Summer 7-30-2020

CONSUMER ATTITUDES, KNOWLEDGE, AND BEHAVIOR: UNDERSTANDING GLUTEN AVOIDANCE AND POINT-OF-DECISION PROMPTS TO INCREASE FIBER CONSUMPTION

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by

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A THESIS

Presented to the Faculty of

The Graduate College of the University of Nebraska

In Partial Fulfillment of Requirements

For the Degree of Master of Science

Major: Food Science and Technology

Under the Supervision of Professors Devin J. Rose and Christopher R. Gustafson

Lincoln, Nebraska

July, 2020

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University of Nebraska, 2020

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Understanding consumer food behavior is important for creating effective health programs and policies that address obesity. In this thesis, two topics of consumer food behavior are explored: understanding gluten avoidance and the use of point-of-decision prompts (PDP) to increase the purchase of healthier food choices. In this first topic, nationally representative data was collected on people's gluten-free (GF) experience and perceptions. It was found that people were more likely to avoid gluten if they believed the (GF) diet was healthier than a gluten-containing diet and if they were recommended to try the diet. The second topic studies the influence of a PDP, about the health benefits of fiber consumption, on consumer cereal, bread, and cracker shopping choices. The fiber PDP was first studied to see if it could influence consumers to purchase products with a greater fiber density. It was found that consumers who viewed the PDP before making food choices selected products that had a greater amount of fiber per serving. Next, the PDP was studied to determine how it promoted such behavior. It was found that the PDP influenced consumers to either consider all product options or to limit their choices to the healthier options. It was also found that consumers were more likely to consider the fiber content of choices if they saw the PDP before making choices. Together, this thesis adds insight to current consumer food behavior literature.

ACKNOWLEDGEMENTS

This thesis could not have been possible if it were not for my two brilliant advisors, Drs. Devin Rose and Christopher Gustafson, who guided me through my master's program and research. I am sincerely grateful to have worked under them and appreciate their ability to teach me to think critically on topics. Their curiosity to thoroughly investigate questions is admirable. Thank you, Drs. Randy Wehling, and Amalia Yiannaka for serving on my committee and providing perspective on the research.

I would also like to thank Pratiksha Baishya, who I worked with to develop the survey used to study consumer gluten avoidance. Pratiksha was always a joy to work with.

Additionally, my laboratory mates have been a huge support in my master's program. They have made work enjoyable and were there to clarify concepts when I was confused with schoolwork or research. I also would like to acknowledge my work-from-home quarantine coworkers for helping to maintain a fun and focused environment.

And of course, a very special thanks to my family for their endless encouragement and support in my academic interest and desires. These last two years have created relationships that I will cherish for the rest of my life.

GRANT INFORMATION

This project is based on research that was supported by the University of Nebraska-Lincoln Agricultural Research Division Wheat Innovation Fund and was partially supported by the Nebraska Agricultural Experiment Station with funding from the Hatch Act (Accession Number 1011290) through the USDA National Institute of Food and Agriculture.

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PREFACE

Early in 2020, the CDC announced that the prevalence of obesity in the United States has risen to 4 in 10 Americans (CDC, 2020a). The consequences of obesity for society are severe. It can shorten a person's lifespan and increase a person's risk for developing type 2 diabetes, heart disease, stroke, osteoarthritis, sleep apnea, infertility and erectile dysfunction, and some cancers (CDC, 2020b). Obesity is primarily caused by the overconsumption of energy (Committee on Accelerating Progress in Obesity Prevention et al., 2012). To create effective programs that can address the overconsumption of energy it is first necessary to understand consumer food behavior (Larson & Story, 2009). In this thesis, I focus on two topics of consumer food behavior: understanding gluten avoidance and the use point-of-decision prompts (PDP) to increase fiber consumption.

Objectives and Hypotheses

Objective one is to determine what factors push people to eat a gluten-free (GF) diet when they do not have Celiac disease (CD) or non-Celiac gluten sensitivity (NCGS). The main factors I investigate are the perceived health benefits of, and the information sources that recommended trying, the GF diet. Given that descriptive surveys report that people believe the GF diet improves one's general health and that such claims have been found in popular media (Newberry et al., 2017), I hypothesized that interest in gluten avoidance would be driven by the individuals' beliefs in health claims brought about by the diet and by receiving a recommendation that they should try a gluten-free (GF) diet.

Objective two is to determine the impact that a PDP, focused on the health benefits of fiber consumption, has on people's grain-based food purchase choices. I investigate if and how a PDP, about the benefits of dietary fiber consumption, can influence consumers to make healthier purchase decisions. Given that studies show that consumers who are presented a health-focused PDP tend to make healthier purchase decisions in grocery stores (Gustafson et al., 2018; Papies et al., 2014), I hypothesized that consumers who were presented with a fiber-focused PDP will purchase products with a greater fiber density. I also hypothesized that participants who were presented the PDP before making food choices would limit their choices to a healthier set of options and consider the fiber content of products when making their purchase choices.

Thesis Organization

This thesis is organized as follows: a literature review (Chapter 1), followed by three manuscripts (Chapters 2, 3, 4). Chapter 2 addresses objective one and aims to understand consumer interest in gluten avoidance. Chapter 3 and 4 address different aspects of objective two. Chapter 3 investigates the product choices when a fiber-focused PDP is presented to consumers. Chapter 4 investigates changes in the process variables that are used to make purchase decisions. Chapter 5 concludes the thesis and summarizes the overall findings.

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CHAPTER 1: REVIEW OF LITERATURE

1 Obesity in the United States and the Need to Understand Consumer Food Behavior

With the increasing prevalence of obesity in the United States, which is now about 4 in 10 Americans (CDC, 2020b), obesity has become the leading cause of death in the United States (CDC, 2020a). Obesity is a disease that consists of unhealthy levels of excess fat in the body (*Definition & Facts for Celiac Disease | NIDDK*, 2016). It is a major public health concern because it is the cause of many negative health consequences (Mayo Clinic, 2020). Physically, obesity increases the person's risk for developing type 2 diabetes, heart disease, stroke, osteoarthritis, sleep apnea, infertility and erectile dysfunction, and some cancers (CDC, 2020a). Quality-of-life wise, obesity can lead to a shorter lifespan and may cause a person to feel ashamed, guilty, depressed, and sexually insecure (Mayo Clinic, 2020). Financially, overweight individuals spend about 42% more on medical bills than normal-weight individuals (Finkelstein et al., 2009), and economically, obesity decreases a person's work output due to needs to take more sick leave and being less productive when at work (CDC, 2020a).

Obesity is caused when a person consumes more energy than is expended. The body stores unexpended energy as fat. If this pattern continues over a period of time, a person can become obese. Weight loss, on the other hand, depends on expending more energy than is consumed. However, obesity-causing habits, such as food choices, are ingrained into people's lifestyles, and so many people find it difficult to lose excess weight (Mayo Clinic, 2020). The complexity of overconsumption and unhealthy diets makes understanding consumer food behavior an important and necessary area of

research. Consumer food behavior research helps to create more effective methods of educating and motivating individuals to make healthier diet changes (Larson & Story, 2009).

In this paper, I explore two topics of consumer food behavior. The first topic I explore is understanding consumers' interest in gluten avoidance. In the past decade, consumers have displayed a high interest in gluten-free (GF) products, which are specialty products that mimic gluten-containing products (Statista, 2018). Consumers' interest in GF products is believed to stem from beliefs that GF foods are healthier than conventional gluten-containing versions. However, scientific research does not support such beliefs (Christoph et al., 2018; Harvard School of Public Health, 2018). I explore the GF diet because of its timely popularity and the need to understand how misinformation about diets emerges.

The second topic I explore is the use of point-of-decision prompts (PDP) to encourage healthier food choices and increase fiber consumption. PDPs are motivational signage that is strategically located to encourage people to consider behaviors that lead to better health (Gustafson et al., 2018). Little research has been done on the use of PDPs to influence food choice, but it has shown to influence healthier grocery purchase choices (Gustafson et al., 2018). In this research, I study the effects on food choices when a consumer is presented with a PDP about the health benefits of fiber consumption. This research will help us understand how to encourage consumers to make healthier food choices. Additionally, it will help us know if PDPs can be an effective way to promote the consumption of fiber, which 95% of Americans do not consume recommended amounts of (Hyland, 2018).

2 Gluten-Free Diet Trend

2.1 What is the gluten-free diet?

The GF diet omits foods that contain gluten, a protein naturally found in wheat, barley, and rye (*Definition & Facts for Celiac Disease | NIDDK*, 2016). It is used as a life-long medical intervention for people diagnosed with either Celiac disease (CD) or non-Celiac gluten sensitivity (NCGS) (Foschia et al., 2016; Gallagher, 2009). CD is a gluten-triggered autoimmune disease that causes abdominal discomfort and damage to the small intestines. Over time this damage leads to issues related to malnutrition, osteoporosis acceleration, the nervous system, and reproduction ability (*Definition & Facts for Celiac Disease | NIDDK*, 2016). Like people with CD, people with NCGS also experience abdominal pain. However, NCGS is not an autoimmune disease nor does it damage the small intestines. NCGS is not yet fully understood (Foschia et al., 2016), and research has not clearly determined if gluten is the trigger for people with NCGS. Some research suggests that the abdominal pain experienced by NCGS may be caused by a different protein that happens to be in many gluten-containing foods (Howard, 2017).

2.2 Adoption of a Gluten-Free Diet by Non-Gluten Sensitive Individuals

Less than 1% of the population is expected to have CD and an estimated 3-6% of the population have NCGS (Foschia et al., 2016). Aside from people with CD and NCGS, there is limited evidence to suggest that people will benefit from eating a GF diet (Howard, 2017). Yet, evidence shows that people without CD or NCGS are choosing to completely avoid or reduce their gluten consumption (Howard, 2017; Prada et al., 2019). In 2013, one-third of Americans reported that they wanted to either cut down, if not fully eliminate, gluten from their diet (NPD Group, 2013). In 2015, 25% of Americans opted

to eat GF specialty products in replacement of the conventional gluten-containing versions (Mintel Press Team, 2015). The number of people interested in GF is much greater than the number of people who suffer from CD or NCGS.

The market value of GF specialty products also demonstrates an inflated interest in GF products. In 2014, the GF food market in the United States had grown to be $6 billion. The market has continued to grow rapidly over the years and is predicted to reach $16 billion by 2025 (Statista, 2018). Given the size of the GF product market and the small proportion of Americans who require these products for medical reasons, it is presumed that the market growth is driven by consumers without CD or NCGS (Christoph et al., 2018).

Several surveys have identified health benefits to be a highly motivating factor for eating GF foods. According to a 2013 Mintel survey, 65% of the people who ate GF foods despite not having a gluten-intolerance did so because they felt GF foods were healthy (Watson, 2013). Dunn et. al. (2014) also noted that 37% of their participants (n=97) perceived GF versions of conventional gluten-containing counterparts to be healthier (Dunn et al., 2014). Hartman Group, Inc. conducted a 1500-person survey asking people for the reason they purchased GF foods. While only 8% indicated “I have a gluten sensitivity”, 26% felt it was the “healthier option”, 19% marked “digestive health,” 9% chose “inflammation”, and 9% were doing a “diet cleanse” (*The Hartman Group’s Health & Wellness 2015 and Organic & Natural 2014 Reports*, 2015). Additional commonly held GF health beliefs include improvements to skin complexion (Dunn et al., 2014) and various autoimmune conditions (Zannini et al., 2012). Despite consumer perception that a GF lifestyle will bring about health benefits, the commonly

believed GF benefits lack scientific evidence. So the general scientific opinion remains that a GF diet, or reduced gluten (RG) diet, does not bring improved outcomes for people without CD or NCGS. (Christoph et al., 2018; Harvard School of Public Health, 2018; Zannini et al., 2012).

2.3 Concerns about the adoption of GF foods among non-gluten sensitive individuals

Adopting a GF diet in the absence of CD or NCGS comes with multiple potential negative consequences. Firstly, a person's risk for developing nutritional deficiencies and constipation is increased when adopting a strict GF diet. Compared to conventional gluten-containing products, GF versions typically contain lower amounts of B vitamins, vitamin D, iron, zinc, magnesium, calcium, dietary fiber, and protein, while also having greater amounts of calories, fat, and sodium (Ahuja et al., 2017; Christoph et al., 2018; Diez-Sampedro et al., 2019; Foschia et al., 2016; Thompson, 2000; Vici et al., 2016). The nutritional inferiority of GF products has much to do with non-wheat substitutes, such as rice, potato, tapioca, and corn flours, used in GF products being lower in fiber and inferior in vitamin content (Diez-Sampedro et al., 2019; Gallagher, 2009). Additionally, since the FDA does not require fortification of GF products as they do with refined wheat products, the GF products are rarely fortified (Miranda et al., 2014; Thompson, 2000). The higher fat content in GF products comes from the need to add additional fats and oils in the products to imitate the mouthfeel of gluten-containing foods (Sloan & Hutt, 2015). GF products also tend to have greater amounts of arsenic and higher glycemic index score (Diez-Sampedro et al., 2019), further decreasing the healthiness of GF products.

Secondly, following a GF diet can come with a greater cost. GF specialty products are two to three times greater than their gluten-containing counterparts (Diez-

Sampedro et al., 2019). This is an unnecessary cost if one does not need to eat gluten-free products.

Thirdly, the popularity of the GF diet brings concern about the spread of health misinformation. The acceptance and promotion of the GF diet for reasons other than CD or NCGS is thought to have spread from within the health and wellness community (Newberry et al., 2017). Misinformation about the GF diet has been found in books, websites, beauty magazines, and health-focused television shows (Newberry et al., 2017; Zannini et al., 2012). It is not yet clear how influential these sources of misinformation are at persuading people to try a GF diet. From a consumer food behavior position, wanting to promote healthy eating habits and prevent less healthy ones, it is especially important to understand how the GF diet transitioned from a medical diet into a fad diet.

3 Use of Point-of-Decision Prompts in Grocery Stores

3.1 Current Grocery Store Initiatives to Promote Healthy Food Choices Among Consumers

Grocery stores serve as a critical point in the improvement of people's health. Since people often shop for a household, food choices made at the grocery store may impact the dietary quality of multiple people over multiple days (Martinez et al., 2018; Papies et al., 2014). Additionally, food purchased at a grocery or other food outlet stores, such as supermarkets, accounts for the majority of people's energy consumption (Drewnowski & Rehm, 2013), making it even more important that healthy choices are made at these locations. The impact that retail food choices have makes grocery stores—and other food retail outlets—a target environment for the promotion of cost-effective and sustainable healthy food choices at the population level (Glanz et al., 2012; Larson &

Story, 2009; WHO, 2003). This has led to several health promotion programs and initiatives to be pursued within the grocery store environment.

The Nutritional Labeling and Education Act of 1990 is one of the most important food-related health policies in the US. This policy requires all packaged food products to carry a nutrition facts panel (NFP) on the package (Nikolova & Inman, 2015). The requirement and standardization of NFPs on all packaged foods allow consumers to make healthy judgments on their food choices. However, a complaint among consumers is that the information on NFPs are difficult to understand and so it remains infrequently used (Cowburn & Stockley, 2005).

Front-of-panel (FOP) nutrition information on packages, an approach that some manufacturers have voluntarily adopted, has emerged as a solution to the complexity of NFPs (Feunekes et al., 2008). The FOP nutrition information helps to make nutrition information more convenient for consumers to utilize by displaying only a few key nutrients that consumers are most likely interested in (Balasubramanian & Cole, 2002). Not only is the FOP information easier to understand than the NFP, but it is also located on the front panel of packages, whereas the NFP is more typically found on the side or back panels. The front-panel positioning makes nutrition information more salient for consumers.

An even more simplified method for identifying healthy information has been shelf-based healthy food labeling systems. These are point-based systems that place shelf tags in grocery stores to identify healthy items for shoppers. Common shelf-based labeling systems in the United States include the Guiding Stars rating system and NuVal (Nikolova & Inman, 2015). The Guiding Stars system scores the nutritional profile of

products and assigns them a score of zero to three stars, with three stars being the healthiest rating (*Guiding Stars*, n.d.). The Guiding Stars system is used in about 1500 stores across the United States (Nikolova & Inman, 2015). The NuVal system in its original form evaluated and assigned product scores. Instead of a star rating, NuVal assigned products a score of 0-100, with 100 being the highest rating. Flaws in the NuVal algorithm and concerns over funding biases led to NuVals termination in 2017 (Xiong, 2017). The NuVal has since reemerged. The NuVal system still works as a shelf tag healthiness indicator, but instead of providing a healthiness score it showcases product claims such as "excellent source of fiber" (NuVal, n.d.)

Grocery stores have also created initiatives to promote healthy food choices among their consumers. According to a 2012 report published by the Food Marketing Institute, 98% of US grocery stores provide health and wellness information on their website and 45% publish health and wellness newsletters for their consumers. Almost 90% of grocery stores provide healthy meal recipes to inspire consumers to improve their diet and make healthier purchase decisions. Additionally, nearly 80% of grocery stores provide grocery tours, that range from topics about reading nutrition labels and shopping for healthy eating, weight management, diet restrictions, and disease states. Many stores even provide consumers access to a dietitian, whether it is through nutritional counseling (59%) or allowing consumers to submit questions online that will be answered by a registered dietitian (43%) (FMI, 2012). In addition to grocery stores providing information and programs to promote healthier food choices, many have also increased the availability of healthy food products in their stores (Glanz et al., 2012).

Despite numerous efforts to provide consumers with the means of making healthier food choices in grocery stores, the prevalence of obesity rates continue to rise (CDC, 2020a). More needs to be done to influence consumer food behavior in grocery stores.

3.2 Use of Point-of-Decision Prompts in Grocery Stores to Promote Healthy Food Choices Among Consumers

The current health promotion tactics used in grocery stores, as mentioned above, are primarily information-based. The information-based initiatives are limited by consumer motivation to use the provided resources to guide their food purchase choices (Rawson et al., 2008; van Herpen & van Trijp, 2011). In addition to lack of motivation, consumers may be unintentionally ignoring the provided nutrition information. The average grocery store hosts around 39,000 different items (Nielsen, 2016) and so consumers may experience cognitive overload if they attempt to compare all possible choices (Masatlioglu et al., 2012). Grocery shopping is often repetitive and so as a default to the excessive amount of product choices and information, consumers might ignore nutritional comparisons and instead reach for familiar products (Masatlioglu et al., 2012; Saarela, 2013).

A way to break these limitations may be to implement health-focused point-of-decision prompts (PDPs) into food shopping settings. PDPs are motivational signage that is strategically located to encourage people to consider behaviors that lead to better health (Gustafson et al., 2018). Shoppers notice signage in grocery stores (Glanz et al., 2012), and the use of health-motivational signage can be used to disrupt consumers' habitual

shopping behavior and encourage them to make healthier food choices (Gustafson et al., 2018).

The use of PDPs to influence healthier food choices in a food store environment is a newer area of study that is showing promising results. Gustafson et al. (2018) experimented on PDPs in a supermarket serving a predominantly minority community. The experiment incorporated a PDP poster into a grocery store that already had a locally developed shelf-based healthy food labeling system (Gustafson & Prate, 2019) in place along with typical nutritional information products, such as NFPs and FOP labels. In the study, a PDP poster placed on an easel at the entrance of the store contained verbiage encouraging consumers to choose healthy items and reminded shoppers they could use the store's healthy food shelf label to identify healthy items. Analysis of itemized purchase receipts from experimental (PDP) and control (no PDP) conditions showed that implementation of the PDP led to a 37% increase in healthy food purchases across all food categories, even though nutrition information—and highly visible shelf labels—were present in both conditions (Gustafson et al., 2018). This suggests that the PDP reminded individuals of underlying healthy eating goals.

In this thesis research, I used a PDP focused on the health benefits of fiber. Fiber is a nutrient that 95% of Americans fail to meet the recommended daily intake of 14g/1000kcal (Hyland, 2018; Kranz et al., 2017). Fiber is a key nutrient in a healthy diet for its health benefits. It helps with weight maintenance and decreasing the risk for many health consequences that obesity increases the risk for such as heart disease. Fiber consumption can help one to feel full, lower cholesterol levels, control blood sugar, and help to maintain bowel movement and health (Mayo Clinic, 2020).

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CHAPTER 2: DETERMINANTS OF GLUTEN-FREE DIET ADOPTION AMONG INDIVIDUALS WITHOUT CELIAC DISEASE OR NON-CELIAC GLUTEN SENSITIVTY

1 Abstract

Objectives: Gluten free (GF) foods are typically less nutritious and more expensive than their gluten-containing variants, yet people without a diagnosed gluten sensitivity continue to adopt this diet. There is a lack of research about what factors drive people without Celiac disease or non-Celiac gluten sensitivity to follow the GF diet. **Methods:** A nationally representative sample of 3051 US residents were surveyed about their attitudes, perceptions, and experiences with the GF diet. After removing respondents who had a diagnosed gluten sensitivity, logistic regression was used to compare respondents who were currently avoiding or had avoided gluten previously (GF consumer) to respondents who had never tried a GF diet (non-GF consumer). **Results:** Over one-fifth of respondents were GF consumers. Beliefs that a gluten-reduced diet is healthier (OR 1.71; 95% CI [1.32,2.21]), that gluten-free products are more nutritious (OR 1.44, 95% CI [1.10,1.88), and that a GF diet can help clear acne (OR 1.45; 95% CI [1.12,1.87]) were all positively associated with trying a GF diet. Personal research was the most influential source of information associated with trying a GF diet (OR 2.93; 95% CI [1.92,4.52]). This was followed by "healthcare center or health professional" (OR 2.55; 95% CI [1.70,3.87]. Respondents that were never encouraged to try the GF diet were less likely to try the diet (OR 0.33, 95% CI [0.23,0.46]). **Conclusions:** Positive, but scientifically

unsubstantiated, beliefs about the benefits of the GF diet were strongly associated with trying a GF diet, and the source of recommendation to try a GF diet was important.

Keywords: gluten-free; food behavior; food trend; belief; perception; attitude

2 Introduction

Celiac disease (CD) and non-Celiac gluten sensitivity (NCGS) are medical conditions that require a gluten-free (GF) diet. However, in the past decade, the GF diet has been adopted by many people that have not been diagnosed with either of these conditions (Foschia et al., 2016; Statista Research Department, 2018). Estimates suggest that only 1% of the population has CD and 3-6% have NCGS (Foschia et al., 2016), yet 25% of Americans consumed GF products in 2015 (Prada et al., 2019). The popularity of the GF diet raises questions about why approximately 20% of the population chooses to eat GF foods despite no scientific evidence that the diet will benefit them.

Interest in the GF diet by non-gluten-sensitive individuals is suspected to stem, at least in part, from inaccurate beliefs about the health benefits afforded by a GF diet (Christoph et al., 2018; Newberry et al., 2017). These beliefs include weight loss, digestive health, clearer skin complexion, and other conditions. However, the ability of the GF diet to deliver these health benefits has not been substantiated by scientific studies for people who are not gluten-sensitive. The scientific consensus remains that, for non-gluten-sensitive individuals, removing gluten from the diet does not improve health (Harvard School of Public Health, 2018).

Positive beliefs about the health benefits of the GF diet appear to be widely held. For instance, in a 2016 survey of over 2000 U.S. residents, 64% considered GF products to be either “very healthy” or “somewhat healthy” (Statista Research Department, 2018). Despite the health perception, GF products are, in many cases, nutritionally inferior to conventional, gluten-containing products. Compared to conventional products, GF versions typically contain more calories, fat, and sodium, while also containing lower

amounts of vitamin B-12, folate, niacin, vitamin D, iron, zinc, magnesium, calcium, dietary fiber, and protein (Ahuja et al., 2017; Christoph et al., 2018; Diez-Sampedro et al., 2019; Foschia et al., 2016; Thompson, 2000; Vici et al., 2016). Indeed, multiple studies have found, through plasma vitamin levels and food record logs, that CD patients following a GF diet are deficient in these very nutrients (Diez-Sampedro et al., 2019; Hallert et al., 2009; Vici et al., 2016). Rather than providing nutritional benefits, consuming GF versions of conventional products may place individuals at risk of nutrient deficiencies.

Although GF products are typically nutritionally inferior to their conventional versions, Christoph et al. (2018) found that among the general public, people that list GF as an important food attribute typically have a healthier diet and lifestyle habits. Compared to people that did not prefer GF products, people preferring GF products consumed more fiber and servings of fruits and vegetables, along with consuming less sodium, trans fats, and calories from saturated fat and added sugar in their diet. Therefore, many people that tend to have healthier eating habits may also choose to consume GF products, creating a non-causal relationship between consuming the GF diet and positive health outcomes in the general population.

The popularity of the GF diet highlights the disconnect between consumer perceptions and scientifically supported facts about nutrition. There is, in general, a lack of academic research on forces that promote consumers to adopt "popular"—which are sometimes referred to as fad—diets. Information on consumer behavior in the context of the GF diet has largely been limited to descriptive results and is not based on nationally representative samples (Dunn et al., 2014; Golmohamadi et al., 2017; Prada et al., 2019;

Schlitt et al., 2013). Descriptive results are unable to link the choice to follow a GF diet with beliefs, knowledge, and whether individuals were advised to follow the diet. Thus, it is unclear what influenced a person to try the diet. For instance, it has been suggested that popular media has influenced many non-gluten sensitive individuals to try a GF diet since unsubstantiated information about purported benefits of the GF diet has been disseminated through these sources (Christoph et al., 2018; Howard, 2017; Jones, 2017; Newberry et al., 2017). However, without research, it is not clear whether exposure to popular media sources promoting the GF diet increases the likelihood that an individual will follow a GF diet.

No previous studies have linked determinants of consumer behavior to a person's decision to follow a GF diet. To address this gap, a nationally representative sample of 3051 residents of the United States was conducted. Respondents were surveyed about their attitudes, perceptions, and experiences with the GF diet. Their experience with the GF diet was related to their beliefs about the diet's health benefits; who recommended the respondent follow a GF diet; objective and subjective nutritional knowledge; perceived health; and demographic variables.

3 Methods

3.1 Data collection

A 55-question survey about people's experience with, perceptions of, and attitudes about the GF diet was distributed online to a sample of residents designed to be representative of the population of the United States by sex, age, and household income. The University of Nebraska-Lincoln Institutional Review Board approved this research (IRB# 20190118770EX). Participants provided written informed consent before

completing the research. Participants that did not complete the survey, finished the survey unreasonably quickly (under five minutes), or answered an "attention check" question incorrectly were not included in the dataset. A subset of survey questions that were relevant to the objectives of this paper were included in the analysis (Appendix A). These included questions related to GF health benefit beliefs, sources that recommended a GF diet, subjective and objective nutrition knowledge, perceived health status, and demographics.

In the analysis, the decision to follow a GF diet among respondents that did not have a medical diagnosis of CD or NCGS was examined as the dependent variable. Participants that had been formally diagnosed with either CD or NCGS were removed from the analysis (n=50; 1.6% of the original dataset). Respondents who currently or in the past had followed a strict GF diet or had consciously limited their gluten consumption constituted observations of the diet and were coded with a value of 1 (abbreviated henceforth as GF consumers), while respondents that also had not been diagnosed with CD nor NCGS, but had never reduced or eliminated gluten from their diet were coded as 0 (non-GF consumers). An additional 19 (0.6% of the original dataset) participants were removed from the dataset because of missing data for a question used in the model. Therefore, out of the total 3051 respondents that completed the survey, 2982 subjects were included in the analysis.

3.2 Data analysis

The survey data were analyzed using R (R Core Team, 2019). Summary statistics, chi square tests, and t-tests were used to report and compare variables of the whole sample and between sub-samples of respondents that had and had not tried a GF diet.

Multivariate logistic regression was used to examine the relationship of multiple independent variables to having followed a GF diet. Independent variables in the model included beliefs about health benefits of the GF diet; the source of the suggestion that the respondent try a GF diet; objective and subjective knowledge about grain-based products, gluten, and nutrition; subjective health status; and demographic variables.

Beliefs about the health benefits of the GF diet were measured using five questions that asked participants to indicate the extent to which they agreed that the GF diet exhibited certain health benefits. The health benefits were expressed through statements asking how much respondents believed a GF diet can help with "acne" and "weight loss"; as well as eliciting agreement with statements such as "Gluten can cause disease in non-gluten sensitive people"; "GF products are generally more nutritious than their gluten containing variant"; and "A gluten-reduced diet is healthier for people than a full-gluten containing diet." Respondents' answers were provided on a 5-point scale, with points ranging from "strongly agree" to "strongly disagree." Since the purpose of the belief questions was to examine which perceived benefits influence people to follow a GF diet, the scale was converted to a binomial variable. The variable took a value of one if the respondent agreed that the GF diet exhibited the benefit in question and zero if the respondent was neutral or disagreed.

To examine which information sources influenced a person's decision to try a GF diet, participants were asked to mark all applicable groups of people or sources of information that had suggested he or she try a GF diet from a list of sources provided in the survey. Information sources included: "Family member or friend"; "Healthcare center or health professional (doctor, dietitian, etc.)"; "Online checklist suggested I try it"; "Self

(including through personal research)"; "TV personality, blogger, video blogger, and or celebrity"; "Wellness coach, personal trainer, and or sports coach/Nutrition/Fitness shop or gym employee"; and "No one has ever suggested that I try a gluten-free diet." The sources were included as separate binomial variables in the model, where a value of "1" was given if the source had recommended the GF diet to the person and "0" if the source had not suggested the diet to the person. A binary variable was also included for the "No one has ever suggested that I try a gluten-free diet" statement.

Objective and subjective knowledge about grain-based products, gluten, and nutrition were also elicited. Subjective knowledge captured participants' self-assessment of their knowledge by asking them to rank how much they agreed with the statement, "I have a lot of knowledge about [grain-based products/gluten/nutrition]." Responses to these questions were presented on a 5-point scale, which was collapsed into a 3-point scale for analysis. "Strongly disagree" and "Disagree" were combined into one category and "Strongly agree" and "Agree" were combined into another category. "Disagree" was used as the reference category. Objective knowledge was assessed using a five-question quiz on each of the three topics. However, one gluten-related question consisted of five sub-questions, which were each scored separately, and, due to ambiguity identified after the survey was administered, one grain question was removed. Therefore, objective knowledge scoring included nine questions about gluten, five questions about nutrition, and four questions about grains. Objective knowledge scores were calculated separately for grain-based products, gluten, and nutrition by taking the sum of correct answers in the category and dividing it by the total number of questions in the category. Objective knowledge scores, therefore, could take values from 0 to 1.

People's health perception was analyzed using three questions. First, participants marked all symptoms he or she experienced when consuming gluten-containing foods. Symptoms that were sex-specific or that were not scientifically supported symptoms of gluten sensitivity were omitted from this symptom count. This left a total of nine symptoms that participants could mark. The other two health questions, "How satisfied are you with your current health status?" and "Select how much you agree or disagree with this statement. *My eating habits are very healthy,*" were asked on a 5-point scale which was converted into a 3-point scale for analysis. People who marked "Prefer not to answer" (n=19) for the health satisfaction question were omitted from the analysis. "Unsatisfied" and "Disagree" were used as the reference categories for these questions, respectively, in the analysis.

Demographics included in the model were sex, age, body mass index (BMI), household income, and education. Sex was collapsed into "female" (1) and "not female" (0) categories (the "not female" category was predominantly male but included six respondents that declined to respond to the question). Respondents indicated their age in 5-year intervals ranging from "19-24 years old" to "65 and older." These categories were merged into "19-44" and "45 and older". The "45 and older" category was used as the reference for age. Self-reported height and weight were used to calculate BMI. Three BMI categories were established: ≤24.9, 25-29.9, and ≥30, which correspond to categories that are commonly used to describe weight status: "under or normal weight," "overweight," and "obese," respectively. A fourth category, "Prefer not to answer," was assigned to participants that did not disclose enough information to calculate BMI. The category "BMI≤24.9" was used as the reference. Household income was recorded in

categories spanning $20,000 intervals, beginning with “Less than $20,000” and stopping at “$100,000 or more.” Due to the small number of people with the income “Less than $20,000”, the category was combined with “$20,000-$39,999” and renamed as “Less than $40,000” for analysis. Finally, respondents indicated their highest level of education completed. Choices included: “Less than high school”; “High school/G.E.D.”; “Some college/associate degree”; “Bachelor’s degree”; “Advanced degree (M.B.A., M.D., J.D., M.S., M.A., Ph.D.)”; and “Prefer not to answer.” Education categories were merged into “No Postsecondary” which included “Prefer not to answer” responses, and “Postsecondary.”

4 Results

4.1 Descriptive Results

Table 2.1 presents summary statistics for participants’ demographic characteristics. The survey was designed to be representative of the US population in terms of sex, age, and income. Females comprised 52.0% of the sample, which is close to the percentage of females in the US population: 50.8% (U.S. Census Bureau, 2019). Participants’ age was split into two categories for this research: 19-44 years of age, and over 45 years of age. The 19-44 age group constituted 44.3% of the sample. This is slightly higher than the percentage of the US population in 2018 between 21 and 44 years of age (43.4%)—which is the most similar range of ages reported by the US Census data relative to our data (U.S. Census Bureau, 2018). According to US Census Quickfacts, median US household income from 2014-2018 was $60,293 (in 2018 dollars), and the median category selected for household income in our sample was $60,000-$79,999 (U.S. Census Bureau, 2019). Nearly 47% of our respondents reported household income

below $60,000 so the precise median value is likely quite similar to the US population's median household income.

Table 2. 1 Participant Demographic Characteristics

	Total Sample		GF Consumer		Non-GF Consumer	
	Count	%	Count	%	Count	%
n	2982	100	667	22.4	2315	77.6
Gender						
Female	1552	52.0	353	52.9	1199	51.8
Not female	1430	48.0	314	47.1	1116	48.2
Age						
19-44	1313	44.0	379	56.8	934	40.3
45 and older	1669	56.0	288	43.2	1381	59.7
BMI						
Underweight or normal	859	28.8	215	32.2	644	27.8
Overweight	916	30.7	213	31.9	703	30.4
Obese	926	31.1	178	26.7	748	32.3
Prefer not to answer	281	9.4	61	9.1	220	9.5
Household Income						
Less than $40,000	832	27.9	189	28.3	643	27.8
$40,000 – $59,999	532	17.8	123	18.4	409	17.7
$60,000 – $79,999	443	14.9	89	13.3	354	15.3
$80,000 – $99,999	325	10.9	76	11.4	249	10.8
$100,000 or more	796	26.7	182	27.3	614	26.5
Prefer not to answer	54	1.8	8	1.2	46	2.0
Education						
No postsecondary	2376	79.7	524	78.9	1846	79.9
Postsecondary	606	20.3	143	21.1	469	20.1

Note: p-value compares significant differences between GF groups (chi-squared test).

Next, the sub-samples of GF consumers and non-GF consumers were tested for differences. A greater proportion of GF than non-GF consumers were between 19-44 years old ($p<0.001$). BMI was also significantly different between GF groups ($p=0.026$). Among the BMI groups, a larger percentage of GF consumers (32.2% of GF consumers), than non-GF consumers (27.8% of non-GF consumers), had a BMI <25.

A larger percentage of GF consumers believed in the health benefit statements (Figure 2.1), all of which were statistically significant ($p<0.001$). The belief held by the most people regardless of GF consumer category was that the GF diet could help with weight loss (48.9% of full sample), although a much higher percentage of GF consumers (66.6%) believed in this benefit than non-GF consumers (43.8%). The second most endorsed benefit was that "in general, a gluten-reduced diet is healthier for people than a full-gluten containing diet" (39.1% of full sample). Nearly two-thirds of GF consumers (62.2% of GF consumers) agreed with this statement.

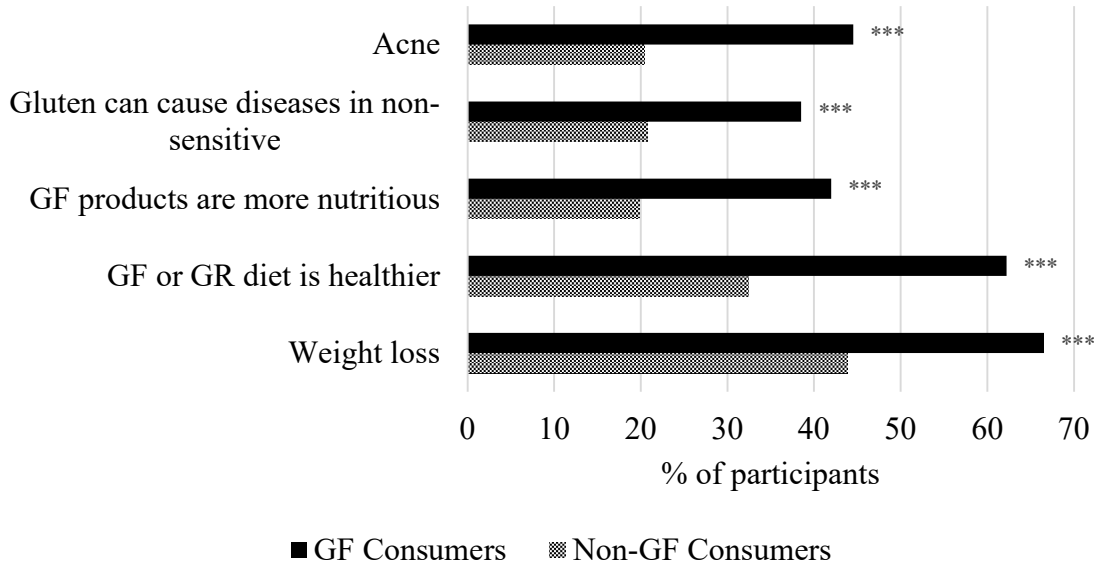

Figure 2. 1 Distribution of Participants' Beliefs in GF Health Benefits

Acne = A GF diet can help with acne; Gluten can cause disease in non-sensitive = Gluten can cause disease in non-gluten sensitive people; GF products are more nutritious = GF products are generally more nutritious than their gluten containing variant; GF or GR diet is healthier = In general, a GF or GR diet is healthier for people than a full gluten

containing diet; Weight loss = A GF diet can help with weight loss. p-values compare the significant differences between GF groups.

***p<0.001

A larger percentage of GF consumers than non-GF consumers reported that they had been encouraged to try a GF diet (Figure 2.2). The differences in the proportion of GF consumer groups that were recommended to try a GF diet by various sources were all significant at p<0.001. Most non-GF consumers had not received a recommendation to try a GF diet (73.3% of non-GF consumers). In both groups, family and friends was the most common recommendation source (43.2% of GF consumers; 14.1% of non-GF consumers). The second most common recommendation source was "Healthcare center or health professional" (6.7% of full sample), which was concentrated among GF consumers (21.6% of GF consumers), which was a significant difference (p<0.001). Other sources that respondents indicated had recommended the GF diet included "TV personality, blogger, video blogger, and or celebrity" (6.3% of full sample); and "Self (including through personal research)" (6.3% of full sample). A larger proportion of people who marked that they self-recommended the diet were GF consumers (21.6% of GF consumers versus 1.9% of non-GF consumers), which constituted a significant difference (p<0.001).

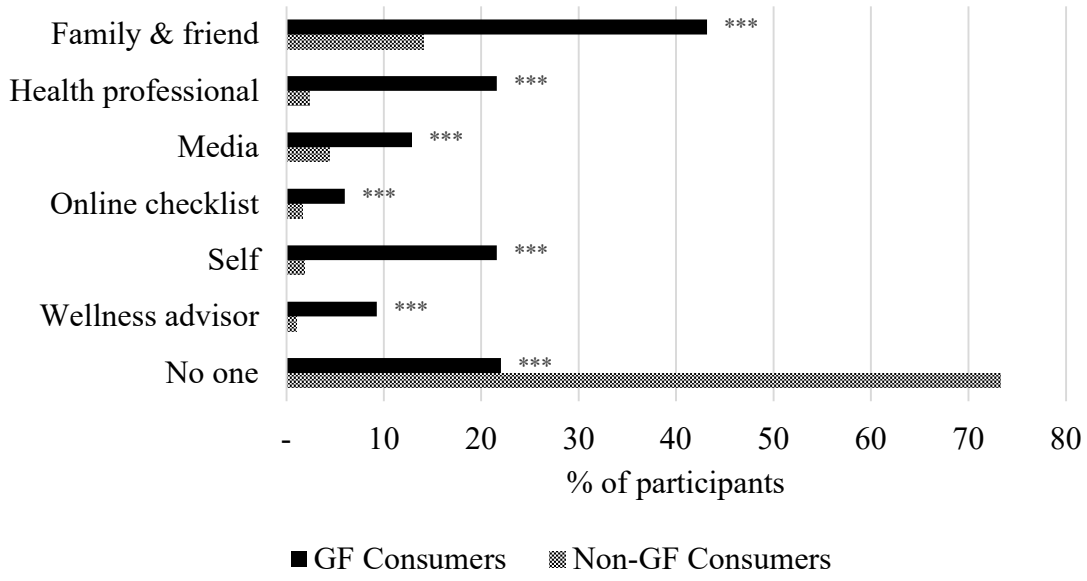

Figure 2. 2 Distribution of Participants who were Recommended to Try a GF Diet by an Information Source

Family & friends = Family member or friend; Healthcare professional = Healthcare center or health professional (doctor, dietitian, etc.); Media = TV personality, blogger, video blogger, and or celebrity; Self = Self (including through personal research); Wellness advisor = Wellness coach, personal trainer, and or sports coach/nutrition/fitness shop or gym employee; No one = No one (has ever suggested I try the diet). p-values compare the significant differences between GF groups. ***$p<0.001$.

GF consumers reported having more grain, gluten, and nutrition knowledge than non-GF consumers (Table 2.2). Less than a fourth of the sample population felt that they "have a lot of knowledge about grains" (17.7% of full sample) or "gluten" (9.2% of full sample). Compared to non-GF consumers, GF consumers felt more confident in their gluten knowledge ($p<0.001$): 23.7% of GF consumers agreed with the statement "I have a lot of knowledge about gluten" compared to 5.0% of non-GF consumers. GF consumers also felt more knowledgeable about nutrition than non-GF consumers ($p<0.001$): 53.4%

of GF consumers agreed with the statement "I have a lot of knowledge about nutrition" compared to 33.8% of non-GF consumers. GF consumers scored significantly higher on the gluten objective knowledge questions ($p<0.001$) (Table 2.3) but did not receive significantly different scores from non-GF consumers for either grains or nutrition objective knowledge.

Table 2. 2 Distribution of Participants' Subjective Knowledge of Grain, Gluten, and Nutrition

	Total Sample		GF Consumer		Non-GF Consumer		p-value
	Count	%	Count	%	Count	%	
Grain							<0.001
Agree	528	17.7	219	32.8	309	13.3	
Neutral	948	31.8	238	35.7	710	30.7	
Disagree	1506	50.5	210	31.5	1296	56.0	
Gluten							<0.001
Agree	274	9.2	158	23.7	116	5.0	
Neutral	731	24.5	263	39.4	468	20.2	
Disagree	1977	66.3	246	36.9	1731	74.8	
Nutrition							<0.001
Agree	1139	38.2	356	53.4	783	33.8	
Neutral	1010	33.9	198	29.7	812	35.1	
Disagree	833	27.9	113	16.9	720	31.1	

Note: Grain = I have a lot of knowledge about grain-based products; Gluten = I have a lot of knowledge about gluten; Nutrition = I have a lot of knowledge about nutrition. p-values compare the significant differences between GF groups (chi squared test).

Respondents were asked three questions about their health. GF consumers experienced more negative symptoms after consuming gluten-containing foods (1.46 ± 1.44) than non-GF consumers (0.24 ± 0.76) ($p<0.001$) (Table 2.3). Although the two GF groups were similarly satisfied with their overall health status, a larger percentage of GF consumers thought their eating habits were very healthy (51.1% of GF consumers) compared to non-GF consumers (34.4% of non-GF consumers) ($p<0.001$) (Table 2.4).

Table 2. 3 Mean and Standard Deviation of Participants' Objective Knowledge Scores and Number of Gluten Intolerance Symptoms

	Total Sample		GF Consumer		Non-GF Consumer		p-value
	Mean	SD	Mean	SD	Mean	SD	
Objective knowledge score							
Grain	0.32	0.20	0.31	0.22	0.32	0.20	0.450
Gluten	0.38	0.20	0.41	0.19	0.37	0.20	<0.001
Nutrition	0.43	0.23	0.43	0.24	0.43	0.23	0.380
Gluten intolerance symptoms							
Number of symptoms	0.52	1.08	1.46	1.44	0.24	0.76	<0.001

Note: Objective knowledge scores are on a scale of 0 to 1 while intolerance symptoms are on a scale of 0-9. Grain = grain-based products. Intolerance symptoms refers to the number of gluten-intolerance related symptoms the person marked that they experienced after consuming gluten. p-values compare the significant differences between GF groups (t-test).

Table 2. 4 Distribution of Participants' Perceived Health Status

	Total Sample		GF Consumer		Non-GF Consumer		p-value
	Count	%	Count	%	Count	%	
Health satisfaction							0.159
Satisfied	1423	47.7	340	51.0	1083	46.8	
Neutral	352	11.8	75	11.2	277	12.0	
Unsatisfied	1207	40.5	252	37.8	955	41.3	
My eating habits are very healthy.							<.0001
Agree	1138	38.2	341	51.1	797	34.4	
Neutral	1024	34.3	208	31.2	816	35.2	
Disagree	820	27.5	118	17.7	702	30.3	

Note: Health satisfaction = How satisfied are you with your current health status? p-values compare the significant differences between GF groups (chi squared test).

4.2 Model Results

Data were analyzed using a multivariate logistic regression model to determine how these independent variables influence a person's decision to eat GF, despite not having been diagnosed with CD or NCGS. In the regression, household income and age

were the only significant demographic variables (Figure 2.3). Younger respondents (19-44 years old) were more likely to have tried the GF diet (Odds Ratio (OR) 1.29; 95% Confidence Interval (CI) [1.02,1.64]), while respondents that had an annual household income of $100,000 or more were less likely to have gone on the diet (OR 0.70; 95% CI [0.51,0.98]).

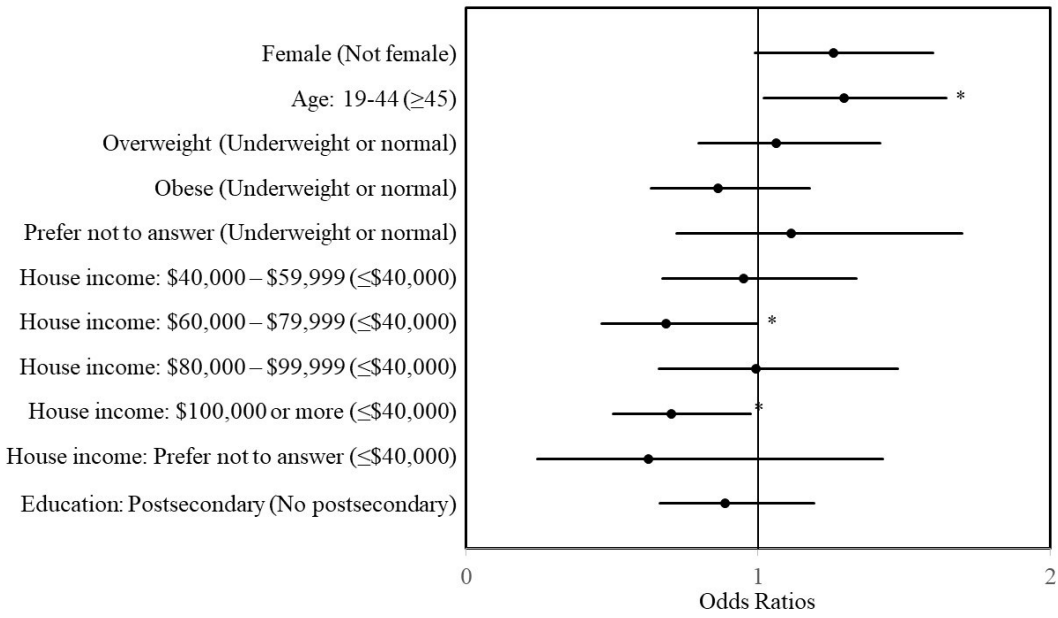

Figure 2. 3 Participant Demographic Characteristics Odds Ratios

Text in parentheses represent the reference category for each variable. *p<0.05.

People were more likely to try a GF diet if they believed the diet improved their health (Figure 2.4). Individuals who believed that a GF or gluten-reduced diet was healthier than a conventional full-gluten containing diet were significantly more likely to have tried the GF diet (OR 1.71; 95% CI [1.32,2.21]). This was followed by the belief that the GF diet helps with acne (OR 1.45; 95% CI [1.12,1.87]) and that GF products are more nutritious than their conventional gluten-containing version (OR 1.44, 95% CI [1.10,1.88]).

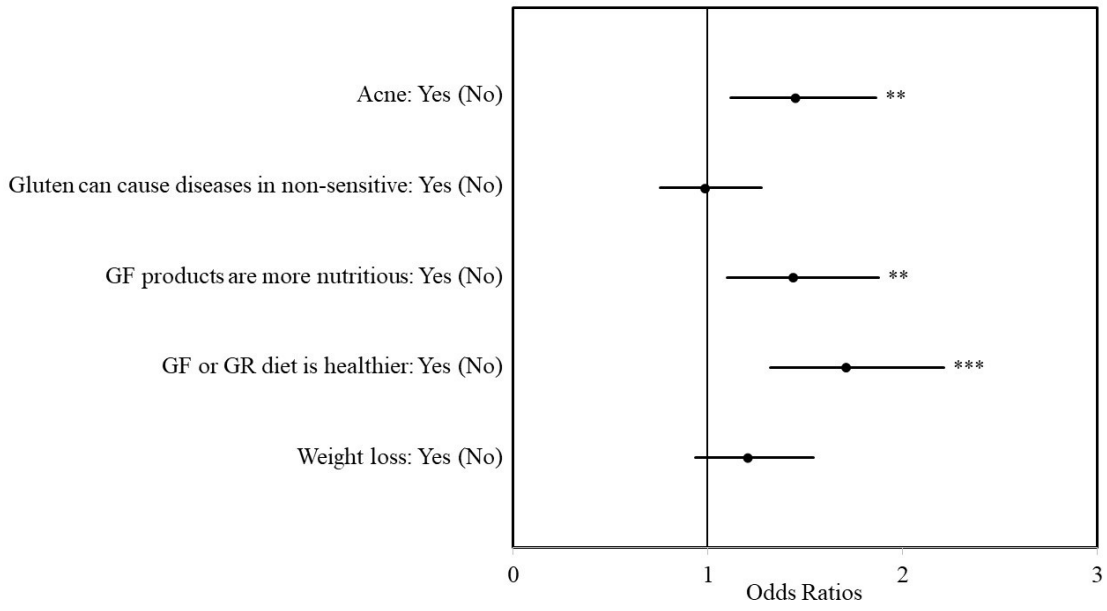

Figure 2. 4 Participants' Beliefs in GF Health Benefits Odds Ratios

Acne = A GF diet can help with acne; Gluten can cause disease in non-sensitive = Gluten can cause disease in non-gluten sensitive people; GF products are more nutritious = GF products are generally more nutritious than their gluten containing variant; GF or GR diet is healthier = In general, a GF or GR diet is healthier for people than a full gluten containing diet; Weight loss = A GF diet can help with weight loss. Text in parenthesis represent the reference category for each variable. **p<0.01, ***p<0.001.

Multiple sources of recommendation significantly influenced whether a person tried the GF diet (Figure 2.5). Self-suggesting, including through personal research, increased the odds of trying the diet the most (OR 2.93; 95% CI [1.92,4.52]), followed by "healthcare center or health professional (doctor, dietitian, etc.)" (OR 2.55; 95% CI [1.70,3.87]). A recommendation from a "wellness coach, personal trainer, and or sports coach/nutrition/fitness shop or gym employee" was also positively correlated with trying

a GF diet (OR 1.88; 95% CI [1.05,3.45]). Receiving no recommendation to follow a GF diet decreased the likelihood of trying the GF diet (OR 0.33, 95% CI [0.23,0.46]).

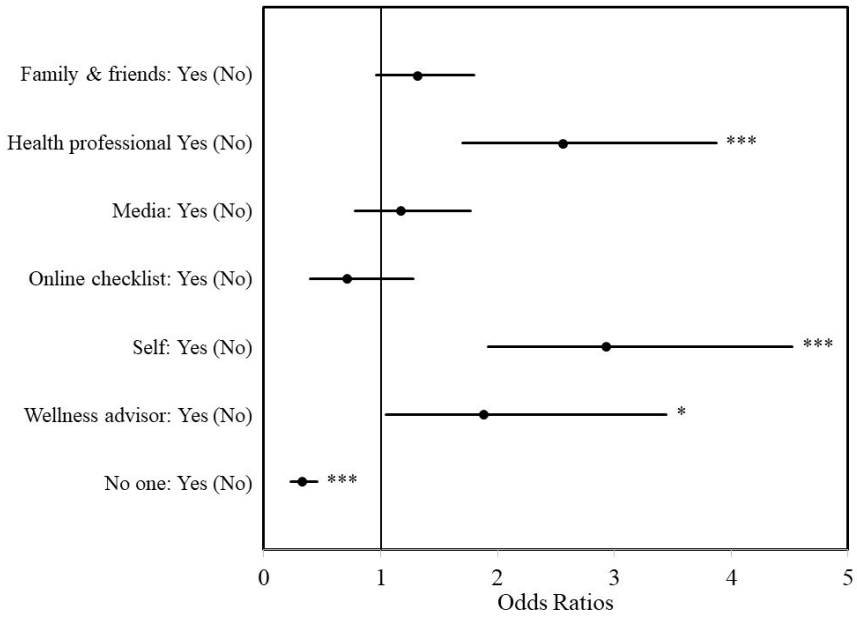

Figure 2. 5 Participants who were Recommended to Try a GF Diet by an Information Source Odds Ratios

Family & friends = Family member or friend; Healthcare professional = Healthcare center or health professional (doctor, dietitian, etc.); Media = TV personality, blogger, video blogger, and or celebrity; Self = Self (including through personal research); Wellness advisor = Wellness coach, personal trainer, and or sports coach/nutrition/fitness shop or gym employee; No one = No one (has ever suggested I try the diet). Text in parenthesis represent the reference category for each variable. *p<0.05, ***p<0.001.

The relationship of subjective and objective knowledge about grain-based products, gluten, and nutrition to eating a GF diet is presented in Figure 2.6. Agreeing (OR 2.34; 95% CI [1.54,3.56]) or feeling neutral (OR 2.45; 95% CI [1.82,3.30]) about the

statement “I have a lot of knowledge about gluten” increased the likelihood that an individual had tried the GFD.

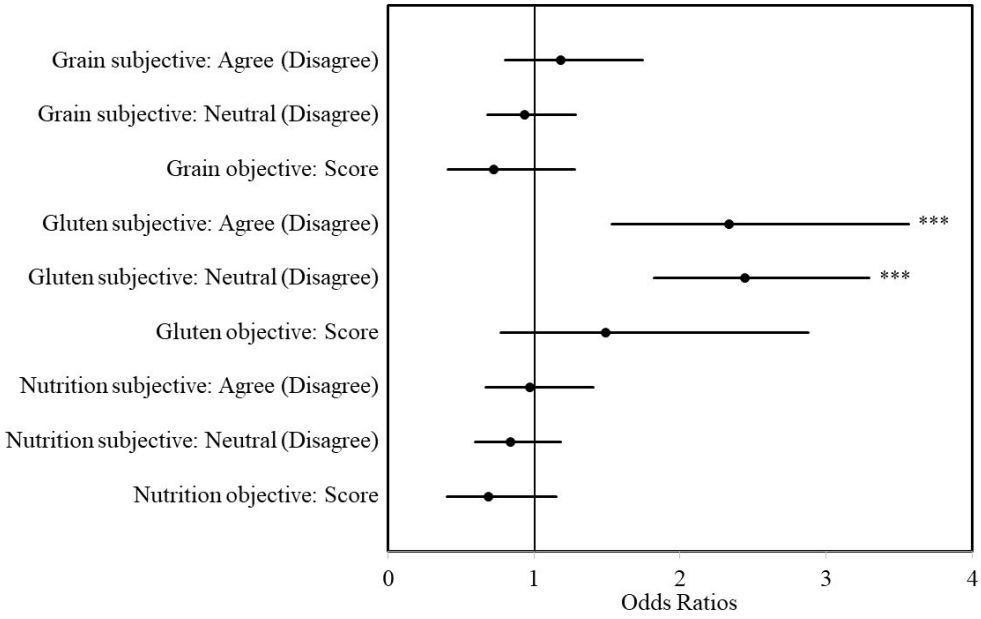

Figure 2. 6 Participants’ Subjective and Objective Knowledge of Grain, Gluten, and Nutrition Odds Ratios

Grain subjective = I have a lot of knowledge about grain-based products; Gluten subjective = I have a lot of knowledge about gluten; Nutrition subjective = I have a lot of knowledge about nutrition. [grain/gluten/nutrition] objective refers to their objective knowledge scores on a scale of 0-1 and calculated as a continuous variable. Text in parenthesis represent the reference category for each variable. ***p<0.001.

Experiencing more symptoms after consuming gluten increased the likelihood that a respondent had consumed the GF diet by 1.58 for each additional symptom (95% CI [1.44,1.73]) (Figure 2.7). Agreeing (OR 2.00; 95% CI [1.41,2.83]) or feeling neutral (OR 1.60; 95% CI [1.16,2.21]) about the statement “My eating habits are very healthy” also increased the likelihood that a respondent was a GF consumer.

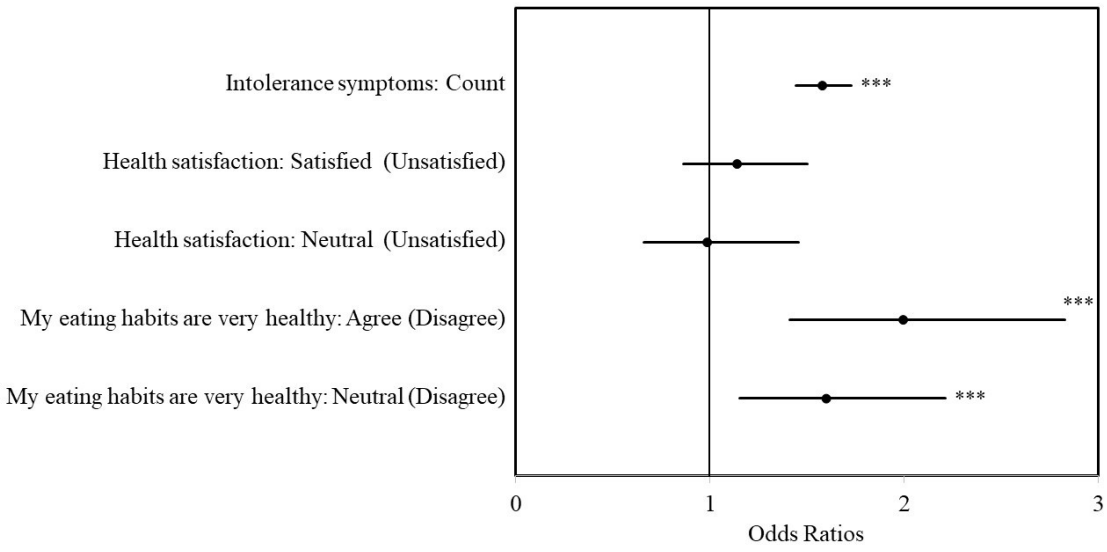

Figure 2. 7 Participants Perceived Health Status Odds Ratios

Intolerance symptoms refers to the number of gluten-intolerance related symptoms the person marked that they experienced after consuming gluten. Health satisfaction = How satisfied are you with your current health status? Intolerance symptoms were counted 0-9. Grain = grain-based products. There were up to 9 gluten-intolerance symptoms in the survey that a person could mark experiencing after gluten consumption. Intolerance symptoms are calculated as a continuous variable. Text in parenthesis represent the reference category for each variable. ***p<0.001.

5 Discussion and Conclusion

Eating a GF diet without a CD or NCGS diagnosis has gained popularity despite a lack of scientific evidence demonstrating its efficacy to help people achieve health goals commonly attributed to the diet. To understand why the GF diet has gained popularity, this research analyzes the influence that factors—such as beliefs, the source of

recommendation to try a GF diet, and knowledge—have on encouraging consumption of gluten-free foods.

An unexpected finding of this research is that believing the GF diet helps with weight-loss does not increase the likelihood that an individual has tried the diet after controlling for other variables. While this research corroborates previous reports that have documented that many people believe that eating a GF diet promotes weight-loss (Christoph et al., 2018; Newberry et al., 2017; Watson, 2013)—this was the most commonly held belief about health benefits of the GF diet among our sample—the belief did not lead people to try the GF diet.

On the other hand, we find that people are more likely to try a GF diet if they believe the diet can help with acne. A possible explanation is that GF consumers are also more likely to be in the age group that suffers from acne in adulthood. Adult acne does not significantly decrease until around age 45 (Goulden et al., 1999), and the model found that people ages 19-44 were more likely to be a GF consumer than people 45 and older.

The model also shows that people that believe that reducing gluten in one's diet improves the health of the diet are more likely to follow a GF diet. Thus, GF consumers are more likely than non-GF consumers to incorrectly treat gluten as a nutrient to limit, such as salt or sugar, rather than an allergen that must be avoided. Gluten must be completely removed for the GF diet to be effective at healing gastrointestinal symptoms of people with CD (Newberry et al., 2017). Yet, most respondents reported simply reducing their gluten-intake rather than exclusively following a GF diet. Additionally, GF consumers were more likely to perceive GF products as more nutritious than their gluten-

containing counterparts, when GF versions are usually the nutritionally inferior product, based on nutrition data (Christoph et al., 2018).

Results related to the source of recommendation to try a GF diet show that respondents that did their own research on the diet had the highest likelihood of following the diet. Self-diagnosis of a condition requiring a GF diet is not uncommon (Biesiekierski et al., 2014) and is an issue that should be addressed. In addition to being more likely to believe in unproven benefits of the diet, our model also identified that people who felt they had a lot of knowledge about gluten were more likely to have followed a GF diet. A person's lack of knowledge about the GF diet and when it is beneficial may lead to the unnecessary eating of the GF diet. Biesiekierski et. al. (2014) reported that a fourth of their sample that self-diagnosed themselves with a condition requiring a GF diet did so incorrectly and that the GF diet did not ameliorate their perceived health issues.

To better understand how to address self-diagnosing a GF diet, "self" as a source of recommendation needs further investigation to understand what people consider "personal research." It is unclear how people distinguish personal research from, for example, the information they read on the internet. While articles have blamed celebrities and media for promoting false GF beliefs and encouraging people to try a GF diet (Christoph et al., 2018; Howard, 2017; Jones, 2017; Newberry et al., 2017)**,** our research found that popular media was not significantly associated with a person eating GF. However, a possibility is that respondents may have first heard about the GF diet through popular media, but then conducted further research on their own, leading them to identify "self" as the ultimate recommendation source. Therefore, while a person may have

reported that they self-suggested the GF diet, the inclination and desire to do research may have stemmed from other sources.

Beyond self-suggesting the diet, many GF consumers were influenced to try a GF diet by wellness advisors and healthcare providers. This finding supports a study by Ianiro et al. (2016) that reported the occurrence of CD misdiagnosis by healthcare professionals in Italy. The study occurred at a clinic where patients came to confirm their CD diagnosis. The clinic identified that 43 of 107 (40.2%) patients were misdiagnosed with CD by a healthcare professional. Upon further inquiry, the clinic also found that over half of the 107 patients (55) had been improperly tested for CD (Ianiro et al., 2016). Therefore, it is possible that healthcare professionals may not thoroughly or correctly test patients before providing a diagnosis—or that patients misunderstand a professional's discussion of a possible condition as a statement of fact. Additionally, healthcare professionals could also be prematurely suggesting a GF diet before fully considering other possible causes of a patient's gastrointestinal symptoms, which may not be as prominent. Falling for an availability bias is a common issue among healthcare professionals (Wellbery, 2011); the increased recognition of CD and NCGS and the rising popularity of the GF diet may have created an availability heuristic.

An important limitation of this study is that because our data about following a GF diet are retrospective—we were unable to recruit and study people just as they made a decision to follow the GF diet—individuals who followed a GF diet have different experiences than those who have not tried a GF diet. This difference in experiences may have influenced some of the measures we collected to be independent variables, such as the subjective and objective gluten knowledge variables—both of which were

significantly higher among GF consumers than non-GF consumers, suggesting some potential for reverse causality. In practice, the only feasible way to conduct a large-scale survey of individuals at the point in time in which they choose whether to follow the diet would necessitate hypothetical choice, since actual choices are difficult to anticipate, which has its own weaknesses.

In conclusion, this research quantifies the influence of common GF perceptions and motivations to eat a GF diet for reasons other than CD or NCGS. Individuals are more likely to follow the diet if they believe GF is generally healthier than gluten-containing foods or if they convinced themselves to try the diet based on their own research, were recommended by healthcare professionals or by a wellness advisor. The identification of these influences is useful for understanding drivers of a behavior—following a GF diet—widely believed to be health-improving for the general population, but which may in reality provide inferior nutrition (Diez-Sampedro et al., 2019; Hallert et al., 2009; Vici et al., 2016).

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CHAPTER 3: POINT-OF-DECISION PROMPTS TO INCREASE FIBER DENSITY OF PRODUCT CHOICE

1 Abstract

Objectives: The prevalence of obesity in the United States is high and the consumption of dietary fiber among Americans is low. We examined the effect of a fiber-focused point-of-decision prompt (PDP) on consumer food purchase decisions and hypothesized that participants who were presented the dietary fiber PDP would choose products with a greater fiber density in the cereal, bread, and cracker categories. **Methods:** An online experiment that mimicked shopping decisions were created and distributed to 753 people across the United States. Some participants were presented the fiber focused PDP before making hypothetical purchase choices in the cereal, bread, and cracker category. Overall nutritional quality and fiber content of product choices were compared in the two conditions. **Results:** Participants in the PDP condition chose products that had a higher Guiding Star rating for cereals (Odds Ratio (OR): 1.45, 95% CI [1.10, 1.92]), bread (OR 1.44, 95% CI [1.09, 1.91]), and crackers (OR 1.66, 95% CI [1.25, 2.21]). Within all three categories, participants in the PDP condition also selected products that had more dietary fiber per serving than participants who were not presented the PDP. Participants in the PDP condition chose cereals that contained 3.93 g dietary fiber/serving (95% CI [3.64, 4.22]) while participants in the no-PDP condition chose products that had an average of 3.22 g dietary fiber/serving (95% CI [2.87, 3.57]) (p=0.002). Breads selected by PDP condition participants averaged 2.59 g dietary fiber/serving (95% CI [2.41, 2.77]) compared to breads selected by no-PDP condition participants which

averaged 2.13 g dietary fiber/serving (95% CI [1.93, 2.33]) (p=0.001). Cracker dietary fiber contained an average of 2.06 g/serving (95% CI [1.89, 2.23]) and 1.63 g/serving (95% CI [1.42, 1.84]) in products chosen by the PDP and no-PDP participants, respectively (p=0.002). **Conclusions:** Across the three product categories, participants who were presented the fiber focused PDP selected products that had a higher Guiding Star rating and contained more dietary fiber per serving.

Keywords: point-of-decision; fiber; food behavior; food choice

2 Introduction

The prevalence of obesity in the United States—which now affects every 4 in 10 Americans (CDC, 2020)—continues to increase, demanding that more must be done to combat this disease. The World Health Organization recognizes addressing the environment in which people make food choices as a strategy that can help reduce obesity. Such changes can facilitate long-term healthier eating habits at the population level (WHO, 2020). A place that has great potential for such environmental influences is the grocery store. Food purchased at grocery and other food retail outlets accounts for the majority of energy consumed by households (Drewnowski & Rehm, 2013) and these purchase decisions likely affect the nutritional quality of the household's diet for multiple days (Martinez et al., 2018; Papies et al., 2014). Up to 70% of grocery decisions occur at the store (Nielsen, 2016), suggesting that the grocery store environment can serve as a critical point in influencing people's food choices.

Current strategies in the grocery store environments (eg. nutrition labeling on food packages, health and wellness information on grocery websites, access to educational grocery tours, etc.), focus on providing nutrition information to consumers (Nikolova & Inman, 2015). While these strategies provide the tools to make a healthy judgment on food choices, more needs to be done to combat obesity. A newer strategy is to increase consumer motivation to eat healthy while they are at the store. Consumers may consider health in their shopping choices if they are presented a health-focused point-of-decision prompt (PDP) before making food choices. PDPs are motivational signage that is strategically located to encourage people to consider behaviors that lead to better health (Gustafson et al., 2018). The use of PDPs in the realm of food purchase

choices is a relatively new area of study, but Gustafson et. al. (2018) have found it to improve the healthiness of consumer grocery purchases.

In this research, we study the effect of a fiber PDP on food choices in three product categories that have a significant variation in fiber levels. We chose to focus on fiber because of its health benefits and the low average fiber consumption among Americans. Fiber consumption aids in weight management and decreases a person's risk for developing many of the same diseases that obesity increases the risk of (Quagliani & Felt-Gunderson, 2017; Warren et al., 2019). Yet currently, only 5% of Americans consume the recommended intake of fiber (14g/1000 kcal) (Hyland, 2018; Kranz et al., 2017). Over half of Americans' dietary fiber consumption comes from grain-based products, but nearly three-fourths of the grain-based fiber intake is from the high consumption of low-fiber refined grains (Kranz et al., 2017). The current makeup of the total dietary fiber intake among Americans includes 12% from bread, rolls, and tortillas, 6% from ready-to-eat cereals, and 6% from savory snacks and crackers. Americans' fiber consumption could be increased by motivating them to choose products within these categories that have a greater fiber density (Hoy & Goldman, 2014). For this reason, we chose to study the effect of the PDP on the cereal, bread, and cracker categories.

Though previous PDP studies have improved consumer food behavior simply by referencing and reminding consumers about health (Gustafson et al., 2018; Papies et al., 2014), the context of our PDP was designed to both remind and educate consumers about the benefits of fiber consumption. We chose to use our PDP as an educational tool because many are unaware of all of the health benefits of fiber (Food Insight, 2013). While the majority of Americans realize that fiber helps with digestion (85%) and weight

management (72%), far fewer realize that fiber also helps with heart health (52%) and blood sugar control (43%) (Food Insight, 2013). Even fewer Americans likely realize that fiber improves the gut microbiota since this is a new benefit that members of the scientific and health community are still working to fully document (Malochleb, 2020). Consumers may be more motivated to increase their fiber consumption if they understand its health benefits (Quagliani & Felt-Gunderson, 2017).

We implemented an online survey in April 2020 to simulate a shopping decision for cereal, bread, and crackers. Participants were randomly assigned to receive no prompt (control condition) or a PDP about the benefits of dietary fiber consumption (PDP condition). We hypothesized that participants who were presented the dietary fiber PDP would choose products with a greater fiber density than participants who were not presented the PDP prompt.

3 Methods

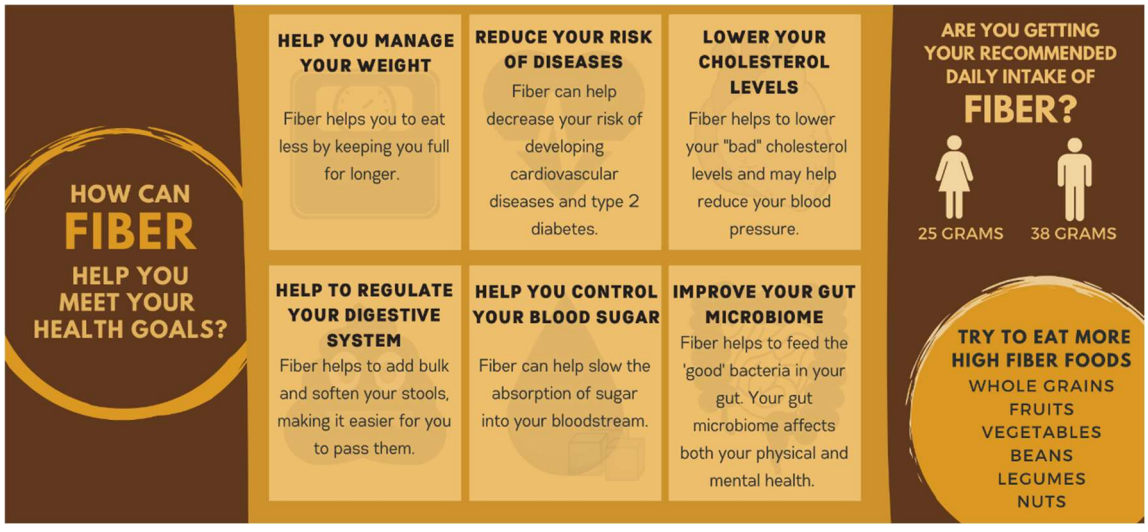
3.1 Survey Design

We used an online food choice experiment, designed to mimic a person's grocery shopping experience, to examine how people's grocery shopping choices are influenced when they are exposed to a PDP. The research consisted of two sections: a shopping task in which participants made hypothetical food choices from three product categories: bread, cereal, and crackers; and a survey. The survey included questions about product choices, typical shopping practices, and demographics. This survey was created in Qualtrics XM (2020, SAP, Provo, Utah) and distributed to adults (≥19 years old) in the United States via Amazon Mechanical Turk from April 15-20, 2020. The University of

Nebraska-Lincoln IRB approved the research (IRB protocol #20171017580EX). All participants provided informed consent before participating in the research.

Participants in the research were randomly assigned to a control group (no-PDP) or one of two PDP groups. Participants in the PDP groups viewed the PDP just before beginning the shopping task, while control-group participants immediately began the shopping task. The two PDP versions contained the same information about the health benefits of fiber consumption but differed slightly in the presentation of the message (Figure 3.1). One group saw a PDP that was written to evoke a personal connection to the messages, by using personal pronouns such as "you" and "your" throughout the messages. We refer to this condition as the *motivation PDP* (M-PDP). The message in the other group replaced the personal pronouns with impersonal articles. We refer to this condition as the *fact PDP* (F-PDP).

a. M-PDP



b. F-PDP

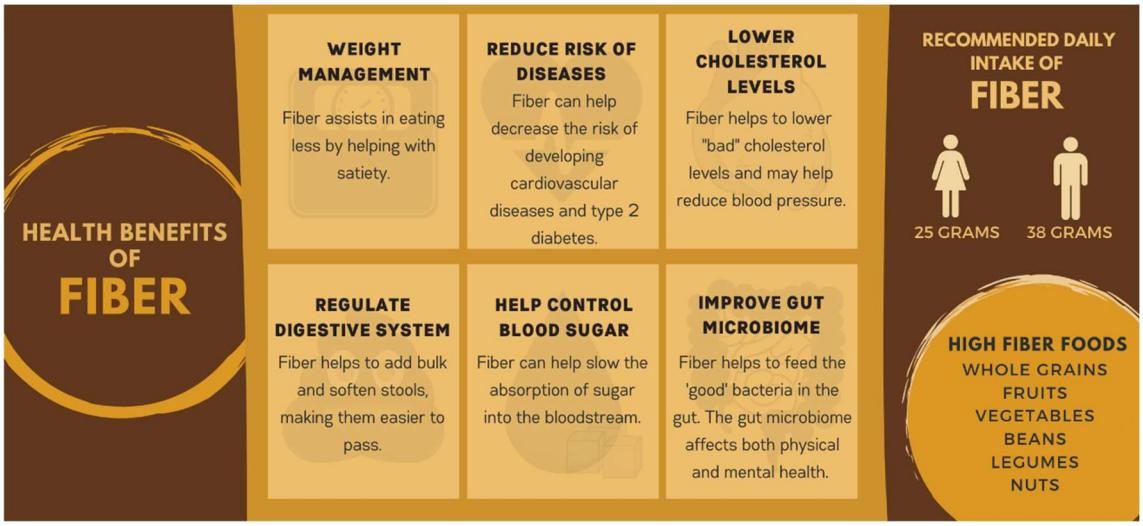


Figure 3. 1 Motivational and Fact PDP

Both PDPs describe the same information. The difference between the M- and F-PDP is how the information is presented. The Motivation PDP uses personal pronouns in an effort to connect the benefits to the reader, while the F-PDP states benefits of fiber using general, factual terms.

In the shopping task, participants made cereal, bread, and cracker choices. Participants read introductory text about the shopping task at the start of the survey that told them to imagine they were making real choices with real money, which has been found to reduce biases in responses to hypothetical choices (Lusk, 2003). Before choosing the specific item to purchase, participants decided whether to examine all product options (N=33 for each of cereal, bread, and crackers) or to view a subset of products (n=11 per category). We refer to these product sets as the participants' *consideration sets*. The subsets categorized the products into less healthy, moderately healthy, and healthy options, using a rubric as described below. To avoid prompting participants to think of the subgroups according to the health of the products, the subsets were instead described by the types of products they contained. For example, the cereal

sets were labeled as “Cereals such as Frosted Flakes, Froot Loops, Reese's Puffs”, “Cereals such as Corn Flakes, Crispix, Special K”, “Cereals such as Cheerios, Wheat Chex, Grape Nuts,” and “All options.” We assume that participants in the US will be familiar with these cereals because these cereals are very common in grocery stores across the US.

A rubric was used to separate foods based on their nutrient contents into less healthy, moderately healthy, and healthy by assigning a star rating to each food product (Guiding Stars, https://guidingstars.com/), ranging from 0 = least healthy to 3 = most healthy. The Guiding Stars system grades the healthiness of the product on a 0 to 11-point scale based on their nutrient content. Products gain points based on meeting certain thresholds for vitamins, minerals, fiber, whole grains, and omega-3 fatty acids; and lose points for surpassing amounts of saturated fat, trans fat, added sodium, added sugar, and artificial colors in a standardized 100-calorie portion. From this score, products receive zero stars if they received 0 points on the scale, or one (1-2 points), two (3-4 points), or three (5-11 points) stars. More details about their scoring method can be found on the Guiding Stars website: https://guidingstars.com. In our study, the less healthy, moderately healthy, and healthy subsets consisted of products with zero, one, and two or three stars, respectively. Two and three-star rated products were combined into one subset because there were not enough three-star product options to create a separate category. There were three three-star rated products to choose from in both the cereal and bread categories and one three-star rated product in the cracker category.

After selecting a consideration set for a product category, participants were then able to select a product to “purchase.” If a participant did not like any of the products,

they had the option to go back and select a different consideration set or to decline to purchase a product for that product category. The no-product option was always listed as the last option, while all other products were presented in random order. The product options were presented in a three-column format with a photograph and the name of each product presented prominently. Underneath each product, the nutrient content per serving for calories, fiber, fat, sodium, and sugar, as well as the price was listed (Figure 3.2).

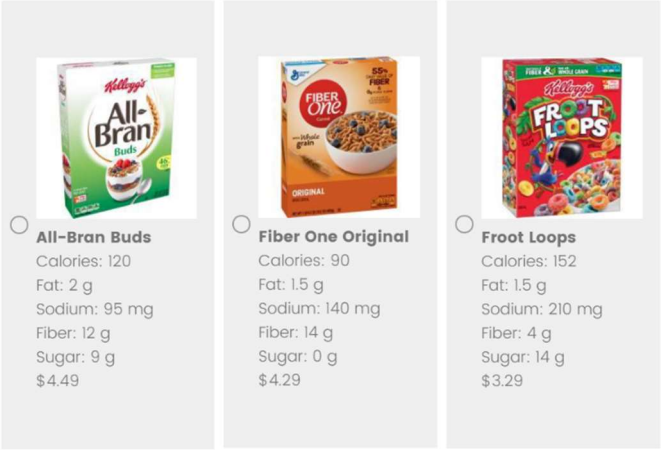


Figure 3. 2 Preview of Product Choices

A preview of how product choices and product information were presented for consumers to select from. This figure displays the cereal product options within the "All options" consideration set. There were 11 *less healthy, moderately healthy, and healthy* cereal products to choose from, totaling 33 product options.

After making product choices, participants answered survey questions about their choices, typical shopping practices, and demographics. These questions were not used in this paper's analysis and will not be discussed in-depth.

3.2 Survey Analysis

The survey data were analyzed using R (R Core Team, 2019). Summary statistics, ordinal regression, linear regression, chi-square tests, and t-tests were used to analyze

demographic data and differences in the healthiness of product choices (dependent variable) between PDP condition groups (independent variable). We analyzed the outcomes of the PDP separately for cereal, bread, and crackers. We consider p-values < 0.05 to be statistically significant.

The healthiness outcome is determined in two ways:

1) We determined the influence of the PDP on the healthiness of product choices. The healthiness of products was determined by its Guiding Star rating which ranged from zero to three stars. The Guiding Stars rating of choices was used as the dependent variable in an ordinal regression model. Zero stars, the lowest Guiding Star rating, was used as the reference category for the dependent variable.
2) We determined the influence of the PDP by the fiber and other nutrient contents of participants' food choices. For each of the nutrients, we calculated the mean content per serving with 95% confidence intervals. T-tests were used to determine significance in mean difference between PDP conditions. We further investigate if any significant differences in the other nutrients are the result of these nutrients being correlated with higher fiber products. For each of the nutrients, we created a linear regression, where the nutrient content of product choices was the dependent variable and the fiber content was the independent variable. This linear regression provided how much the nutrient content increased per 1 g fiber. To quantify how much nutrients changed due to correlations, this value was then multiplied by the difference in mean g dietary fiber/serving between PDP conditions.

Initially, we examined PDP versus no-PDP as a binary variable by pooling participants in the M- and F-PDP conditions to create a pooled-PDP group (P-PDP). We compared the P-PDP to the no-PDP, where the no-PDP condition was used as the reference group. We then examined differences between the M-PDP and F-PDP conditions. The F-PDP was used as the reference group. Results from the M-PDP and F-PDP models are not reported in this paper because we found no significant differences in their outcomes. Participants that indicated they would not choose any of the products in a product category were excluded from the analyses for that specific category.

Note that demographic variables were not included in this model. Since participants were randomized into conditions, demographic variables should not affect the impact of the PDP. As a robustness check, all analyses were additionally conducted with the demographic variables included. The inclusion of demographic variables did not affect the estimated impact of the PDP but did require more participants to be dropped from the data set because of "prefer not the answer" responses. We chose to report the version without the demographic variables for simplicity and to avoid removing additional participants from the cereal, bread, and cracker models. The regression results with demographics included can be found in Appendix B.

4 Results

4.1 Participant Demographics

In total, 753 participants completed the experiment. There were 253 participants in the no-PDP condition, 251 in the M-PDP condition, and 249 participants in the F-PDP condition (and therefore 500 in the P-PDP condition). No significant differences existed for demographics between the P-PDP and no-PDP conditions, or the M-PDP versus F-

PDP conditions. Table 3.1 reports demographic information. Of the 753 participants, 35.6% of the participants were female, 63.6% were male, and 0.8% preferred not to disclose. Most of the participants were within the age of 25-34 y (47.4% of the sample population) or 35-44 y (25.8% of the sample population).

Table 3. 1 Characteristics of Sample Population.

	Total (n=753)	no-PDP (n=253)	M-PDP (n=251)	F-PDP (n=249)
	Count	%	%	%
Gender				
Female	268	36.0	36.3	34.5
Male	479	63.6	62.9	64.3
Prefer not to answer	6	0.4	0.8	1.2
Age				
19-24	40	4.7	5.2	6.0
25-34	357	47.0	47.0	48.2
35-44	194	25.3	24.7	27.3
45-54	103	14.2	15.1	11.6
55-64	43	7.9	4.8	4.4
65 and older	12	0.8	2.4	1.6
Prefer not to answer	4	0.0	0.8	0.8
Household Income				
Less than $20,000	54	7.1	6.8	7.6
$20,000 - $39,999	146	17.4	19.1	21.7
$40,000 - $59,999	177	24.1	23.1	23.3
$60,000 - $79,999	179	23.3	24.7	23.3
$80,000 - $99,999	100	14.6	12.7	12.4
$100,000 or more	87	12.6	12.0	10.0
Prefer not to answer	10	0.8	1.6	1.6
Education				
Less than high school	2	0.4	0.4	0.0
High school/G.E.D.	80	10.3	10.8	10.8
Associate's degree or some college	124	18.6	15.1	15.7
Bachelor's degree	400	49.0	55.8	54.6
Advanced degree (master's level or higher)	143	21.7	17.5	17.7
Prefer not to answer	4	0.0	0.4	1.2

Note: There were no significant differences between conditions (chi-squared test).

4.2 PDP Effect on Guiding Stars Ratings of Choices

Odds ratios were used to report the effect of the P-PDP on the Guiding Star rating of products selected (Figure 3.3). Exposure to the PDP led participants to choose a product with a higher Guiding Star rating for cereals (Odds Ratio (OR): 1.45, 95% CI [1.10, 1.92]), bread (OR 1.44, 95% CI [1.09, 1.91]), and crackers (OR 1.66, 95% CI [1.25, 2.21]).

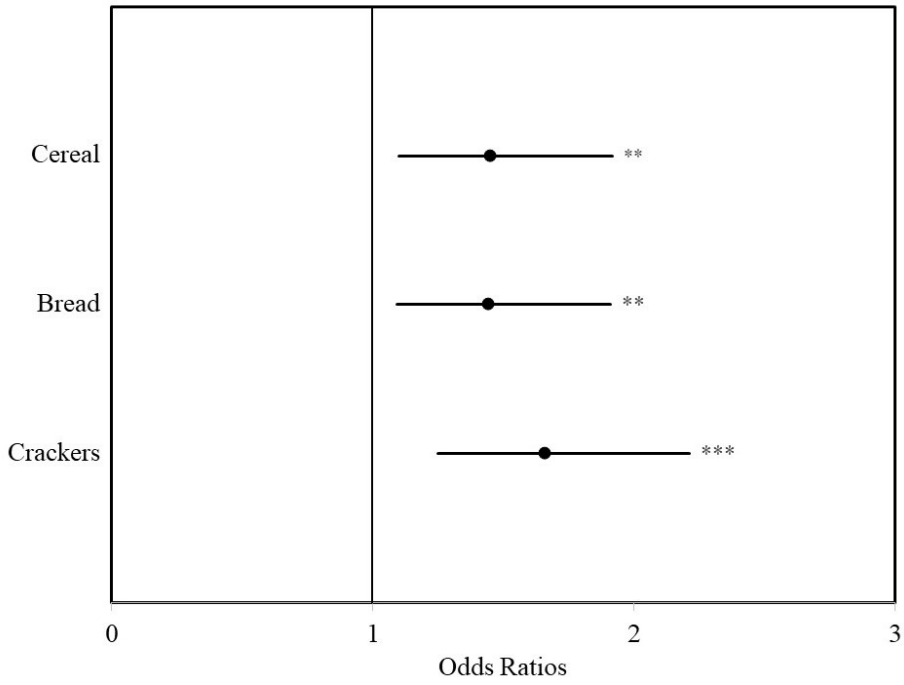


Figure 3. 3 Influence of a PDP on Healthiness of Choices Odds Ratios

The comparison shows how the relationship between the PDP condition (versus the no-PDP condition, reference category) and the Guiding Star rating of their choices (0=least healthy; 3=most healthy). There were 34, 28, and 28 participants removed from the cereal, bread, and cracker models, respectively. *p<0.05 **p<0.01 ***p<0.001

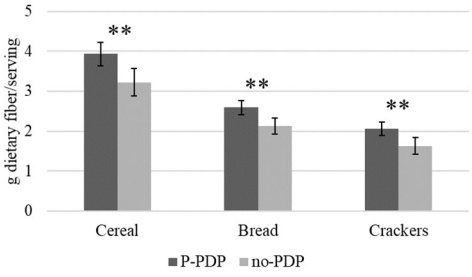
4.3 PDP Effect on Nutrition Content of Choices

Next, we examined how the PDP influenced the nutrient content of participants' cereal, bread, and cracker choices (Figure 3.4). The nutrient content range within the Guiding Star ratings for the cereal, bread, and cracker categories can be found in Appendix C. Differences by condition was found in the fiber, calories, fat, and sugar in at least one product category. Significant differences between the PDP groups existed within all three product categories. The dietary fiber in the chosen cereal products ranged from 0-14 g/serving, with an average of 3.93 g/serving (95% CI [3.64, 4.22]) in products chosen by the P-PDP group and 3.22 g/serving (95% CI [2.87, 3.57]) in products chosen by the no-PDP group ($p=0.002$). For the bread category, the fiber ranged between 0-8 g/serving. Participants in the P-PDP condition chose breads with an average of 2.59 g/serving (95% CI [2.41, 2.77]), while participants in the no-PDP condition averaged 2.13 g/serving (95% CI [1.93, 2.33]) ($p=0.001$). The dietary fiber content in the cracker products ranged between 0-7 g/serving. Crackers chosen by participants in the P-PDP condition had an average of 2.06 g dietary fiber/serving (95% CI [1.89, 2.23]) while the average by the no-PDP condition was 1.63 g/serving (95% CI [1.42, 1.84]) ($p=0.002$).

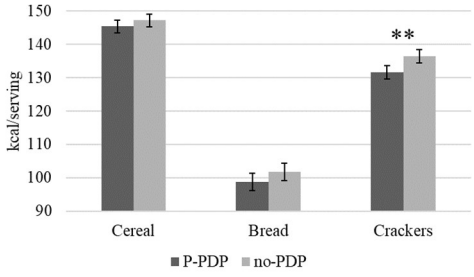
The average calorie content of products chosen in the P-PDP and no-PDP groups was only significantly different within the cracker category. The calories per serving for cracker choices ranged between 67-150 kcals. The average calorie content of crackers chosen by participants in the P-PDP group and the no-PDP group were 132 kcal/serving (95% CI [130, 134]) and 137 kcal/serving (95% CI [134, 139]) respectively ($p=0.002$). Differences in the grams of fat per serving between choices made by the P-PDP and no-PDP participants were also significantly different within the cracker category. Fat content

in cracker products ranged from 0-7 g/serving. Choices made by the P-PDP participants had a lower mean fat content (4.98 g/serving, 95% CI [4.76, 5.20]) compared to choices made by the no-PDP participants (5.61 g/serving, 95% CI [5.30, 5.92]) (p=0.001). The sugar content of the cereal products ranged between 0-16 g/serving. Cereals chosen by the P-PDP participants had an average of 7.77 g sugar/serving (95% CI [7.36, 8.18]) while choices made by the no-PDP participants had an average of 8.53 g sugar/serving (95% CI [7.96, 9.10]) and (p=0.033).

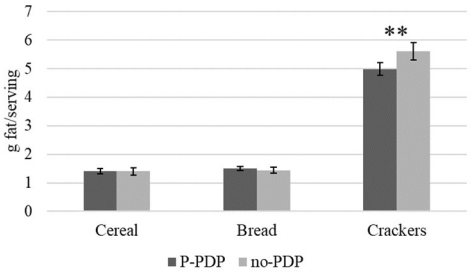
a. Fiber



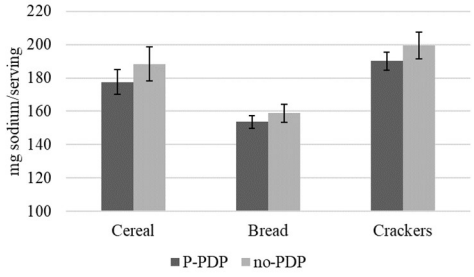
b. Calories



c. Fat



d. Sodium



e. Sugar

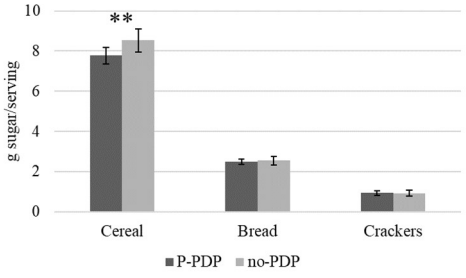


Figure 3. 4 P-PDP and no-PDP Mean Nutrition Content in Product Choices

Displayed is the mean nutrition content within product choices. Error bars represent the confidence interval around the mean. p-values compare significant differences between the mean nutrition content of product choices made by the P-PDP and the no-PDP condition (t-test). **$p<0.01$.

Next, we determined how much of the significant differences found in the calorie and fat content of cracker options and the sugar content of cereal options were due to the nutrient correlating with the fiber content [Table 3.2]. For every additional gram of dietary fiber, the calorie content in crackers decreased by 10.12 (95% CI [-12.13, -8.10]) kcals/serving. Given that the PDP influenced a 0.43 g fiber/serving increase in product choices, a decrease of 4.35 kcals/serving were due to correlations between the fiber and calorie content of product options. For every additional gram of dietary fiber, the fat content of crackers decreased by 0.94 g fat/serving (95% CI -1.29, -0.59]), thus 0.40 g fat/serving were from correlations between the fiber and fat content of product options. For every additional gram of dietary fiber, the sugar content of cereals decreased by 0.74 g sugar/serving (95% CI [-1.21, -0.26]). Given that the PDP influenced a 0.71 g fiber/serving increase in product choices, a decrease of 0.52 g sugar/serving were due to correlations between the fiber and calorie content of product options.

Table 3. 2 Correlation of Fiber Content to Other Nutrients

	Estimate	CI Low	CI High	
Cereal				
Calories (kcal)	-3.52	-5.22	-1.83	***
Fat (g)	0.03	-0.09	0.15	
Sodium (mg)	-10.26	-19.21	-1.31	*
Sugar (g)	-0.74	-1.21	-0.26	**
Bread				
Calories (kcal)	1.47	-5.13	8.08	
Fat (g)	0.09	-0.11	0.28	
Sodium (mg)	1.68	-7.94	11.31	
Sugar (g)	0.24	-0.05	0.54	
Crackers				
Calories (kcal)	-10.12	-12.13	-8.10	***
Fat (g)	-0.94	-1.29	-0.59	***
Sodium (mg)	-20.21	-31.32	-9.09	***
Sugar (g)	-0.25	-0.45	-0.04	*

Note: *p<0.05 **p<0.01 ***p<0.001

5 Discussion and Conclusion

Our research corroborates with earlier findings of the effects of PDPs on the nutritional quality of food choices (Gustafson et al., 2018; Papies et al., 2014). In this research, we determined the effect of a PDP highlighting the benefits of dietary fiber consumption on the healthfulness of cereal, bread, and cracker products chosen in a grocery store environment. In all three product categories, participants in the P-PDP condition were more likely to choose higher Guiding Star rated products and products that contained a greater fiber density compared to participants in the no-PDP condition.

Though the fiber increases are less than 1 g dietary fiber/serving consumers likely eat several servings per day across these categories of products, meaning their daily fiber intake could increase by a few to several grams. Currently, the majority of consumer

grain-based fiber consumption comes from the high consumption of low fiber foods, so increasing the fiber in products consumers choose to eat will show noticeable increases in their daily consumption of dietary fiber. Participants in the P-PDP condition also selected products that had lower mean calorie and fat content and cereals that had lower sugar content. However, the higher fiber crackers offered in the experiment had lower amounts of calories and fat and the higher fiber cereals had less sugar in them than the lower fiber versions. The significant differences in the other nutrients may be a result of consumers choosing higher fiber products.

Inattentiveness to long-term goals, such as health during decision-making, has been documented in extensive literature on executive function (Allan et al., 2016; Nelson et al., 2019). Low executive function is associated with the inability to successfully ignore short-term temptations – such as taste - over long-term rewards that have less of an immediate benefit – such as health (Allan et al., 2016). PDPs may work better than the nutrition information at reminding consumers of their long-term health. Laboratory studies that simultaneously capture behavioral and neurocognitive data provide evidence on how PDPs may remind one of their long-term health goals. Hare et al. (2011) discovered that people experience different neural activations when prompted to think about health before making food choices compared to when they are prompted to think of taste or not prompted at all. The neural activation of health-primed individuals resembled dieters who successfully exerted self-control during food choice in an earlier study (Hare et al., 2009). Behaviorally, health-primed individuals placed greater value on health attributes and as a result, were more likely to choose a healthy item (Hare et al., 2011). PDPs may be able to help consumers value their long-term goals over short-term rewards

by recruiting neural systems that are necessary for self-control. However, future research would like to investigate if the PDP affects steps in decision making.

The WHO recommends creating personal relevance to health issues for the audience as a component of creating effective health communications (WHO, 2017). We aimed to make the M-PDP more relevant to our readers by connecting the health benefits of fiber consumption to the reader through the usage of personal pronouns. However, our study found no significant differences in the healthiness of product choices between participants in the M- and F-PDP conditions. Given the high prevalence of obesity in the United States (CDC, 2020), it is possible that people may already feel a personal connection from reading the F-PDP. Another possibility is that simply changing articles (e.g., "the risk") to personal pronouns (e.g., "your risk") is not enough to effectively personalize the message.

An interesting aspect of this paper is that the data were collected during the midst of the COVID-19 pandemic. We collected our data from April 15th - 20th of 2020 amid the COVID-19 outbreak in the US. The COVID-19 pandemic has led to increased stress in individuals and an economic downturn. During this time a third of US consumers reported experiencing a high level of psychological distress (Keeter, 2020) and increased purchases of less healthy foods (Creswell, 2020). Historically, people consume more unhealthy foods when under these types of pressures (Creswell, 2020). Despite consumers feeling stressed, our study still found that the PDP encouraged healthier choices. Our PDP might have shown greater influential results if the data had not been collected during the COVID-19 pandemic. In future work, it may be interesting to re-distribute this online simulation once the COVID-19 pandemic has passed. This would

allow us to compare the effect of the PDP during and not during a time when consumers are experiencing high levels of stress.

Simulating the shopping experience online allows our findings to relate to online grocery shopping experiences. Our research is particularly relevant for the growing segment of the population purchasing groceries online or through an app. An increasing number of consumers have begun to do their grocery shopping online. In 2018, the Food Marketing Institute and Nielsen predicted that nearly three-fourths of consumers will do their grocery shopping online by 2024 (Nielsen, 2018). As of 2019, over 36% of Americans reported they purchased groceries online (Redman, 2019). More people have since reported transitioning to their grocery shopping online due to the COVID-19 pandemic (Food Insight, 2020). With the transition from brick-and-mortar to e-commerce grocery shopping, policymakers, researchers, and public health professionals must understand how to encourage healthier food choices in an online grocery shopping platform. The findings in our study support presenting a health PDP on the computer screen before consumers begin to fill their online grocery cart.

A limitation of this study is that product choices were hypothetical. By choosing hypothetical products, participants may have been urged to take less time to observe product options or read product nutrition information. We address this potential bias through the use of a "cheap-talk" script prompting participants to imagine they are making real choices and facing the same budget constraints they do in real life, which has been found to reduce hypothetical bias (Lusk, 2003).

In conclusion, our data show that participants who were presented a PDP about the health benefits of fiber made healthier product choices within the cereal, bread, and

cracker categories by leading consumers to select products with higher fiber. This study adds to the burgeoning literature about the use of health PDPs to promote healthy food choices.

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CHAPTER 4: POINT-OF-DECISION PROMPTS PROMOTE ATTENTION TO HEALTHIER PRODUCTS AND NUTRITION INFORMATION, LEADING TO SELECTION OF FOODS WITH HIGHER DIETARY FIBER

1 Abstract

Objectives: Health-focused point-of-decision prompts (PDP) can influence consumers to purchase healthier food products. We use a fiber-focused PDP to examine how the PDP influences consumers to select healthier products. We hypothesize that presenting the PDP will influence consumers to focus their attention to a healthier set of product options and to consider the fiber content of products when making their purchase choices. **Methods:** An online experiment that mimicked shopping decisions was created and distributed to 753 people across the United States. Participants were randomized assigned to either a fiber focused PDP or a no-PDP condition before making hypothetical purchase choices in the cereal, bread, and cracker category. For each of the food types, participants had the opportunity to select to view a subset of products—or all products—before making a product choice. After completing the choice process, they indicated the nutrient information they considered in their decision process. We examined differences in product sets and the nutrient information between conditions. **Results:** Participants in the PDP condition were more likely to consider all product options or only healthy options in the cereal (healthy Odds Ratios (OR) 1.73. 95% CI [1.13, 2.64]; all options OR 1.73 (95% CI [1.10, 2.74]) and cracker food categories (all options OR 2.33, 95% CI

[1.48, 3.66]; healthy OR 2.00, 95% CI [1.30, 3.09]). Participants in the PDP condition were also more likely to consider the fiber content of cereal (OR 2.24, 95% CI [1.64, 3.08]) and crackers (OR 1.99, 95% CI [1.43, 2.79]) options. **Conclusions:** The fiber PDP influenced healthier purchase choices by leading consumers to consider to healthier product options and promoting attention to fiber content of product options.

Keywords: point-of-decision; fiber; food behavior; food choice; nutrition labeling

2 Introduction

Environmental triggers promoting healthier food choices are a strategy for combatting rising obesity rates in the United States (CDC, 2020; WHO, 2020). Current environmental interventions in the grocery store setting primarily focus on providing nutrition information to help consumers make informed judgments about the healthiness of their food choices (FMI, 2012; Nikolova & Inman, 2015). However, the effect of nutrition information on choice is limited by consumer motivation to use it (Rawson et al., 2008; van Herpen & van Trijp, 2011). Tasking participants in an experiment to find food products that match assigned health goals can increase the use of nutrition information to make purchase decisions (van Herpen & van Trijp, 2011). Consumers who are presented with health-focused messages or primes before making food choices select healthier products on average (Gustafson et al., 2018; Papies et al., 2014).

Point-of-decision prompts (PDPs) constitute messaging that is strategically located to encourage people to consider behaviors that lead to better health (Gustafson et al., 2018). Consumers who are presented with health-focused PDPs before making food choices tend to select healthier products (Gustafson et al., 2018), possibly by recruiting neural systems that are necessary for self-control and causing individuals to more immediately consider the health attributes of foods during decision-making (Hare et al., 2009; Sullivan et al. 2015; Lim et al. 2018).

A fiber-focused PDP could be used improve the chronically low intake of this nutrient among the population of the US as well as a general lack of knowledge about the importance of consuming adequate amounts of dietary fiber. Currently, only 5% of Americans consume the recommended daily amount of fiber (14g/1000 kcal) (Hyland,

2018). The low intake may be partially due to people not realizing the importance of fiber in the diet. Most Americans recognize that fiber aids in digestion and weight management, however far fewer realize that it also helps with heart health, blood sugar control, and the gut microbiota (Food Insight, 2013; Malochleb, 2020). Educating consumers about the benefits of dietary fiber may increase their interest in eating more dietary fiber (Quagliani & Felt-Gunderson, 2017).

Previously, we investigated if a fiber PDP that educated consumers about the health benefits of dietary fiber results in healthier cereal, bread, and cracker purchases. We chose to focus on these three categories because grains, a major ingredient in all three categories, contribute to over half of Americans' dietary fiber consumption, but nearly three-fourths of the grain-based fiber intake is from the consumption of low-fiber refined grains (Kranz et al., 2017). Fiber density of foods is important for preventing the overconsumption of energy because foods that contain a greater amount of fiber per serving tend to take longer to eat and contain less calories per serving (Mayo Clinic, 2018). The current makeup of the total dietary fiber intake among Americans includes 12% from bread, rolls, and tortillas, 6% from ready-to-eat cereals, and 6% from savory snacks and crackers. Americans' dietary fiber consumption could be increased by motivating them to choose products within these categories that have a greater fiber density (Hoy & Goldman, 2014). The results of our work showed that the PDP influenced consumers to choose products that had a greater fiber density. However, it is unclear how the PDP influenced consumers to change their shopping behavior that resulted in healthier choices.

Van Herpen & van Trijp (2011) suggested that tasking consumers to consider health and diet in their product choices reminds them to use the NFPs on food packages to help make their food choices. A PDP may encourage a consumer to consider the NFPs more fully when making food choices, but it is unlikely that consumers will consider all possible NFPs in a product category. Masatlioglu et al. (2012) argued that it is unreasonable to assume that people consider all feasible options, suggesting that people limit their choices to a consideration set—a subset of the available products—because they are cognitively unable to consider all options (Masatlioglu et al., 2012). This is quite plausible in a grocery store setting, where the average store carries nearly 39,000 items (Nielsen, 2016).

In addition to choosing from a consideration set due to cognitive and time constraints, the product organization on store shelves encourages consumers to shop in such a way. For instance, in the breakfast cereal aisle in a grocery store many stores have created "Kids' Cereal," "Family Favorites," and "Healthy" subcategories on the cereal shelves (Figure 4.1). In general, Kids' Cereal consists of breakfast cereals that are low in fiber and high in added sugar; the Family Favorites consist of cereals that contain moderate amounts of fiber and added sugar; and Healthy consists of cereals that are high fiber and low in added sugar.

This subcategorization of cereals is also observed online. When shopping for cereals on Walmart's website (https://www.walmart.com/search/?query=cereal), the top of the page provides suggested categories to refine the search by: "New Cereal Favorites", "Kids' Classic Cereal", "Family Favorite Cereal", "Healthy Cereal", and "Granola & Muesli" (Figure 4.2). Again the "Kids' Classic Cereal", "Family Favorite

Cereal", "Healthy Cereal" largely translate into less healthy cereals, moderately healthy cereals, and healthy cereals. This sort of health-segregated organization is possible in all packaged food categories. Food companies work with food retailers to decide where their products are placed on the grocery store shelves and so it is likely that products are organized on the shelves by brands (Ruhs, 2017). But a company's product line may be more focused on products that are less healthy or healthy and so to the consumer the shelf layout appears to have healthier and less healthy choices separated.

Figure 4. 1 Kid's Classic Subsection of Cereals on Grocery Shelves

Hyvee, a midwest grocery chain with over 200 stores, has created subcategories for cereals. The "Kids Cereal" primarily contains low fiber, high sugar cereals. This photo was taken in Hyvee, a midwest grocery chain, located on 5020 N 27th St, Lincoln, NE 68521.

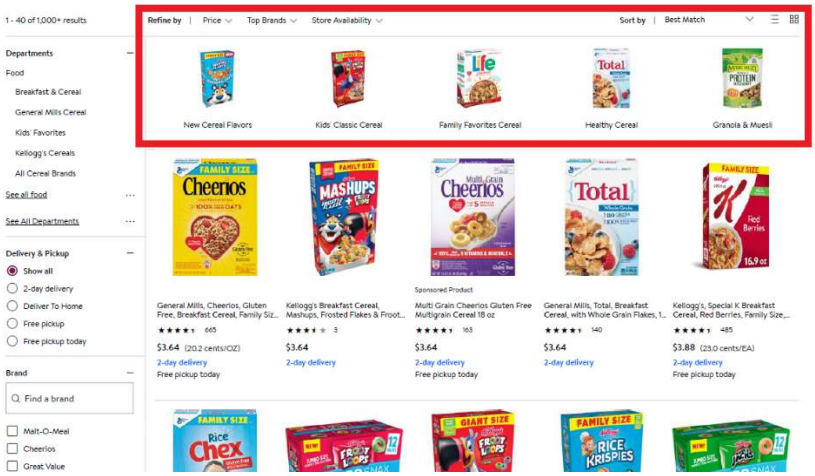


Figure 4. 2 Walmart's Website Suggested Product Search Refinement for Cereals

For convenience, Walmart suggests quick buttons to refine cereal buttons by. These include "New Cereal Flavors", "Kid's Classic Cereal", "Family Favorite Cereal", "Healthy Cereal", and "Granola & Museli". The middle three suggested refinements, associate heavily with low fiber, high sugar cereals, moderate fiber and sugar cereals, and low sugar and high fiber cereals respectively.

In this experiment, we investigate the effect of a dietary fiber PDP on process variables—such as attention to products, use of information, etc.—that influence choices in the cereal, bread, and crackers category. First, we examine the effect of the PDP on the set of products participants considered when making their selections. Before selecting products, participants decided which products to consider for the three product categories. These consideration sets divided the products into less healthy, moderately healthy, and healthy options, as well as the full set of all available products. We hypothesized that participants who saw the PDP would choose a healthier consideration set than participants in the control condition. Second, we examined if the PDP influenced participants to consider certain nutrition information when making their product

selections. We hypothesized that participants would use information on fiber content more if shown a PDP before making food choices.

3 Methods

3.1 Survey Design

An online food choice experiment designed to mimic a person's grocery shopping experience was developed to examine how consumers' grocery shopping choices are influenced when they are exposed to a PDP. Details of the survey and its development are provided in Chapter 3. In short, the survey consisted of two sections: a shopping task in which participants made hypothetical food product choices from three food categories: bread, cereal, and crackers, and a survey. The survey included questions about product choices, typical shopping practices, and demographics. This survey was created in Qualtrics XM (2020, SAP, Provo, Utah) and distributed to adults (≥19 years old) in the United States via Amazon Mechanical Turk from April 15-20, 2020. The University of Nebraska-Lincoln IRB approved the research (IRB protocol #20171017580EX). All participants provided written informed consent before participating in the research.

Participants in the research were randomly assigned to a control group (no-PDP) or one of two PDP groups. Participants in the PDP groups viewed different PDP versions just before beginning the shopping task, while control-group participants immediately began the shopping task. The two PDP versions contained the same information about the health benefits of fiber consumption but differed in how the PDP presented the information (Figure 4.3). One group saw a PDP that was written to evoke a personal connection to the messages, by using personal pronouns such as "you" and "your" throughout the messages. We refer to this condition as the *motivation PDP* (M-PDP). The

message in the other group contained the same information, but without reference to the reader through personal pronouns. We refer to this condition as the *fact PDP* (F-PDP).

a. M-PDP

b. F-PDP

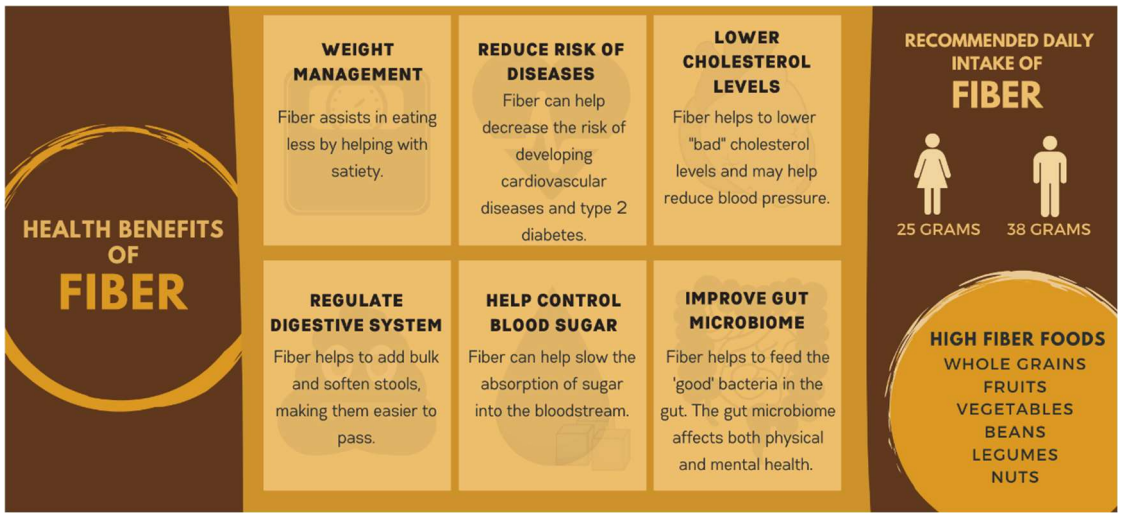


Figure 4. 3 Motivational and Fact PDP

Both PDPs describe the same information. The difference between the M- and F-PDP is how the information is presented. The Motivation PDP uses personal pronouns in an effort to connect the benefits to the reader, while the F-PDP states benefits of fiber using general, factual terms.

In the shopping task, participants made cereal, bread, and cracker purchase choices. Participants read introductory text about the shopping task at the start of the survey that told them to imagine they were making real choices with real money, which has been found to reduce biases in responses to hypothetical choices of food items (Lusk, 2003). Before choosing the specific item to purchase, participants decided whether to view all product options (N=33 for each of cereal, bread, and crackers) or to view a subset of products (n=11 per category). We refer to these product sets as the participants' *consideration sets*. The subsets categorized the products into less healthy, moderately healthy, and healthy options. To avoid prompting participants to think of the subgroups according to the health of the products, the subsets were instead described by the types of products they contained. For example, the cereal sets were labeled as "Cereals such as Frosted Flakes, Froot Loops, Reese's Puffs", "Cereals such as Corn Flakes, Crispix, Special K", "Cereals such as Cheerios, Wheat Chex, Grape Nuts," and "All options."

A rubric was used to separate foods based on their nutrient contents into less healthy, moderately healthy, and healthy by assigning a star rating to each food product (Guiding Stars, https://guidingstars.com/), ranging from 0 = least healthy to 3 = most healthy. The Guiding Stars system grades the healthiness of products on a 0 to 11-point scale based on their nutrient content. Products gain points based on meeting certain thresholds for vitamins, minerals, fiber, whole grains, and omega-3 fatty acids; and lose points for surpassing amounts of saturated fat, trans fat, added sodium, added sugar, and artificial colors in a standardized 100-calorie portion. From this score, products receive zero stars if they received 0 points on the scale, or one (1-2 points), two (3-4 points), or three (5-11 points) stars. More details about their scoring method can be found on the

Guiding Stars website: https://guidingstars.com. In our study, the less healthy, moderately healthy, and healthy subsets consisted of products with zero, one, and two or three stars, respectively. Two and three-star rated products were combined into one subset because there were not enough three-star product options to create a separate category. There were three three-star rated products to choose from in both the cereal and bread categories and one three-star rated product in the cracker category.

After selecting a consideration set for a product category, participants were then able to select a product to "purchase." If a participant did not like any of the products, they had the option to go back and select a different consideration set or to choose no product for the product category. The product options were presented in a three-column format with a photograph and the name of each product presented prominently. Underneath the product name, the nutrient content per serving for calories, fiber, fat, sodium, and sugar, as well as the price was listed (Figure 4.4).

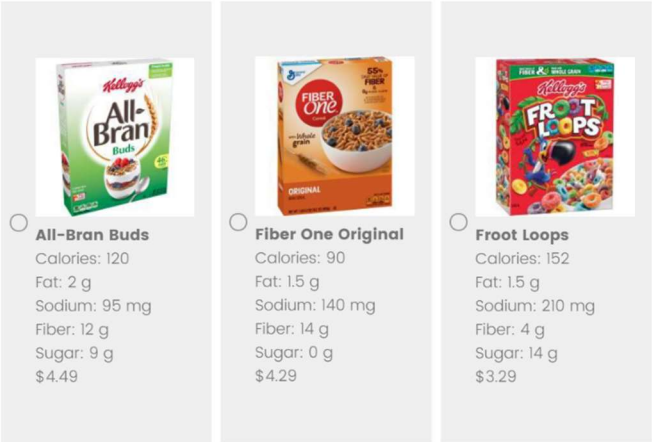


Figure 4. 4 Preview of Product Choices

A preview of how product choices and product information were presented for consumers to select from. This figure displays the cereal product options within the "All options"

consideration set. There were 11 *less healthy, moderately healthy, and healthy* cereal products to choose from, totaling 33 product options.

After making product choices, participants answered survey questions about their product choices, typical shopping practices, and demographics. The questions from this survey section asked participants to indicate any attribute(s) (fiber, calories, fat, sodium, sugar, price) they had considered when selecting their products.

3.2 Survey Analysis

The survey data were analyzed using R (R Core Team, 2019). Summary statistics, multinomial, binomial, ordinal and linear regression, chi-square tests, and t-tests were used to analyze demographic data and differences in process variables used to make purchase choices. The process variables we investigate are if people limit their choices to a consideration set and what nutrient information consumers considered when making their food choices. We analyzed outcomes of the PDP separately for cereal, bread, and crackers. We considered p-values < 0.05 to be statistically significant.

We examined the influence of the PDP on process variables in four ways.

1) We examined the influence of the PDP on the consideration set participants selected. The consideration set was assigned as the dependent variable in a multinomial logistic regression. The least healthy consideration set was used as the reference category.
2) We determined the influence of the PDP on the nutrient information participants considered when making their decisions in a binomial logistic regression model. For each of the nutrients under the three food categories, we created a binomial

variable with their response (yes, the nutrient was considered / no, the nutrient was not considered). “No” was used as the reference category.

3) We analyzed the influence of the PDP and consideration of the fiber content of products (yes/no) on the Guiding Stars rating of product choices (0-3 stars) in an ordinal logistic regression model. The zero-star rating (least healthy) was used as the reference category.
4) We determined the influence of the PDP and consideration of the fiber content of products (yes/no) on the fiber content of product choices. We created a linear regression, where the fiber content of product choices was the dependent variable.

Initially, we examined PDP versus no-PDP as a binary variable by pooling participants in the M- and F-PDP conditions to create a pooled-PDP group (P-PDP). We compared the P-PDP to the no-PDP, where the no-PDP condition was used as the reference group. We then examined differences between the M-PDP and F-PDP conditions. The F-PDP was used as the reference group. Participants that indicated they would not choose any of the products in a product category were excluded from the analyses for that specific category.

Since participants were randomized into conditions, demographic variables should not have affected the impact of the PDP. As a check, all analyses were conducted with and without the demographic variables. The inclusion of demographic variables did not affect the impact of the PDP but did require more participants to be dropped from the data set because of “prefer not the answer” responses on the demographic questions. We chose to report the version without the demographic variables for simplicity and to avoid

removing additional participants from the cereal, bread, and cracker models. In Appendix D, we provide the regression results for models with demographic variables.

4 Results

4.1 Participant Demographics

There were 753 participants who completed the experiment, consisting of 253 participants in the control condition, 251 in the M-PDP condition, and 249 participants in the F-PDP condition. No significant differences existed for demographics between PDP and no-PDP or the M-PDP and F-PDP conditions. Of the 753 participants, 35.6% of the participants were female, 63.6% were male, and 0.8% preferred not to disclose. Most of the participants were within the age of 25-34 y (47.4% of the sample population) or 35-44 y (25.8% of the sample population) (Table 4.1).

Table 4. 1 Sample Characteristics

	Total (n=753)	no-PDP (n=253)	M-PDP (n=251)	F-PDP (n=249)
	Count	%	%	%
Gender				
Female	268	36.0	36.3	34.5
Male	479	63.6	62.9	64.3
Prefer not to answer	6	0.4	0.8	1.2
Age				
19-24	40	4.7	5.2	6.0
25-34	357	47.0	47.0	48.2
35-44	194	25.3	24.7	27.3
45-54	103	14.2	15.1	11.6
55-64	43	7.9	4.8	4.4
65 and older	12	0.8	2.4	1.6
Prefer not to answer	4	0.0	0.8	0.8
Household Income				
Less than $20,000	54	7.1	6.8	7.6
$20,000 - $39,999	146	17.4	19.1	21.7
$40,000 - $59,999	177	24.1	23.1	23.3
$60,000 - $79,999	179	23.3	24.7	23.3
$80,000 - $99,999	100	14.6	12.7	12.4
$100,000 or more	87	12.6	12.0	10.0
Prefer not to answer	10	0.8	1.6	1.6
Education				
Less than high school	2	0.4	0.4	0.0
High school/G.E.D.	80	10.3	10.8	10.8
Associate's degree or some college	124	18.6	15.1	15.7
Bachelor's degree	400	49.0	55.8	54.6
Advanced degree (master's level or higher)	143	21.7	17.5	17.7
Prefer not to answer	4	0.0	0.4	1.2

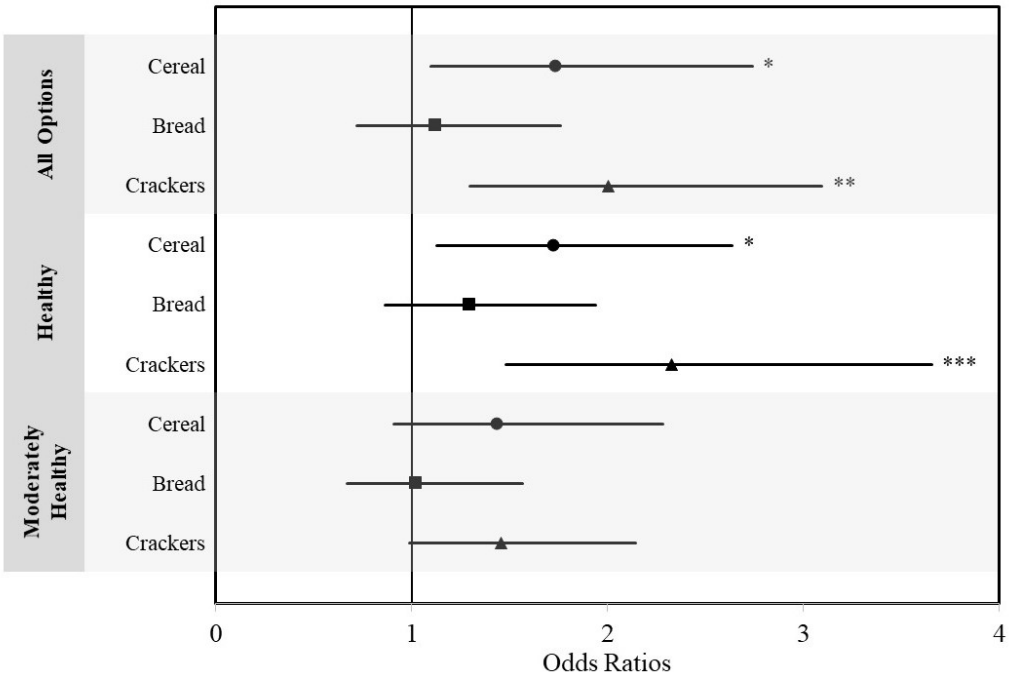
Note: There were no significant differences between conditions (chi-squared test). The M- and F-PDP were combined to create the P-PDP variable.

4.2 Influence of the PDP Condition on Consideration Sets

We first looked at differences in consideration sets among the PDP conditions. Compared to participants in the no-PDP condition, participants in the P-PDP condition

were more likely to choose the healthy or all options consideration sets when choosing cereals and crackers (Figure 4.5a). Within the cereal category, the P-PDP participants were 1.73 (95% CI [1.13, 2.64]) times more likely to select the healthy consideration set and were 1.73 (95% CI [1.10, 2.74]) times more likely to consider all cereal options. Within the crackers category, P-PDP participants were 2.33 (95% CI [1.48, 3.66]) times more likely to select the healthy consideration set and 2.00 (95% CI [1.30, 3.09]) more likely to select the all options consideration set than the less healthy consideration set. Compared to participants in the F-PDP condition, participants in the M-PDP condition were more likely to select the moderately healthy cereal consideration set (OR 1.87, 95% CI [1.04, 3.34]) (Figure 4.5b).

a. P-PDP (versus no-PDP, reference category)



b. M-PDP (versus F-PDP, reference category)

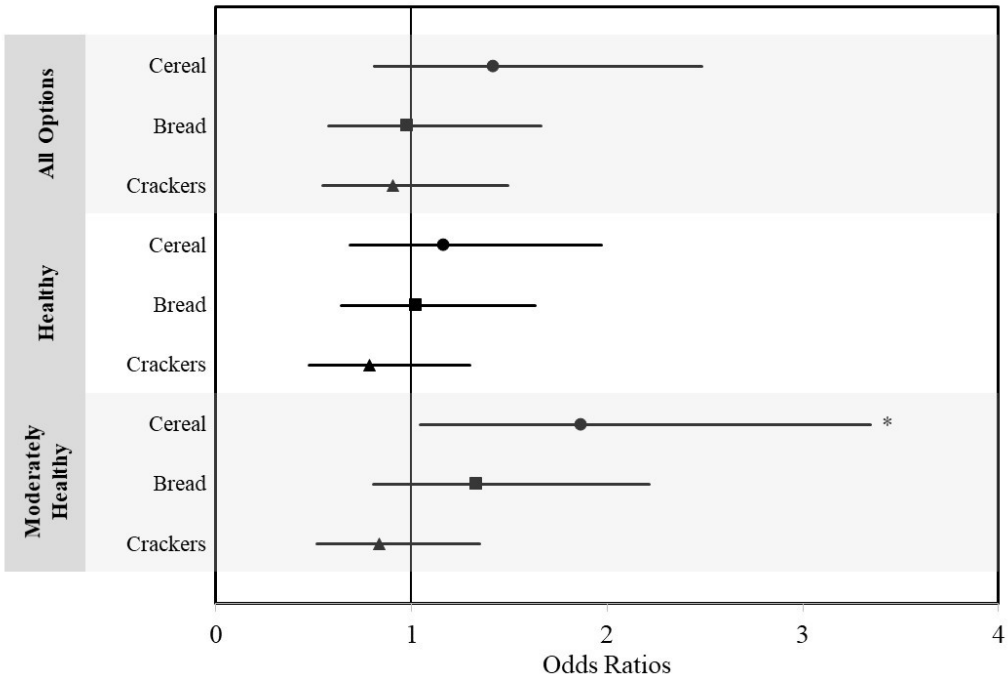


Figure 4. 5 Consideration Set Choices Odds Ratios

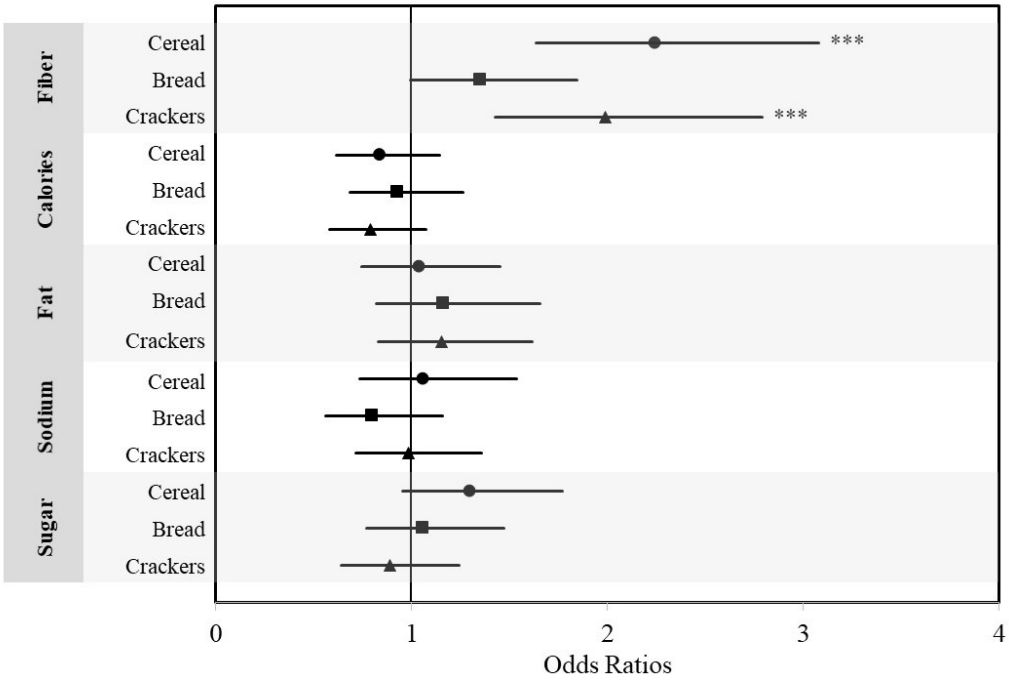
Comparisons show the condition group relationships, as it relates to participants selecting certain consideration sets. All participants were able to choose one of four consideration sets for each of the food categories (all options, healthy options, moderately healthy options, and less healthy options). The less healthy subset was used as the reference category. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

4.3 Influence of the PDP Condition on Consideration of Specific Nutrition Information

There were 24 (3.2% of whole sample), 19 (2.5% of whole sample), and 18 (2.4% of whole sample) participants who chose no product in the cereal, bread, and cracker models, respectively. Due to lack of nutrition data, these participants are not included in models that analyze product choices. Participants in the P-PDP condition were more likely to consider the fiber content of product choices when selecting cereals (OR 2.24, 95% CI [1.64, 3.08]) and crackers (OR 1.99, 95% CI [1.43, 2.79]) (Figure 4.6a). The

difference in use of fiber information within the bread category was not significant between the PDP and no-PDP condition, though it was close at p=0.054 (OR 1.35, 95% CI [1.00, 1.84]). There were no significant differences between the M-PDP and F-PDP for any of the three food categories (Figure 4.6b) When only the M- and F-PDP conditions are included in the models, 18 (3.6% of PDP sample) , 12 (2.4% of PDP sample), and 13 (2.6% of PDP sample) participants did not select cereal, bread or cracker products, respectively.

a. P-PDP (versus no-PDP, reference category)



b. M-PDP (versus F-PDP, reference category)

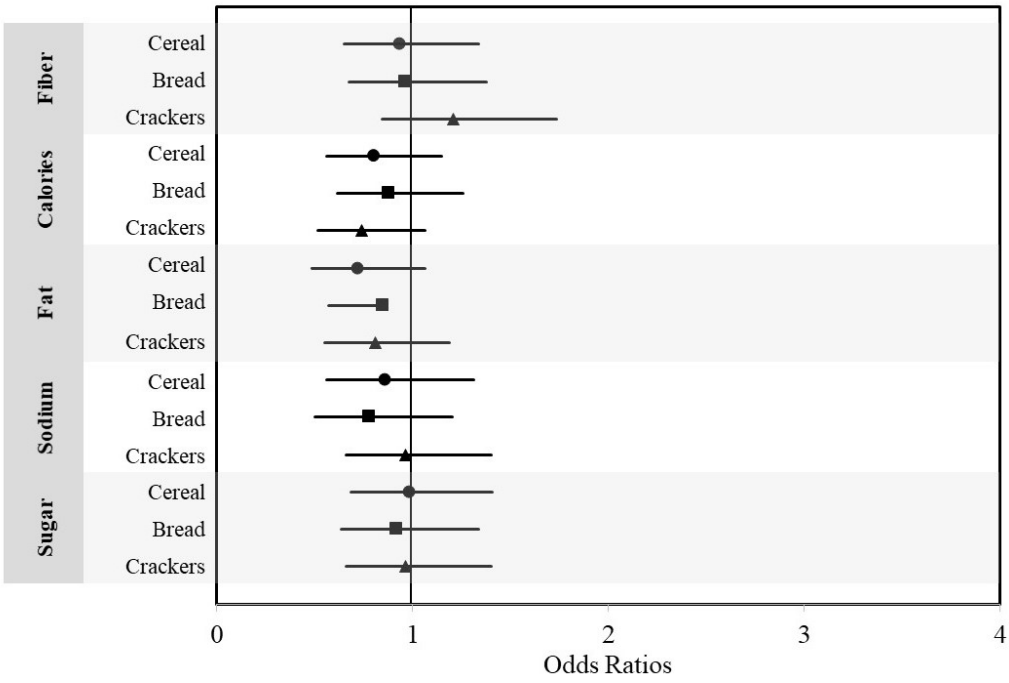


Figure 4. 6 Consideration of Specific Nutrient Information Odds Ratios

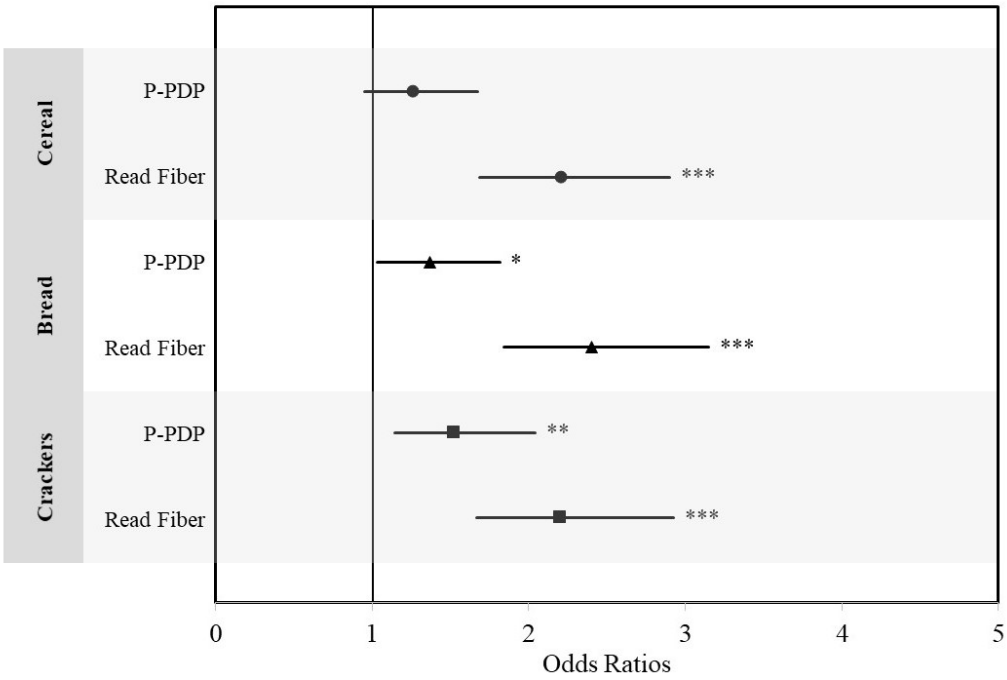
Comparison shows the PDP relationship between reading specific nutrition information (to not reading) when making purchase choices. ***p<0.001.

4.4 Influence of the PDP Condition and Consideration to Fiber Content to the Healthiness of Choices

Next, we examined the influence of the P-PDP condition and consideration of fiber information effects on the healthfulness of product choices (Figure 4.7). Both P-PDP and attention to fiber content were significant in the bread and cracker category, while in the cereal category, only consideration of the fiber content was significantly influential (OR 2.21, 95% CI [1.68, 2.90]). In the bread category, participants in the P-PDP condition were 1.37 (95% CI [1.03, 1.82]) times more likely to choose a product with a higher Guiding Stars rating, and participants who read the fiber information were 2.41 (95% CI [1.84, 3.15]) times more likely to choose a healthier

product. Within the cracker category, participants in the P-PDP condition (OR 1.53 (95% CI [1.14, 2.04]) and participants who read the fiber content (OR 2.41, 95% CI [1.84, 3.15]) were more likely to select products with higher Guiding Stars. Between the M-PDP and the F-PDP, only consideration of the fiber content showed significant differences. Use of information about the fiber content when making choices was associated with healthier choices among the cereal (OR 1.73, 95% CI [1.25, 2.40]), bread (OR 2.88, 95% CI [2.07, 4.02]), and cracker (OR 2.29, 95% CI [1.63, 3.21]) categories.

a. P-PDP (versus no-PDP, reference category)



b. M-PDP (versus F-PDP, reference category)

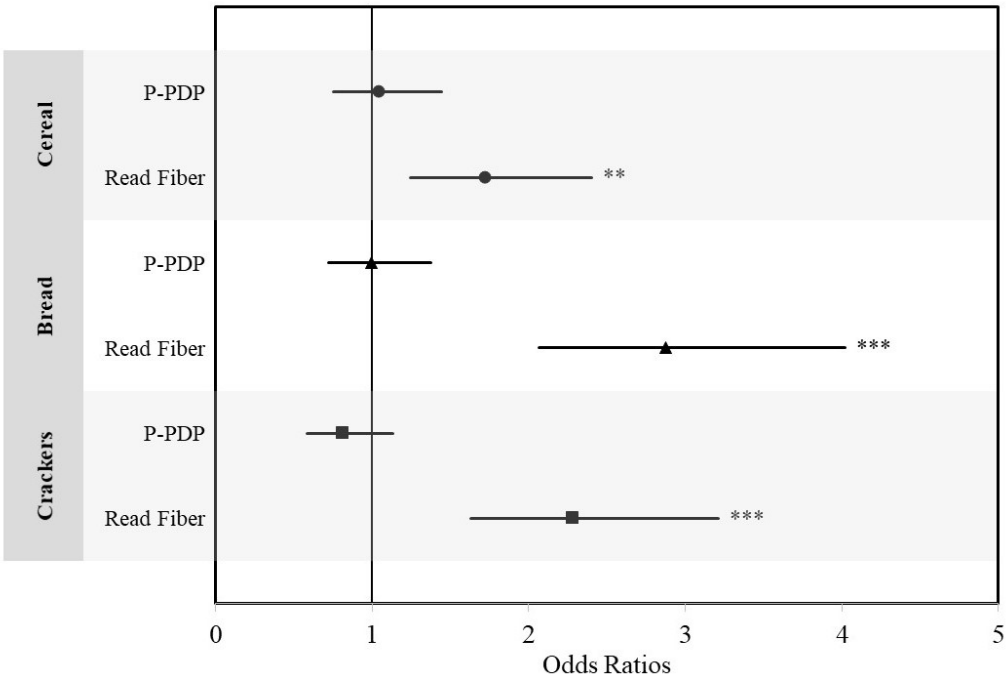


Figure 4. 7 Relationship of PDP Condition and Consideration of Fiber Content to the Healthiness of Choices Odds Ratios

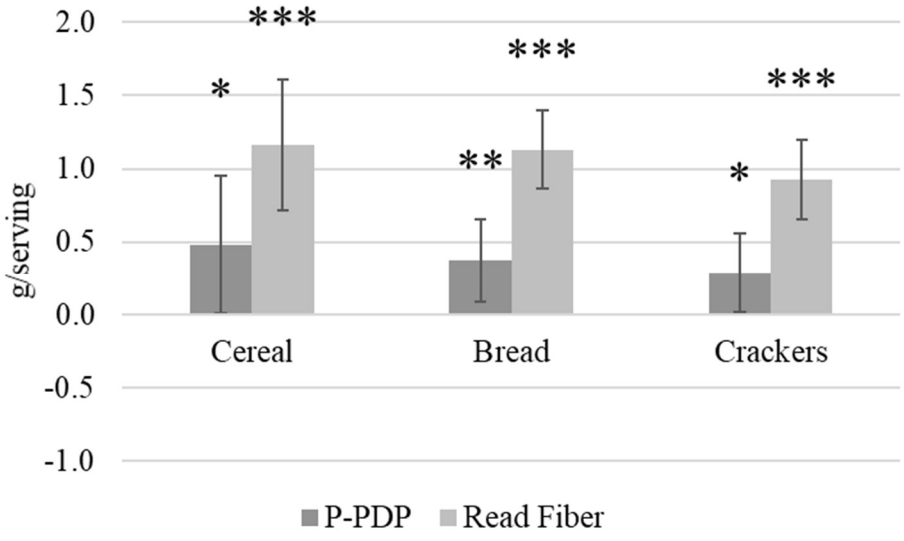
Comparison shows how the relationship between the prompt conditions and if the participant looked at the fiber content of products when making purchase choices to the outcome of the star rating of their choices (0=least healthy; 3=most healthy). Provided information included fiber along with calorie, fat, sodium, and sugar information. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

4.5 Influence of the PDP Condition and Consideration of Fiber Content to the Fiber Content of Choices

Both the PDP condition and use of information on the fiber content of products led participants to choose higher fiber products (Figure 4.8). The PDP helped to encourage cereal choices that had 0.48 more g dietary fiber/serving (95% CI [0.01, 0.95]) and reading the fiber information helped to increase the fiber content by 1.16 g dietary fiber/serving (95% CI [0.72, 1.61]). For the bread choices, participants in the

P-PDP condition chose products with 0.37 g dietary fiber/serving more than the no-PDP condition (95% CI [0.09, 0.66]). Considering the fiber information increased the fiber content of choices by 1.13 g dietary fiber/serving (95% CI [0.86, 1.40]). When shopping for crackers, seeing the PDP influenced participants to choose crackers with an average of 0.29 g more dietary fiber/serving (95% CI [0.01, 0.56]) and reading the fiber information increased the content by 0.93 g dietary fiber/serving (95% CI [0.66, 1.20]). Between the M- and F-PDP conditions, no significant differences were found; only subjects that also considered the fiber nutrition information chose products with significantly more fiber (1.02 g dietary fiber/serving, 95% CI [0.45, 1.60]), bread (1.38 g dietary fiber/serving, 95% CI [1.04, 1.72]), and crackers (1.10 g dietary fiber/serving, 95% CI [0.77, 1.44]).

a. P-PDP (versus no-PDP, reference category)



b. M-PDP (versus F-PDP, reference category)

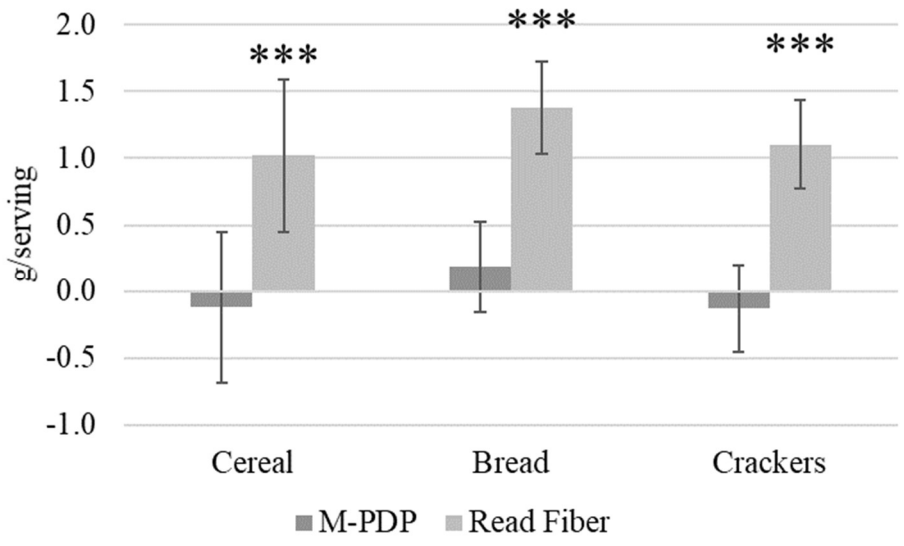


Figure 4. 8 Relationship of the PDP Condition and Consideration of Fiber Content to the Fiber Content of Choices

Comparison shows the relationship of the PDP condition and whether the participant looked at the fiber information of products to the nutrition content in product choices. Error bars represent the 95% confidence interval. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

5 Discussion and Conclusion

PDPs have been shown to facilitate healthier purchase decisions among consumers, but how PDPs lead to these changes has received little attention, particularly in the types of complex choice sets that consumers face in the real world. In our study, we found that PDPs influence people to make healthier choices 1) by changing their consideration set, i.e., the set of products they choose to examine when making a selection, and 2) by focusing their attention on nutrition information provided. This contributes to evidence from simple choice settings showing that prompts recruit parts of the brain involved in self-control (Hare et al., 2011) and speed the use of nutrition information in food choice (Sullivan et al., 2015; Lim et al., 2018).

Participants in the P-PDP condition were more likely than participants in the no-PDP condition to choose to view a healthier subset of products. Selecting a consideration set helps consumers deal with the cognitive overload of excessive product alternatives and allows them to more thoroughly compare a smaller set of items (Chakravarti & Janiszewski, 2003). The PDP likely motivated consumers to consider their health and therefore influenced them to limit their product choices to a healthy consideration set. However, we also found that P-PDP participants were more likely to consider all choice options than no-PDP participants (relative to the unhealthy consideration set). There are two potential interpretations here. First, participants in P-PDP were more willing to include the healthiest items in their consideration set than participants not exposed to a prompt. Second, when narrowing choices down to a consideration set requires a trade-off in benefits (e.g., taste and health) that a consumer is not yet willing to give up, they are more likely to consider a broader set a products (Chakravarti & Janiszewski, 2003). PDP participants may have been motivated by health after reading the PDP but were not yet willing to ignore more taste-satisfying product options.

We found that the fiber-focused PDP influenced consumers to look at the fiber content when making their product choices in the cereal and cracker categories. Our findings also showed that while the fiber-focused PDP increased use of the fiber content of products, it did not decrease attention from the other nutrition attributes listed under the products. A PDP can remind people of long-term health goals, but we wanted to see how the PDP functioned in conjunction with reading the nutrition information. We found that the PDP and the fiber information worked together to facilitate healthier choices in the bread and cracker categories. Across all three food categories, we saw that both the

PDP and reading the fiber information were influential in leading consumers to choose products with significantly higher dietary fiber content/serving. Reading the fiber information had more of an influence on the healthiness of product choices than the PDP; however, the PDP was important for influencing consumers to use the nutrition information.

Overall, the differences between the M- and F-PDPs were limited. In Chapter 3, we saw no significant differences between the M- and F-PDP on the healthiness of purchase choices. As explained in Chapter 3, we presume that the lack of significance between the PDP times may be due to the F-PDP motivating consumers enough or that the M- and F-PDP were too similar to influence outcome differences.

An interesting aspect of this paper is when the data was collected. We collected our data from 15-20 April of 2020, in the midst of the COVID-19 pandemic. The COVID-19 pandemic led to increased stress in individuals and an economic downturn. During this time a third of US consumers reported feeling high levels of psychological distress (Keeter, 2020) and increased purchases of less healthy foods (Creswell, 2020). Despite conducting our study during a time that consumers were likely feeling stressed and drawn to unhealthy comfort foods, our study still found that the PDP encouraged healthier choices. Our PDP might have had an even greater positive influence on the healthiness of product choices if consumers were not experiencing stress-driven desires for unhealthy foods. In future work, it may be interesting to re-conduct this experiment during lower stress time. This would allow us to compare the effect of the PDP during and not during a time when consumers are experiencing high levels of stress.

A limitation of this research is that the shopping choices were hypothetical. By choosing hypothetical products, participants may have been urged to take less time to observe product options or read product nutrition information. We address this potential bias through the use of a “cheap-talk” script prompting participants to imagine they are making real choices and facing the same budget constraints they do in real life, which has been found to reduce hypothetical bias (Lusk, 2003).

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CHAPTER 5: GENERAL CONCLUSIONS

This thesis adds to current consumer food behavior literature by generating novel insights into food choice behaviors to help create more effective methods to combat the increasing prevalence of obesity in the United States. In this thesis, I explored two topics of consumer food behavior: understanding gluten avoidance and the use of point-of-decision prompts (PDP) to increase the purchase of healthier food choices and fiber consumption.

In Chapter 2, I examined the factors that influenced a person to avoid gluten. I hypothesized that interest in gluten avoidance would be driven by the individuals' beliefs in health claims brought about by the diet and by receiving a recommendation that they should try a gluten-free (GF) diet. I found that people were influenced to eat GF when they viewed GF products to be more nutritious or if they perceived gluten to be a sort of "nutrient" that should be limited. I also found that people were most influenced to try a GF diet when they self-suggested the diet, which includes personal research, or were recommended to try the diet by conventional sources of health information, such as a healthcare professional or wellness advisor.

In Chapter 3, I examined consumer cereal, bread, and cracker choices when presented a PDP, about the benefits of dietary fiber consumption, prior to making food decisions. I hypothesized that participants who were presented the dietary fiber PDP would choose products with a greater fiber density than participants who were not presented the PDP prompt. I found that viewing a fiber PDP before making food purchase decisions influenced people to make healthier food choices and to select products that had a greater fiber density.

After determining that the fiber PDP influenced consumers to choose products that were healthier and contained more dietary fiber per serving (Chapter 3), in Chapter 4 I further examined the PDP to determine how it promoted this behavior. I hypothesized that participants who were presented the PDP before making food choices would choose a healthier consideration sets of products and be more likely to consider the fiber content of choices than participants who were not presented the PDP. Presenting the PDP to consumers before making food choices influenced them to focus their attention on all products or only on a healthier subset of products. The PDP also worked to influence healthier food choices and purchase of products higher in fiber by influencing consumers to read the fiber content in products when making their decisions.

This thesis helped to answer what motivates a person to eat a GF diet. Self-suggesting (including personal research) and health-care professionals are top recommending sources who influenced consumers to eat GF. Future investigation should seek to better understand what motivates consumers to research the GF diet and other popular diets, and to examine consumers' ability to evaluate the credibility of health information. Additionally, understanding the beliefs of healthcare professionals about the GF diet could shed light on why some are suggesting that patients try a GF diet if they have not been diagnosed with a gluten sensitivity. It may also be of interest to study what influences consumers to follow popular diets, such as the ketogenic diet, in general. Drawing comparisons between the factors that influence a person to try fad diets is a pathway to understanding how fad diets emerge and how to prevent them in the future.

The fiber PDP worked to encourage consumers to make healthier food choices. The next step in establishing the efficacy of prompts focused on under-consumed

nutrients is to implement the PDP in a grocery store environment, which could include an online grocery shopping platform, to generate data on the effect of the prompt when individuals are making non-hypothetical choices. Conducting a study in the field is important for collecting data that avoids hypothetical biases. To note, I limit the hypothetical bias in the PDP experiment by prompting consumers to imagine they are making real choices with real money and by providing accurate price information underneath all product options.

APPENDICES

APPENDIX A: Survey questions used in the gluten-avoidance analysis

* Indicates the question was *not* used in the survey

1. Have you ever tried the following diets? *Please select one response per row.*

<only allow one response option per row, RANDOMIZE>	Never tried 0	Not currently following, but followed in the past 1	Currently following 2
1. Pescatarian*			
2. Vegetarian, Vegan*			
3. Gluten-free diet			
4. Low-gluten diet or avoid, but not completely remove, gluten			
5. Low FODMAP*			
6. Ketogenic “Keto” diet (High fat, low carbohydrate diet)*			
7. Atkins diet (High protein, low carbohydrate)*			
8. Paleo or “caveman diet”*			
9. Alkaline diet*			
10. Military or Israeli Army diet *			
11. Mediterranean diet*			
12. Baby Food diet*			
13. Whole 30 diet*			
14. Liquid diet including juice fasting*			

15. South Beach diet*			
16. Grapefruit "Hollywood" diet*			
17. DASH diet*			
18. Blood type diet*			
19. Cabbage soup diet*			
20. KE diet or feeding tube diet*			

2. What was the diagnosis? *Please select one.*
    1. Celiac disease
    2. Non-celiac gluten sensitivity
    3. Other
    4. No condition
    5. I am not sure
    6. Prefer not to answer

3. Age *(Please select one)*
    1. Under 19 <thank and terminate>
    2. 19-24
    3. 25-34
    4. 35-44
    5. 45-54
    6. 55-64
    7. 65 and older
    8. Prefer not to answer <thank and terminate>

4. Gender *(Please select one)*
    1. Female
    2. Male
    3. Prefer not to answer

5. Household Income *(Please select one)*
    1. Less than $20,000
    2. $20,000 - $39,999
    3. $40,000 – $59,999
    4. $60,000 – $79,999
    5. $80,000 – $99,999
    6. $100,000 or more
    7. Prefer not to answer

6. Education completed *(Please select one)*

1. Less than high school
2. High school/G.E.D.
3. Some college/associate degree
4. Bachelor's degree
5. Advanced degree (M.B.A., M.D., J.D., M.S., M.A., Ph.D.)
6. Prefer not to answer

7.

a. Height <Fill in the box> feet <Fill in the box> inches
<For feet feet box, include a drop down box with 3-8 and prefer not to answer at the bottom, for height inches box, include a drop down with 1-11 with .5 increments thought out (ie 1.5, 2, 2.5, 3…) and prefer not to answer at the bottom>

b. Weight <Fill in the box> pounds
<for weight, include a blank text box but have a check box below that shows 'prefer not to answer'>

8. To what extent do you believe a gluten-free diet can help with the following health issues? *Please select one per row.*

<RANDOMIZE>	Disbelieve	Somewhat Disbelieve	Neutral	Somewhat Believe	Believe
1. Acne					
2. Chronic stomach pain, bloating, inflammation or acid reflux*					
3. Chronic constipation or diarrhea*					
4. Bone Loss (Osteoporosis or osteopenia)*					
5. Fatigue or low energy*					
6. Ability to lose weight					
7. Celiac Disease*					
8. Tingling, numbness or pain in the hands and feet (Peripheral neuropathy)*					
9. Seasonal allergies*					
10. Infertility or recurrent miscarriage*					

11. Painful menstrual periods*					
12. High cholesterol*					
13. Headaches, migraines, or brain fog*					
14. Nausea*					
15. Depression or anxiety*					
16. Cancer*					

9. We would like to know your opinion about the following statements. Please indicate whether you agree, disagree or do not have an opinion about the statement. *Please select one per row.*

<RANDOMIZE>	Strongly Agree 1	Agree 2	No opinion 3	Disagree 4	Strongly disagree 5
1. Wheat allergy and celiac disease are the same thing*					
2. The gluten-free diet is only beneficial for people suffering from celiac disease or non-celiac gluten sensitivity.*					
3. The gluten-free diet can prevent the development of celiac disease or non-celiac gluten sensitivity.*					
4. Gluten can cause diseases in non-gluten sensitive people.					
5. In general, a gluten-free or gluten-reduced diet is healthier for people than a full-gluten containing diet.					
6. Gluten-free products are generally more nutritious than their gluten-containing variant.					
7. Gluten is only present in bread, bakery items, pasta, and crackers*					

8. Occasionally there will be a survey respondent who will attempt to rush through a survey by submitting answers without reading the questions. To help us ensure the accuracy of your survey, please select "No opinion" for this row.*					
9. "Wheat-free" and "gluten-free" are interchangeable terms.*					
10. It is deceptive for a food company to label a food gluten-free when the original product is naturally gluten-free.*					
11. Gluten should be listed as an allergen on food packages.*					

10. Who, if anyone, has suggested that you try a gluten-free diet? *Select all that apply*. <RANDOMIZE>
    1. Healthcare center or health professional (doctor, dietitian, etc.)
    2. Wellness coach, personal trainer, and or sports coach/Nutrition/Fitness shop or gym employee
    3. Online checklist suggested I try it
    4. Family member or friend
    5. TV personality, blogger, video blogger, and or celebrity
    6. Self (including through personal research)
    7. Other (please specify _____) <*ANCHOR*>*
    8. No one has ever suggested that I try a gluten-free diet<*ANCHOR, EXCLUSIVE* >
    9. I do not recall <*ANCHOR, EXCLUSIVE* >*

11. When you consume foods that contain gluten, what symptoms do you experience? *Select all that apply.* <RANDOMIZE>
    1. Acne or facial breakout*
    2. Acid Reflux
    3. Abdominal pain
    4. Bloating or inflammation
    5. Body aching (including muscle or joint discomfort)
    6. Diarrhea or constipation
    7. Nausea
    8. Headache or migraine
    9. Brain fog
    10. Fatigue or lack of energy

11. Seasonal allergies
12. Painful menstrual periods*
13. Other (please specify _____) <*ANCHOR*>*
14. I do not recall or I do not know <*ANCHOR, EXCLUSIVE*>*
15. I do not experience any symptoms <*ANCHOR, EXCLUSIVE*>*

12. Select how much you agree or disagree with this statement: My eating habits are very healthy. *Select one.*
    1. Strongly Disagree
    2. Disagree
    3. Neutral
    4. Agree
    5. Strongly Agree

13. How satisfied are you with your current health status? *Please select one.*
    1. Not Satisfied
    2. Somewhat Unsatisfied
    3. Neutral
    4. Somewhat Satisfied
    5. Satisfied
    6. Prefer not to answer

14. Please mark how much you agree with the following statements. *Please select one per row.*

<RANDOMIZE>	Strongly Disagree 5	Disagree 4	Neutral 3	Agree 2	Strongly Agree 1
"I have a lot of knowledge about nutrition."					
"I have a lot of knowledge about gluten."					
I have a lot of knowledge about grain-based products.					

15. Which is the healthiest fat to consume? *Please select one.* <RANDOMIZE>
    1. Saturated fat
    2. Unsaturated Fat
    3. Trans fat
    4. All fat is bad
    5. None of the above <*ANCHOR* >

16. Which is a good source of Vitamin D? *Please select one.* <RANDOMIZE>
    1. Cheese
    2. Fatty Fish
    3. Vegetables
    4. Liver

5. None of the above <*ANCHOR* >

17. What are the 3 macronutrients? *Please select one.* <RANDOMIZE>
    1. Fat, Sugar, Protein
    2. Fat, Carbohydrates, Protein
    3. Fiber, Sugar, Salt
    4. Vitamin A, B, C
    5. None of the above <*ANCHOR* >

14. The American Heart Association suggests people should consume less than (____) mg of sodium in a day? *Please select one.*
    1. 2300 mg
    2. 2500 mg
    3. 3500 mg
    4. 5000 mg
    5. None of the above <*ANCHOR* >

15. Which of these is not considered a nutrient? *Please select one.* <RANDOMIZE>
    1. Vitamins
    2. Minerals
    3. Fiber
    4. Fats
    5. None of the above <*ANCHOR* >

16. All foods with carbohydrates contain gluten. *Please select one.*
    1. True
    2. False
    3. I am not sure

17. Complete the sentence. Gluten is (____). *Please select one.* <RANDOMIZE>
    1. a fat
    2. a preservative
    3. an artificial sugar
    4. a protein
    5. a genetically modified organism (GMO)

18. Does this product have gluten in it? *Please select one per row.*

<RANDOMIZE>	Yes 1	No 2	I am not sure 97
Ingredients: Organic Whole Grain Wheat Flour, Canola Oil, Salt, Sugar, Cornstarch, Maple Syrup, Natural Flavor, Vitamin E			

Ingredients: Beef Broth, Beans, Rice, Tomatoes, Celery, Onion, Salt			
Ingredients: Vegetable Stock, Lentils, Barley, Tomato, Carrots, Celery, Onion, Salt			
Ingredients: Quinoa, Spelt, Amaranth, Peanuts, Date, Cane Sugar, Cocoa Powder			
Ingredients: Buckwheat, Peanuts, Date, Cane Sugar, Cocoa Powder			

19. Please choose the correct definition of celiac disease. *Please select one.* <RANDOMIZE>
    1. A modern disease that attacks the gastrointestinal system that arises from the consumption of genetically modified foods and the use of pesticides
    2. A contagious bacterial disease similar to a cold
    3. An autoimmune disorder where the gastrointestinal system becomes inflamed and damaged
    4. A virus transported by animals that attacks the gastrointestinal system
    5. I do not know <*ANCHOR* >
20. What percent of people around the world have celiac disease? *Please select one.*
    1. Less than 1%
    2. 1%-10%
    3. 11%-20%
    4. 21%-30%
    5. 31%-40%
    6. 41%-50%
    7. <include a drop down menu with 51-100%>
    8. I do not know
21. In the United States, are there GMO wheat varieties? *Please select one.*
    1. Yes
    2. No
    3. I am not sure

22. Which grain provides a complete source of protein (contains all of the essential amino acids)? *Please select one.* <RANDOMIZE>
    1. Brown Rice
    2. Oats
    3. Sprouted wheat
    4. Quinoa
    5. None of the above <*ANCHOR* >

23. Whole grains help to reduce your risk of which disease? *Please select one.* <RANDOMIZE>

1. Diabetes
2. Stroke
3. Heart Disease
4. Hypertension
5. All of the above <*ANCHOR* >

24. What nutrient is lost during the processing of refined wheat products before any enrichment or fortification is added? *Please select one.* <RANDOMIZE>
    1. Iron
    2. Vitamin D
    3. Vitamin A
    4. Sodium
    5. All of the above <*ANCHOR* >

APPENDIX B: Chapter 3 Model results with demographics

Table B - 1 Influence of a PDP on Healthiness of Choices Odds Ratios with Demographics

	P-PDP (vs. no-PDP)				Female (vs. Not-Female)		
	OR	CI Low	CI High		OR	CI Low	CI High
Cereal	1.49	1.13	1.98	**	1.49	1.13	1.98
Bread	1.50	1.13	1.99	**	1.50	1.13	1.99
Crackers	1.72	1.28	2.30	***	1.72	1.28	2.30

Notes: Comparison shows how the relationship between the PDP condition and the Guiding Star rating of their choices (0=least healthy; 3=most healthy). Demographics included in the model are age, sex, household income, and education. There were 34, 28, and 28 participants removed from the cereal, bread, and cracker models, respectively. **p<0.01 ***p<0.001

Table B - 2 P-PDP and no-PDP Mean Nutrition Content in Product Choices with Demographics.

	P-PDP (vs. no-PDP)			Female (vs. Not-Female)		
	Estimate	CI Low	CI High	Estimate	CI Low	CI High
Fiber (g/serving)						
Cereal	0.74	0.27	1.21 **	-0.20	-0.68	0.27
Bread	0.47	0.18	0.77 **	-0.04	-0.34	0.26
Crackers	0.46	0.17	0.74 **	-0.05	-0.33	0.24
Calories (kcals/serving)						
Cereal	-1.64	-4.65	1.37	2.25	-0.78	5.29
Bread	-3.14	-7.67	1.39	3.60	-0.96	8.16
Crackers	-5.16	-8.50	-1.82 **	0.71	-2.66	4.08
Fat(g/serving)						
Cereal	0.00	-0.15	0.16	0.06	-0.10	0.21
Bread	0.07	-0.05	0.20	0.07	-0.06	0.19
Crackers	-0.65	-1.03	-0.26 ***	0.02	-0.37	0.41
Sodium (mg/serving)						
Cereal	-11.07	-23.84	1.70	-0.17	-13.07	12.73
Bread	-5.37	-11.91	1.17	4.83	-1.75	11.41
Crackers	-9.59	-19.27	0.10	7.20	-2.57	16.96
Sugar (g/serving)						
Cereal	-0.74	-1.45	-0.04 *	0.34	-0.37	1.05
Bread	-0.05	-0.27	0.18	0.12	-0.11	0.34
Crackers	0.00	-0.18	0.18	0.04	-0.14	0.23

Notes: Displayed is the mean nutrition content within product choices. Error bars represent the confidence interval around the mean. p-values compare significant differences between the mean nutrition content of product choices made by the P-PDP and the no-PDP condition (t-test). *p<0.05 **p<0.01 ***p<0.001

APPENDIX C: Nutrition Content of Product Choices within Guiding Star Ratings

Table C - 1 Nutrition Content of Product Choices within Guiding Star Ratings

	Fiber (g/serving)			Calories (kcal/serving)			Fat (g/serving)			Sodium (mg/serving)			Sugar (g/serving)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Cereal															
0 Stars	1.4	0	4	154	140	170	1.8	0	4.5	204	140	270	13.2	12	16
1 Stars	2.6	0	4	152	140	160	1.1	0	2.5	241	136	300	8.9	4	12
2 Stars	5.3	4	12	145	120	200	1.4	0.5	2.5	137	0	267	6.8	2	13
3 Stars	8.0	5	14	123	90	140	1.2	1	1.5	111	0	193	1.0	0	3
Bread															
0 Stars	1.0	0.5	2	121	70	160	1.5	0.5	5	196	120	295	3.0	0	5.5
1 Stars	1.9	0	3.5	79	45	125	1.1	0.5	2	126	85	180	1.5	0.5	3.5
2 Stars	3.9	1.5	8	92	60	120	1.8	1	3	153	115	220	2.8	0.5	5
3 Stars	3.7	3	4	93	50	130	2.0	1	2.5	117	85	135	1.5	0.5	3
Crackers															
0 Stars	0.4	0	1	147	140	150	7.3	5	9.5	259	210	380	1.5	0	4
1 Stars	1.8	0	3	132	120	140	3.9	1.5	5.5	147	85	250	1.1	0	3
2 Stars	3.5	1	7	121	69	150	4.0	0	8	172	115	270	0.1	0	0.5
3 Stars	7.0	7	7	67	67	67	0.0	0	0	117	117	117	0.0	0	0

Notes: Displayed is the nutrition mean and distribution of content per serving within each of the Guiding Star ratings (0=least healthy; 3=most healthy).

APPENDIX D: Chapter 4 Results with Demographics Included in Models

Table D - 1 Consideration Set Choices Odds Ratios with Demographics, P-PDP (versus no-PDP, reference group)

	P-PDP (vs. no-PDP)				Female (vs. Not-Female)		
	OR	CI Low	CI High		OR	CI Low	CI High
All Options							
Cereal	1.77	1.11	2.82	*	1.00	0.61	1.63
Bread	1.16	0.73	1.84		0.69	0.43	1.11
Crackers	2.02	1.30	3.15	**	1.10	0.71	1.71
Healthy							
Cereal	1.84	1.19	2.84	**	0.75	0.48	1.18
Bread	1.36	0.90	2.06		0.75	0.49	1.14
Crackers	2.36	1.50	3.72	***	1.01	0.65	1.56
Moderately Healthy							
Cereal	1.49	0.93	2.38		0.86	0.52	1.40
Bread	1.12	0.72	1.73		0.78	0.50	1.22
Crackers	1.46	0.99	2.17		1.49	0.99	2.26

Notes: Comparisons show the PDP relationships, as it relates to participants selecting certain consideration sets. All participants were able to choose one of four consideration sets for each of the food categories (all options, healthy options, moderately healthy options, and less healthy options). The less healthy subset was used as the reference category. Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

Table D - 2 Consideration Set Choices Odds Ratios with Demographics, M-PDP (versus F-PDP, reference group)

	M-PDP (vs. F-PDP)				Female (vs. Not-Female)			
	OR	CI Low	CI High		OR	CI Low	CI High	
All Options								
Cereal	1.41	0.79	2.50		0.66	0.34	1.29	
Bread	0.97	0.56	1.69		0.62	0.34	1.13	
Crackers	0.92	0.55	1.53		0.96	0.55	1.65	
Healthy								
Cereal	1.15	0.67	1.98		0.48	0.26	0.89	*
Bread	1.00	0.61	1.61		0.80	0.47	1.36	
Crackers	0.79	0.48	1.31		1.02	0.60	1.74	
Moderately Healthy								
Cereal	1.92	1.05	3.49	*	0.54	0.28	1.06	
Bread	1.36	0.80	2.32		0.67	0.38	1.20	
Crackers	0.91	0.56	1.48		1.78	1.04	3.06	*

Notes: Comparisons show the PDP relationships, as it relates to participants selecting certain consideration sets. All participants were able to choose one of four consideration sets for each of the food categories (all options, healthy options, moderately healthy options, and less healthy options). The less healthy subset was used as the reference category. Demographics included in the model are age, sex, household income, and education. * $p<0.05$.

Table D - 3 Consideration of Specific Nutrient Information Odds Ratios with Demographics, P-PDP (versus no-PDP, reference group)

	P-PDP (vs. no-PDP)				Female (vs. Not-Female)			
	OR	CI Low	CI High		OR	CI Low	CI High	
Fiber								
Cereal	2.33	1.69	3.23	***	1.40	1.02	1.95	*
Bread	1.37	1.00	1.89	*	1.39	1.01	1.91	*
Crackers	2.09	1.49	2.95	***	1.10	0.79	1.53	
Calories								
Cereal	0.85	0.62	1.17		1.25	0.90	1.72	
Bread	0.96	0.70	1.31		1.22	0.89	1.68	
Crackers	0.80	0.58	1.09		1.18	0.86	1.62	
Fat								
Cereal	1.06	0.75	1.51		1.10	0.78	1.57	
Bread	1.21	0.85	1.76		1.30	0.91	1.89	
Crackers	1.19	0.84	1.68		1.35	0.95	1.92	
Sodium								
Cereal	1.10	0.76	1.62		1.26	0.86	1.86	
Bread	0.80	0.55	1.16		1.05	0.72	1.54	
Crackers	0.97	0.70	1.35	*	1.46	1.05	2.05	*
Sugar								
Cereal	1.31	0.96	1.80		1.48	1.08	2.04	*
Bread	1.12	0.80	1.56		1.43	1.02	2.01	*
Crackers	0.89	0.63	1.25		1.02	0.72	1.44	

Notes: Comparison shows the PDP relationship between reading specific nutrition information (to not reading) when making purchase choices. Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ***$p<0.001$.

Table D - 4 Consideration of Specific Nutrient Information Odds Ratios with Demographics, M-PDP (versus F-PDP, reference group)

	M-PDP (vs. F-PDP)			Female (vs. Not-Female)			
	OR	CI Low	CI High	OR	CI Low	CI High	
Fiber							
Cereal	0.92	0.63	1.33	1.44	0.97	2.16	
Bread	0.93	0.64	1.34	1.50	1.01	2.25	*
Crackers	1.22	0.85	1.77	1.08	0.73	1.61	
Calories							
Cereal	0.81	0.56	1.18	1.26	0.85	1.88	
Bread	0.90	0.62	1.29	1.56	1.05	2.33	*
Crackers	0.77	0.53	1.11	1.16	0.78	1.73	
Fat							
Cereal	0.71	0.47	1.07	1.01	0.66	1.56	
Bread	0.88	0.58	1.34	1.20	0.77	1.89	
Crackers	0.79	0.53	1.17	1.48	0.96	2.30	
Sodium							
Cereal	0.90	0.58	1.40	1.32	0.82	2.15	
Bread	0.81	0.52	1.26	1.10	0.69	1.80	
Crackers	0.99	0.67	1.46	1.76	1.15	2.72	**
Sugar							
Cereal	0.96	0.67	1.38	1.40	0.95	2.08	
Bread	0.89	0.60	1.30	1.82	1.19	2.83	**
Crackers	0.98	0.66	1.47	0.88	0.58	1.36	

Notes: Comparison shows the PDP relationship between reading specific nutrition information (to not reading) when making purchase choices. Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ** $p<0.01$.

Table D - 5 Relationship of PDP Condition and Consideration of Fiber Content to the Healthiness of Choices Odds Ratios with Demographics, P-PDP (versus no-PDP, reference group)

	P-PDP (vs. no-PDP)				Read Attribute (vs. No)				Female (vs. Not-Female)		
	OR	CI Low	CI High		OR	CI Low	CI High		OR	CI Low	CI High
Fiber											
Cereal	1.30	0.98	1.73		2.13	1.61	2.81	***	0.78	0.59	1.04
Bread	1.41	1.06	1.88	*	2.36	1.80	3.12	***	0.84	0.63	1.11
Crackers	1.58	1.18	2.12	**	2.08	1.57	2.78	***	1.00	0.75	1.34

Notes: Comparison shows how the relationship between the PDP conditions and if the participant considered the fiber content of products when making purchase choices to the outcome of the star rating of their choices (0=least healthy; 3=most healthy). Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

Table D - 6 Relationship of PDP Condition and Consideration of Fiber Content to the Healthiness of Choices Odds Ratios with Demographics, M-PDP (versus F-PDP, reference group)

	M-PDP (vs. F-PDP)			Read Attribute (vs. No)			Female (vs. Not-Female)		
	OR	CI Low	CI High	OR	CI Low	CI High	OR	CI Low	CI High
Fiber									
Cereal	1.06	0.77	1.48	1.65	1.17	2.31 **	0.66	0.46	0.94 *
Bread	0.95	0.69	1.32	2.79	1.98	3.94 ***	0.89	0.63	1.27
Crackers	0.81	0.58	1.13	2.23	1.59	3.16 ***	0.95	0.66	1.36

Notes: Comparison shows how the relationship between the PDP conditions and if the participant considered the fiber content of products when making purchase choices to the outcome of the star rating of their choices (0=least healthy; 3=most healthy). Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

Table D - 7 Relationship of the PDP Condition and Consideration of Fiber Content to the Fiber Content in Purchase Choices with Demographics, P-PDP (versus no-PDP, reference group)

	P-PDP (vs. no-PDP)				Read Attribute (vs. No)				Female (vs. Not-Female)		
	Estimate	CI Low	CI High		Estimate	CI Low	CI High		Estimate	CI Low	CI High
Fiber											
Cereal	0.51	0.03	0.98	*	1.18	0.72	1.63	***	-0.30	-0.77	0.17
Bread	0.39	0.11	0.67	**	1.11	0.83	1.38	***	-0.13	-0.41	0.16
Crackers	0.32	0.04	0.59	*	0.90	0.62	1.17	***	-0.07	-0.34	0.21

Notes: Comparison shows the relationship of the PDP condition and if the participant considered the fiber content of products to the fiber content in product choices. Demographics included in the model are age, sex, household income, and education. * $p<0.05$ ** $p<0.01$ *** $p<0.001$.

Table D - 8 Relationship of the PDP Condition and Consideration of Fiber Content to the Fiber Content in Purchase Choices with Demographics, M-PDP (versus F-PDP, reference group)

	M-PDP (vs. F-PDP)			Read Attribute (vs. No)				Female (vs. Not-Female)			
	Estimate	CI Low	CI High	Estimate	CI Low	CI High		Estimate	CI Low	CI High	
Fiber											
Cereal	-0.10	-0.67	0.46	1.04	0.46	1.62	***	-0.77	-1.38	-0.16	*
Bread	0.17	-0.17	0.52	1.37	1.01	1.72	***	-0.15	-0.52	0.22	
Crackers	-0.13	-0.46	0.20	1.08	0.74	1.42	***	-0.13	-0.46	0.20	

Notes: Comparison shows the relationship of the PDP condition and if the participant considered the fiber content of products to the fiber content in product choices. Demographics included in the model are age, sex, household income, and education. * $p<0.05$ *** $p<0.001$.