know that if I want, like you’re saying...if I want that medium cut, I just don’t buy that. These are...this selection is made and it puts me in ... I feel more empowered. Puts me in control of keeping my family safe.”</p> <p>“I don’t know that I’ve ever purchased it already tenderized like that. Anything that I felt like I want to get tenderized, I will go to ask the meat department to do. So, I would already have it. So then it’s less, exposed to unknowns with all the holes. I feel like I’ve got a little bit more control, I guess.”</p> <p>“that makes you aware [...] I just want to be able to look at stuff and go, ‘oh that’s blade tenderized, okay’ and this was not, and they’re about the same price. [...] I’m probably not going to buy a thermometer – because that feel like an extra step and maybe it’s because I don’t have a fancy thermometer and it’s not an extra step and I don’t know that? [...] So, I just certainly would be more aware to cook the meat in a different way if there was something that that told me that now that I know this information”</p> <p>“I thinks, so many people don’t know what that means and they don’t read the labels, but I will read it a lot closer now that I’ve done this; but, I too feel like so many people will panic and not buy meats at all if you put too much information out there”</p>
	Trust	<p>"Yeah I think I’ll still continue to do it my same way cause I’m not surprised by anything that the government does that issues me so you always kind of have that suspicion anyway; just continue doing it the same way that I’ve been doing it.”</p>

“I would just have something even underneath that... which is I really value transparency. More and more I value transparency. So, I’m gonna feel a sense of betrayal if I find that one of my regular retailers like Food Lion or Safeway or Giant (which does Martin’s) is intentionally not to label something or choosing a labeling that is unnecessarily obscure.”
“I feel that if something un-natural has been done to the meat, then the purchaser should be made aware of”

“It just brings up, again, I know this is huge...but the whole ethic, what is mandated, and it’s awesome, I think that we are moving towards having to have [this labeling] on our products, but I’m not a super picky person, I promise, but then it’s like huh... I’ll have to put it on there, how will we know...”

Table 3. 4: Content analysis of focus group participants on interventions for mechanically tenderized beef products

Category	Theme	Example
Label Clarity	Pictogram / Symbol	“a picture of a blade going in” “a picture of a machete”
	Separate Sticker	“Symbol! Some sort of symbol that makes you aware that this has had some sort of tenderization process so I can make your choice” “sort of sticker that is just some sort of picture that conveys blade tenderization [...] as long as you knew what the picture meant” “red warning sticker”
	Color	“At a store, but like [stickers that] said good for grilling; you don’t read the label, you could read the little things they put on there like: ‘Manager’s mark-down ticket’. Put it: ‘non-intact meat, cook to 160’ as an additional sticker on top of the label”. “they should do some colorization on the label so that you know that it’s a warning there” “yellow highlighter or something on there” “color code it somehow; even if it’s a color-coded sticker” “exact opposite color”
	Font	“larger print label on the back” “writing is really small on these [labels]; it should be bigger and up higher” “if it is in bold writing or in a different color of writing”
	Language	“I ignore labels, to be honest with you, especially when the font is smaller than the actual thing” “You gotta put it in layman’s terms in a way easy for the beef connoisseur to [regular joe] and stuff in a way that makes it easy for the beef connoisseur to joe schmoe at the bottom [...] use words that we can pronounce” “I think they should have to be clearer [...] a description”
	Format	“You need a friendly, non-threatening way to inform people that this meat is tenderized and needs to be cooked at a higher temperature” “would be better to have two different blocks with information in it” “Another key is making sure that you realize these two things are connected because they’re on a different lines

		“So ‘mechanically tenderized’ can be a lot smaller; but, the cooking instructions need to be a lot bigger”
		“Have a bigger label that just [says], ‘[160’s] not recommended; it is required for your personal safety”
Technology	Internet	“warning of <i>E. coli</i> or whatever so people know that it needed to be cooked higher”
		“QR code that you can scan and learn more about the process”
		“with technology today [...] a website [...] to y’know, educate people to different terminology and stuff and so if they have something like that on these products, once you looked at it, you would generally know which one that you picking out, and which one you don’t want to pick out, after that”
		“People have their phones nowadays put a little scan thing right here that says ‘for more info’ because everybody always has their phones on them”
Knowledge	Media	“The other thing is to use cooking shows”
	Lack of Knowledge	“I don’t think that it’s clear that it’s different than usual because I don’t think any of us automatically know that ‘Oh normally intact beef only has to be cooked up to 145’; so I’d look at this and go, ‘Why do they want me to overcook my meat?’ And I would just ignore it and I wouldn’t realize that his was different”
	Information / Explanation	"Just more information about the process [...] they don't have anything to hide"
		“If it had an asterisk, or something, like on the back [and] it explained that the majority of folks don’t know”
		“It’s good to show the 160 degrees because there might be somebody that don’t know how to cook or they just started. That would give them a clue with how to start”
In-Store	Signage	“Explain what that is [...] “you know proper food handling, at the right temperatures will cook off any <i>E. coli</i> ” ... of course you’d phrase it more elegantly”
		“[T]hey should have a sign like they do for the country-of-origin; cause I would pay attention to that”
		“Signs next to the meat case [or meat counter] or whatever”
	Demonstrations	“Poster or infographic in the stores”
		“I would see it at the butcher shop, like next to the ‘SALE’ sign”
Campaign	They could do demos at the store [...] in-store demos like [to] use this recipe [for MTB]”	
		“Could you introduce an in-store campaign?”

		“Put people in the <i>E. coli</i> costumes [and] walk around the store”
		“Something in the store that moves around”
		“Video section in the meat department; the video plays on the loop about what is happening to your meat”
	Trust	“Or the butcher telling you [about the process] as you buy it”
	Physical Barrier	“Physically separate the cuts of meats that are intact and a section that, I mean, the store can’t do much; but, they can be clear about whether or not something has been [tenderized]”
		“separate [them] like the organics in the vegetables”
	Certifications	“I’m looking at certificates up on the wall”
		“But if this is a USDA-approved process, have that acknowledged on there”
Dissemination	Multi-prong approach	“In a commercial, you have social media presence, it does a campaigns and that goes along with the sticker that goes on the meat so you know which ones are intact and non-intact”
		“They need to come in two ways. I think they need to come from the government or the government offices that handles that; but also, [the stores] need to begin talking with, for example, the food shows. I need to see these cuts being used and to see them actually using it and explaining it because it's only through this education piece that you’re doing right now [focus groups] that we fully get an understanding of this”
		“Going out to different organizations and providing training so they can go forth. It’s got to be spread! That total dispersion of the information”
	Refocus Conversation	“Would it be a better approach if you gonna do some kind of communication to literature for the public? Instead of talking directly about blade tenderization, would it not come to the broad concern of the public of <i>E. coli</i> and then [later] bring in all this [about MTBs]? [First] bring broad concern of public to <i>E. coli</i> ”
		“If you approach it from the ‘mechanical’ standpoint, you’re more or less scaring people potentially. Whereas, if you address it, starting with the temperature [focus], you’re grabbing [people’s] attention without scaring them first”
		“Maybe education[al] materials can’t concentrate on blade-tenderized or nothin’; it’s got to say, ‘tenderized meat’ because the same problem exists if we do it at home. So it’s gotta be a broader topic”

CHAPTER 4

Research Paper

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Consumer awareness and attitudes towards mechanically tenderized and enhanced beef products: a study on how consumers purchase and prepare mechanically tenderized and enhanced beef products.

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ABSTRACT

Mechanically tenderized beef products [MTBs] are a subset of enhanced beef products, where an intact piece of meat is tenderized with blades, needles, or other mechanical mechanisms to improve consumer palatability. MTBs have been associated with outbreaks of Shiga toxin producing *Escherichia coli* [STEC]. As a result, the labeling of MTBs was mandated in May 2016. The objective of this exploratory nationwide survey study was to build upon a previous study which identified urban and rural Virginians and North Carolinians' knowledge of, attitudes towards, and behaviors about MTBs. Many consumers were unaware of proper preparation instructions and risks associated with MTBs. A nationwide survey examining knowledge, attitudes, awareness, and awareness of enhanced beef products was distributed to a representative sample (n=500) throughout the United States. Survey results were analyzed with Chi-square goodness-of-fit tests ($p \leq 0.05$; Cramer's $V \geq 0.15$); open-response answers were coded and analyzed with NVivo 11 Pro. Consumers either purchased enhanced products or enhanced non-enhanced products at home. Conducting tenderization processes at home can also contribute to pathogen internalization and increase risk if product is not prepared properly. Findings show that consumers do not often associate cubed beef, a commonly purchased mechanically tenderized product, as an MTB. Individuals who purchased MTBs were aware of the designation label and were able to associate and identify an MTB product with certain beef cuts. Hispanic/Latino populations, different ethnicities, and rural populations were more likely to enhance un-enhanced beef products through mechanical tenderization or marinade tenderization at home. Although individuals that prepared MTBs were more likely to say that they cooked MTBs to $\geq 160^\circ\text{F}$, the usage of internal temperature to measure doneness

of product was not involved Timely, repetitive, targeted messaging through clear definitions, other modes of interaction and distribution channels across various ethnicities and communities must be implemented to bring awareness of potential risks to underrepresented populations.

INTRODUCTION

Consumers desire beef products that are tender, juicy, and flavorful. In order to improve the palatability and desirability of beef cuts that do not meet these characteristics, cuts can be enhanced through value-added processes (Grunert, 1997; Miller et al., 2001). Value-added processes include, but are not limited to: grinding, comminution (i.e.: chop, or mince), mechanical tenderization (i.e.: needling, cubing, pounding), marinade tenderization, injection, vacuum tumbling (Miller et al., 2001). Annually 2.7B pounds (~11%) of American beef is mechanically tenderized (USDA-FSIS, 2016). Mechanical tenderization is often performed upon steaks and larger roasts (i.e. rounds, loins, and flanks) sold at large and small/independent retail establishments, restaurants, and other food service institutions (Robbins et al., 2003; Muth et al., 2012; Klassen & Gill, 2016; Arnold, 2018). Some of the processes mentioned above result in beef products that are no longer intact as the beef muscle fibers are no longer consecutive.

Although a non-intact product will achieve a tenderer characteristic, the process may increase the potential of introducing pathogens, like Shiga-toxin producing *Escherichia coli* O157:H7 [STEC] from the exterior of the intact beef cut to the once-sterile interior of the beef muscle or product (USDA-FSIS, 2015). Outwardly, some mechanically tenderized beef products [MTBs] may appear non-intact (e.g.: cubed steaks), but other MTBs may appear to resemble intact cuts (e.g. larger roasts). Intact beef cuts should be cooked to a minimum internal temperature of 145°F, followed by a three-minute rest time. Similarly, with MTBs, one should either prepare the product directly to 160°F or can now prepare the product to a minimum internal temperature of 145°F followed by a three-minute rest following removal from the heat source (FSIS, 2015; FSIS, 2016). Although

the cooking instructions are similar, the risk and necessity to hold the temperature pre-consumption of MTBs is more necessary to destroy potential pathogens within the beef product that may not be present within the muscle fibers of an intact cut. There is concern that consumers may handle visually-similar non-intact cuts the same way as intact cuts. Improper handling and consumption of undercooked or “inadequately heated” non-intact product could result in foodborne illness (Klassen & Gill, 2016; Yoon et al., 2009).

Since 2006, the Center for Disease Control [CDC] has identified six MTB-associated STEC outbreaks both at home and in restaurants, resulting in 157 cases of illness, 27 hospitalizations, and 4 cases of HUS (USDA-FSIS, 2015; USDA-FSIS, 2016). Due to the increased risk potential, the USDA began mandating the labeling of all “needle- or blade- tenderized raw beef products May 2016 (USDA-FSIS, 2016). The final United States Department of Agriculture – Food Safety and Inspection Services [USDA-FSIS] label designation (9 CFR 317.2 (d)(3)) must include: (1) a descriptive designation (i.e. “mechanically tenderized”, “blade tenderized”, or “needled tenderized”) accompanied by an accurate description of the beef component in the product name; (2) within close proximity of one another without intervening texts or graphics; (3) with all descriptive words in the same style, color, on a single-color contrasting background; (4) allowing for upper and lower cases with the smallest letter at least 1/3 the size of the largest letter; and (5) validated cooking instructions including cooking method, specified minimum internal temperature, hold time and temperature prior to consumption to ensure inactivation of potential pathogens, and internal temperature measurement by thermometer (Figure 4.1).

In 2017, the U.S. Food Code defined the term “mechanically tenderized” as “manipulating meat with deep penetration by processes which may be referred to as ‘blade

tenderizing’, ‘jacquarding’, ‘pinning’, ‘needling’ or using blades, pins, needles, or any mechanical device” (FDA, 2017). The labeling rule does not cover cubed or pounded beef products which are visually obvious as being non-intact, corned beef, raw or partially cooked beef products <math><1/8</math>” thick, nor products that will be fully cooked at an official establishment. Additionally, the rule does not cover vacuum-tumbled or injection marinated beef products, which, while not visually apparent, also undergo a process that may distribute bacteria into the interior.

Although some research has explored potential consumer interactions with the “mechanical tenderization” label, at this time, there has been limited research into consumers’ knowledge, attitudes, awareness, and behaviors related to these types of enhanced beef products. The purpose of this survey is to identify, define, explore, and assess previously unexplored consumer knowledge, awareness, attitudes, and behaviors regarding MTBs and throughout the United States through a nationwide survey.

MATERIALS AND METHODS

4.1 – Nationwide Survey

A nationwide survey was conducted to explore consumers' knowledge, attitudes, awareness, and behaviors of enhanced products. The structure and questions were developed based on focus group data collected and analyzed by Yang et al., 2018 to identify key themes around consumer's attitudes and behaviors related to MTB products. This study was reviewed and accepted under Virginia Tech's Institutional Review Board, protocol IRB #15-521.

The survey included questions about self-reported attitudes, awareness, beliefs, behaviors, and perceptions regarding beef purchasing behaviors, storage behaviors, preparation behaviors, and trust-interventions. An initial version of the survey, designed and created in Qualtrics, was pilot-tested online through convenience sampling with 62 individuals around the U.S. A member of the research team collected, summarized, and incorporated feedback from the pilot-survey participants after the completion of survey. After feedback was incorporated, the revised survey was dispersed online by Qualtrics, a market research company (Provo, UT; <http://www.qualtrics.com>).

The questions from the survey pertaining specifically to enhanced beef products (i.e. cubed beef, mechanically tenderized beef products, and marinated beef products) were analyzed in this study. Specific survey questions are available in Appendix B3. Skip logic and display logic were used for ease of completion and to create an accessible user experience.***4.2 – Nationwide Survey Participant Recruitment***

In April 2018, a nonprobability sample of United States participants was recruited through Qualtrics. Participants were recruited from Qualtrics' opt-in lists; participants

receiving invitations via email that focused on diversifying 500 complete participant respondents to slice a representative sample of the U.S. population based on gender, age, income, and location (urban/rural) for sufficient statistical power. Prescreening of potential respondents included: (a) being 18 years or older; (b) being a primary food shopper; (c) being a primary meal preparer; (d) purchasing and consuming beef products. Demographic information of participants were also collected (Appendix B1, Appendix B2). No incentives were given for Qualtrics panelists.

4.3 – Nationwide Survey Data Analyses

Descriptive statistics were provided by Qualtrics. Quantitative data was further analyzed with SPSS for Macintosh (IBM; Armonk, NY). Qualitative data was coded by hand or with NVIVO 12 Pro for Windows (QSR International; Victoria, Australia). Contingency tables and inferential chi-square tests of association (i.e. chi-square goodness of fit tests) statistics were performed, with reported Cramer’s V (≥ 0.15) and Pearson’s phi (≥ 0.15) coefficients. Significance was determined at a level of $p \leq 0.05$.

4.4 – Survey Limitations

Due to the limitations of low responses, some responses were reorganized or excluded from certain demographic factor and categorical statistics. The two participants above the age of 85 years old were combined with the “75-84 years old” age group and renamed “>75 years old”. Due to low numbers of respondents with doctoral degrees, these two values were combined with individuals with “Professional” degrees. Due to low numbers, participants indicating “Mixed-Race” or “American Indian/Native American”

were reclassified into “Other”; statistical analysis was only run on “Asian/Pacific Islander”, “Black/African-American”, “White/Caucasian”, and “Other”. Also due to low responses, but to remain true to marked, individuals identifying as “trans-male” or “gender variant/non-conforming” were excluded from analysis with “Gender” as a factor; in such cases, n=497.

RESULTS

1: Purchasing Behaviors of Enhanced Beef Products

Participants were surveyed on their purchasing habits of three types of enhanced beef products (cubed, mechanically tenderized and marinated beef) (Table 4.1). 209 participants (~42%) purchased some type of enhanced beef product. 158 participants (~32%) of participants indicated purchasing cubed beef, 83 purchased marinated beef products, and 52 participants purchased MTBs. Participants' purchases of each type of enhanced product were significantly correlated with purchase of other types of enhanced products. For example, respondents who purchased MTB were more likely to also purchase marinated beef ($X^2(1, N=500) = 23.714, \Phi = 0.218, p < 0.01$). However, the exception was that participants who regularly purchase cubed beef products did not also indicate that they purchased MTBs (Table 4.2). Individual demographic factors (i.e. gender, age, Hispanic/Latino, ethnicity/race, education level, income, and location) were not associated with a person purchasing MTBs. However, income and age demographics were significantly associated with purchasing cubed and/or marinated beef (Figure 4.2). Half of all cubed beef was purchased by participants in a lower-income bracket (<\$40,000) ($X^2(11, N=500) = 19.614, V = 0.198, p = 0.051$). Individuals in the low- and mid-range income bracket (\$40,000-\$80,000 range) were significantly more likely to purchase marinated beef products than upper- range income brackets ($X^2(11, N=500) = 19.843, V = 0.199, p = 0.048$). Additionally, marinated beef products were purchased more frequently by participants under 45 y.o. ($X^2(10, N=500) = 19.925, V = 0.200, p = 0.030$).

2: Attitudes Toward Mechanically Tenderized Beef Products

Participants were asked: “How do you feel about Mechanically Tenderized or Needle Tenderized or Blade Tenderized beef products? (If you are unaware of these types of products, please state ‘Unaware’).” Open-answer responses were coded. Demographic factors (i.e. gender, age, ethnicity, education level, income, and location) did not significantly affect participant’s feelings or attitudes (i.e. positive feelings, neutral feelings, negative feelings, unsure feelings, other feelings, risk-related feelings, or unaware feelings) towards MTBs. Sixty-four percent of survey respondents were unaware of mechanically- or blade- tenderized beef products, despite purchasing cubed steaks ($\chi^2(1, N=500) = 34.235, \Phi = 0.262, p < 0.01$). Individuals who purchased cubed beef had a generally more positive attitude towards MTBs, as did Hispanic/Latino respondents (Table 4.3).

3: Awareness of Mechanical Tenderization Label and Safe Handling Instructions

Label

Seventy-one percent of total respondents (71%) were not aware of the MTB label on beef products. Of the 52 participants who reported purchasing tenderized products, about half (~54%) indicated that they were aware of the MTB delineator on the label. As expected, 74% of those who did not purchase MTBs were not aware of the label; although 26% were (Table 4.4). Nineteen (68%) of MTB purchasers were able to state where they’d seen a tenderized product (e.g. roast, raw and partially cooked foods, tenderloins, steaks, stew meat, brisket cuts, thin cuts); however, only two respondents were able to correctly state one or more elements of the MTB label (e.g. temperature or time).

Participants who were aware of the “mechanical tenderization” label were also significantly more likely to be aware of the “Safe Handling Instructions” label [SHI] (Table 4.5) ($\chi^2(4, N=500) = 31.098, V=0.176, p<0.001$). A respondent’s educational level was significantly associated with their awareness of both the MTB label ($\chi^2(12, N=500) = 25.555, V=0.160, p=0.012$) and the SHI label ($\chi^2(12, N=500) = 21.204, V=0.146, p=0.047$); respondents who had completed some higher degree were more aware of the labels (Table 4.6). Participants with higher levels of education were more likely to be aware of and know where the SHI label was located on the meat package.

Although not significantly correlated, it is worth noting that almost 80% of participants who purchased cubed beef were aware of the SHI and that the SHI is found on product packaging (68%). However, no cubed beef purchasers correctly identified all the elements of the SHI, although the majority could correctly name at least one aspect of the label.

4: Self-Enhancement Behaviors at Home

Participants were surveyed on whether they enhanced the meat that they cook after purchasing but prior to preparation (Table 4.7). About 40% of respondents indicated tenderizing and/or marinating, prior to preparation. Fifty-six participants marinated their beef products and 23% tenderized before cooking. Demographic factors (i.e. gender, age, Hispanic/Latino, ethnicity/race, education, income, and location) did not significantly affect whether a respondent would tenderize or marinate beef products prior to preparation.

Over 50% of participants who did not purchase cubed beef, reported that they marinated or tenderized beef products at home prior to preparation. Additionally, over 70%

of respondents who self-reported not purchasing marinated beef products, reported marinating and tenderizing beef products at home, prior to preparation (Table 4.8).

On the survey, participants selected the tenderization behaviors that they most engaged in (mechanical tenderization, tenderizer tenderization, marinade tenderization, or long cooking time tenderization) (Table 4.9). There were no significant demographic and purchasing associations with participants tenderizing with a tenderizer or by cooking for a long time (i.e. low-and-slow). Despite the lower numbers, Caucasian/White and Asian/Pacific Islanders mechanically self-tenderized beef products more frequently than other ethnicities prior to preparation ($X^2(3, N=176) = 9.023, V=0.226, p=0.029$) (Table 4.10). Participants in self-identified suburban and rural locations self-reported that they more frequently mechanically tenderized their beef products prior to consumption than those in urban locations ($X^2(2, N=176) = 6.239, V=0.188, p=0.044$) (Table 4.11).

Ninety-six percent of respondents reported marinating beef products for flavor. ~60% of participants who marinated to tenderize were between 25 – 54 years old ($X^2(10, N=280) = 18.850, V=0.259, p=0.042$) (Table 4.12).

5: Preparation of Enhanced Beef Products

Participants were asked to select all variables (i.e. inside/outside color, texture/firmness of product, juices and/or blood, smell, time elapsed, thermometer for internal temperature) that they used to determine the doneness of prepared cubed steak/tenderized beef products. Observing the color of the inside and/or outside of beef product and observing the juices and/or blood of beef product were not significant for demographic

factors (i.e.: gender, age, Hispanic/Latino, ethnicity/race, education level, income, and location).

Asian/Pacific-Islander and African-American/Black participants were more likely to use both texture ($X^2(3, N=398) = 8.460, V=0.146, p=0.037$) and smell ($X^2(3, N=398) = 13.486, V = 0.184, p=0.004$) as indicators of doneness (Table 4.13). Respondents under 25 y.o. and >45 y.o. more frequently used time as an indicator of doneness ($X^2(10, N=398) = 18.313, V=0.215, p=0.050$) (Table 4.14). Although non-significant, participants who indicated purchasing MTBs were also more likely to check that the temperature of tenderized beef products were cooked above 160°F (Table 4.15). While thermometer usage is considerably low, of the 81 participants that indicated using temperature for doneness, participants residing in self-identified suburban and rural locations tended to use temperature and thermometer as an indicator of doneness ($X^2(2, N=398) = 10.107, V=0.159, p=0.006$) (Table 4.16).

If participants selected any of the above indicators of doneness, they were directed to identify the frequency of which they cooked tenderized beef products (including cubed steaks) to 160°F or higher (1=always, 2=most of the time, 3=half-the-time, 4=sometimes/rarely, 5=never). Of 309 respondents, the median score of the Likert scale responses was 2 (IQR: 1 to 2). In the majority of income brackets, participants indicated cooking tenderized beef products to $\geq 160^\circ\text{F}$ (Table 4.15). However, those with an annual income $< \$80,000$ indicated “Always” using a thermometer less than respondents $> \$80,000$; similarly, in the mid-range income brackets, respondents more frequently “sometimes” used a thermometer (Table 4.17).

DISCUSSION

1: Purchase of Enhanced Beef Products

As seen in Chapter 3, consumers tended to purchase enhanced beef products and/or cubed beef/cubed steak, because of its price, convenience, and palatability. While focus group participants had been aware that “something had been done” to the beef, they were not necessarily aware of the process of mechanical tenderization. Cubed beef is a mechanically tenderized product; however, it does not have to be labeled as such due to its visually obvious manipulation. As with focus groups, though, survey participants were unaware and had little knowledge of cubed beef being a mechanically tenderized product. Along with the focus group studies, in 2016, a Canadian study found that only 38% of Canadian consumers were aware of the mechanical tenderization process, further emphasizing that consumers do not even understand what the term “mechanical tenderization” means (Klassen & Gill, 2016; Yang et al., 2018).

Participants used a mix of extrinsic and intrinsic quality cues to guide their beef purchasing decisions, with price and appearance being the primary indicators for purchase (Acebron & Dopico, 2000; Realini et al., 2014; Grunert et al., 2004; Korzen & Lassen, 2010; Troy & Kerry, 2010; Reicks et al., 2011; Henchion et al., 2014). Also seen in focus groups, mid- to lower-income households would continue to purchase cubed beef products and MTBs due to the importance of price (Yang et al., 2018). Price, as a cue, can also be used to indicate quality, and with a greater disposable income, it is possible that participants in a higher-income bracket not only perceive cubed steaks as lower-quality products; but, are more willing to spend more on a perceived higher-quality cut (Henchion et al., 2014; Acebron & Dopico, 2000; Grunert et al., 2004; Yang et al., 2018).

Consumers not only desire and prefer to purchase enhanced beef products that result in a more tender product, they have also demanded more consistent, higher quality, and convenient-to-prepare meat products; marinated beef products are convenient for flavor, tenderization, and ease of preparation (Robbins et al., 2003; Reicks et al., 2011; Yang et al., 2018). The high percentage of younger participants purchasing marinated beef products may be due to convenience in a busy lifestyle and a lack of disposable time (Scholderer & Grunert, 2005; Grunert, 2006).

2: Attitudes Towards Mechanically Tenderized Beef Products

As expected, the majority of participants were unaware of mechanically tenderized beef products; this was seen not only as low numbers of individuals who associated purchasing cubed steaks with also purchasing MTBs, but was also observed in Yang et al., 2018's focus groups. Like previous findings, consumers are divided in how they may feel towards MTBs; in British Columbia and in Virginia and North Carolina, participants were split evenly (Yang et al., 2018; Heran & Sidhu, 2014). Similar to the responses seen in focus groups in Yang et al. (2018), those who understood and were aware of MTBs had a generally positive attitude towards the product and process, stating that "it seems like it would be a good idea", that the process created a flavorful and tender product while adding convenience since the work was done, and that it was oftentimes within price-range and cost-effective. On the other hand, participants' negative attitudes also stemmed from conceptions regarding the safety of product and cleanliness of equipment post-tenderization. Survey respondents also felt that the terminologies "sound yucky" and speculated that it may be unnatural (Yang et al., 2018).

Because attitudes towards MTBs appear fluid, this allows space for discussion, education, and outreach of not only MTB process and methods – but potentially other beef product-related things – through consistent communication of both risk and benefits associated with specific processes targeted to the needs of various audiences (van Dijk, et al., 2012).

3: Awareness of the Mechanical Tenderization Label

In 1994, the Safe Handling Instructions label was mandated for all raw meat and poultry products. As such, it is understandable that over 77% of participants were aware of the SHI label. On the other hand, the U.S. MTB label of beef products has only been in place since May 2016. This short duration of time may contribute to the current low levels of MTB label awareness. In addition, this low awareness was also previously seen in 16% of respondents to a Canadian survey of MTB label instructions (Klassen & Gill, 2016). While there are a few media articles that mentioned this labeling process around the time of its presentation, little to no other distribution media discussion may also contribute to high rates of unawareness in the U.S.

In 2014, only 42% of surveyed British Columbians were aware of the associated health risks of MTBs (Heran & Sidhu, 2014). However, of those who did purchase MTBs, most were aware of the MTB label and on what products it was placed on; but, respondents were unaware of the specific elements of the MTB label (i.e. name designation and cooking guidance). In previous research, label awareness and risky behaviors were associated with increasing income and education levels. Awareness of SHI label and MTB label is also

associated with increasing income and education levels in this study. (Yang et al., 1998; Altekruise et al., 1999; Yang et al., 2000).

These findings are compounded by people's original reactions to MTB labels in Virginia and North America focus groups: both MTB and SHI labels are not only easily ignored, but there is a lack of MTB label recognition that may result from the inaccessible descriptive format that is not meaningful to the target audience (despite having a specific regulation, see Figure 4.1). However, awareness of MTB labels and SHI labels increased with increasing educational levels. On the other hand, cubed beef does not require an MTB label, even though it is a tenderized product, and it still has a SHI label. Participants in focus groups agreed that while simply the appearance of cubed steak indicated to the consumer that it needed to be cooked thoroughly; they did not pay attention to the SHI labels because they relied upon many personal experience and other factors (including duration of cooking time and smell) to assess product doneness. Due to consumer's lack of understanding and awareness of MTBs, labels should not be the only mode of raising awareness and education of MTB products and other food safety news.

In fact, it is common for consumers to disregard preparation guidelines if they not only perceive high control and confidence in their skills and knowledge; but, also have more trust in their own prior knowledge (Hall and Osses, 2013; Young & Waddell, 2016). Conversely, though reading labels and food safety knowledges increases with education level, increased risky behaviors are also associated with more education. At a more basic level, it may be useful to introduce basic food safety education in primary education.

4: Self-Enhancement Behaviors at Home

Since consumers do want a tenderer and more flavorful beef product, it makes sense that they could either tenderize marinade, or do both, at home! Without proper handling and preparation behaviors, the potential for introducing pathogens from the surface of a product to the inside is also present. And as with purchased items, if product is not properly prepared, it is possible to acquire foodborne illness. However, consumers are less likely to prepare foods with proper food safety behaviors, even if guidelines are provided due to the inherent structures of optimism bias and perceived self-control.

Consumers very obviously prefer to eat tender, flavorful, and juicy products since those that do not purchase cubed or marinated products at retail tend to tenderize or marinate their beef at home. Discussion in focus groups highlighted that individuals preferred to marinate beef products at home as opposed to purchasing marinated products because it allowed for more control and was more cost effective. Additionally, participants in both the survey and in focus groups used marinades for tenderizing and softening beef while enhancing flavor (Yang et al., 2018).

Since Hispanic/Latino and various ethnicities/races mechanically tenderized or marinated (to tenderize or for flavor) their beef products prior to cooking, developing specific targeted messaging to be delivered at retail locations and markets may be helpful. Effectiveness of labels in Spanish has been demonstrated and should be continued (Marin, 1994; Yang et al., 2000). Ethnic and cultural communities tend to be insular with their own respective meat retailers or markets. A study surveying small ethnic-focused meat retailers determined that the process of mechanical tenderization not only occurred at retail; but, that the depending on locality, the inspectors enforcing the Food Code did not always

enforce labeling, thus creating a gap in policy implementation and also knowledge within the independent meat retailers (Arnold, 2018). Thus, developing different types of programming to be delivered by trusted people within the communities could spread awareness not just of the MTB process within the stores, but also for the potential risks when performed at home.

Specific programming could be developed for suburban or rural locations. Rural communities tend to be remote, small, and spatially distant which creates varied demographics. Especially in rural locations, information may be more difficult to access due “real or perceived isolation” geographically, demographically, and culturally. Thus, it is imperative to identify the needs of rural residents (and concepts of rural poverty) throughout various U.S. regions in not only addressing health, but tying in food issues (Hartley, 2004; Hart et al., 2005). In the United States, such programming can be developed at land grants and dispersed through Extension programs or even through local or regional factors (e.g. Appalachian Regional Commission, Southern Rural Access Project, etc.), whom, rural populations do trust (Hartley, 2004; Yang et al., 2018).

5: Preparation of Enhanced and Mechanically Tenderized Beef Products

The best practice for safe preparation and handling of beef products is utilizing a food thermometer to measure the internal temperature of beef products; unfortunately, consumers often use sensory evaluations to indicate doneness although it is not indicative of microbial safety. In focus group discussions, participants also mentioned using smell as an indicator of doneness. In British Columbia, almost all surveyed respondents failed to follow the information provided on the MTB labels (Heran & Sidhu, 2014). Consumers,

due to optimism bias, are confident in their own preparation abilities and not inducing foodborne illness, while also rejecting behaviors that may be viewed as socially unacceptable (e.g. thermometer use); but, do worry about food prepared externally (Young & Waddell, 2016). Due to their optimism, consumers are also less likely to use thermometers even when it would be safer.

Although Canadian consumers expressed low difficulty in understanding the safe cooking instructions for MTBs, consumers with higher education levels are and were more likely to practice risky behaviors (Klassen & Gill, 2016; Yang et al., 2010). In fact, while 9 in 10 consumers are aware that certain beef products should be prepared to >160°F, they do not often follow temperature guidelines nor use thermometers during food preparation. This is often due to inconvenience of using thermometers, lack of common guidelines for thermometer use, and the prominent promotion of using indicators such as color, time, juices, and texture in cookbooks, on popular cooking shows, in media, and through familial experience. (Byrd-Bredbenner et al., 2013; 75/105). In this survey, while participants in all income brackets reported frequently using a thermometer; those within higher income brackets used a thermometer less frequently than in lower income brackets. A limitation of this may be that due to the survey's self-reported behavior, participants' definitions of time frequencies may be different. Additionally, survey respondents may also want to make themselves appear in a better light.

As much of one's handling behavior is marked by a mix of routine and experience, it may be difficult to change behaviors. In addition to targeting larger groups, personalized messaging may both contribute to greater awareness while providing consumers with the ability to choose what to do with said information (Jacob et al., 2010; Young & Waddell,

2016). Additionally, beef practices for younger populations seem to be more associated with intentions and perceived control; while, in older individuals, actualized behavior is derived from past experiences (Mari et al., 2012). Thus, it is necessary to understand the target audience to provide salient risk-benefit information into underrepresented demographics, hard-to-reach locations, and vulnerable populations (van Dijk et al., 2012; Jacob et al., 2010). Young & Waddell (2016) note that individuals with health-status changes are more likely to seek out and implement food safety information; thus, making trusted health professional locations a good place to discuss messaging.

Understanding sociocultural factors and the cultural relevancy of food attitudes and issues for various populations may allow for wider acceptance of risk information (Jacob et al., 2010). Label recognition is less common in persons of Asian race and amongst “less-aculturated, Spanish-speaking Hispanics”, especially if such labels are written only in English. Culturally and language-specific messages, though, have been shown to improve label awareness and recognition (Marin, 1994; Yang et al., 2000; Parra et al., 2014). Due to differing cultural food norms, development of materials focused on meeting under-represented populations with where their needs are may also increase compliance.

CONCLUSION

Ultimately, it may be useful to review, revise, and examine word choice and semantics of phrasing. When provided with different schematics of preparation instructions, participants judging MTB cooking temperatures were more likely to follow an instruction that also provided a subjective cue (i.e. “medium rare”) and utilized specific wordings. Specific wordings, along with label ambiguity and confusion, can be better honed to develop labels to positively reinforce consumers who do read and interact with labels for information. As it currently stands, compliance with all the rules on the label are both theorized as low – with various types of wordings – but have been shown to be ineffective when implemented (Heran & Sidhu, 2014; Klassen & Gill, 2016; Yang et al., 2018).

Distribution of messaging – be it about MTBs or other new processes – needs to be clear, frequent, consistent, and timely (Jacob et al., 2010). Distribution channels should also complement specific audiences and more research should be done regarding how under-represented populations receive information. If new information is given out, then all information regarding that topic should be timely updated so as not to cause confusion (i.e. USDA guidelines for not using color as a reliable indicator for doneness). Succinct and consistent language should be used for clarity; saying too much without using graphics or symbols nor a baseline understanding of terminology will lead to confusion and disregard (Jacob et al, 2010; Yang et al., 2018). As other studies have demonstrated, a multi-prong approach of in-store communication, technological dispersal, larger fonts with clear definitions would be welcomed for learning more (Yang et al., 2018).

Socio-economic demographics play an important role in communicating food safety risks. Despite considerable types of communications distributed regarding food safety messaging, consumers may disregard these communiques as being “irrelevant or useless” since their blanket messages may not be targeted towards the correct audience nor demonstrate the “net health impact on both life expectancy and quality of life” (Verbeke et al., 2007; van Dijk et al., 2012). Despite the risks associated with MTBs, low awareness of such products (handling and risks) is indicative of lack of knowledge and discussion. Ultimately, the dispersal of infrequently discussed food safety topics, including mechanically tenderized beef products, must be a multi-faceted approach exploring and taking into consideration socio-cultural factors relevant to more nuanced populations.

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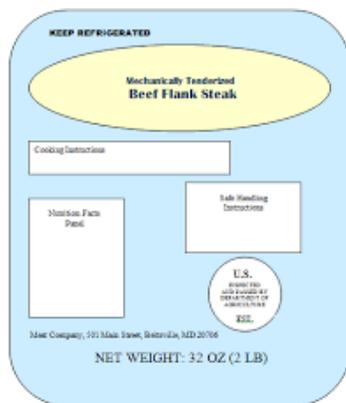


Figure 4.1a



Figure 4.1b

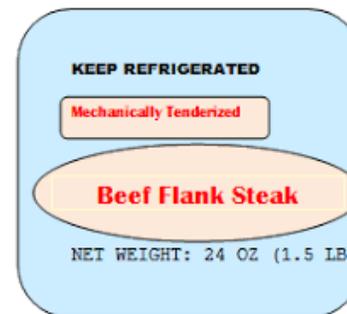


Figure 4.1c

Figure 4. 1: Examples of mechanically tenderized label designation format (FSIS, 2016) (a) Example MTB label from a Federal establishment with all required information; (b) Example MTB with solution label from a Federal establishment with all required information; (c) Example of principal display for MTB produced at a retail store

Table 4. 1: Number of respondents (n=500) who purchase enhanced beef products

Product	#	%¹
Total	209	41.8
Cubed beef	158	31.60
Mechanically tenderized beef products	52	10.40
Marinated beef products	83	16.60

¹ # responded/total number of respondents (500)

Table 4. 2: Number of respondents who indicated purchasing mechanically tenderized beef products and also purchasing other enhanced beef products

Enhanced Beef Product Purchase	Purchase of MTB	
	#	%
Cubed beef ¹	35/158	22.2
Marinated beef products ²	21/83	25.3

¹ Cubed beef (n=158)

² Marinated beef products (n=83)

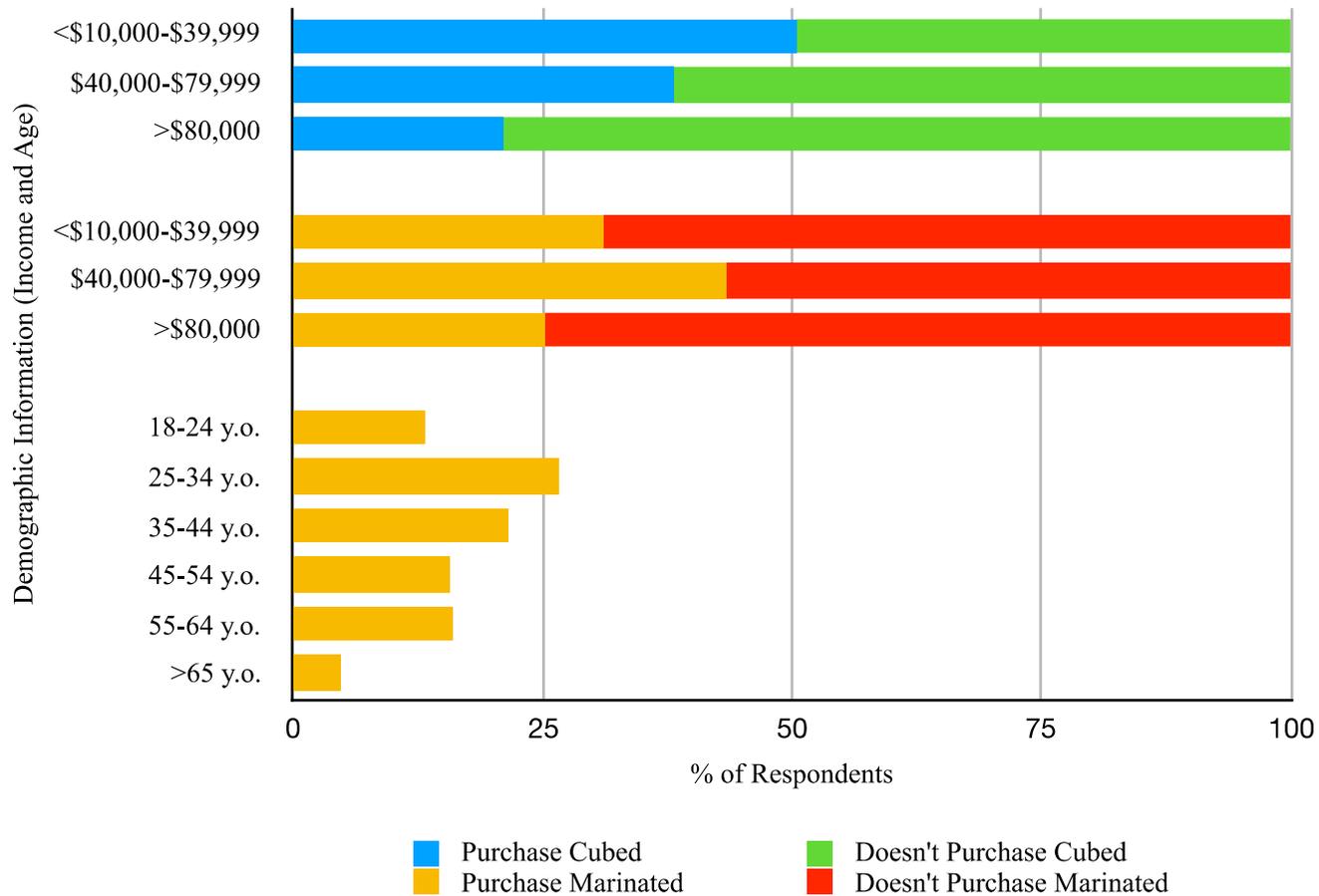


Figure 4. 2: Percentage of respondents that self-reported purchasing cubed (n=158) and marinated (n=83) beef products based on income level and marinated beef products based on age (n=83)

Table 4. 3: Attitudes and feelings of Hispanic/Latino (n=89) and cubed steak purchasers (n=158) towards mechanically tenderized beef products

Attitude	Hispanic/Latino ¹		Purchaser of Cubed Beef ²	
	#	%	#	%
Positive Attitude	16	18	28	17.7
Neutral Attitude	17	19.1	20	12.7
Negative Attitude	10	12.3	18	11.4
Unaware	46	51.6	92	58.2

¹ # responded/total number of Hispanic/Latino respondents (89)

² #responding/total number purchasers of cubed beef products (158)

Table 4. 4: Number of respondents that self-report purchasing MTBs (n=52) and are aware of the MTB label

Label Awareness	Purchase MTBs (n=52)		Do Not Purchase MTBs (n=448)	
	#	%	#	%
Yes	28	53.9	117	26.4
No	24	46.2	331	73.9

Table 4. 5: Number of respondents' self-reported awareness of SHI label and MTB labels

SHI Label Awareness	Aware of MTB Label¹		Not Aware of MTB Label	
	#	%	#	%
Yes	132	26.4	255	51.0
No	13	2.6	100	20.0

¹ #Respondents aware of MTB label (n=500)

Table 4. 6: Number of respondents' self-reported awareness of the mechanically tenderized beef (MTB) label and the safe handling instructions (SHI) label

Education level	#		% (of aware respondents)		% (within group)	
	MTB ^a	SHI ^b	MTB ¹	SHI ³	MTB ²	SHI
Completed some high school (17)	11	17	7.6	4.4	64.7	100
High school graduate (120)	34	90	23.4	23.3	28.3	75
Completed some college (133)	29	109	20	28.2	21.8	81.9
Associate's degree (70)	30	57	20.7	14.7	42.9	81.4
Bachelor's degree (106)	26	78	17.9	20.2	24.5	73.6
Master's degree (42)	11	25	7.6	6.5	26.2	59.6
Ph.D. or Professional degree (12)	5	11	3.4	2.8	41.7	91.7

¹ Respondents aware of MTB label (n=145)

² Respondents of each educational level group (Completed high school=17; high school graduate=120; Completed some college=133; AA=70; BA=106; Master's=42; Prof=12)

³ Respondents aware of SHI label (n=387)

Table 4. 7: Number of respondents that self-report marinating or tenderizing beef products prior to preparation

	#	% ¹
Total	318	39.8
Tenderize prior to preparation¹	117	23.4
Marinade prior to preparation²	280	56

¹ #responded/total number participants (500)

Table 4. 8: Number of respondents who self-reported tenderizing or marinating beef products prior to preparation based on purchase cubed beef and marinated beef products

	Purchase Cubed Beef				Purchase Marinated Beef			
	Yes		No		Yes		No	
	#	%	#	%	#	%	#	%
Tenderize prior to preparation ¹	80	45.8	97	54.8	48	27.1	129	72.9
Marinate prior to preparation ²	106	37.9	174	62.1	68	24.3	212	75.7

¹#responded/total number of respondents who tenderize-prior-to-preparation (177)

²responded/total number of participants who marinate-prior-to-preparation (280)

Table 4. 9: Participants' (n=176) self-reported self-tenderization methods

I tenderize my beef products with:	#	%
Mechanically with a mallet, cuber, hand-held tenderizer, fork/knife	100	56.82
With a tenderizer or meat softener	91	51.70
With a marinade	118	67.05
By cooking for a long time	60	34.09
Other	3	1.70

Table 4. 10: Number of participants who self-report mechanical tenderization of beef products (n=176) prior to preparation within ethnicity

Ethnicity	#	%
Asian/Pacific-Islander (10)	6	60.0
Black/African-American (39)	15	38.5
White (119)	76	63.9
Other (8)	3	37.5

Table 4. 11: Number of respondents that self-report mechanically tenderizing beef products prior to preparation based on self-reported location

Location	#	%
Urban	34/74	45.9
Suburban	42/66	63.6
Rural	24/36	66.7

Table 4. 12: Number of respondents (n=148) who marinade beef products to tenderize prior to preparation by age

Age (y.o.)	#	% ¹
18-24	14	9.5
25-34	34	23.0
35-44	28	19.0
45-54	25	16.9
55-64	24	16.2
>65	23	15.6

¹ # responded/total number of respondents who marinade beef products prior to preparation (148)

Table 4. 13: Number of respondents by ethnicity/race that self-report using texture and smell as indicators of doneness

Ethnicity	Texture¹		Smell²	
	#	%	#	%
Asian/Pacific Islander	15	65.2	11	47.8
African-American/Black	34	50.7	20	29.9
Caucasian/White	113	38.7	54	18.5
Other	7	43.8	3	18.8

¹ # responded/total number of respondents using texture for doneness (169)

² # responded/total number of respondents using smell for doneness (88)

Table 4. 14: Number of respondents self-reported using time as an indicator of doneness within age group

Age (y.o.)	#	% ¹
18-24	16/50	32.0
25-34	9/78	11.5
35-44	11/66	16.7
45-54	20/73	27.4
55-64	10/68	14.7
>65	15/55	27.3

¹ # responded/total number of respondents who purchase marinated beef products

Table 4. 15: Self-reported preparation of mechanically tenderized beef products to >160F for purchasers (n=44) of MTB products

Frequency of Cooking to >160F	#	%
Always	14	31.8
Most of the time	25	56.8
Half the time	2	4.5
Sometimes	1	2.3
Never	2	4.5

Table 4. 16: Number of respondents that use a thermometer to measure internal temperature (n=81) to check for doneness of tenderized beef products based on location

Location	#	%¹
Urban	25	30.9
Suburban	29	35.8
Rural	27	33.3

¹ # responded/total number of respondents using a thermometer to measure internal temperature of tenderized beef products

Table 4. 17: Frequency of self-reported cooking of tenderized beef products to $\geq 160^{\circ}\text{F}$ by income bracket

	Always		Most of the time		Half the time		Sometimes		Never	
	#	%	#	%	#	%	#	%	#	%
<\$20,000 ¹	30	53.6	13	23.2	10	17.9	1	1.8	2	3.6
\$20,000- \$39,999 ²	33	35.9	33	35.9	12	13.0	7	7.6	7	7.6
\$40,000- \$59,999 ³	23	39.0	28	47.5	2	3.4	6	10.2	0	0
\$60,000- \$79,999 ⁴	22	56.4	10	25.6	1	2.6	3	7.7	4	10.3
\$80,000- \$99,000 ⁵	3	18.8	10	62.5	2	12.5	0	0	1	6.3
\$100,000- \$150,000 ⁶	12	36.4	19	57.6	1	3.0	1	3.0	0	0
>\$150,000 ⁷	6	42.9	7	50.0	0	0	1	7.1	0	0

¹ #respondents / total number of respondents earning <\$20,000 (56)

² #respondents / total number of respondents earning \$20,000-\$39,999 (92)

³ #respondents / total number of respondents earning \$40,000-\$59,999 (59)

⁴ #respondents / total number of respondents earning \$60,000-\$79,999 (39)

⁵ #respondents / total number of respondents earning \$80,000-\$99,000 (16)

⁶ #respondents / total number of respondents earning \$100,000-\$150,000 (33)

⁷ #respondents / total number of respondents earning >\$150,000 (14)

CHAPTER 5

Research Paper

Journal: Formatted for *Food Control*

Article Title: A mixed-methods approach to assess consumer's risky food safety behaviors regarding beef and kitchen through the Theory of Planned Behavior

Author details

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Key Words: food safety, mixed methods, beef, theory of planned behavior, consumer behavior, thermometer, meat washing, defrost

ABSTRACT

The World Health Organization, Center for Disease Control, and the Food and Drug Administration promote similar messages for controlling the safety of food to prevent foodborne illness. These messages promote hygiene, proper preparation and cooking of foods, prevention of cross-contamination, and use of safe foods through proper temperature control. Food handling attitudes and behaviors vary between socio-cultural demographics. The theory of planned behavior is a conceptual framework that has been used to pinpoint specific attributes that contribute to a person's behavior. The purpose of this exploratory sequential mixed-methods study is to identify and assess risky consumer knowledge, attitudes, and behaviors regarding safe food and beef handling in the home kitchen. Thirty-five qualitative focus groups were conducted in urban and rural Virginia and North Carolina. Thirteen focus groups were coded and analyzed with NVivo 11 Pro. A codebook developed via inductive and deductive constructionist approaches with a secondary coder (Cohen's-kappa=0.92). Resulting categories and themes guided the development the 69-question quantitative nationwide survey on storage and handling behaviors. Survey results were analyzed with Chi-square goodness-of-fit tests ($p \leq 0.05$; Cramer's $V \geq 0.15$); open-response answers were coded and analyzed with NVivo 12 Pro. Both focus group participants and survey respondents engaged in risky behaviors regarding beef handling including storing raw beef products on the top shelf in the refrigerator, using other indicators to indicate the temperature of the refrigerator, defrosting beef on the counter for longer than four hours, washing beef and meat products prior to preparation, underutilizing thermometers when preparing meat products, and using indicators (e.g. color, smell, texture, and juices) to determine doneness of beef products. Risky behaviors are

significantly associated with ethnicity and race; minority and under-represented populations (Hispanic/Latino, Asian/Pacific-Islander, Black/African-American) were more frequently practiced risky behaviors like defrosting meat on counter for extended periods of time, washing meat products prior to preparation, and not owning or using a thermometer to measure beef doneness ($p \leq 0.05$). Hispanic/Latino populations were knowledgeable that the safe internal temperature of beef was between 145°F - 165°F. Income, gender, age, and education also affected thermometer knowledge and use. Older individuals were more likely to own thermometers but were less likely to use it ($p \leq 0.05$), males were more cognizant of correct temperatures (in the refrigerator and for beef preparation) than females. Respondents with higher educations and higher incomes practiced riskier behaviors. Personal experience, self-efficacy, and personal control were commonly cited reasons for partaking in risky behaviors. There is a need for culturally competent, linguistically compatible, and targeted development of risk messages and interventions to address the needs of various cultural-socio demographics. Alternative strategies to accommodate and develop into consumers' current risky food safety behaviors may increase likelihood of behavior change and adoption.

INTRODUCTION

Every year, one in six Americans fall ill to foodborne illness; this costs the United States a yearly estimated \$15.6B (CDC, 2018). The Center for Disease Control [CDC], Food and Drug Administration [FDA], and World Health Organization [WHO] have promoted similar types of food safety controls to keeping food safe. The CDC promotes 4 Simple Steps: Clean, Separate, Cook, Chill (CDC, 2018). To build upon that, the WHO promotes the Five Keys to Safer Food: (1) keep clean; (2) separate raw and cooked foods; (3) clean thoroughly; (4) keep foods at safe temperatures; and (5) use safe water and raw materials (WHO, 2006). Both methods promote hygiene, proper cooking and preparation, prevention of cross-contamination, and use of safe foods through temperature control.

This paper will focus specifically on consumers' keeping of foods at safe temperatures (storage behaviors of food on the counter and in the refrigerator, refrigerator temperature, defrosting meat, meat preparation, and thermometer usage and ownership) and cross-contamination (meat washing).

Theory & Conceptual Framework

The strength of one's attitude is more closely tied and predictive of one's behavior, creating an attitude-behavior relationship. In fact, one's specific behavior has been shown to be more predictable of behavior if (a) a strong attitude is expressed; (b) attitude is "accessible in memory"; or (c) there is personal involvement (Armitage & Christian, 2004; Baron & Kenny, 1986; Conner & Sparks, 2002; Kokkinaki & Lunt, 1998; Thomsen et al., 1995; Kraus, 1995).

Proposed by Ajzen (1988, 1991, 2002), the Theory of Planned Behavior [TPB] has been frequently used to understand and predict consumers' food safety behaviors and

responses to interventions (Shapiro et al., 2011; Jacob et al., 2010; Alberts & Stevenson, 2017; Mari et al., 2012; Medeiros et al., 2004; Pilling et al., 2008; Parra et al., 2014; Mullan et al., 2016; Henley, 2013). TPB builds off of Fishbein and Azjen's 1975 *theory of reasoned action*. TPB seeks to explain a person's behavior and possibly predict future behaviors through three determinants of intention: (a) attitude; (b) subjective norm; (c) perceived behavioral control (Figure 5.1). In this, not only is one's attitude able to predict behavior; additionally, perceived social pressures from one's circle would influence the outcome of a behavior. In addition, perceived behavior control [PBC] not only impacts behavioral intent; but, also can affect behavior, directly. If one perceives that they have the power to facilitate or inhibit a behavior, they will (or won't) do such a behavior (Armitage & Christian, 2004). PBC is similar to "Bandura's notion of self-efficacy" in which if someone believes "that a particular behavior is under their personal control" they are more likely to intend to engage in the behavior and actually follow-through with the behavior (O'Connor and Armitage, 2004; Bandura, 1997; Ajzen, 1991; Armitage & Conner, 2001). This can be expressed back in exploring food safety behaviors and how/why consumers act/react the way they do.

The purpose of this exploratory (QUAL > QUANT) mixed methods study design was to identify, explore, assess, and expand upon current consumer knowledge, awareness, attitudes, and beef and food safety behaviors. Focus groups allowed a glimpse into the beliefs and food preparation behaviors of urban and rural populations within Virginia and North Carolina. The resulting discussion led to the development of a nationwide survey to better explore nationwide "sentiments".

MATERIALS AND METHODS

An exploratory sequential mixed methods study incorporating both qualitative and quantitative methods was designed to explore consumer's food and beef safety behaviors, beliefs, and attitudes. Phase I's, qualitative focus group responses guided the development of Phase II's quantitative and representative nationwide survey. This project was approved by the Institutional Review Board of Virginia Tech, protocol 15-521.

2.1 – Phase 1: Focus Groups

Methods of focus group development and analysis are described in Yang et al., 2018. Briefly, focus groups were conducted in centralized locations within urban and rural counties of Virginia and North Carolina. Participants were recruited through stratified random sampling, snowball sampling, and convenience sampling. Focus group sessions, lasting 1 – 2 hrs, were audio-recorded with Olympus DS-30 digital recorders (Olympus America, Inc., Center Valley, PA) to ensure data completeness, then transcribed verbatim. Semi-structured focus group questions discussing (a) purchasing behaviors, (b) storage behaviors, (c) preparation behaviors, and (d) intervention methods, allowed for discussion, probing, and elaboration of participants' answers. Demographic information of each participant was also collected. Thirteen of 35 completed focus groups were randomly selected for constant-comparison, interpretive, inductive, and constructivist analysis. NVIVO11 Pro for Windows (QSR International; Victoria, Australia) was used for coding and data analysis. A codebook of themes and categories with a secondary coder was developed (Cohen's kappa=0.92)

2.2 – Phase 2: Nationwide Survey

The methodology for nationwide survey development is described in Yang et al., 2018 (2). Briefly, a nationwide, non-probability 69-question online survey, “Beef Study Nationwide Survey” was distributed by Qualtrics (Provo, UT; <http://www.qualtrics.com>). An initial survey was created in Qualtrics and conveniently pilot-tested with 62 individuals across the U.S. Feedback was incorporated and the revised survey was prepared and distributed by Qualtrics in April 2018.

Survey topics covered: (a) purchasing and shopping behaviors around groceries and beef; (b) storage knowledge, attitudes, awareness, and behaviors; (c) food and beef preparation knowledge, attitudes, awareness, and behaviors; (d) food safety messaging (Appendix C1). Demographic information of participants was also collected (Appendix B1).

500 completed participants were recruited via email recruitment from Qualtrics’ opt-in lists representing gender, age, income, and location (urban/rural); there was an attrition rate of 33%. Participants were pre-screened by (i) gender, (ii) age over 18 years old, (iii) ethnicity, (iv) purchaser *and* consumer of beef products, (v) primary meal purchaser *and* meal preparer of beef products.

Quantitative data was analyzed with SPSS for Macintosh (IBM; Armonk, NY). Qualitative “open-answer” responses were nominally coded in NVIVO12 Pro for Windows (QSR International; Victoria, Australia) then analyzed. Coupled with contingency tables, chi-square tests of association (chi-square goodness-of-fit) statistics were performed. A Pearson’s coefficient for significance was measured at $p \leq 0.05$.

RESULTS

5.1 – Storage of Beef Products

5.1.1: Storage Behaviors

Focus Groups: Upon purchase, participants stored beef in the refrigerator if meat would be prepared “immediately” or within a few days. Freezers were also frequently utilized. Meat is often purchased in “bulk” at the grocery store or direct from producer and frozen for later use. Participants expressed a dislike for the “overall texture” of frozen beef.

Survey: Participants were surveyed on their beef storage habits, behaviors, and beliefs (i.e. where beef products were stored, where in the refrigerator beef was stored, and their knowledge regarding refrigerator temperatures). Although, 72% of participants put their purchases away upon returning from the grocery store within 30 minutes, two respondents waited at least four hours (Table 5.1). Participants selected as many storage locations as they utilized including refrigerator, freezer, and/or counter. 409 participants utilized the freezer and 287 utilized the refrigerator; but, nine individuals stored beef on the counter (Table 5.2). Significant demographic factors regarding storage in refrigerator practices were identified for gender ($X^2(1, N=500) = 16.749, \Phi=0.184, p<0.001$), ethnicity ($X^2(3, N=500) = 18.544, V=0.193, p<0.001$), education level ($X^2(6, N=500) = 15.225, V=0.174, p=0.019$), income ($X^2(11, N=500) = 21.359, V=0.207, p=0.030$), and location ($X^2(2, N=500) = 8.488, V=0.130, p=0.014$) (Figure 5.2). Males tended to store beef products more frequently in the refrigerator, as did Asians/Pacific-Islanders and White respondents. Those with a high school degree or more were apt to store more food in the refrigerator, too. Participants identifying as living in suburban areas were significantly more also likely to use refrigerators.

5.1.2: Risky Behavior – Storage on Top Shelf of Fridge

Focus Group: Participants mostly kept their beef and other meats separated and quarantined, utilizing “the coldest part of [the] refrigerator”, “refrigerator bottom”, “meat drawer”, “bottom shelf”, “plate underneath”, “compartment” in the refrigerator. Similarly, participants would also “keep [meat] in the bag”, use “shelf liners”, “double bag”, “bucket”, or place beef in “platter or dish towel” to prevent “blood dropping”, “packaging leaks”, and other “nasty” things from “ruin[ing] the good food”. In urban areas, however, participants were more likely to store their beef “where it fits” be it on the top shelf or the “second shelf”. Even in instances in which participants recognized they were unable to store products safely, participants attempted to prevent and mitigate cross-contamination.

Survey: If participants indicated storage in the refrigerator, they then selected where in the refrigerator they stored their products (Table 5.2). While, 72% of participants rightly stored their beef products on the bottom shelf, in a designated drawer, and separated from other foods; 57% of participants put beef products on the top shelf, on another shelf, or wherever there was space. Significant interactions were seen between the factors of age ($X^2(10, N=286) = 25.434, V=0.298, p=0.005$), Hispanic/Latino ($X^2(1, N=286) = 6.044, \Phi=0.145, p=0.014$), and race/ethnicity ($X^2(3, N=286) = 13.304, V= 0.216, p=0.004$) with storing beef products on the top shelf. Based on individual demographics, participants between 25 – 40 y.o. were more likely to store their beef products on the top shelf, as were Hispanic/Latino and Asian/Pacific-Islander respondents (Figure 5.3).

5.1.3: Temperature of Refrigerator

Focus Group: Not only did participants mostly not know the temperatures of their refrigerators, many did not have refrigerator thermometers; instead, other indicators were used to signify level of refrigerator coldness. Due to temperature distribution variability, beef products would be placed in different locations inside the refrigerator depending on what constituted the coldest part of the refrigerator. Participants recognized the necessity of having a thermometer in refrigerators; however, the majority did not have one. Phrases including “low”, “normal”, “cold”, “freezing” were used as indicators of proper refrigerator coldness using dials, gauges, or other relative measurements with their “milk”, “asparagus”, and “beer”. Many refrigerators had dials with relative numbers (“3”, “5”) or phrases (“high”, “low”, “cold”) and other indicators instead of thermometers. Participants desired to keep their refrigerators and freezers as “super cold” or “cold as the freezer”. For those cognizant of their refrigerator temperatures, temperatures ranged from 20°F – 45°F with most between 34°F – 38°F.

Survey: Survey participants were asked to identify the coldness level, temperature awareness, and mechanism of determining/ascertaining refrigerator temperature. More females were unaware of the temperature of their refrigerators while more males were able to correctly state and identify the temperature of the refrigerator ($\chi^2(4, N=497) = 16.212$, $\Phi=0.181$, $p=0.003$). Another common response was that the refrigerator was some rendition of “cold” (Table 5.3). When asked to elaborate upon the exact temperature of their refrigerators, gender ($\chi^2(3, N=497) = 21.348$, $\Phi=0.207$, $p<0.001$) and education level ($\chi^2(18, N=500) = 33.220$, $V= 0.149$, $p=0.016$) of participants were both correlated. Males were aware of the correct temperature of their refrigerators, while more females

were unaware of the temperature. Around 30% of participants at each educational factor were unaware of the temperature of their refrigerators; in fact, individuals without a high school degree were less likely to identify the proper temperature of their refrigerator (Figure 5.4). While no other demographic factors were correlated with knowledge of temperature or coldness of refrigerator, 208 participants (41%) of participants utilized some type of mechanism (dial, gauge, indicator, display) inside their refrigerators to alert them of the temperature (Table 5.4). Participants with an annual income of \$20,000 - \$60,000 were more likely to indicate having thermometers in their refrigerators ($X^2(33, N=500) = 47.718, V=0.178, p=0.047$).

Part 5.2: Preparation of Beef Products

Participants were surveyed on their beef preparation behaviors including defrosting of beef, preparation of beef for cooking, and cooking behaviors. Focus group participants were asked to describe their process of preparing beef products from “start to finish”.

5.2.1: Defrosting Beef on the Counter

Focus group: The most common method for defrosting meat was in the refrigerator. Participants generally disliked microwaving because meat would “turn brown and slimy” creating meat that “tastes awful”. If in a rush, participants tended to defrost beef products in a sink or receptacle with cold or warm water; water may or may not be changed. All participants were cognizant of possible package or product leaking and were inclined to keep product in “sink”, “double bagged”, “plate”, or “bowl”. Participants across both rural and urban groups mentioned the importance of bringing beef products to room temperature

as celebrity chefs have said it would impart “flavor” to the beef product. One participant even described defrosting meat in an “empty dishwasher”.

Survey: Participants were asked to indicate all defrosting behaviors that they used (Table 5.5). The most common method of defrosting was in the refrigerator. Participants also commonly defrosted beef in a water bath or sink. Geographical location and annual income were not associated with any variables. Of the 191 participants who defrosted beef on the counter, 171 (90%) indicated the time elapsed. Of these, 31 (~20%) of participants left beef on the counter for over four hours, while 51 (~30%) of participants stated that duration of defrost on counter depended on how they would use the product and other factors. Hispanic/Latino respondents were more likely to leave beef products to defrost on the counter for over four hours ($\chi^2(3, N=171) = 7.733, V=0.213, p=0.052$). Participants with an Associate degree were also much more likely to leave beef out for great lengths of time ($\chi^2(18, N=171) = 30.500, V = 0.244, p=0.033$) (Figure 5.5).

5.2.2: Risky Behavior – Meat Washing

Focus Groups: There was a high prevalence of meat washing. Rural Black, urban Black, Hispanic/Latino, and other rural participants tended to wash chicken and other big meat cuts to “de-slime” and eliminate “blood”; however, “hamburger” and ground beefs were not washed. “Baking soda”, “vinegar”, “liquid detergent”, “Clorox”, “lemon”, “vinegar”, “salt”, or “boiling” were used to rid meats of its perceived dirtiness. Meat washing was perceived as a safety precaution in which meat washers were “brought up”, “saw”, and were taught to wash meats. Participants who did not wash their beef and meats explained that they “worry with contamination”, learned not to, or “never thought about”

meat-washing. In fact, non-washers were cognizant of being told not to wash meats in “cooking class” and by other media.

Survey: Participants were surveyed about their beef washing behaviors, attitudes, and beliefs. Neither education level nor income factors were associated with meat washing behaviors, attitudes, or beliefs. About 45% of participants washed beef products prior to preparation (Table 5.6). Demographics populations <35 y.o. being more likely to wash their meats ($X^2(10, N=500) = 25.404, V=0.225, p=0.005$). Asian/Pacific-Islanders and Black/African-Americans were also more likely to wash beef products than other ethnicity/race groups ($X^2(3, N=500) = 57.789, V=0.340, p<001$). Urban respondents also indicated washing their beef products more than suburban or rural respondents ($X^2(2, N=500) = 6.928, V=0.118, p=0.031$) (Figure 5.6).

92% of participants that reported washing beef, washed it with water (both hot and cold), while 8% rinsed beef with water containing an extra agent (i.e. lemon, lime, soap, salt, disinfectant, etc.) (Table 5.7). Females ($X^2(1, N=201) = 5.114, \Phi=-0.0160, p=0.024$) and Hispanic/Latino respondents ($X^2(1, N=203) = 4.996, \Phi=-0.157, p=0.025$) were significantly more likely to wash beef products with water+extra agent. Ethnicity was highly associated with the use of water+extra agent; in fact, over 20% of Black/African-Americans and 11% of Asian/Pacific-Islanders did so ($X^2(2, N=195) = 6.116, V=0.177, p=0.047$) (Figure 5.7)

Of the 195 individuals who wash meat, gender was slightly associated with meat washing, while other demographic factors were not. Females tended to wash meats to clean off blood, while more males washed beef to rid beef of contaminants, for increased safety

and cleanliness. Males also tended to wash beef due to habit or previous experience ($X^2(2, N=195) = 6.116, V=0.177, p=0.047$) (Figure 5.8).

5.2.3: Doneness Level

Focus Groups: Meat color was the primary indicator of doneness and (perceived) safety. Both urban and rural participants expressed a preference for a “burnt”, “nice brown”, “browning” of product, with some opting for “pinkish” to darker meats, going as far as to desire “overcooked”. With ground beef products, specifically, participants would break apart their food to ensure the “pink is gone”. The color indicator for doneness was often coupled with juice appearance, time, smell, and touch or feel for texture. Some participants also used temperature or thermometers, in addition to judging meat color. Additionally, participants in Virginia and North Carolina had a high preference for well-done beef products (in both ground beef and steaks), regardless of thermometers were used to verify temperature or not. The preference for this doneness level resulted from personal preferences and beliefs about the meat, previous experiences with foodborne illness (specifically, *E. coli*) and familial preferences.

Survey: Participants prepare their beef products using a variety of methods (Table 5.7). At least 57 individuals reported intentionally preparing and consuming beef raw. Half of participants who specified preparing and consuming raw beef were <40 y.o. ($X^2(10, N=500) = 22.199, V=0.211, p=0.014$); overwhelming Caucasians ($X^2(1, N=500) = 7.730, V=0.124, p=0.052$).

Behavior and attitude are significantly correlated (Figure 5.9, Figure 5.10, and Figure 5.11). Participants were asked to rank the frequency of and attitude towards using

various techniques (i.e. color, texture/firmness, juices and/or blood, smell, time, or internal temperature) as indicators of beef doneness (Figure 5.8 and Figure 5.9). Some demographic factors (i.e. Hispanic/Latino, education, income, or location) had no significant associations with participants' frequencies for applying techniques to determine doneness. On the other hand, gender was correlated with all indicators, especially color. Both females and males highly agree that color ($X^2(4, N=497) = 17.921, V=0.190, p=0.001$), texture ($X^2(4, N=497) = 15.091, V=0.174, p<0.001$), and blood/juices ($X^2(4, N=497) = 19.563, V=0.198, p=0.001$) are good indicators of beef doneness, this is reflected in their behaviors as both more frequently use color, more females use texture than males, and both genders also use juices/blood as an indicator of doneness. Both genders also believe that time is a reliable or somewhat reliable indicator of doneness ($X^2(4, N=497) = 13.164, V=0.163, p=0.010$); however, time is used "most of the time" and not always ($X^2(4, N=497) = 21.016, V=0.206, p<0.001$). Thermometer use is infrequent regardless of gender, despite males agreeing more than females that using a food thermometer to measure the internal temperature of a food product is reliable ($X^2(4, N=497) = 12.314, V=0.157, p=0.015$).

The number of people using color as an indicator decreased with increasing age ($X^2(40, N=500) = 65.962, V=0.182, p=0.006$). In the different ethnicities, color was agreed upon as being a great indicator ($X^2(12, N=500) = 24.324, V=0.127, p=0.018$). Smell was also used for the majority of participants between the ages of 25-64 y.o. ($X^2(40, N=500) = 56.155, V=0.168, p=0.046$). Over 70% of Asians/Pacific-Islanders utilized texture as an indicator of doneness ($X^2(12, N=500) = 25.886, V=0.131, p=0.011$). Across all ethnicities/races and within Hispanic/Latino respondents, color ($X^2(12, N=500) = 24.324, V=0.127, p=0.018$), and texture ($X^2(4, N=500) = 11.780, V=0.153, p=0.019$) were agreed

to be reliable indicators of doneness. Black/African-Americans less frequently measured internal temperatures of beef products to determine doneness. Hispanic/Latino respondents agreed more than non-Hispanic/Latino respondents that smell was a reliable indicator of doneness ($X^2(4, N=500) = 10.085, V=0.142, p=0.039$). With increasing education level, the agreements that internal temperature was a reliable indicator for doneness goes up; however, actual use of thermometers is low ($X^2(24, N=500) = 53.404, V=0.163, p=0.001$).

5.2.4: Food Thermometer Ownership & Usage

Focus Group: Personal experiences, personal beliefs, and beliefs related to perceptions guided people's knowledge and attitudes towards beef doneness between urban and rural focus groups. Participants generally stated "repetition" from having been cooking "for so long", being "taught to handle it", and familial education as their basis for not using a thermometer. However, participants whose immediate family members had experienced foodborne illnesses (*E. coli*) were more apt to use thermometers. Even participants who had previously worked in the food industry stated that they were taught to judge doneness by texture and juices. Those who used thermometers generally knew temperatures or knew where to find the temperatures desired. When asked, participants in urban and rural counties were all aware of the presence of the *Safe Handling Instructions* label.

Survey: The majority (62%) of participants owned a food thermometer (Table 5.8). Gender ($X^2(1, N=497) = 21.110, \Phi=-0.206, p<0.001$), ethnicity/race ($X^2(3, N=500) = 13.515, V= 0.164, p=0.04$), education level ($X^2(6, N=500) = 13.346, V=0.163, p=0.038$), and location ($X^2(2, N=500) = 6.939, V=0.118, p=0.031$) were associated with owning a food thermometer; males, those with at least a high school degree to a Bachelor's degree,

and urban and suburban participants were more likely to own a food thermometer. White/Caucasians reported owning a food thermometer for “safety” reasons.

Gender was highly correlated with thermometer use $X^2(3, N=179) = 7.806$, $V=0.209$, $p=0.050$). Males more frequently cited that thermometer use depended on product, personal-previous experience, the appearance of cooked product, and inconvenience of use for not using a thermometer; while females were more apt to cook products to doneness or did not own a thermometer. Males and females who did own food thermometers wanted to ensure product was “done”, at a safe temperature, and because it was necessary for food safety. Older individuals more frequently judged the type of product before using a thermometer, while younger participants (<24 y.o.) and between 40-65 y.o. also cited previous experience and “just knowing” as reasons for not using a food thermometer. Individuals >50 y.o. also judged the doneness of their beef products by appearance while also citing that thermometers are fairly inconvenient to use. For Hispanic/Latino respondents, not owning a thermometer was the primary reason for not using a thermometer.

The majority (60%) of respondents indicated awareness of safe internal temperature (Table 5.9). Of those, 65% were able to identify the safe internal cooking temperature of beef as being above 145°F. Despite using a thermometer for safety, males were more aware of safe internal temperatures, with 69% declaring the safe internal temperature of beef products to be above 145°F. While 60% of females also knew the safe internal temperature of beef products to be above 145, 25% of females did not know the safe internal temperature, contrasted to 13% of males. Participants with an educational level between high school graduate through a bachelor’s degree were aware of the safe internal

temperatures – indicating that such a temperature was above 145°F; however, those with higher or lower degrees were not aware and either indicated that the temperature was <145°F or that they didn't know what it could be either. Amongst Hispanic/Latino participants, the majority knew the safe internal temperature to be above 145°F, specifically >165°F ($X^2(4, N=247) = 25.186, V= 0.319, p<0.001$).

There is a strong correlation that although individuals who own a food thermometer only “sometimes” use the thermometer as an indicator for doneness, 64% agree that a thermometer to measure internal temperature is important to establishing product doneness ($X^2(6, N=500)= 227.026, V=0.674, p<0.001$). However, those that do not use a thermometer, even though they own one, cite that “they just know”. However, those who do own a thermometer, are much more likely to be aware of safe internal temperatures, selecting such a temperature to be 145°F-165°F; additionally, they more frequently cook beef to temperatures >160°F.

5.2.5: Frequency of Preparing Beef Products to 160°F

Focus Groups: Thermometer use to determine beef doneness was varied. Users of thermometers either expressed that “the key to perfect food is cooking to the proper temperature” indicating previous experience or lack of experience. Indeed, those that used thermometers when cooking seemed to be armed with various types of thermometers. Thermometers were more often used for “roast[s]”, “round[s]”, and other “large pieces of meat” and less for ground beef products. Participants using thermometers gave perceived safe/done temperatures ranging from 145°F – 150°F for ground beef products and 130°F – 160°F for bigger cuts with temperatures ranging by doneness expectation. Participants

reported referring to indicated temperatures on thermometer, recipes, or “Google” searches to determine cooking temperature if not readily known. To validate doneness, color, juice, and time would also be used. Many individuals did not use thermometers, citing personal experiences of having been “cooking so long”, having learned “my mother never did and she’s the one who taught me how to cook” and being able to “guestimate”, going so far as to claim that they “make sure [the meat is] done”. Additionally, there was a perception that the time-temperature combinations listed on labels created products that were “like sawdust”.

Survey: Preparation of beef products using a food thermometer to reach an internal temperature of 160°F was not significantly associated with ethnicity, age, education, income level, or location. However, there is significantly high association of males using a food thermometer to cook beef products to 160°F than females ($X^2(6, N=497) = 24.322, V=0.221, p<0.001$). Hispanic/Latino participants were less likely to prepare beef products to 160°F ($X^2(6, N=500) = 14.632, V=0.171, p=0.023$).

Part 5.3: Locus of Control

Focus groups: Personal experiences, personal beliefs, and beliefs related to perceptions guided people’s knowledge and attitudes towards beef doneness between urban and rural focus groups. Participants generally stated “repetition” from having been cooking “for so long”, being “taught to handle it”, and familial education as their basis for not using a thermometer. In fact, participants recognized risks with undercooking their beef as “my risk” and while they are aware of food safety issues if “nobodies got sick” they were more willing to “take chances”. However, participants whose immediate family members had

experienced foodborne illnesses (*E. coli*) were more apt to use thermometers. Temperatures were referenced on Safe Handling Instruction labels if a new recipe was used. Similarly, those who used thermometers generally knew temperatures or knew where to find the temperatures desired. Repeatedly, participants expressed that people would “revert back to what they know”; thus, in order to change behavior to encourage thermometer use, it would be important to “train another generation” through “education”. Participants expressed that the print was oftentimes too small to read. Additionally, while they “don’t really abide [by] them” because they “kinda know how to handle it”, participants were able to recognize the safety cues referring to cooking temperatures, cross-contamination prevention, refrigeration with an emphasis on temperatures (regardless if they were able to provide the correct temperature).

Survey: At the end of the survey, participants were asked about their perceived level of concern with the safety of products that were prepared and eaten. Participants are pretty concerned; Asians/Pacific Islanders, Black/African-Americans, and Others’ concerns were associated with higher levels of concern ($X^2(12, N=500) = 33.782, V=0.260, p=0.001$). Also significantly, participants in lower income brackets tended to be more concerned of the safety of beef products ($X^2(44, N=500) = 61.302, V=0.350, p=0.043$). Similarly, there is significantly high correlation between participants who wash their meats and their level of concern about the safety of beef products ($X^2(4, N=500) = 43.555, V= 0.295, p<0.01$). When asked about the control they felt about beef products prepared by oneself, participants generally felt that they had a great deal of control over the products they prepared.

DISCUSSION

This study explores and validates consumer food safety behavior research regarding some risky practices at home, specifically regarding storage, knowledge and use of refrigerator thermometers, defrosting behaviors, washing of meat, and knowledge, use, and preparation of beef products with a thermometer through the Theory of Planned Behavior to use Attitude, Subjective Norms, and Perceived Behavioral Control (internal and external loci of control) to associate and indicate Behavior. Locus of control (external: concern of beef safety; internal: self-efficacy and one's own control)

Storage Behaviors

Cold chain knowledge and subsequent behaviors are important in ensuring the safety of food; Ovca and Jevšnik (2009) have since identified that cold chain maintenance of foods (from purchase to storage) leads to significant decreases in proper food handling practices. Findings of storage behaviors, to refrigerate (for immediate use) and to freezer (for longer term storage) are consistent with this study (Jevšnik et al., 2008). Storage of products that are to be refrigerated on the counter should not exceed four hours as this may increase the risk of bacteria proliferation.

Refrigerator Temperatures

The number of participants that were able to identify their refrigerator temperature (in this study) is similar to that of other studies; however, the number participants who were unaware of their refrigerator temperature was also much higher than previous studies (Jevšnik et al., 2008; Jay et al., 1999; Marklinder et al., 2004; Kennedy et al. 2005). This

difference may result from differences in consumer's interaction and understanding of refrigerator temperatures. Participants were aware of the temperature of their refrigerators by using a type of display, dial, or indicator; however, barring an actual calibrated thermometer in the refrigerator, a dial is not a reliable indicator of the actual temperature. Thus, in this study, participants who did not specify having a thermometer in the refrigerator and only indicated using a dial, gauge, or indicator were considered in the wrong. Other participants expressed that if products were cold, then their refrigerator must be at the proper temperature. For these individuals, perceived behavioral control and attitude was indicated by their foods. Consistent with other findings, not only were most people unaware of the "temperature control of retail units", respondents who tended to be unaware were of higher educational levels. Contrary to Ovca and Jevšnik's study, males in this study were more cognizant of their refrigerator temperature. This may be due to a difference in participants surveyed (Europeans versus Americans). Additionally, over the past years, risk information in the United States has led to significant improvements in food safety behaviors (Patil et al., 2005; Fein et al., 2011).

Storage on the Top Shelf

A comprehensive study by Godwin et al. (2007) was conducted to evaluate temperature within home refrigerators. In this, data loggers showed that temperatures did indeed vary within the refrigerator, with top shelves being significantly cooler than bottom shelves. Even with normal temperature variations, the fluctuation of temperatures within the refrigerator could in the danger zone for >2 hours/day. Even then, the recommendation that consumers need to check their refrigerators regularly.

Best practices and recommendations direct that meat products should be stored on the bottom shelf. Although consumers are aware that storing beef on the bottom shelf or keeping raw meat separated from other foods is safer and a best practice, 60% of participants in this study indicated storing beef on a shelf that wasn't the bottom shelf, a separated drawer, or separated from other foods. By storing beef improperly, consumers increase the risk of cross-contamination by "dripping raw meat juices down onto other foods stored beneath" (McCarthy et al., 2007). Other studies have also found similarly high rates of improper beef and meat storage either on top or middle shelves, which aligns with Godwin's findings of refrigerators being colder on the top and middle shelves (Jay et al., 1999; Marklinder et al.; Ovca & Jevšnik, 2009; Godwin et al., 2007). Consumers state that they are storing their beef in the coldest locations in their refrigerator or are trying to find whatever space is available (given refrigerator size); both of which fall into the internal locus of perceived behavioral control which directly correlates with improper storage.

Since participants are unlikely to change this behavior (and due to what is known about temperature fluctuations in the refrigerator), it may be more advisable to recommend participants who do store products in the refrigerator (either on a non-bottom shelf or non-separated container) to store said meat products in a deeper plastic container (on whichever shelf) that can be pulled out, cleaned, and sanitized. Similarly, within the industry, it could be advisable that refrigerator manufacturers create more separated containers to accommodate separated storage spaces, although this may be difficult to clean, in the long run; or create a separate shelving unit on the top shelves. Although new refrigerators are being made, refrigerators also tend to be heavily priced; as a result, it may be necessary to make adjusted recommendations for those who may not be able to afford a new refrigerator.

Preparation Behaviors

Defrost Behaviors

Contrary to the findings in Jevšnik et al. (2008), survey respondents self-reported properly defrosting beef products in the refrigerator. The risky practice of storing and thawing meat on the counter was slightly lower than other studies; but, still evident (Jay et al., 1999; Marklinder et al.; Ovca & Jevšnik, 2009; Jevšnik et al., 2008). In such, participants who defrosted on the counter, in an empty sink, or “left out” their beef often recognized that “it’s not real safe; but I do it anyway” because defrosting in the refrigerator or sink took too long. Additionally, participants were more inclined to leave food out over four hours or all day because their subjective normality of their personal experiences (both socially and personally), it was considered safe as they had done it in their youth, were “old school”, and whose families also practiced this risky behavior. In Ireland, 40% of surveyed individual felt that the kitchen counter was a safe place to defrost meat; although the majority, as in this study, recognized and did defrost in the refrigerator (McCarthy et al., 2007). Based on perceived control, participants also mentioned that time constraints and forgetfulness prevented them from thawing beef in the refrigerator. Additionally, as they had practiced this risky behavior so many times without becoming ill, there was a perception and positive attitude that they were unlikely to become ill. Thus, defrosting on the counter was a perceived behavioral control in that they could control how quickly something would thaw for use.

The finding of this study based on educational level differed from that within Patil et al. (2005) in which proper defrosting was seen more significantly in those with higher educations. Results may have differed due to lower respondent numbers in this study. On

the other hand, ethnic and racial findings of this study are echoed in other studies. In Parra et al. (2014), focus groups of Mexican-Americans also found that Mexican-Americans would thaw products either in a sink or on the countertop. Individuals who left meat out at room temperature often did so for over two hours. In another recent study, urban Baltimore African-Americans more frequently defrosted on the counter; this is corroborated not only in this study, but also through anecdotal focus group examples in both urban and rural Blacks with Virginia and North Carolina (Steeves et al., 2012). Additionally, focus groups done with African-Americans in urban Chicago normalized thawing practices in cold water and on the counter for extended periods of time. (Dworkin et al., 2015). In those focus groups, participants who were enrolled in governmental assistance programs (e.g. WIC) rarely received food safety information from these organizations. To discuss food safety behaviors, governmental assistance programs may be an important mode of information distribution for vulnerable populations of children and women (pregnant or recently pregnant).

Meat Washing

Soaking and washing meat and poultry is highly discouraged by governmental agencies throughout the world (i.e. USDA-FSIS, Food Safety Information Council, and UK Food Standards Agency) due the ability to spread and aerosolize pathogens (e.g. *Salmonella* or *Campylobacter*). Washing meat is an ineffective method of removing bacteria and constitutes a risky food safety behavior. Despite this, the practice of washing meats and poultry is commonly promoted by resources that consumers may refer to and trust (e.g. cookbooks, popular media, cooking shows, etc.) (Henley, 2013). As females are

still predominantly the primary meal preparers; as such, it is not remiss to reconcile washing behavior with gender. There is a perception that washing meat – like washing hands – will make the meat cleaner and may also provide better texture and flavor. Additionally, the attitude towards cleaning meat, observed in both focus groups and surveys, is that there is a strong perception that the meat is dirty with excess blood and surface contaminants. Indeed, survey participants who indicated a high level of concern about beef safety (as an external locus of control) in which they had no control over, were most likely to wash beef products. Washing meat not only was out of concern for food safety and reducing contaminants; but, as elaborated upon in focus groups, was a subjective norm of something that they'd always done or had learned from their parent. In fact, many participants in the focus groups swore by meat washing as it also allowed them to exert an internal locus control over the situation through self-efficacy. Findings of race-ethnicity meat washing behaviors, including using an extra cleansing agent (lime, salt, and even detergent) in African-American, Hispanic, and Asian/Pacific-Islander populations have also been previously identified through focus group interviews in urban locations. In this study, African-American focus group participants were also more likely to clean meats with an extra cleansing agent like bleach or dishwashing soap with the claim that these agents were used in low enough concentrations to inactivate pathogens but not be harmful if ingested (Henley et al., 2012).

During the focus groups, although the reasons for cross-contamination and not washing meats were explored and evaluated amongst the group, participants – glad to have learned the information – were reluctant to discontinue this risky behavior citing perceived control and personal belief of their own safety and cleanliness and not washing as “the

grossest thing”. The unwillingness to adopt practices once new information is received is common and indicates the need to have more individualized messaging not only for the group; but varied messaging to counteract what is currently available on popular media (Young & Waddell, 2016; Jacob et al., 2010). As shopping behaviors of ethnic-racial backgrounds may vary dramatically and may not be located in populations that Caucasian’s shop at, specified messaging and targeting in target audience’s language is needed (Henley et al., 2012).

While individuals who washed beef products did so for cleanliness and contamination removal, ironically enough, those who did not wash their meats responded in-kind. Non-meat-washing respondents indicated that they had previously learned not to wash meat; in fact, they were worried that doing so would increase contamination. Further research into where and how individuals have received their information to or not to wash meat and poultry products ought to be explored and to identify specific behavioral controls that may enable the design and intervention for behavior change.

Preparation of Beef Products: Thermometer & Preparation

While there are associated foodborne illnesses common in certain racial/ethnic groups due to cultural practices and preparation/handling practices; it is interesting to note that “compared to minority groups, *E. coli O157:H7* infections are more common among Caucasians because of their tendency to eat more raw and undercooked foods” despite them being significantly more likely to own a food thermometer for safety (Byrd-Bredbenner et al., 2013; Patil et al., 2005; Taylor et al., 2012). On the other hand, sociodemographic (race-ethnicity, income, geographical location, and education) factors

are correlated with incidences of foodborne illnesses. An ecological survey analysis found that communities with higher populations of Black/African-Americans and Hispanic/Latino populations had more positive correlations with higher incidences of salmonellosis. Additionally, low SES urban areas may also correlated with higher incidences of gastroenteritis (Chang et al., 2009; Henley, 2013). As seen in this study, the age group and ethnicity of participants who tended to consume raw beef is consistent with previous findings (Patil et al., 2005). Although, a separate study has shown that people are aware and knowledgeable that safe food is not measured by visual appearance and smell, underpreparing beef products – more commonly burgers – may results from the promotion on food cooking shows and other forms of societal pressures that more red color or juices can impart better flavor. (McCarthy et al. 2007).

The USDA encourages and stresses that the only method of ascertaining safe meats is by way of a food thermometer to the proper internal temperature; as such, owning a food thermometer is paramount to food safety (Murray et al., 2017). Despite USDA recommendations and a delayed update of FightBac messaging, visual indicators, including color, are still the most frequently used indicators for doneness (Jacob et al., 2010). Thermometer ownership has been estimated at 70%, with higher ownership seen in African-American and Caucasian consumers, men, individuals with college educations, higher incomes, and >65 y.o. (Lando & Chen, 2012; Henley et al., 2013). Usage in African-American respondents, though, were low (Henley et al., 2013). In a large Canadian survey, over half of participants, like in this study, owned food thermometers; however, there was considerable difficult in using it (Murray et al., 2017). Reported thermometer use also differs depending on what it is used for; for example, thermometers are more frequently

used for roasts than chicken and hamburgers (Lando & Chen, 2012). In this, a barrier to proper behavior is one's perceived behavioral control of not owning, as opposed to attitude and subjective norm; PBC is a direct effector to engaging in behaviors. As an external locus of group, focus group participants have also indicated that it is difficult to buy a food thermometer in that they are price prohibitive (especially for lower-income or rural populations) and often difficult to find in the stores.

Previous studies have shown that not only are men more likely to mishandle food; consumers with higher education levels, are less than 30 y.o. or above 65 y.o. are, too (Byrd-Bredbenner et al., 2013; Byrd-Bedbenner et al., 2007; Patil et al., 2005; Jevšnik et al., 2008; Redmond & Griffith, 2003; Fein et al., 2011; Christensen et al., 2005; Fischer et al, 2006). The decline in food safety of individuals under 50 y.o. has been associated with older individuals not being as affected by media outcry. Cohorts who grew up in a period when recognition of pathogens were frequent, were also more inclined to follow proper food safety behavior. There is strong correlation in cohort differences that individuals between 30 y.o. to 65 y.o. who lived through and were affected by the *Salmonella* outbreaks in eggs, *Listeria* in cheese, *E. coli* outbreaks associated with undercooked beef products of the early 1980's through 1990's which resulted in outbreaks, recalls, deaths, and subsequent risk messages put out by the USDA, Thermy, and FightBac! (Teisl et al., 2016; Fien et al., 2011). These same risk messages (and non-smoking campaigns) were cited as reasons participants of the focus group portion of this study prepared their meat products to well-done. Conversely, although meat was prepared to "well-done", doneness was subjective as participants mainly used color and texture. There is an assumption that if something is thoroughly browned and tough to chew, it must be

thoroughly cooked. Younger age groups have also previously been found to rely more on visual cues; while middle-age participants did use a thermometer (Murray et al., 2017). Within younger generations, optimism bias contributes to the locus of control and self-efficacy in that ‘it can’t happen to me’ and a perception of invincibility (Young & Waddell, 2016). On the other hand, those in the middle age bracket may be more inclined to use a thermometer for safety reasons and from previously learned experiences (not only for themselves, but for their families). In the middle age groups, health changes may arise which can be instrumental in catalyzing consumer’s focus on improving their own food safety behaviors (Young & Waddell, 2016).

Although participants have an agreeable attitude towards the use of thermometers for measuring internal temperature and doneness; the lower frequency of usage is comparable to what other studies have shown. Recent USDA and FDA research finds that only 34% of consumers use thermometers when measuring the doneness of ground beef; a statistic that is similarly supported in other food safety studies (Kosa et al., 2017; Byrd-Bredbenner et al., 2013). Reasons cited in this study for not using a thermometer echoed that of previous studies in that participants described thermometer use as inconvenient, difficult, and confusing due to varied temperatures for different products(although many would look it up online, if needed), one’s personal experiences, and societal norms (Byrd-Bredbenner et al., 2013).

Varied and conflicting risk and health messages have sown a level of distrust in consumers (Young & Waddell, 2016; van Dijk et al., 2012; Morgan et al., 2013; Liu et al., 2014; Jacob et al., 2010; Wilcock et al., 2004; Tonkin et al., 2016) In addition to media messaging (i.e. television, cooking shows) and cookbooks which promote using visual

indicators of doneness, participants who have worked in the food industry and have taken safe food handling classes were taught to use visual cues for doneness due to time constraints of serving food. The nonchalant attitude and promoted subjective norm by trusted and authoritative bodies further complicates the outcome of proper thermometer use.

Although respondents were aware of the recommended safe internal cooking temperatures of beef between 145°F-165°F for beef, as demonstrated they are often still unlikely to engage in the behavior (Young & Waddell, 2016; Mazengia et al., 2015; Nesbitt et al., 2014; Patil et al., 2005; Fein et al., 2011). Although respondents who self-reported owning a thermometer were not more likely to use their thermometer, they tended to have a more positive attitude towards thermometers and safe internal temperatures. There is a perception that the recommended temperatures on Safe Handling Instructions label lead to an extremely overcooked product; on the other hand, others strongly feel that it is necessary to follow such directions in order to obtain the perfectly cooked product. Of those preparing food to 160°F, the numbers were higher than expected; however, this can often be reflected in overreporting behaviors as a perception of appearing to look better – which itself is a limitation of conducting surveys and conducting focus groups.

Perhaps these perception differences to the same recommendations and instructions are more an effect of how people prepare and cook; indeed, Jevšnick et al. (2008) demonstrate that those practicing improper handling behavior were also those that “learned cooking practices by themselves” or from their parents/family. While thermometer use is highly recommended; thermometer ownership is oftentimes lacking in “disadvantaged groups (24.1%) when compared to the general population (66%)” (Fein et al., 2011;

Henley, 2013; Lando, 2006; Trepka et al., 2007). In focus groups, both urban and rural African-Americans anecdotally reported learning to cook for their families when younger as their contribution to the family. The internal locus of perceived behavioral control, when survey-takers were asked about their control over products they prepare was overwhelmingly positive; they felt they indeed had a good deal of control. Similarly, across ethnic/minority populations, other visual and physical indicators are used to judge beef for its doneness; in many minority groups, thermometer usage was not only lowered, but Asians, Hispanics, and African-American groups did not feel that thermometers would be a reliable indicator for doneness (Henley et al., 2013).

Although Hispanic meal preparers were less likely to use food thermometers, previous studies have demonstrated that Hispanic populations have a higher risk perception than Caucasians, understand the underlying risks, want to know more, and would use a thermometer (with meat and in the refrigerator) if provided with one. In this study, they were aware that the proper cooking temperatures for beef to be above 145°F (Fein et al., 2011; Henley, 2013; Lando, 2006; Trepka et al., 2007). A primary reason that Hispanic consumers did not measure temperature was due to their not owning of a food thermometer; additionally, within the Hispanic culture, meat preparation was indicated by color and texture. Rejection of thermometer usage was indicated by societal norm that thermometers are not use “in Mexico” (Parra et al., 2014). Although Hispanic behaviors were not found to be significant, this may have resulted from a smaller population sample size. Additionally, there is a significant difference in levels of risk awareness between Mexican-Americans born in the United States versus those that have immigrated to the U.S. (Parra et al., 2014). Similar findings of lack of understanding in labels has also been observed in

Spanish-speaking Hispanics versus those who could not read English (Marín, 1999; Yang et al., 2000).

While not much can change people's behaviors, Young & Waddell's scoping analysis have shown that individuals "experience a change in health status" are much more willing "to actively seek out food safety information and to modify at least some of their behaviors accordingly" (2016). Consumers who have been exposed to foodborne illness (whether at home or from outside food) do recognize the importance of proper handling of food; however, this is not necessarily reflected in proper food safety behaviors. As such, only 17% of consumers associate foodborne illness with at-home food handling practices; instead, they are more likely to attribute illness from food outside the house (Fein et al., 2011) Such individuals, while not necessarily believing that they may have caused their own illness previously, do discuss an increased distrust in the food system while also using a thermometer because they did not want to have such an experience again. Some focus group participants even mentioned to their non-thermometer scoffing participants that they did not care what others thought (the subjective norm being thermometer use is unnecessary). By using a thermometer, respondents felt they had the most control over the food's outcome.

As findings from both the focus group study and Young & Waddell's (2016) paper suggest, if proper food safety education was taught to children in schools at a younger age, there would more likely be behavior changes at home for parents who paid more attention to their kids. In fact, although lower education levels have been associated with safer handling and higher risk perceptions in some studies other studies demonstrate that those with lower education levels have "lower risk perceptions" (Fien et al., 2011; FMI, 2009).

The latter is similar to findings in this study in which lower education level is also associated with poor food safety behaviors, which could be indicative of not being learned in schools.

While people seem to be mostly aware of safe internal cooking temperatures or recognize where they may be able to find this, behavior change to own and use a thermometer is complicated by many factors including inaccessibility, perceived inconvenience, perceived personal control and self-efficacy in food preparation, and socio-cultural norms. As a result, risk messaging may only be one segment of a multi-prong solution.

CONCLUSION

Food safety behaviors are dictated and developed through attitudes regarding one's feelings towards a specific incidence, the subjective norms dictated by one's socio-cultural factors, and perceived control of what they themselves can control through self-efficacy or cannot control (like the safety of the food system). Not only is what is found in this mixed-method study confirmatory of the theoretical framework; but, it also allows for exploration into specific factors that can guide intervention design.

Awareness and knowledge is not necessarily translatable to incorporation of proper food safety behaviors (Patil et al., 2005; Byrd-Bredbenner, 2009). Ultimately, socio-cultural factors through cultural competency and cultural humility must be accounted for when developing risk messages (Fisher-Borne et al., 2014). Despite the increasing number of authoritative risk messages around food safety behaviors (e.g. FightBac! Be Food Safe, and Thermy) have been shown to increase overall food safety behaviors but are developed for and seen by Caucasian populations. This information is not distilled and recognized by minority populations; thus, interventions for underrepresented populations that acknowledge the power dynamics "between provider and client" while challenging "institutional-level barriers" must be developed (Fisher-Borne et al., 2014; Dworkin et al., 2015; Parra et al., 2005, Yang et al.; 2000, Fein et al., 2011). Concern for food safety is especially apparent in minority populations (Hispanic, African-American, and Asian/Pacific Islander). In Steeve's et al. (2012), urban African-Americans have a high overall concern in food safety; however, practiced variable food safety behaviors. Currently, there are many interventions developed for compromised and vulnerable populations; however, the increasing number of non-English speaking (or non-Caucasian)

people necessitate the need to develop a framework encompassing more culturally and socially relevant interventions. Targeted messaging in various languages not only elicits appropriate responses from targeted populations in geographical locations; but, is necessary to address any concerns these populations may have (Henley et al., 2013; Parra et al., 2014; Marín, 1994; Dworken et al., 2015; Hart et al., 2005; Hartley, 2004).

Currently, there are many types of programs, linguistically-relevant, and culturally-relevant systems used in the health education system (i.e. storytelling, patient discussion and bedside manner, etc.); these systems could be adopted and incorporated into the distribution and discussion of food safety. It could be useful to work together with community organizations working to improve health literacy (especially amongst immigrant populations) to combine health-food safety aspects together (Kreps et al., 2008). On the other hand, as people move more towards health, it could be useful to compound food safety with health behavior messaging; but because of confusion between constantly changing messages, this has the potential of backfiring (Steeve's et al., 2012; Jacob et al., 2010; Young & Waddell, 2016).

The current didactic nature of food safety information does not allow for easy adoption and behavior change. Interventions and messages must: (a) ensure clarity – not only through language, but also using pictograms that can create better associations, especially for those that may not be fluent in the language; (b) “promote public trust” through “credible information sources”, thus ensuring that information is distributed through trusted channels, which are oftentimes different between and within populations; (c) develop balanced messages with both risks-and-benefits to health, life, and everyday context for relatability without causing unnecessary fear; (d) thus leading to more

personalized message systems; (e) address the gaps between scientific knowledge and public sphere of knowledge; (f) be updated and consistent across all distributing bodies (Wilcock et al., 2004; Jacob et al., 2010, van Dijk et al., 2012; Verbeke et al., 2007; Young & Waddell et al., 2017, Byrd-Bredbenner et al., 2013; Kreps et al., 2008; Mitchell et al. 2015; Knox, 2000). As Young & Waddell have shown, consumers are open to knowing more information; however, depending on how it may fit into their perceived behavior control, this may or may not allow them to adopt the behavior due to either intent, perceived control, or past behaviors (Mari et al., 2012).

The authors of this study would like to suggest the necessity of developing alternative strategies that are more easily adapted and incorporated into the current behaviors exhibited by consumers. This requires further research into how populations at increasingly specific levels acquire information (along with what that information may look like).

STUDY LIMITATIONS

Although this study attempted to also explore more into under-represented minority populations; unfortunately, there may have been too few recruited survey participants to make fully valid assumptions. Out of 1,200 participants who began the survey, only 500 were deemed acceptable; even within these, there were issues with response completeness. Finally, due to time constraints, not all focus groups were analyzed

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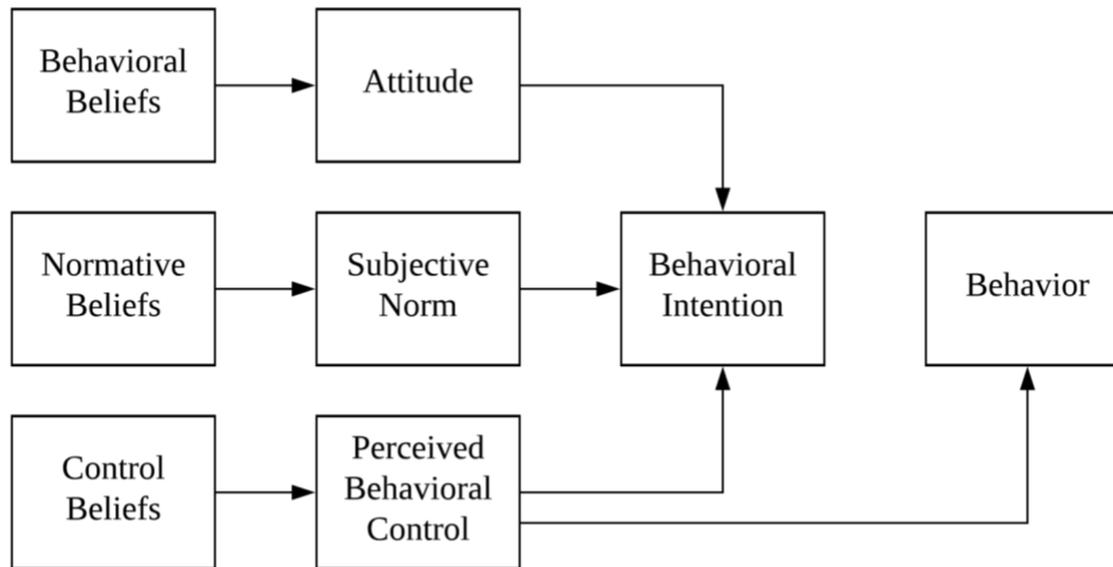


Figure 5. 1: Theory of Planned Behavior

Table 5. 1: Elapsed time of respondents (n=500) putting away groceries from the store

Time Elapsed	#	%¹
<30 minutes	359	71.80
30 minutes – 1 hour	123	24.60
1 hour – 4 hours	16	3.20
>4 hours	2	0.50

¹ # responded / total number of respondents (500)

Table 5. 2: Location where respondents (n=500) store beef products in their home prior to preparation

Storage location	#	%
Freezer	409	81.8 ¹
Refrigerator³	287	57.4 ¹
Bottom shelf	112	39.0 ²
Top shelf	64	22.3 ²
Other shelf (not top/bottom)	31	10.8 ²
Wherever there is space	74	25.8 ²
Designate drawer	52	18.1 ²
Separated from other foods	44	15.3 ²
Counter	9	1.8%

¹ # responded/total number of respondents (500)

² # responding/total number responding that they store beef in refrigerator (287)

³ When respondents selected “refrigerator” they were then prompted to select location within refrigerator, multiple locations could be selected.

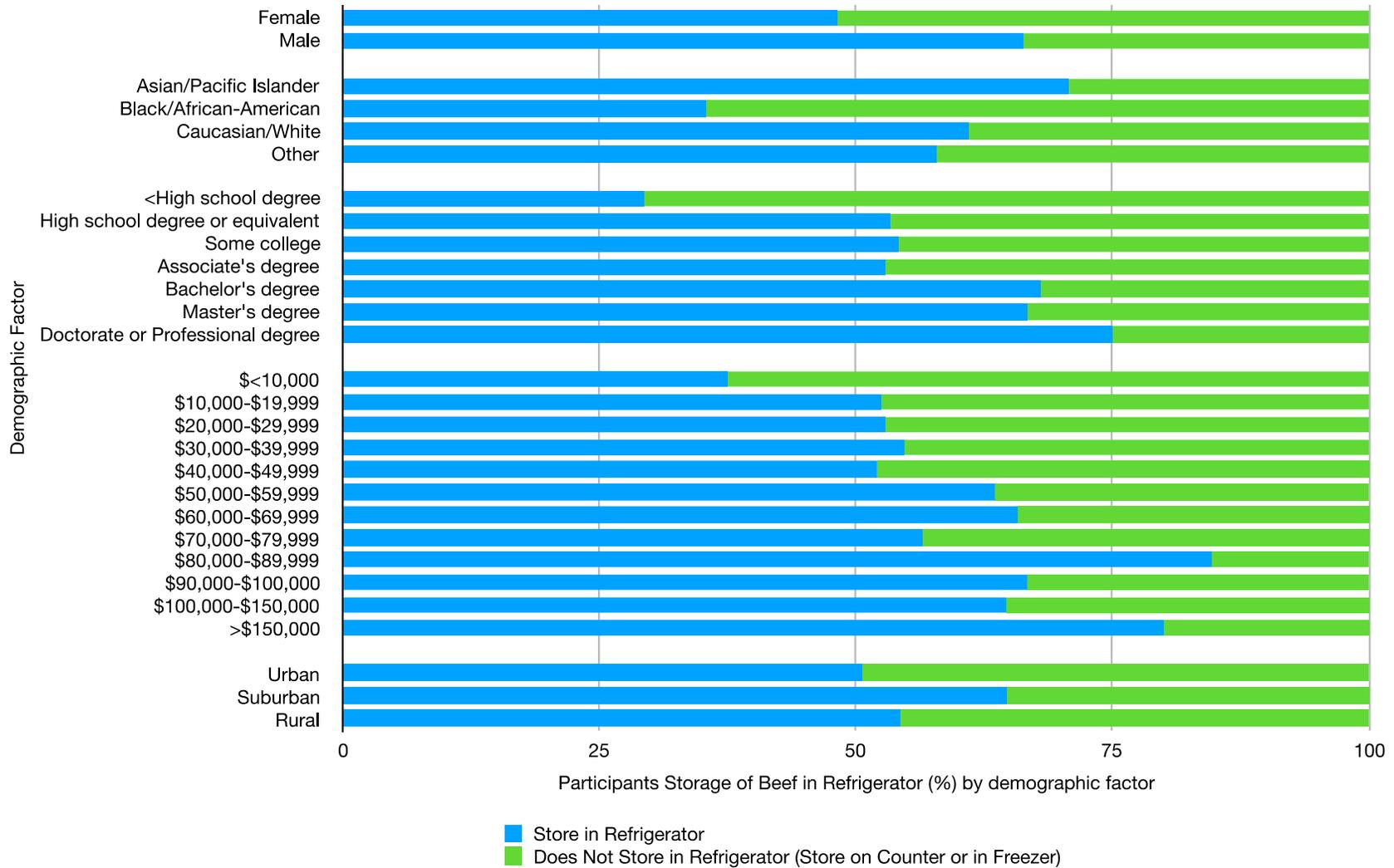


Figure 5. 2: Respondents' (n=500) storage of beef in refrigerator only by demographic factors

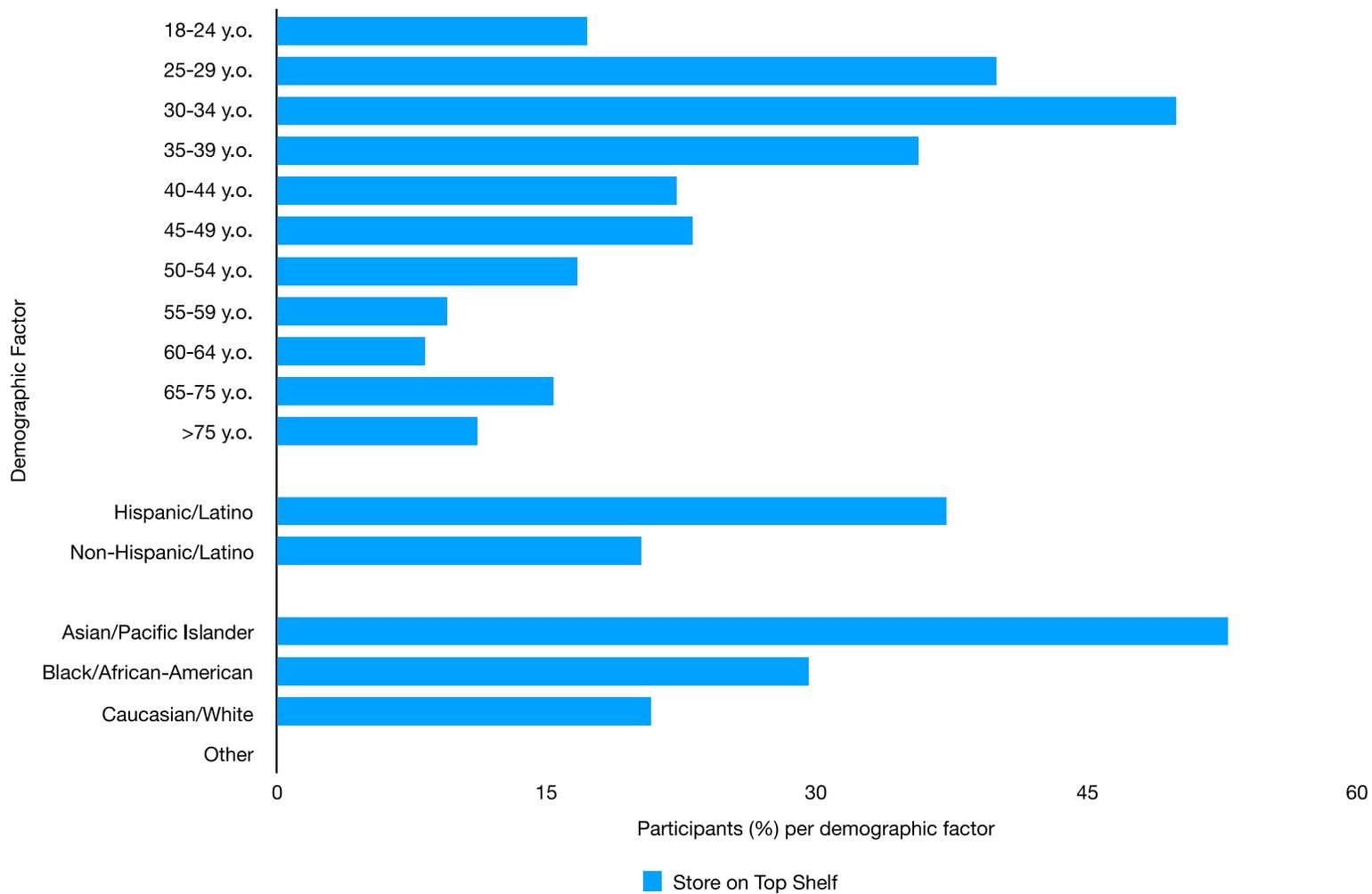


Figure 5. 3: Participant's (n=500) self-reported storage of beef on refrigerator top shelf within each group of demographic factors

Table 5. 3: Participants self-reported (n=500) perceived coldness of refrigerator

	#	%
Correct Temperature (<42F)	172	34.6 ¹
Incorrect Temperature	24	4.8
“Cold”	137	27.6
Unknown	164	33.0

¹ # respondents/total responded (500)

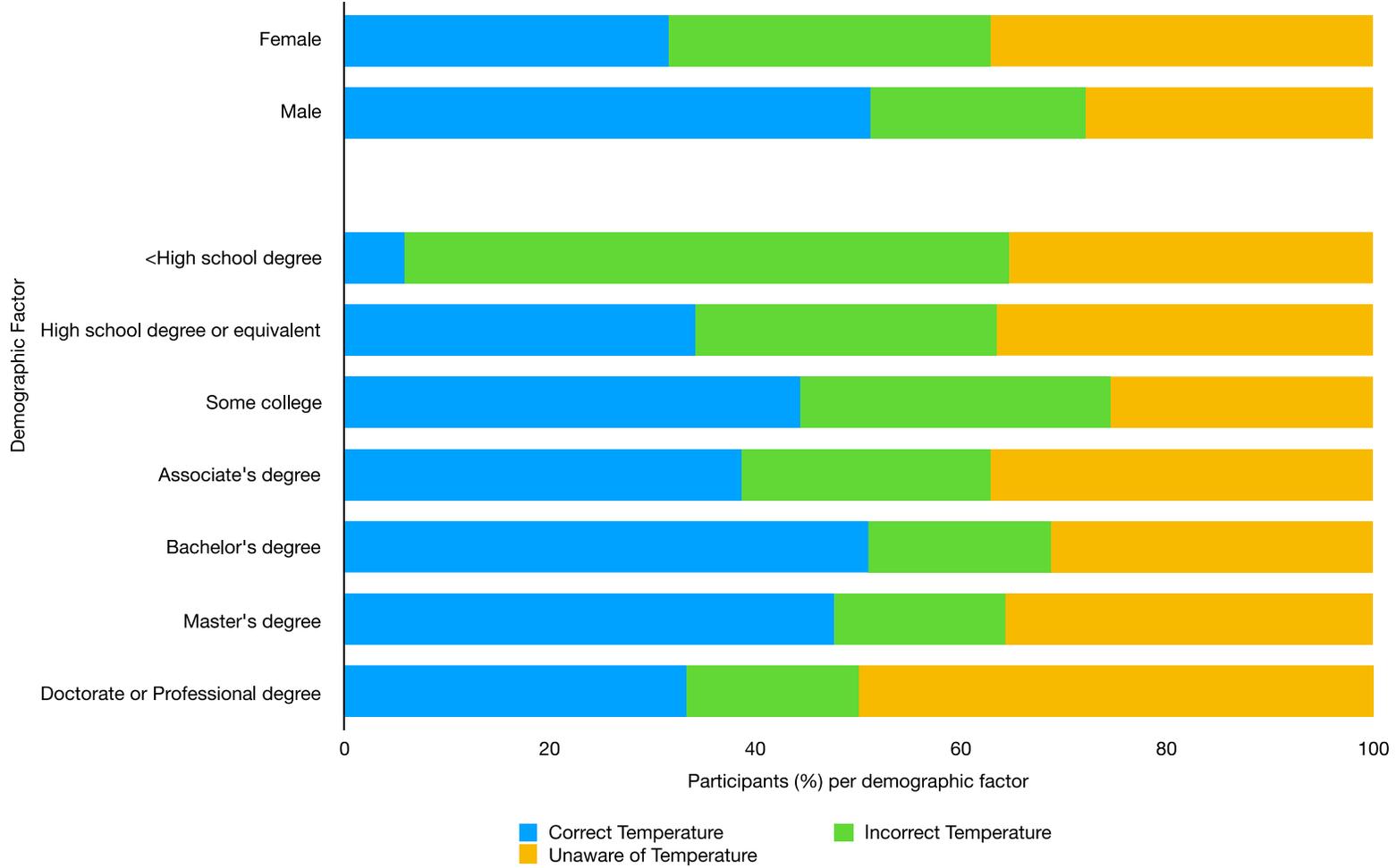


Figure 5. 4: Respondent's (n=500) knowledge of refrigerator temperature based on gender and educational level

Table 5. 4: Participant’s awareness of refrigerator temperature using an indicator by income

Income	Thermometer in Refrigerator ¹		Indicator: Dial, Gauge, or Display ²		Unaware (Feeling, Don’t Know) ³	
	#	%	#	%	#	%
<\$20,000	19	15.4	31	14.9	40	23.7
\$20,000-\$39,999	40	32.5	67	32.2	39	23.1
\$40,000-\$59,999	26	21.1	49	23.6	30	17.8
\$60,000-\$79,999	12	9.8	22	10.6	27	16.0
\$80,000-\$99,999	10	8.1	10	4.8	11	6.5
\$100,000-\$150,000	12	9.8	25	12.0	11	6.5
>\$150,000	4	3.3	4	1.9	12	7.1

¹ Participants having thermometer in refrigerator (n=123)

² Participants having an Indicator (not thermometer) in refrigerator (n=208)

³ Participants unaware / do not have indicator in refrigerator (n=169)

Table 5. 5: Location where respondents (n=500) defrosted beef products in their home prior to preparation

Defrost Location	#	%
Refrigerator	277	55.4 ¹
Counter	191 ³	38.2 ¹
<1 hour	27	15.8 ²
1 hour – 4 hours	62	36.3 ²
>4 hours	31	18.1 ²
Dependent on Product	51	29.8 ²
Water Bath or Sink	171	34.2 ¹
Microwave	69	13.8 ¹
Don't Freeze Product	12	2.4 ¹

¹ # responded / total respondents (500)

² # responded defrost on counter / total respondents who defrost on counter (171)

³ 171 responses with time were captured out of 191

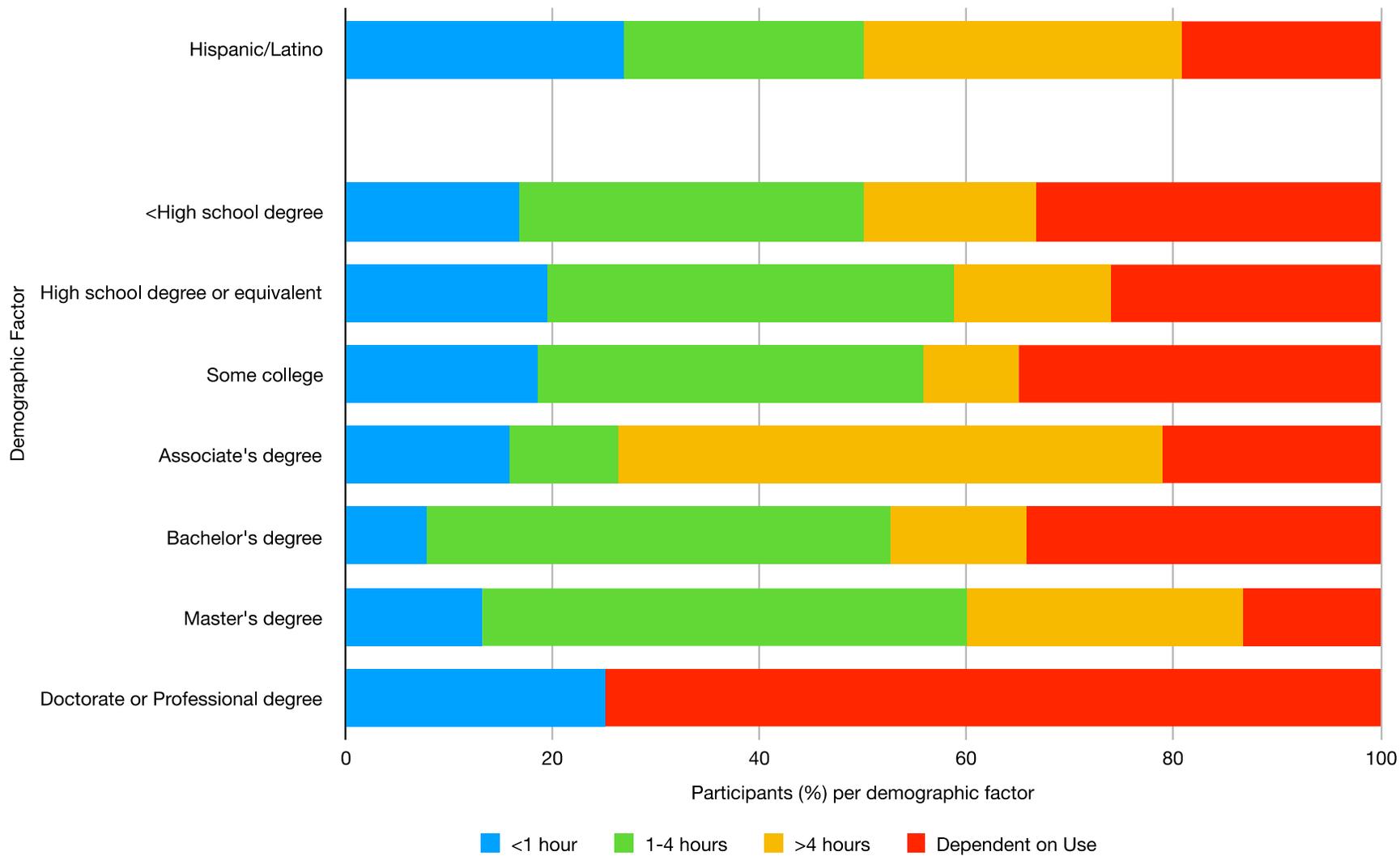


Figure 5. 5: Respondent's self-reported duration of defrosting beef products on counter (n=171) within Hispanic/Latino populations and within educational groups

Table 5. 6: Methods and reasons for washing meats

Meat Washing		#	%
Does Not Wash Meat		277	55.4 ¹
Washes Meat		223	44.6 ¹
Cleaning agent	Water Only	187 ³	92.1 ²
	Water + Cleaning Agent	16 ³	7.9 ²
Reason for washing	Clean Blood	33 ⁴	16.8
	Safety Concerns, Cleanliness	129 ⁴	65.8
	Habit, Previous Experience	34 ⁴	17.3

¹ # responded / total respondents (500)

² # responded defrost on counter / total respondents who washed (203)

³ Only 203 of 223 responses described method of meat washing.

⁴ 196 Respondents described reason for cleaning

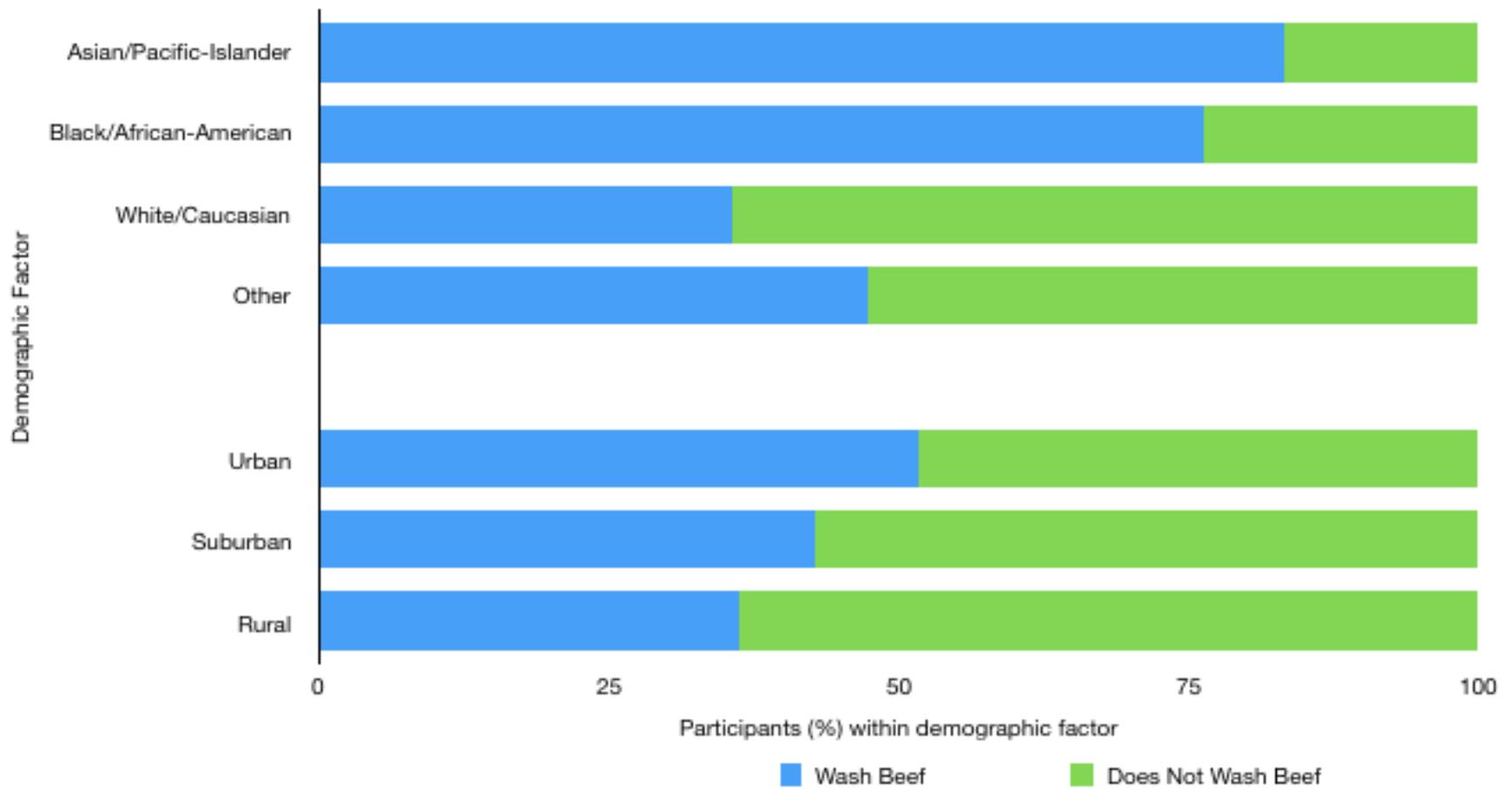


Figure 5. 6: Respondent's self-reported washing of beef products (n=223) within ethnicity/race and by location

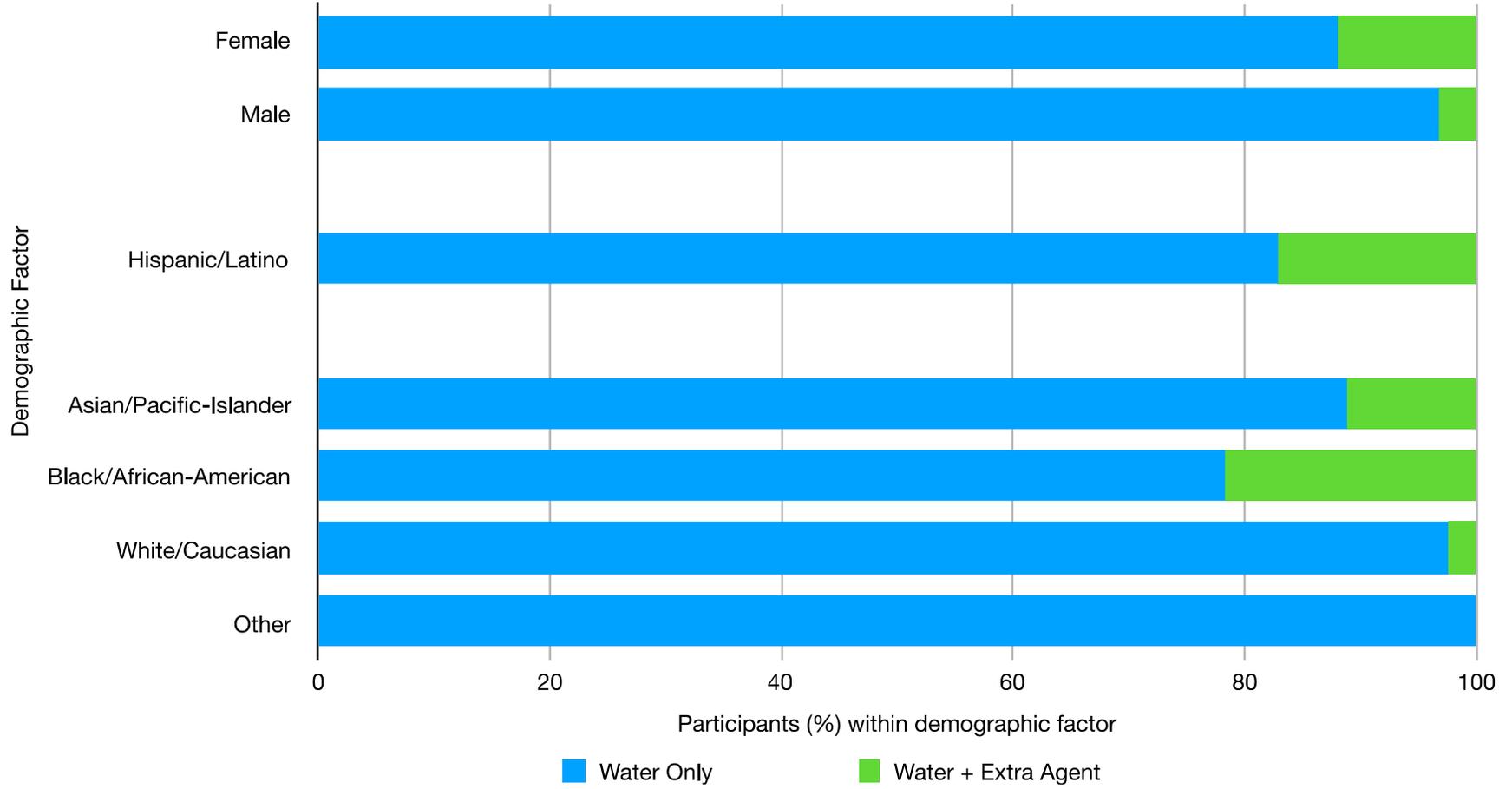


Figure 5. 7: Respondents' methods of washing beef products (n=223) within gender, Hispanic/Latino populations, and ethnicity/race

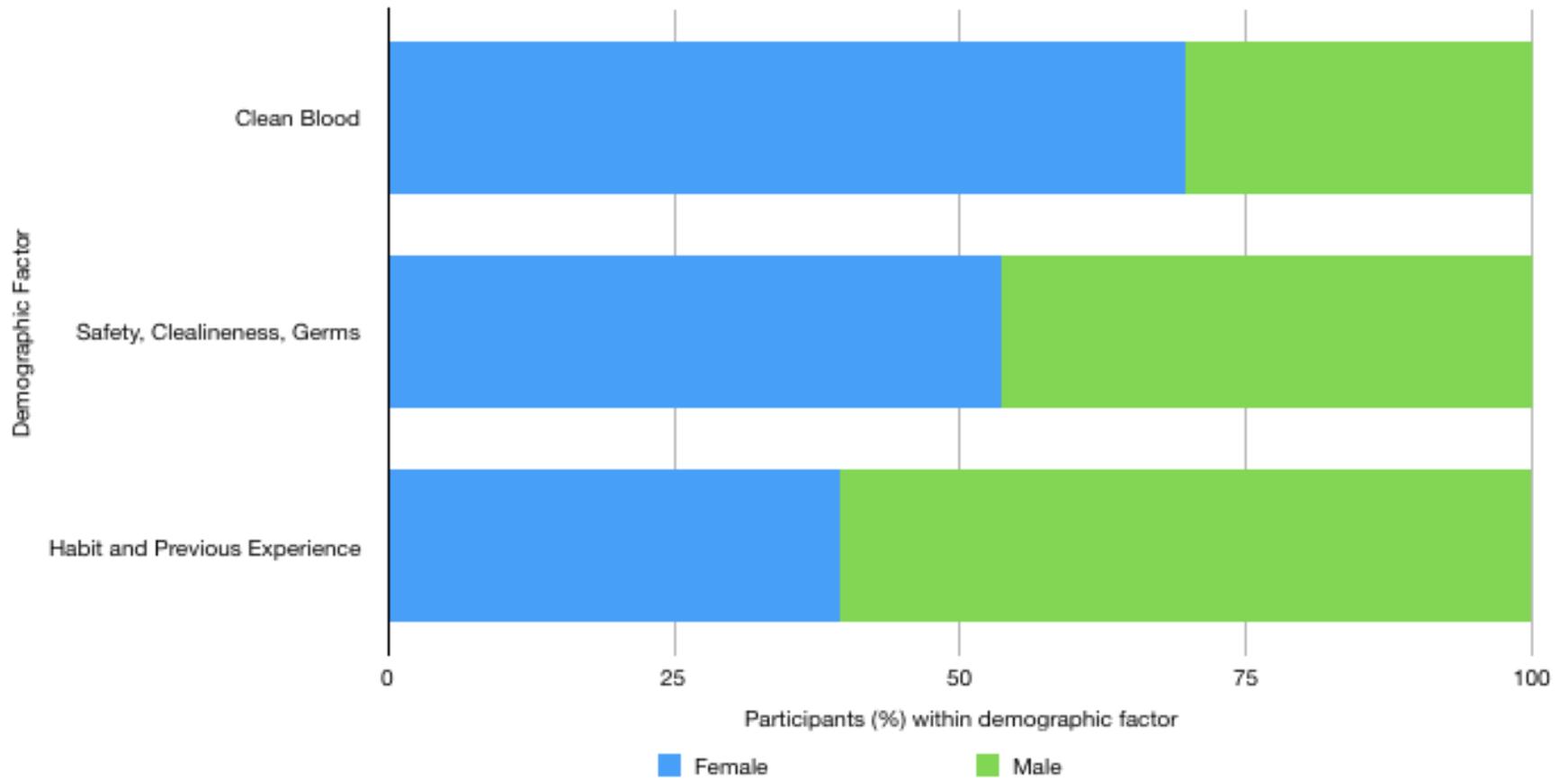


Figure 5. 8: Percentage of respondent's reasons for washing beef products by gender (n=195)

Table 5. 7: Participant's (n=500) self-reported preparation methods of beef products

Preparation Style	n	%
Raw (e.g. steak tartare)	57	11.4
Slow cook (e.g. crock-pot, braise, stew)	320	64.0
Oven, roast	338	67.6
Grill, broil	354	70.8
Barbecue, smoke	254	50.8
Pan fry, pan sear, stir fry, saute	338	67.6
Other	11	2.2

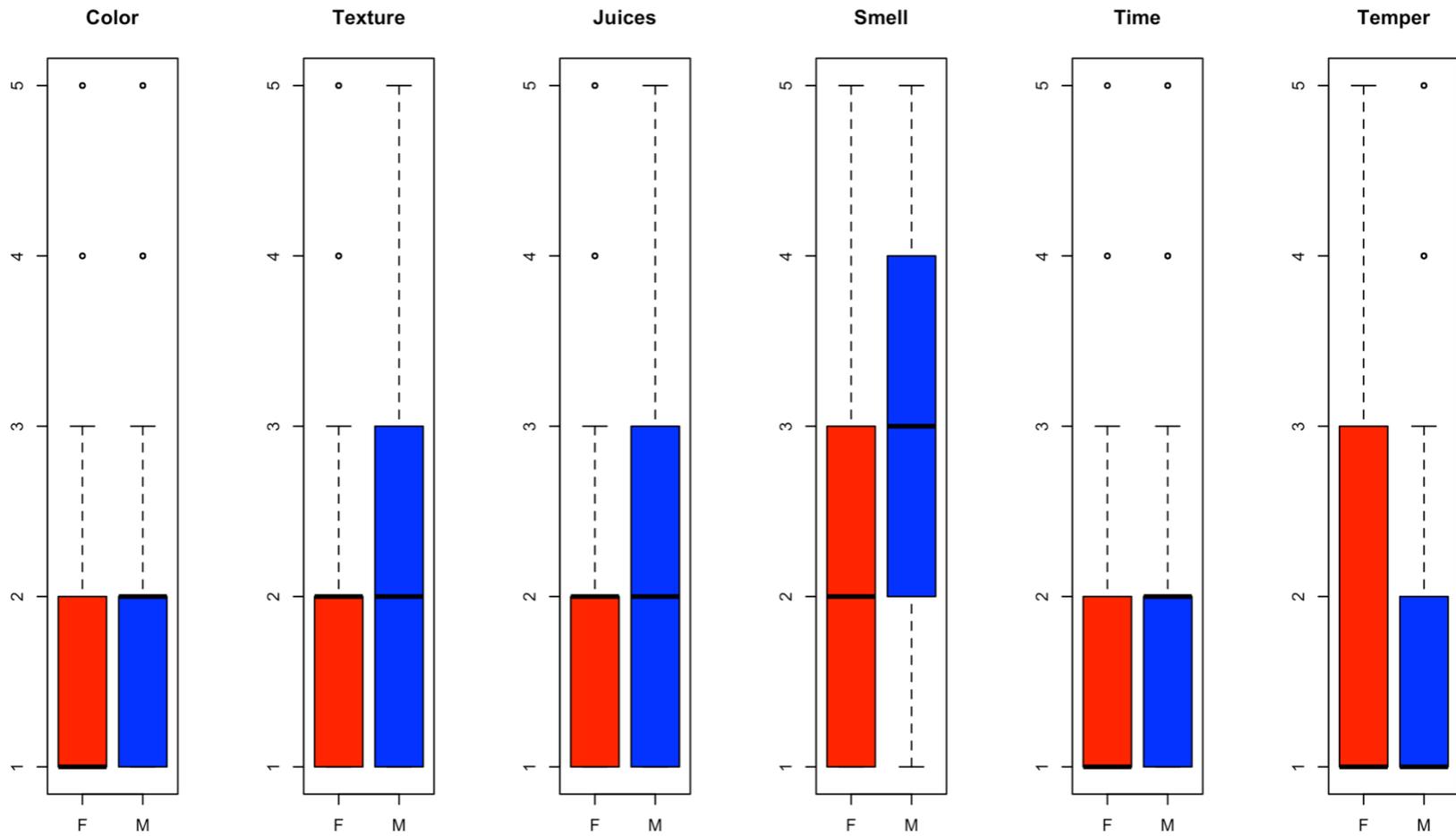


Figure 5. 9: Median attitudes of properties (color, texture, juices, smell, time, and temperature) as indicators of doneness. (1=Agree; 2=Somewhat Agree; 3=Neither Agree nor Disagree; 4=Somewhat Disagree; 5=Disagree)

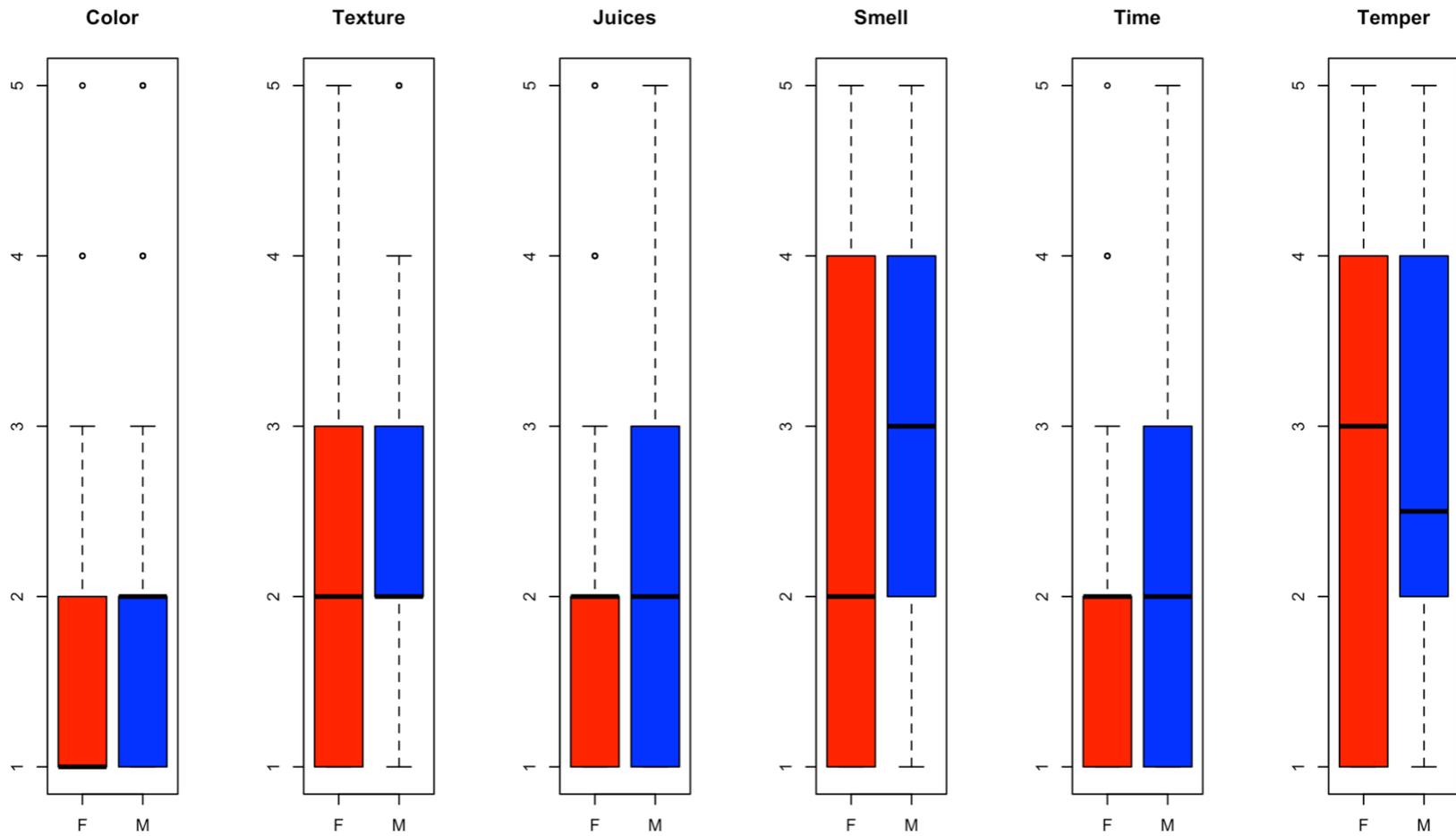


Figure 5. 10: Frequency of behaviors of properties (color, texture, juices, smell, time, and temperature) used as indicators of doneness. (1=Agree; 2=Somewhat Agree; 3=Neither Agree nor Disagree; 4=Somewhat Disagree; 5=Disagree)

Spearman correlation: Behavior vs Attitude

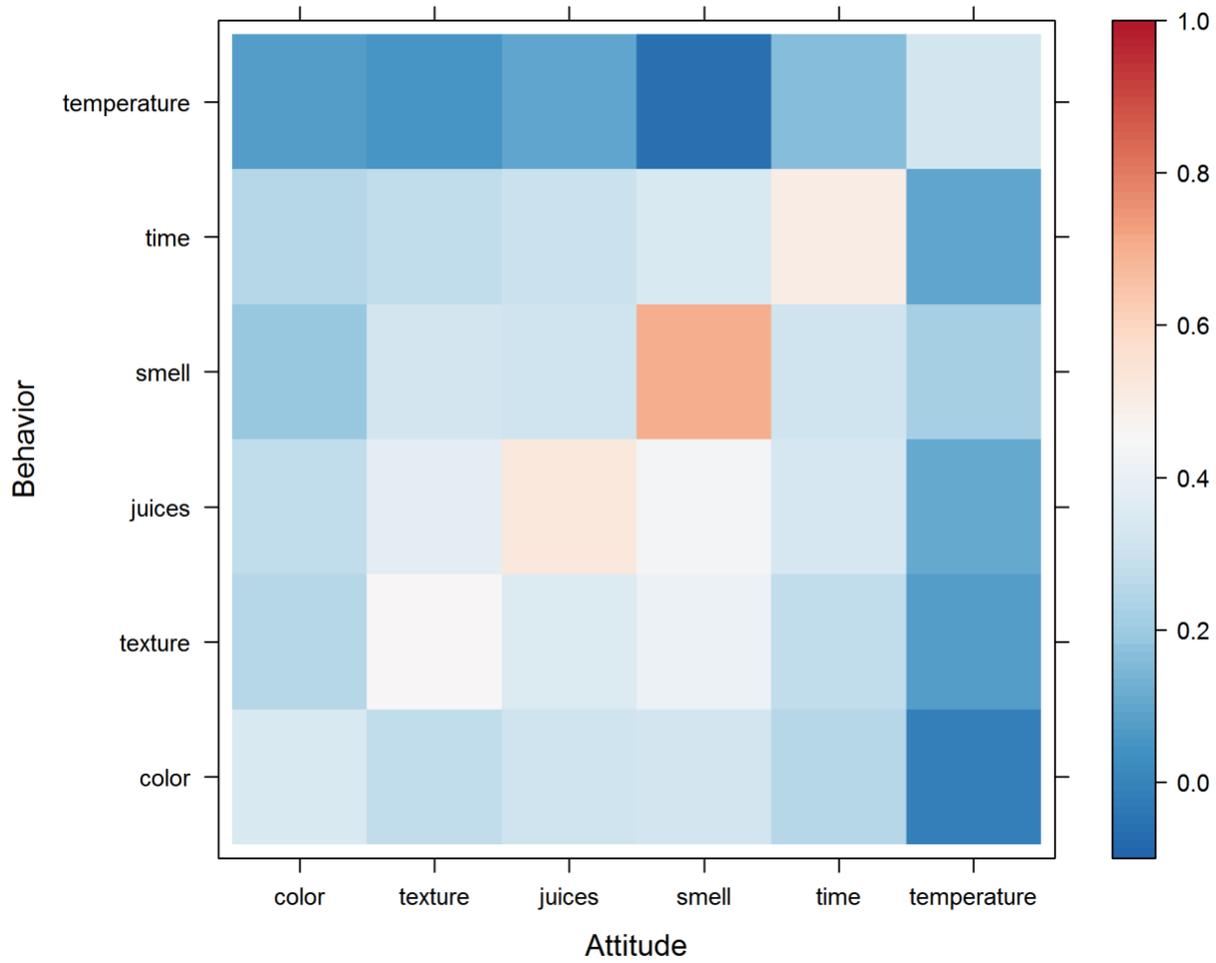


Figure 5. 11: Correlation of Behavior vs Attitude regarding doneness via Spearman correlation coefficient

Table 5. 8: Participants owning of food thermometer

		#	%
Does not own thermometer		190	38.0 ¹
Owns thermometer		310	62.0 ¹
Gender	Females	133	42.9 ²
	Males	177	57.1 ²
Education Level	<High school degree	6	19.4 ²
	High school degree	81	26.1 ²
	Some college	71	22.9 ²
	Associate's degree	48	15.5 ²
	Bachelor's degree	71	22.9 ²
	Master's degree	26	8.4 ²
	PhD or Professional degree	7	2.3 ²
Location	Urban	98	31.6 ²
	Suburban	141	45.5 ²
	Rural	71	22.9 ²

¹# responded / total respondents (500)

²# responded / total respondents who own thermometer (310)

Table 5. 9: Behaviors and attitudes of food thermometer owners (n=310) to use food thermometer in determining internal temperature of beef product

		#	%
Frequency of Thermometer Use			
	Always	103	33.2
	Most of the time	89	28.7
	Sometimes	66	21.3
	Rarely	37	11.9
	Never	15	4.8
Reasons to Not Use			
	Overcook Product	6	1.9
	Depends on Product	19	6.1
	“Just Know”	38	12.3
	Unsure of How to Use	1	0.3
	Physical Appearance	13	4.2
	Inconvenience	20	6.5
	Currently Broken/Can’t Find	13	4.2
Awareness of Safe Internal Temperature			
	Not Aware	80	25.8
	Aware	230	74.2
	Depends on Cut	10	3.2
	<145°F	22	7.1
	145°F – 165°F	104	33.5
	>165°F	31	9.8
	Unsure	25	7.9
Belief of Using Thermometer as Indicator of Doneness			
	Agree	199	64.2

Somewhat Agree	71	22.9
Neither agree nor disagree	27	8.7
Somewhat Disagree	9	2.9
Disagree	4	2.8

**Frequency of Preparing Beef
≥160°F**

Always	101	36.7
Most of the time	101	36.7
Sometimes	43	15.6
Rarely	22	8.0
Never	8	2.9

CHAPTER 6: CONCLUSION

Ultimately, the goal of this study was two-fold: (1) to assess consumer knowledge and awareness of mechanically tenderized beef products [MTBs]; and (2) to assess and define consumer knowledge, awareness, attitudes, and behaviors related to food safety and beef safety with regards various socio-cultural demographics. Using a pragmatic epistemological exploratory sequential mixed-method design, this study explored consumer's knowledge and awareness on a local level (within Virginia and North Carolina), while also surveying nationwide attitudes to develop a larger glimpse at knowledge and behaviors throughout the United States. The additional application of the Theory of Planned Behavior and socio-ecological models to encapsulate the constructs of attitude, subjective norm, and perceived behavioral controls better define and explain the variable behaviors affecting demographic differences.

While mechanical tenderization is prevalent, consumer awareness of this process is low; in fact, even consumers who purchased tenderized beef products did not realize that the product was tenderized. Consumers also frequently enhanced their beef products (through mechanical tenderization or with marinades) at home. Generally, consumers were unaware of the risks associated with MTB, either product they purchased or tenderized themselves at home. Although consumers are aware of the necessity to cook some tenderized products (e.g. cubed beef) more thoroughly than others, the majority still do not cook to the recommended temperatures of 145°F or 160°F; instead, incorrect indicators of doneness like color, smell, and time were commonly utilized. Incorrect behaviors were significant between different ethnicities and within age groups. Within ethnicities, the use of color and smell were more common than the use of or ownership a thermometer. Certain behaviors were more prevalent with certain demographics (ethnicity, gender,

age, socioeconomic status. Consumers realized the importance of using thermometers; yet, thermometers were viewed as inconvenient and unnecessary.

Consumer awareness of the newly implemented “mechanical tenderization” label is just as low; although, this may be due to label implementation only occurring recently (May 2016). Education, income, and age were significant socio-economic demographics affecting label awareness. While participants are able to identify the products that they had seen with the new label, the language in the label itself was deemed confusing and unintelligible. Despite this, consumers definitely did want to know and understand if their beef products were tenderized or not because they wanted to be in control of their purchasing decisions. Half of participants were willing to continue to purchase MTBs because of convenience, price, and the recognition that they must be cautious about preparing it. The other half of participants were unwilling to continue to purchase MTBs because they deemed the tenderization process to be “unsafe” and “risky”.

Similarly, the risky behaviors of consumer food handling and beef handling were assessed. Consumers do improperly and continuously engage in risky behaviors when storing beef products inside the refrigerator. Additionally, consumers were generally unaware of the temperature of the refrigerators; instead, relying heavily on other indicators, instead of a calibrated thermometer. Non-white consumers and lower education consumers were more likely to engage in risky behaviors when defrosting meat like leaving beef products on the counter for >4 hours to defrost. Ethnic consumers were also more likely to engage in washing meat prior to preparation; either using water or water+cleaning agent. Washing meat was a necessity due to perceived dirtiness and filth on beef products. While thermometer use was recognized as being one of the most reliable methods of indicating beef doneness; it was infrequently used. Instead, color, texture, smell, juices/blood, and time were much more frequently used, with color being the most frequently used

method of indicating doneness. In such, white, male, higher-educated consumers were mostly aware of the safe internal preparation temperatures of beef; however, thermometers were not used due, again, to inconvenience and price. Additionally, participants cited personal experience and self-efficacy to know when their beef products were done and ready to eat.

A few limitations of this three-part study can be defined. Firstly, only thirteen of 35 focus groups were analyzed; there is very likely even more information to be gleaned regarding demographic behaviors and breakdowns of food safety, beef handling, and mechanically tenderized beef behaviors within all the focus groups. However, due to time constraints only a portion of the focus groups were included. In addition, it may have been much more representative to have a larger number of survey participants; there was a high predominance of white respondents and much less of other ethnicities/races. As part of this study was to also understand the differences between geographical locations and underrepresented populations, a larger diversity of participants may have yielded more conclusive information. Finally, analysis of relationships were done only with Chi-square goodness-of-fit and association tests. Further along, it may be necessary and possible to determine relationships between factors using a multinomial logistic regression and/or ordinal logistic regression models.

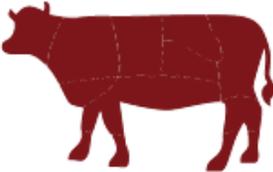
The future of this study is a multi-pronged approach for future dissemination of risk messages. On one hand, it is necessary to further describe the specific extrinsic and intrinsic characteristics of beef purchasing qualities for various socio-cultural demographics. Knowledge of this would enable targeting relevant interventions and messaging at the front-end of purchasing when consumers interact with food purchasing and product. Both risk and benefit messages need to be developed; consumers do not want to be biased with only the risk messages or only the beneficial messages – they want both sets of information. Participants recommended the use of

varied labeling systems in order to convey little-known or varied risk messages. Additionally, consumers also suggested reframing the bigger picture of food safety; instead of focusing on only one aspect of safety (e.g. *Escherichia coli* in beef or *Salmonella* in egg), there needs to be more consistent, systematic, multi-pronged and specific interventions developed. Interventions should also be carried out not just with labels and words; but, also through interaction and within the usages of technology and media. Since different populations have various loci of trust and control, it is necessary to create socio-culturally targeted messaging. Additionally, messages framed around different models (socio-ecological model, transtheoretical framework, health behavior models) can refocus messaging. Message distribution should also be combined with governmental and public services (e.g. Extension and Outreach, WIC, Veteran's Affairs, etc.) and within healthcare practices (e.g. healthcare professional, etc.). Future work and communications regarding food safety and beef safety behaviors should not focus simply on didactic methods of guidance; instead, by incorporating cultural humility and cultural competency, it is necessary to work within various social groups to develop more individualized and alternative interventions and messages that can better accommodate a person's capabilities while providing them with different methods and solutions of approaching a problem.

APPENDIX A

Appendix A1: Recruitment poster for focus group sessions

DO YOU EAT BEEF?



Focus group participants needed!!
Are you...
The primary meal purchaser?
The primary meal preparer?
Do you...
Purchase Beef at this Store?

Share your thoughts with us!

Participants eligible to receive a \$30 gift card.*
This study is affiliated with Virginia Tech.

CONTACT
Lily Yang
beefstudy@gmail.com
(540) 923 - 3577
@BeefStudyNow
for more info

**ARE WE OUT?
CONTACT US ANYWAY!**

Lily Yang
beefstudy@gmail.com
(540) 923 - 3577



Interested and Ready?
Scan QR Here and Sign Up!



TAKE ONE!!!

*Store is not a sponsor of focus group.
Participation will be kept strictly confidential.
Pictures: www.freepik.com

Appendix A2: Attached pull-off tab and flyer for recruitment posters (Appendix IA).

Focus group participants needed for beef study



FOR MORE INFO, CONTACT

Lily Yang

beefstudy@gmail.com

(540) 923 - 3577

or SIGN UP HERE: <https://goo.gl/izrTpK>



VirginiaTech
Invent the Future®

Appendix A3: Semi-structure focus group interview questions on mechanically tenderized beef and safe handling practices.

Focus Group Questions

Pre-Arrival:

Hello everyone. Thanks for coming today; hope you found everything okay. As you are all coming in now, if you wouldn't mind checking in with myself (Lily).

Minh will be able to help you with anything you may need. Please write your name on the large triangle placard in front of you or on the name-tag sticker.

[Once everyone has arrived, is situated, and is seated.]

Opening

Moderator - Hello everyone! Thank you for coming in today for this focus group. I will be your moderator; and [name] will be the co-moderator. We are the ones who have been in contact with you regarding this study. We are both students at Virginia Tech. [Brief Introduction]

Firstly, this focus group can take up to two hours; is anyone unable to stay for the whole time? If you find this to be inconvenient, you may reschedule with us now. [Await focus group participants.]

We will begin with a review of the consent forms that you have in front of you. Please look over the consent form as I read over the document; if you have any questions or concerns, please do not hesitate to ask. We will collect the consent forms and hand out a second copy for you to keep. [Review consent forms.]

Thank you. Please remember, you may withdraw from this study at any time. As mentioned, we will be audio recording this session, today. [Pass the audio recorder around so everyone can have a chance to look at it.]

I'll be asking questions, and [name] will be taking notes on the side. At the end of the focus group, s/he will review what has been said to make sure that we've understood everything that you've said. Also, some of the things that we will be talking about today may be new to you; please let us know if they are. There are no right or wrong answers. We are hoping to start a discussion with you. We are conducting this research to be able to find out more about how you interact with beef products in the store. Our hope is to take the responses from our discussion today to create more effective beef safety messages.

At any time during this focus group, feel free to get up and grab snacks or freshen up.

Participants will be asked the following questions*:

*Note: Questions may be slightly modified depending on participant response.

Basics of Beef Purchase

- I. As a way of introducing yourselves, could you please state your name, how often you purchase beef of any type from the grocery store, and what your favorite cut of beef to purchase and to eat is?
- II. What type of beef do you usually purchase?
- III. What do you look for when choosing beef products?
 - A. *Price? Specific cuts? Are you choosing it for a recipe?*
 - B. *Brand? Color? Fat Content?*
 - C. *Sell By” or “Use By” Date? Country of Origin? Label?*
- IV. How does the labeling on the packages of beef products influence your purchasing decision?
 - A. *Do you look at the labels specifically?*
 - B. *If so, what are you looking for: [For the cut? For the brand?] Country of Origin?*
 - C. *Do you only look at the meat?*
 - D. *Have you ever seen safety instructions (for cooking and handling) on the package?*

Beef Preparation

- V. How do you store your beef? [pause]
 - A. *How soon after you buy beef do you put the beef you’ve purchased into the fridge or freezer?*
 - B. *Where do you store your beef?*
- VI. What temperature do you store your beef at?
 - A. *Do you have a refrigerator thermometer? How do you know?*
- VII. Do you wash your beef products prior to cooking?
- VIII. How do you prepare [Predominantly Discuss Beef Type]?
 - A. *[Beef Type] -- Ground beef? Steaks? Cubed steak? (cubed beef could be confused with beef cubes for stewing*
 - B. *If Frozen? How do you thaw? Transfer to freezer from fridge handling?*
 - C. *Refrigeration?*
- IX. How do you know if [beef type predominantly discussed] is safe to eat?
 - A. *Visually? Temperature? How thoroughly is X cooked?*
 - B. *[beef type predominantly discussed] → GB. Then discuss other types.*

Tenderized Beefs

Moderator – Thank you for all the input you’ve provided us so far. Right now, we’d like to show you a picture of a label. [Pass around “Costco” label – without name – to participants].

- X. Looking at this label, what can you tell us about the product?
- XI. How do you feel about the label or label description?

Processors, food services, and retailers will sometimes process whole cuts of meats to improve the tenderness, quality, and flavor. Sometimes, the tenderization process is mechanical – as in, they may use blades or needles to tenderize meat – other times it is marinated, or a combination of both. Marinades for meat may not always be used for tenderization; sometimes marinades are used only for flavor enhancement.

- XII. Have you ever heard of tenderized meat or beef products?
 - A. *What is your personal experience with tenderized meats or beefs?*
 - B. *Do you – and how do you – tenderize your own meat?*
- XIII. How do you feel when you hear the term: “mechanically-tenderized beef”?
 - A. *Is this new information, to you?*

Moderator - One common type of meat tenderization is mechanical tenderization using needles or blades to break-down and penetrate the muscle fibers. Tenderization can also occur when marinade or tenderizing solution is injected into the muscle fibers.

Tenderized beef is not always obvious; it can look and feel very similar to whole cuts of beef and steaks.

Because of the potential for pathogens to be on the surface of meat, it is important to cook ground beef to 160F, and steaks or chops to 145F. With tenderized beef, on the other hand, there is a potential for bacteria to be transferred from the surface to the center of the meat by increasing the internal surface area of the meat that is exposed; thereby, increasing risk to consumers. If beef is tenderized, it should *also* be cooked to 145F (63C) and flipped “at least twice during cooking”.

- XIV. Are you aware of having purchased tenderized beef products, before?
- XV. What is your experience with purchasing cube steak?
 - A. *How do you prepare it?*
- XVI. What are your experiences with pre-marinated or enhanced beef?
 - A. *Do you make your own marinade? Do you buy pre-marinated meats?*
 - B. *What influences your decision to choose the pre-marinated meats?*
 - C. *How do you prepare it?*

Moderator - Thermometer use is recommended to ensure that you are cooking beef to the correct temperature. Improperly handling or cooking of any beef products (tenderized or not) can lead to

Appendix

foodborne illness - like *E. coli* or *Salmonella* illnesses. This can happen if beef is not cooked to safe temperatures.

- XVII. Knowing all this, what are your thoughts on mechanically tenderized (blade/needle tenderized) products?
- A. *Would you continue to purchase them? Does this affect your decision when choosing meat?*
- XVIII. Knowing all this, what are your thoughts on marinade-tenderized products?
- Would you continue to purchase them? Does this affect your decision when choosing meat?*
- XIX. How would you want the store or the manufacturer to make you aware that you are purchasing tenderized beef?
- A. *How would you like this information conveyed?*
- B. *Like signs, bigger labels, commercials, or pamphlets could supermarkets, producers, etc. engage in to influence your behavior?*
- C. *Who do you trust to give you information on food safety?*
- D. *What are other ways that you receive information?*
- XX. Will what we've talked about today affect how you will prepare tenderized beef in the future?
- A. *How? In What Ways?*
- B. *Would you want to know if your product was tenderized?*

Mod - There is currently a rule mandating the labeling of all tenderized beef in the United States by next May 2016. If you want to know more about this, please let us know and we will be happy to provide you with further information when we've developed them. We also encourage you to check out the USDA (United States Department of Agriculture) website.

- XXI. In light of everything that we've discussed regarding beef products, is there anything that you want to add or comment on that we may have missed?

Please feel free to ask us any questions at any time regarding this. Right now, [name] will quickly summarize everything that we've discussed here today to make sure we got everything right.

Co-Mod- [Provide summary]

Thank you so much for your time and participation in this. We really appreciate all that you've done to help us out! We are happy to provide you with further information regarding anything we've discussed today; please let us know. Please fill out the demographic form before you leave and hand it to us in exchange for your gift card.

APPENDIX B

Appendix B1: Demographic Questions

Q7.1 To which gender do you most identify with?

- Female (1)
 - Male (2)
 - Transgender female (3)
 - Transgender male (4)
 - Gender variant / Non-conforming (5)
 - Not listed (please specify if desired): (6)
-

- Prefer not to answer (7)

Q7.2 What is your age?

- 18 - 24 (1)
- 25 - 29 (2)
- 30 - 34 (3)
- 35 - 39 (4)
- 40 - 44 (5)
- 45 - 49 (6)
- 50 - 54 (7)
- 55 - 59 (8)
- 60 - 64 (9)

Appendix

- o 65 - 74 (10)
- o 75 - 84 (11)
- o 85 or older (12)

Q7.3 Are you of Hispanic, Latino, or Spanish ethnicity?

- o Yes (1)
- o No (2)

Q7.4 How would you describe yourself? (Please select all that apply.)

- American Indian or Alaska Native (1)
- Asian and/or Pacific Islander (2)
- Black or African-American (3)
- White (4)
- Other (please specify): (5)

Q7.5 What is the highest degree or level of school you have completed? (If you are currently enrolled in school, please indicate the highest degree you have received).

- o Less than high school (1)
- o High school graduate or equivalent (e.g.: GED) (2)
- o Some college (3)
- o Associate degree / 2 year degree (e.g.: AA, AS) (4)
- o Bachelor's degree / 4 year degree (e.g.: BA, BS) (5)
- o Master's degree (e.g.: MA, MS, Med) (6)

Appendix

- o Professional degree (e.g.: MD, DDS, DVM) (7)
- o Doctorate (e.g.: PhD, EdD, NP) (8)

Q7.6 What is your marital status?

- o Single / Never Married (1)
- o Married (or in a domestic partnership) (2)
- o Widowed (3)
- o Divorced (4)
- o Separated (5)
- o Prefer not to answer (6)

Q7.7 What is your total highest household income?

- o Less than \$10,000 (1)
- o \$10,000 - \$19,999 (2)
- o \$20,000 - \$29,999 (3)
- o \$30,000 - \$39,999 (4)
- o \$40,000 - \$49,999 (5)
- o \$50,000 - \$59,999 (6)
- o \$60,000 - \$69,999 (7)
- o \$70,000 - \$79,999 (8)
- o \$80,000 - \$89,999 (9)
- o \$90,000 - \$99,999 (10)
- o \$100,000 - \$149,999 (11)

Appendix

- More than \$150,000 (12)

Q7.8 What city do you live in?

Q7.9 What state do you live in?

Q7.10 Which of the following describes the area in which you live?

- Urban (1)
- Suburban (2)
- Rural (3)

Q7.11 Are you currently enrolled in a government assistance program for food?

- Yes (1)
- No (2)
- Prefer not to answer (3)

Display This Question:

If Q7.11 = Yes

Q7.12 Which governmental assistance programs for food are you enrolled in? (Please select all that apply.)

- Supplemental Nutrition Assistance Program (SNAP) (1)

Appendix

- School Lunch Program (2)
- Women, Infant, Children (WIC) (3)
- Expanded Food and Nutrition Education Program (EFNEP) (4)
- Other (please specify): (5) _____
- Prefer Not to Answer (6)

Q7.13 Have you ever received food safety training (e.g.: Servsafe, Safe Plates, etc.)?

- Yes (please specify type of training): (1)

- No (2)

Q7.14 Do you currently work in or have you ever worked in food service / food industry / retail establishments?

- Currently employed in (1)
- Have previously been employed in (2)
- Have NEVER been employed in (3)

Display This Question:

If Q7.14 = Currently employed in

Or Q7.14 = Have previously been employed in

Q7.15 Have you ever received food safety training when working in food service / food industry / retail establishments?

Appendix

- Yes (please specify type of training): (1)

- No (2)

Appendix B2: Demographic characteristics of survey participants in a study of consumer beliefs, knowledge, attitudes, and behaviors regarding mechanically tenderized beef products and enhanced beef products.

		Survey	
		(n = 500)	
		No.	% ^a
Age			
	18 - 24	65	13
	25 - 29	47	9
	30 - 34	41	8
	35 - 39	50	10
	40 - 44	32	6
	45 - 49	44	9
	50 - 54	45	9
	55 - 59	43	9
	60 - 64	39	8
	65 - 74	82	16
	>75 – 84	12	2
Gender			
	Female	253	51
	Male	244	49
	Other	3	<1
Hispanic, Latino, or Spanish Ethnicity			
	Hispanic/Latino	89	18
	Non-Hispanic/Latino	411	82
Race/Ethnicity (mark all)^b			
	Asian / Pacific Islander	27	5
	Black or African American	78	15
	White / Caucasian	385	76
	Other (i.e. Mixed, American-Indian/Alaska Native, Other)	16	3

Appendix

Total Household Income

<\$10,000	48	10
\$10,000-\$19,999	42	8
\$20,000-\$29,999	70	14
\$30,000-\$39,999	75	15
\$40,000-\$49,999	50	10
\$50,000-\$59,999	55	11
\$60,000-\$69,999	38	7
\$70,000-\$79,999	23	5
\$80,000-\$89,999	13	3
\$90,000-\$99,999	18	4
\$100,000-\$149,999	48	10
>\$150,000	20	4

Education Level

Less than high school	17	3
High School Graduate or High School Equivalent	120	24
Some College	133	27
Associate's degree	70	14
Bachelor's degree	106	21
Master's degree	42	8.4
Doctoral degree	2	<1
Professional degree	10	2

Location (Self- Identified)

Urban	180	36
Suburban	215	43
Rural	105	21

Appendix B3: Survey Questions related to enhanced beef products and MTBs.

Q3.5 In the last year, what types of beef products have you purchased? (Please select all that apply.)

- Steaks (e.g.: ribeye steak, sirloin steak, top round steak porterhouse, t-bones, etc.) (1)
- Roasts (e.g.: brisket, pot roasts, tenderloin roast, chuck roast, bottom round, ribeye roast, shank, etc.) (2)
- Beef ribs (3)
- Beef for stew (4)
- Ground beef (e.g.: ground beef sausage, hamburger patties, etc.) (5)
- Cubed beef (i.e.: country-fried steaks) (6)
- Mechanically tenderized beef products (7)
- Marinated beef products (8)
- Offal (e.g.: liver, tongue, tripe) (9)

Q3.16 Are you aware of the Safe Handling Instructions label?

- Yes (1)
- No (2)
- Maybe (3)

Skip To: Q3.20 If Q3.16 = No

Display This Question:

If Q3.16 = Yes

Q3.17 Where have you seen the Safe Handling Instructions label?

Display This Question:

If Q3.16 = Maybe

Q3.18 Where might you have seen the Safe Handling Instructions label?

Display This Question:

If Q3.16 = Yes

Or Q3.16 = Maybe

Q3.19 What are the elements of the Safe Handling Instructions label ?

Q3.20 When purchasing beef products, are you aware of the Mechanically Tenderized or Needle Tenderized or Blade Tenderized label?

- Yes (1)
- No (2)
- Maybe (3)

Skip To: Q3.24 If Q3.20 = No

Display This Question:

If Q3.20 = Yes

Appendix

Q3.21 On what beef products have you seen the Mechanically Tenderized or Needle Tenderized or Blade Tenderized label?

Display This Question:

If Q3.20 = Maybe

Q3.22 On what beef products might you have seen the Mechanically Tenderized or Needle Tenderized or Blade Tenderized label?

Display This Question:

If Q3.20 = Maybe

Or Q3.20 = Yes

Q3.23 What are the elements of the Mechanically Tenderized or Needle Tenderized or Blade Tenderized label?

Q3.24 How do you feel about Mechanically Tenderized or Needle Tenderized or Blade Tenderized beef products? (If you are unaware of these types of products, please type: Unaware.)

Q5.5 Please tell us how you prepare your beef products prior to cooking? (Please select all that apply.)

Appendix

- I wash my beef products. (1)
- I tenderize my beef products. (2)
- I marinate my beef products. (3)
- None of the above. (4)

Display This Question:

If Q5.5 = I tenderize my beef products.

Q5.8 I tenderize my beef products (please select all that apply):

- Mechanically with a mallet, cuber, hand-held tenderizer, and/or fork/knife. (1)
- With a tenderizer or meat softener (e.g.: salt, papain enzyme, bromelain enzyme) (2)
- With a marinade. (3)
- By cooking for a long time (4)
- Other (please specify): (5) _____

Display This Question:

If Q5.5 = I marinate my beef products.

Q5.9 I marinate my beef products (please select all that apply):

- For flavor. (1)
- To tenderize the beef. (2)
- Other (please specify): (3) _____

Q5.22 If you prepare cubed steak or tenderized beef products, how do you know when your cubed steak or tenderized beef products are done? (Please select all that apply.)

Appendix

- Look at the outside and/or inside color of the beef product. (1)
- Refer to the texture and/or firmness of the beef product. (2)
- Look at the juices and/or blood of the beef product. (3)
- By the smell of the beef product. (4)
- The amount of time beef product has been cooking. (5)
- Use of thermometer to check internal temperature. (6)
- I DO NOT prepare cubed steak or tenderized beef products. (7)

Skip To: Q5.24 If Q5.22 = I DO NOT prepare cubed steak or tenderized beef products.

Q5.23 If you prepare cubed steak (i.e.: country fried steak) or tenderized beef products (either purchased or self-tenderized), how often do you cook these products to 160 degrees F (71C) or higher?

- Always (1)
- Most of the time (2)
- About half the time / Sometimes (3)
- Sometimes (4)
- Never (5)
- It depends (please specify why): (6)

-
- This question does not apply to me. (7)

APPENDIX C

Q4.1 When in the shopping process do you pick up beef product(s)?

- I go to the meat/beef section first and it'll be one of the first things I shop for. (1)
- The meat/beef section will be somewhere in the middle of my shopping process. (2)
- I will pick up meat/beef towards the end of my shopping process before I check out. (3)

Q4.2 How do you put your beef product(s) in the shopping cart?

- I put it in the cart in its original packaging. (1)
- I will put the packaging in another bag before putting it into my cart. (2)
- Depends on the product, I may do both. (3)

Q4.3 How often do you use a cooler bag (or separate bag) to transport cold groceries?

- Every time (1)
- Frequently (2)
- Once in awhile, rarely, and/or when I remember (3)
- Only in the summer (4)
- Never (5)

Q4.4 How long does it usually take you to put away your groceries after purchasing them?

- Less than 30 minutes (1)
- 30 minutes - 1 hour (2)
- 1 hour - 4 hours (3)
- More than 4 hours (4)

Q4.5 Where do you usually store your beef? (Please select all that apply.)

- In the refrigerator (1)
- In the freezer (2)
- On the counter (3)

Display This Question:

If Q4.5 = In the refrigerator

Q4.6 Where in the refrigerator do you store your beef? (Please select all that apply.)

- Bottom shelf (1)
- Top shelf (2)
- Other shelf that is not the top nor bottom shelves. (6)
- Wherever there is space/room (3)
- In a designated drawer (4)
- Separately from other foods (5)

Q4.7 How cold is your refrigerator?

Appendix

Q4.8 What temperature is your refrigerator set to?

Q4.9 How do you know what temperature (or how cold) your refrigerator is set to?

Q5.1 If you defrost your beef product(s), where do you defrost it? (Please select all that apply.)

- In the refrigerator (1)
- On the counter (2)
- Water bath or sink (3)
- Microwave (4)
- I don't freeze my beef products (5)

Skip To: Q5.5 If Q5.1 = I don't freeze my beef products

Display This Question:

If Q5.1 = In the refrigerator

Q5.2 How do you defrost your beef product in the refrigerator?

Display This Question:

If Q5.1 = On the counter

Q5.3 How long do you defrost your beef product on the counter?

Display This Question:

If Q5.1 = Water bath or sink

Q5.4 How do you defrost your beef product in the water bath or sink?

Q5.5 Please tell us how you prepare your beef products prior to cooking? (Please select all that apply.)

- I wash my beef products. (1)
- I tenderize my beef products. (2)
- I marinate my beef products. (3)
- None of the above. (4)

Skip To: Q5.10 If Q5.5 = None of the above.

Display This Question:

If Q5.5 = I wash my beef products.

Q5.6 How do you wash your beef products?

Display This Question:

If Q5.5 = I wash my beef products.

Q5.7 Why do you wash your beef products?

Q5.10 Please tell us how you prepare your beef products? (Please select all that apply.)

- Raw (e.g.: steak tartare) (1)
- Slow cook (e.g.: crock-pot, braise, stew) (2)
- Oven, Roast (3)
- Grill, Broil (4)
- Barbecue, Smoke (5)
- Pan fry, pan sear, stir fry, saute (6)
- Other (please specify): (7) _____

Q5.11 How often do you use the following techniques to determine if your beef products are **done** and **ready-to-eat**?

	Always (1)	Most of the time (2)	About half the time & Sometimes (3)	Rarely (4)	Never (5)
Look at the outside and/or inside color of the beef product (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Refer to the texture and/or firmness of the beef product (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Look at the juices and/or blood of the beef product (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
By the smell of the beef product (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The amount of time beef product has been cooking (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Appendix

Measure the
internal
temperature
of the beef
product with
a food
thermometer
(6)



Display This Question:

If Q5.11 = Measure the internal temperature of the beef product with a food thermometer
[Never]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [Rarely]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [About half the time & Sometimes]

Q5.12 Why do you NOT use a food thermometer to measure the internal temperature of the beef
product?

Display This Question:

If Q5.11 = Measure the internal temperature of the beef product with a food thermometer
[Always]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [Most of the time]

Q5.13 Why do use a food thermometer to measure the internal temperature of the beef product?

Display This Question:

If Q5.11 = Measure the internal temperature of the beef product with a food thermometer
[Always]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [Most of the time]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [About half the time & Sometimes]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [Rarely]

Or Q5.11 = Measure the internal temperature of the beef product with a food
thermometer [Never]

Q5.14 Are you aware of the internal temperatures at which cooked beef products are considered
safe-to-eat?

- Yes (1)
- No (2)

Display This Question:

Appendix

If Q5.14 = Yes

Q5.15 What are the safe internal temperature(s) at which beef products are considered safe-to-eat?

Q5.16 Please indicate your level of agreement for each **FACTOR** as a reliable indicator that beef product is done and safe to eat.

	Agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Disagree (5)
Color (inside or outside) is a reliable indicator that beef product is done and safe to eat (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Texture and/or firmness (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Juices and/or blood exuded (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Smell (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Amount of cooking time (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Use of a food thermometer to measure internal temperature (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q5.17 Do you own a food thermometer?

Appendix

- Yes (1)
 - No (3)
- Skip To: Q5.20 If Q5.17 = No

Display This Question:

If Q5.17 = Yes

Q5.18 Why do you own a food thermometer? (Please select all that apply.)

- For safety. (1)
- Someone bought it for me. (2)
- Other (please specify): (3) _____

Display This Question:

If Q5.17 = Yes

Q5.19 How long have you owned a food thermometer for?

- Less than 3 months (1)
- 3 - 6 months (2)
- 6 months - 1 year (3)
- More than 1 year (4)

Q5.20 What type of food thermometer(s) do you use most often? (Please select all that apply.)

- A digital thermometer (1)
- A thermometer with a dial (2)
- Liquid-filled thermometer (3)
- Not Sure (4)
- None / I never use a thermometer (5)

Q5.21 When using a food thermometer, how often do you cook beef products to 160 degrees F (71C) or higher?

- Always (1)
- Most of the time (2)
- About half the time / Sometimes (3)
- Rarely (4)
- Never (5)
- It depends (please specify why): (6)

-
- This question does not apply to me. (7)

Q5.24 Do you use a food thermometer when cooking any of the following other types of food for safety?

Always (1)	Most of the time (2)	About half the time / Sometimes (3)	Rarely (4)	Never (5)	I do not prepare this product (6)	I do not use a food thermometer (7)
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Appendix

Chicken (1)	<input type="radio"/>						
Turkey (2)	<input type="radio"/>						
Pork (3)	<input type="radio"/>						
Fish (4)	<input type="radio"/>						
Shellfish (7)	<input type="radio"/>						
Eggs (5)	<input type="radio"/>						
Vegetable Dishes (6)	<input type="radio"/>						

Q5.25 How would you rate your overall level of concern with the SAFETY of the beef products that you prepare and eat?

- Extremely concerned (1)
- Very concerned (2)
- Moderately/Sometimes concerned (3)
- Slightly concerned (4)
- Not at all concerned (5)

Q5.26 When preparing and cooking beef products yourself, how much control do you feel you have over how safe it is to eat?

- A great deal of control (1)
- A moderate amount of control (2)
- Some control (3)
- Very little control (4)
- No control (5)