2021

Healthcare Professionals' Perceptions Regarding The Nutrition Of Dairy And Plant-Based Dairy Alternatives

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HEALTHCARE PROFESSIONALS' PERCEPTIONS REGARDING THE NUTRITION OF DAIRY AND PLANT-BASED DAIRY ALTERNATIVES

A Thesis Presented

by

Bridget Clark

to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements
for the Degree of Master of Science
Specializing in Nutrition and Food Science

August, 2021

Defense Date: June 29, 2021
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ABSTRACT

Plant-based (PB) dietary patterns have seen an upsurge in popularity over the past two decades. With this, has come an increase in consumption of PB alternatives to animal food products, including alternatives to dairy. However, because PB dairy alternatives are nutritionally different from dairy, there is concern that consumers of these products may unknowingly fall short on essential nutrients in their diet. Healthcare providers are key sources of nutrition information for U.S. consumers. This work examined U.S. healthcare professionals' beliefs and recommendations regarding dairy and PB dairy alternatives. Two methods were used: (1) analysis of all public comments submitted the U.S. Food and Drug Administration (FDA) by health professionals (n=191) in response to a request for public comment on the nutrition and use of dairy terms on PB product labels, and (2) a national survey of healthcare professionals' (n=417) beliefs on the nutrition and labeling of PB dairy alternatives, personal dietary habits, and professional recommendations on dairy and dairy alternatives. Comments and open-ended survey responses were coded in NVivo using a template approach and analyzed by themes. Close-ended survey responses were analyzed in SPSS. Unadjusted and adjusted logistic regression models examined demographic and professional characteristics associated with beliefs about the nutrition, consumer awareness, and labeling of PB dairy alternatives, and examined if personal dietary preference predicted nutrition recommendations on dairy and dairy alternatives.

Three fourths of health professionals who participated in the survey believed consumers are confused about the nutritional differences between dairy and dairy alternatives, yet over half did not consider either product nutritionally superior, and most would recommend both dairy (81%) and dairy alternatives (72%) to their patients. Still, many believed dairy to have higher nutrient value. Health professionals who submitted comments to the FDA showed stronger opinions in favor of PB dairy alternatives, and less than one fourth mentioned concern for consumer confusion. Survey data showed that, compared to other types of health professionals, dietetics professionals demonstrated a more accurate understanding of the nutritional value of both products and were more likely to believe nutrients like protein and vitamin D may be lacking in the diets of those who prefer dairy alternatives. Personal preference for PB milk and PB dietary patterns were associated with greater odds of recommending PB dairy alternatives and lessor odds of recommending dairy to a patient. Improved nutrition training focused on PB nutrition and reducing personal bias in practice may be necessary in certain healthcare disciplines to ensure healthcare providers are equipped to help consumers make informed nutrition decisions. Furthermore, health professionals who participated in the federal rulemaking process may represent over-polarized views on PB dietary patterns.

DEDICATION

I dedicate this thesis to my father, Wesley Clark. Thank you for teaching me to live life to the fullest and believing that I could accomplish anything.

ACKNOWLEDGMENTS

I have received a tremendous amount of support throughout writing this thesis. I would first like to thank my advisor, Emily Belarmino, for believing in me and providing me with a wonderful graduate experience. I could not have completed this project without her endless guidance, patience, and kindness. Her expertise was invaluable. I am also grateful to Lizzy Pope for her guidance and enthusiasm about my work, and always being a welcoming faculty member to talk to. I am grateful as well to Jennifer Laurent for agreeing to chair my thesis committee and offering her expertise to this project. I would also like to thank Jean Harvey, for her guidance while serving on an earlier version of my committee when I was first designing this project. Thank you also to Mattie Alpaugh for her support, especially when I was first beginning this work.

I would like to thank Sarah Geller, whose support when I first came to UVM was instrumental in preparing me for this work. I deeply admire her intelligence and determination. I would also like to thank Katie Schlepphorst, Reilly Donahue, Paige Vaccaro, Sydney Brouse, and Catherine Pellegrini, for being an outstanding group of researchers and a pleasure to work with.

Thank you, above all, to my mom, Cathleen Clark, whose love and encouragement has helped me through my many years of schooling. Thank you to the rest of my loving family, for their continuous support. I would like to thank my friend and roommate, Clair Russell. I am happy we could be there for each

other through many overwhelming times throughout graduate school. Thank you as well to Patrick Mooney, Julie Falk, Jake Molgano, and Patrick Gustavson for your endless love and friendship.

In addition, I would like to thank all of the healthcare professionals who took time out of their busy schedules during an extraordinary year to participate in this study. Thank you as well to the Vermont Academy of Nutrition and Dietetics, the Vermont Nurses Association, the UVM Department of Nursing, the UVM Larner College of Medicine, and all others who took interest in this project and helped me to recruit participants. Lastly, I am grateful to the UVM Office of the Vice President for Research, for their financial support for this project.

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CHAPTER 1: LITERATURE REVIEW

1.1. Plant-Based (PB) Dietary Patterns

Over the past decade, there has been an increase in the popularity of plant-based (PB) dietary patterns in the U.S. and around the world (Bourassa, 2021; Ipsos Retail Performance, n.d.; Plant Based Foods Association, 2020). PB diets are those that emphasize vegetables, fruits, whole grains, nuts and legumes, and reduce animal-source foods (Satija & Hu, 2018). PB diets can range from a small reduction in animal protein intake to the exclusion of complete food groups, namely vegetarianism (not consuming meat products) and veganism (not consuming meat, egg, or dairy products) (Satija & Hu, 2018). Although the number of Americans identifying as strict vegans and vegetarians has increased only slightly (Bourassa, 2021), Ipsos market research reports that the number of Americans seeking PB food has grown by over 9.4 million in the last 15 years (Ipsos Retail Performance, n.d.). According to findings from a nationally representative survey from the Yale Program on Climate Change Communication of 1,043 U.S. adults, about half show willingness to consume a diet lower in animal-source foods (Leiserowitz, Ballew, Rosenthal, & Semaan, 2020). In another nationally representative sample of 1,112 U.S. adults, two thirds reported reducing their meat intake between 2012 and 2015 (Neff et al., 2018).

With this shift in eating patterns in the U.S., the market for PB products – foods often meant to replace common animal products but made with ingredients not of animal origin, such as PB meat and milk alternatives (Plant Based Foods Association, 2018a) – is growing at a faster rate than the total food market. PB foods sales increased by 20% from 2017 to 2018, compared to a 2% sales increase for all food (Plant Based

Foods Association, 2020). Consumer reports indicate that younger generations are leading this shift. 79% of millennials are now incorporating PB meats into their diet, and 79% of generation-z's are eating PB meals 1-2 times per week, suggesting this trend will continue (Plant Based Foods Association, n.d.).

PB dietary patterns have become prevalent for a number of reasons, including their health and environmental benefits. There is mounting evidence that PB dietary patterns are protective against multiple non-communicable diseases (NCD), including cardiovascular diseases (CVD) (Hemler & Hu, 2019; Magkos et al., 2020; Orlich et al., 2019; Satija & Hu, 2018; Sterling & Bowen, 2019), type 2 diabetes (Hemler & Hu, 2019; Magkos et al., 2020; Sterling & Bowen, 2019), obesity (Hemler & Hu, 2019; Orlich et al., 2019; Sterling & Bowen, 2019), and certain cancers (Hemler & Hu, 2019; Magkos et al., 2020; Orlich et al., 2019; Sterling & Bowen, 2019). The World Health Organization has promoted diets that are predominantly PB for prevention of NCDs (World Health Organization and Food and Agriculture Organization, 2004). In their 2020 report, the Dietary Guidelines Advisory Committee highlighted evidence supporting diets consisting of predominantly PB foods for protection against chronic disease and all-cause mortality (Dietary Guidelines Advisory Committee, 2020).

Vegetarian diets appear to significantly improve blood pressure, glycemic control, and plasma lipid profiles (Satija & Hu, 2018). In a meta-analysis of 19 clinical studies, vegetarians and vegans were found to have a 12.2 mg/dL lower mean LDL cholesterol concentration compared to omnivores (Yokoyama, Levin, & Barnard, 2017). Evidence suggests that health benefits do not exist only for strict vegetarians and vegans. Replacing animal protein, especially red meat, with plant protein sources appears to

lower the risk of these NCDs as well as premature death (Hemler & Hu, 2019; McMacken & Shah, 2017). The EAT-Lancet Commission recommends a diet consisting of less than 28 grams (about 1 ounce) of red meat per day, highlighting the association between red meat consumption and increased risk of stroke, type 2 diabetes, colorectal cancer, and cardiovascular and all-cause mortality (Willett et al., 2019).

PB dietary patterns also may benefit the environment. It has become evident that the modern food system is not sustainable for the growing population (Chai et al., 2019). Diets low in animal-based foods degrade less land (Aleksandrowicz, Green, Joy, Smith, & Haines, 2016; Nelson, Hamm, Hu, Abrams, & Griffin, 2016; Röös, Garnett, Watz, & Sjörs, 2018; Sabaté & Soret, 2014; Springmann et al., 2018), water (Aleksandrowicz et al., 2016; Nelson et al., 2016; Röös et al., 2018; Sabaté & Soret, 2014; Springmann et al., 2018), and energy resources (Nelson et al., 2016; Sabaté & Soret, 2014) as compared to meat-based diets. It is estimated that reducing meat and other animal product consumption can also significantly reduce greenhouse gas emissions (Chai et al., 2019).

Despite this existing research, the long-term health and environmental effects of diets that mostly or fully omit animal-source foods remains unclear. Unhealthful PB diets, those that omit animal products but remain high in refined carbohydrates and sugar-sweetened products, do not appear to be as protective against chronic disease and mortality risk (Baden et al., 2019; Hemler & Hu, 2019). Likewise, the health and environmental benefits of unhealthful PB diets may be mitigated by the overconsumption of highly processed substitute products meant to replace animal products (Chai et al., 2019; Gehring et al., 2020; Satija et al., 2017). Moreover, PB

diets are not all equal, and the complete exclusion of certain foods may lead to nutrient inadequacies if not planned correctly (Craig, 2009; Magkos et al., 2020; Satija & Hu, 2018).

1.2. Nutrition and Health of Dairy Foods

Dairy foods have become a pressure point in the discussion surrounding the healthfulness of diets that mostly or fully exclude animal-source foods. Consumers have become inundated with claims about negative health outcomes associated with dairy consumption from popular media sources and other proponents of vegan diets (Carroll, 2014; Ettinger, 2019; Ochao, 2016). However, the breadth of scientific research on dairy and health tells a different story. Dairy is a good source of carbohydrates and high-quality protein (Chalupa-Krebzdak, Long, & Bohrer, 2018). It is a top source of nutrients of public health concern in the U.S., including calcium, vitamin D, and potassium (U.S. Department of Health and Human Services and U.S. Department of Agriculture., 2020), as well as a good source other micronutrients like vitamin A, phosphorous, and magnesium (Schuster, Wang, Hawkins, & Painter, 2018). Still, dairy is a top source of saturated fat in the American diet (National Cancer Institute, 2019), and there are concerns due to the association between saturated fat and CVD (Li et al., 2015; Mensink, Zock, Kester, & Katan, 2003; National Cancer Institute, 2019). In large cohort studies, the replacement of saturated fats with polyunsaturated fats (PUFA) was significantly associated with reduced CVD risk (Chen et al., 2016; Jakobsen et al., 2009). However, most studies have not found a direct association between dairy consumption and CVD, and some have found an inverse association

(Chen et al., 2016; Dehghan et al., 2018; Siri-Tarino, Sun, Hu, & Krauss, 2010; Thorning et al., 2016).

The evidence on other health concerns is also inconsistent. Dairy may be protective against the development of type 2 diabetes (Kraft, Jetton, Satish, & Gupta, 2015; Rice Bradley, 2018; Santaren et al., 2014; Unger, Torres-Gonzalez, & Kraft, 2019). Multiple cross-sectional studies and clinical trials have observed a relationship between dairy fat consumption and improved insulin sensitivity (Unger et al., 2019). One review also concluded that consuming dairy may be associated with lower risk of obesity (Thorning et al., 2016), while a meta-analysis of 29 randomized control trials found that consumption did not facilitate weight loss long-term or without also being paired with calorie restriction (Chen, Pan, Malik, & Hu, 2012). Despite promotion of dairy milk for bone health, research over the past two decades has not found significant evidence supporting calcium or milk intake for improved bone mineral density or reduced fracture risk in adults (Feskanich, Willett, & Colditz, 2003; Hannan et al., 2000; Thorning et al., 2016; Wadolowska et al., 2013; Weinsier & Krumdieck, 2000), although intake does appear important during childhood and adolescence (Thorning et al., 2016; Wadolowska et al., 2013). However, one meta-analysis did report lower bone mineral density and higher fracture risk among vegans compared to omnivores (Iguacel, Miguel-Berges, Omez-Bruton, Moreno, & Juli, 2019).

One association that is less contradictory is the association between dairy consumption and increased risk for prostate cancer, according to data from the Physicians' Health Study (Song et al., 2013; Vieth & Chan, 2002) and a recent meta-analysis of 32 cohort studies (Aune et al., 2015). Interestingly, that meta-analysis found

that total calcium and dairy calcium was associated with increased prostate cancer risk, but supplemental and non-dairy calcium was not, suggesting that other components of dairy may affect prostate cancer risk (Aune et al., 2015). Nevertheless, there appears to also be an association between dairy consumption and decreased risk of other types of cancer, namely colorectal cancer (Tantamango-Bartley et al., 2017; Thorning et al., 2016) and breast cancer (Dong, Zhang, He, & Qin, 2011; Thorning et al., 2016).

Lastly, the majority of studies that set the stage for current guidelines on dairy consumption were performed predominantly with white participants (Bertron, Barnard, & Mills, 1999). Research since the 1960s has found that the prevalence of lactose intolerance is much higher among non-white racial groups, suggesting it affects over 70% of Black and Native American individuals, and over 90% of Asian individuals (Bertron et al., 1999). Research has also found slower bone loss, higher calcium retention, and lower fracture incidence and prevalence of osteoporosis among minority groups (Bertron et al., 1999; Hochberg, 2007; Opotowsky & Bilezikian, 2003). There may be racial differences that need to be considered when providing consumers with dairy recommendations.

1.3. PB Dairy Alternatives

PB dairy alternative products, including non-dairy milk, cheese, and yogurt, have increased in popularity over the past decade (Good Food Institute, 2020; Plant Based Foods Association, 2018b, 2020). PB dairy alternatives originally gained popularity because of their benefit to individuals with dairy allergies or intolerances (Mäkinen, Wanhalinna, Zannini, & Arendt, 2016; Sethi, Tyagi, & Anurag, 2016). Today, other

main drivers include environmental (Leiserowitz et al., 2020; Vanga & Raghavan, 2018), animal welfare (Leiserowitz et al., 2020), and health impacts (Leiserowitz et al., 2020; Sethi et al., 2016; Vanga & Raghavan, 2018). In 2018, sales of PB milk alternatives grew 9%, while cow's milk sales fell 6% (Plant Based Foods Association, 2018b). Sales of other dairy alternative products including cheeses and yogurts also grew a combined total of 28% from 2019 to 2020 (Good Food Institute, 2020). Fluid milk consumption per person in the U.S. has decreased 41% since 1975 (USDA Economic Research Service, n.d.) and the percentage of U.S. households purchasing dairy milk at all is declining (Dairy Management Inc., 2017).

As sales increase (Good Food Institute, 2020), concerns have been raised about the nutritional adequacy of PB dairy alternative products. Most dairy alternatives contain little or no saturated fat (Schuster et al., 2018), and some are high in PUFAs (Chalupa-Krebzdak et al., 2018; Vanga & Raghavan, 2018), which may decrease CVD risk (Chen et al., 2016; Jakobsen et al., 2009). PB milks also tend to be lower in calories, supporting weight maintenance, and higher in vitamin E, supporting protection against cancer-promoting free radicals (Chalupa-Krebzdak et al., 2018). Conversely, research has found that most PB milks have a higher glycemic index when compared to dairy milk, indicating they may not be the best choice for individuals who need to control their blood glucose levels (Chalupa-Krebzdak et al., 2018). Likewise, other than soy, most PB dairy alternatives contain little protein (Schuster et al., 2018; Singhal, Baker, & Baker, 2017; Vanga & Raghavan, 2018).

Most PB dairy alternatives are fortified with certain micronutrients that are found in dairy, including calcium, vitamin D and vitamin A, but are less often fortified with

potassium, phosphorous, and magnesium. However, research shows that fortified nutrients may have reduced bioavailability. The bioavailability of calcium in PB dairy alternatives may be impaired by bioactive plant components, commonly referred to as anti-nutrients, such as phytic acid, oxalates, lectins, and saponins, which can chemically bind to minerals, inhibiting their absorption (Chalupa-Krebzdak et al., 2018). Likewise, fortified calcium in milk alternatives may settle out of solution to the bottom of the carton, making most servings absent of the nutrient if the product is not shaken well (Chalupa-Krebzdak et al., 2018). Fortified soy products remain the only dairy alternatives to be considered an adequate replacement for dairy in the DGA (U.S. Department of Health and Human Services and U.S. Department of Agriculture., 2020).

1.4. Public Understanding of PB Dairy Alternatives

Uncertainty about the nutritional adequacy of PB dairy alternatives has called into question what the public's perceptions are towards these products, and how consumers perceive their nutritional differences from dairy. In a survey of Canadian consumers on nutrition knowledge and beliefs related to milk products, respondents with lower perceptions of dairy's health benefits and the severity of nutrient deficiencies were more likely to exclude dairy from their diet (Allen, Goddard, & Farmer, 2018). In another study of consumers' attitudes toward dairy versus PB milk in Raleigh, North Carolina, interviews revealed a main attribute influencing milk choice was nutritional content. This study found that consumers valued healthy lifestyles when choosing between milk products, but there was disagreement on what constitutes a "healthy" milk product. The authors also noted misconceptions exist among consumers about the

nutritional properties of different milk products (McCarthy, Parker, Ameerally, Drake, & Drake, 2017).

Ensuring consumer understanding of the nutritional differences between dairy and dairy alternatives is a top priority among dairy organizations and nutrition researchers in the U.S. (Ferreira, 2019; National Dairy Council, 2018; Vanga & Raghavan, 2018). Experts and government officials have argued that labeling PB products with known dairy food names like "milk" "cheese" and yogurt" may be leading consumers to misunderstand their nutritional differences from animal dairy products (Chalupa-Krebzdak et al., 2018; DAIRY PRIDE Act, S.130, 115th Cong., 2017; Mercer, 2020; Newhart, 2020). PB alternatives do not meet the Food and Drug Administration's (FDA) standards of identity to be labeled as milk products (Milk, 2019), although the FDA does not currently enforce these labeling regulations.

In other countries, such as those in the European Union and Canada, PB products are not allowed to use dairy terms in their packaging (Leialohilani & de Boer, 2020; Tremblay-Huet, 2017). There is debate whether PB dairy alternatives should legally be allowed to be labeled with dairy names in the U.S. (Newhart, 2020). Among the top stakeholders in this debate is the dairy industry (Mercer, 2020). As demand decreases, many dairy farmers have struggled economically, especially in top dairy producing states (Farm Bureau, 2020). Over 1,600 dairy farms have closed in New York State since 2006 (Nargi, 2018). The number of dairy farms in Vermont has decreased from over 4,000 to just over 700 since 1969 (Bates, 2021). The U.S. dairy industry supports state and federal economies. It generates nearly 3 million jobs, many in top dairy producing states like Wisconsin (O'Keefe, 2018), making the PB market strong

competition for many dairy industry workers. In January 2017, the National Milk Producers Federation first helped introduce The DAIRY PRIDE Act to Congress, which called to prohibit PB products from using dairy terms in their packaging unless derived from a hooved animal (DAIRY PRIDE Act, S.130, 115th Cong., 2017). This bill was also reintroduced in March of 2019 (DAIRY PRIDE Act, H.R.1769, 116th Cong., 2019), but again did not pass. Still, in September 2018, the FDA requested public comment in the Federal Register on issues related to the current labeling of PB alternative products, to gather information on if consumers understand the differences between dairy and dairy alternatives (Use of the Names of Dairy Foods in the Labeling of Plant-Based Products, 83 FR 49103, 2018). The Federal Register is a U.S. government daily publication of Federal agency rules, proposed rules, and public notices, which are open to public comment (Office of the Federal Register, n.d.).

In previous work, use of public comments submitted to federal and local government agencies has been an effective tool for research on public health and nutrition issues (Dinour & Pole, 2017; Haynes-Maslow et al., 2018; Hemmerich, Klein, & Berman, 2017; Pomeranz & Pertschuk, 2019). In a 2018 analysis of perceptions towards the revised Supplemental Nutrition Assistance Program (SNAP) regulations requiring SNAP retailers to carry more nutritious foods, public comments submitted to the Federal Register were used to understand stakeholder perspectives on this proposed policy change (Haynes-Maslow et al., 2018). Another study used Federal Register comments to understand public participation in the rulemaking process on the proposed rule to increase limitations on unhealthful foods sold in school lunches (Dinour & Pole, 2017).

1.5. Healthcare Professionals' Perceptions of Dairy and PB Dairy Alternative Products

Among those who submitted a comment in response to the FDA's request, were numerous healthcare professionals. Primary healthcare professionals, including registered dietitian nutritionists (RDN), physicians, physician assistants, nurses, dentists and dental hygienists are point persons for health information and health promotion. Despite the growing popularity of online media sources for health information (McCully, Don, & Updegraff, 2013; Ramachandran et al., 2018), surveys show that Americans consider healthcare providers among the most trustworthy and accurate sources of nutrition information. A Gallup poll found that nurses and medical doctors were rated highest by Americans in honesty and ethical standards (Brenan, 2018). Data from the Pew Research Center found that almost half of respondents trust RDNs for accurate information on health issues (Funk, Hefferon, Kennedy, & Johnson, 2019). Likewise, a survey from the Academy of Nutrition and Dietetics (AND) revealed that Americans believed RDNs, doctors, and nurses to be the top three most credible sources of food and nutrition information (American Dietetic Association, 2008).

As the prevalence of PB dietary patterns increases, health professionals may receive questions about replacing animal-source foods with PB alternatives, including dairy alternatives. To date there is limited documentation of health professionals' beliefs about PB diets and PB dairy alternatives. Health organizations such as the British Dietetic Association and the AND support vegan and vegetarian dietary choices with appropriate nutrition planning, but provide limited information specifically concerning PB dairy substitute products (British Dietetic Association, 2017; Vesanto,

Craig, & Levin, 2016). The American Medical Association recently passed a resolution encouraging the availability of PB meal options at all healthcare facilities (American Medical Association, n.d.). However, a report produced by the AND, the American Academy of Pediatric Dentistry, the American Academy of Pediatrics, and the American Heart Association recommends children ages one to five years only consume dairy alternative beverages when there is a medical necessity (Lott, Callahan, Welker Duffy, Story, & Daniels S, 2019).

Early research on RDNs in Nebraska, Vermont, and Washington emphasized a lack of knowledge and confidence among many in their ability to counsel patients following PB diets. However, those RDNs showed overall support for PB dietary patterns (Duncan & Bergman, 1999). A survey of 205 dietetics program directors in the U.S. found 90% agreed that vegetarian and vegan nutrition should be taught in dietetics education (Hawkins, Mangels, Goldman, & Wood, 2019). A study assessing Missouri RDNs' perceptions of PB protein sources indicated a high level of support for PB protein consumption, although less knowledge on differences in protein quality between plant and animal sources (Hughes, Kress, Armbrecht, Mukherjea, & Mattfeldt-Beman, 2014).

A limited number of studies have examined perceptions of PB diets among other health professional types as well. A survey of medical doctors from Rush University Medical Center in Chicago found the majority to believe PB diets were health-promoting, while only one-third were willing to recommend a PB diet to their patients (Krause & Williams, 2019). In another mixed-method study of nutrition beliefs among physicians, nurses, and pharmacists in New Zealand, nearly two thirds agreed that PB

diets were beneficial to health, and 80% agreed that diets high in meat would be harmful to health. Over half felt that consuming greater than 3 servings of dairy daily was harmful to health, although many also agreed that dairy was the best source of calcium (McHugh, Smith, Wright, Bush, & Pullon, 2019). A small study that included 15 Canadian physicians found mixed beliefs on dairy fat recommendations for children, although over two thirds believed there were no drawbacks to recommending either full-fat or reduced-fat milk for children. Over a third stated they do not provide any dairy recommendations to children at their 2-year check-up (Vanderhout, Juando-Prats, Birken, Thorpe, & Maguire, 2019).

1.6. Healthcare Professionals' Nutrition Guidance

Guidance from a health professional has been shown to be effective in changing patients' nutrition behaviors. In a systematic review of nine randomized controlled trials, seven found greater positive nutrition outcomes in participants who received nutrition counseling from practitioners compared to participants in control groups (Ball, Johnson, Desbrow, & Leveritt, 2016). Specifically, health professionals may influence patients' milk product choices. In a study investigating beliefs influencing dairy versus PB milk consumption using focus groups with 161 Canadian adults, healthcare provider approval or disapproval was stated as a major influence of milk and cheese product consumption by several participants (Lacroix et al., 2016).

Health professionals are trained to provide sound health advice and are expected to remain knowledgeable in the most up-to-date scientific evidence, and use this in practice (Andersen et al., 2018; DiMaria-Ghalili et al., 2014). Unfortunately, with the

exception of the dietetics profession, nutrition education and training appears to be lacking in health professional degree programs (Adams, Lindell, Kohlmeier, & Zeisel, 2006; Adams, Scott Butsch, & Kohlmeier, 2015; Aggarwal et al., 2018; Crowley, Ball, & Hiddink, 2019; DiMaria-Ghalili et al., 2014; Vetter, Herring, Sood, Shah, & Kalet, 2008). In a 2004 survey of 106 U.S. medical schools, less than half required the National Academy of Sciences minimum recommendation of 25 hours of nutrition education. Furthermore, these hours tended to occur in the first two years of medical training and were not well emphasized during clinical years (Adams et al., 2006). More recent research on medical schools suggests that this problem has not improved (Adams et al., 2015). In studies of medical students' knowledge and attitudes towards nutrition care, nutrition knowledge gaps were identified. In both of these studies, students' average nutrition assessment scores barely surpassed 60% (Mogre, Aryee, Stevens, & Scherpbier, 2017; Vetter et al., 2008) Additionally, many health professionals do not feel confident providing adequate nutrition advice (Crowley et al., 2015; Mogre et al., 2017).

Prior research also shows that health professionals' personal health behaviors may influence the health advice they give to patients (Abramson, Stein, Schaufele, Frates, & Rogan, 2000; Frank, 2004; Frank, Carrera, Elon, & Hertzberg, 2007; Frank, Segura, Shen, & Oberg, 2010; Frank, Tong, Lobelo, Carrera, & Duperly, 2008; Frank, Wright, Serdula, Elon, & Baldwin, 2002; Lobelo, Duperly, & Frank, 2009; Oberg & Frank, 2009), and evidence suggests they are more confident in counseling patients on health and nutrition behaviors they practice themselves (Vickers, Kircher, Smith, Petersen, & Rasmussen, 2007). Work examining this relationship has found that physical activity

habits among health professionals and health professional degree students are likely to influence how much physical activity guidance they provide (Abramson et al., 2000; Frank et al., 2010, 2008; Lobelo et al., 2009). Likewise, in a study of 4,501 U.S. female physicians from the Woman Physicians' Health Study, those who were more concerned with their own eating habits or identified as a vegetarian were more likely to advise patients on nutrition (Frank et al., 2002). A study of Canadian physicians found that those who consumed more fruits and vegetables advised patients on nutrition more often (Frank et al., 2010).

1.7. Conclusion

In the U.S. today, 15% of the total milk market comprises products that some Americans do not even consider "milk" (Plant Based Foods Association, 2020). U.S. consumers are choosing PB diets and eliminating dairy in favor of dairy alternatives more than ever before. These products have their place in certain diets, but dairy is an important source of essential nutrients for many individuals, and it is unclear if consumers realize that these alternatives are not equal to dairy in nutritional value. Healthcare professionals directly advise consumers and are likely to influence their dietary choices. It is important to examine their perceptions of PB dairy alternatives in the U.S. food market and on the nutrition and healthfulness of dairy and PB dairy alternatives. No national studies have examined health professionals' perceptions of dairy compared to PB dairy alternatives, and no research to date has examined the potential relationship between health professionals' personal dietary preferences and their milk product recommendations. Additionally, no studies have used the U.S.

Federal Register as a qualitative method of analyzing health professionals' perceptions on a national nutrition issue. Examining these may be critical to understanding health professionals' participation in the federal rulemaking process and understanding the quality of nutrition advice given to U.S. consumers.

CHAPTER 2: PERSPECTIVES FROM HEALTHCARE PROFESSIONALS ON THE NUTRITIONAL ADEQUACY OF PLANT-BASED DAIRY ALTERNATIVES: RESULTS OF A MIXED-METHODS INQUIRY

2.1. Abstract

2.1.1. Background

Healthcare professionals are important sources of nutrition and health information for Americans. As plant-based (PB) dairy alternative products increase in popularity, concerns have been raised about their nutritional adequacy, and whether consumers understand that they are not nutritionally equal to dairy. Healthcare professionals directly advise consumers on dietary choices, therefore we sought to examine their understanding and opinions of PB dairy alternatives.

2.1.2. Methods

We analyzed comments submitted to the U.S. Food and Drug Administration (FDA) by health professionals (n=191) in 2018-2019 in response to a request for public comment on the nutrition and use of dairy terms like “milk”, “cheese”, and “yogurt" on PB product labels. Survey data from healthcare professionals (n=417) was collected in 2020-2021. Comments and survey responses to open-ended questions were coded using template analysis and thematically analyzed. Multivariate logistic regression models examined perceptions across health professional characteristics for close-ended survey responses.

2.1.3. Results

Three-fourths of health professionals believe consumers are confused about the nutritional differences between dairy and PB dairy alternatives. Over half (53%) do not

believe either product is nutritionally superior to the other. Many believe dairy products have higher nutrient value, but also believe PB dairy alternatives can be part of a healthful diet. Compared to other types of health professionals, dietetics professionals demonstrated a more accurate understanding of the nutritional value of both products and were more likely to believe nutrients like protein (OR 2.02 95% CI 1.22–3.34, p=0.006) and vitamin D (OR 2.46; 95% CI 1.48-4.09, p=0.001) may be nutrients of concern for PB dairy alternative consumers. They were also more likely to believe consumers are confused about these products (OR 3.44; 95% CI 1.65-7.21; p=0.001). Health professionals who submitted comments to the FDA showed stronger opinions in favor of PB dairy alternatives.

2.1.4. Conclusions

Although PB dairy alternatives have nutritional value in certain diets, responses from health professionals suggest that changing their labeling may reduce confusion. Improved nutrition education among health professionals may also be necessary, and health professionals participating in the federal rulemaking process may not be representative of the views held by all U.S. healthcare professionals.

2.2. Background

Healthcare professionals including registered dietitian nutritionists (RDN), primary care providers, dentists, dental hygienists, and nurses provide nutrition care and advice to Americans, and many view these professionals as trustworthy and credible sources of nutrition and health information (1–3). Research shows that healthcare providers' nutrition guidance can positively impact patient dietary behavior

(4). One dietary trend that health providers may be asked about is the replacement of animal-source foods with plant-based (PB) alternatives. Although the number of Americans identifying as vegans and vegetarians is small, about half of Americans show willingness to consume a diet lower in animal-source foods (5). Over the past decade, demand for PB dairy alternatives, including non-dairy "milk," "cheese," and "yogurt," has increased significantly, disrupting the dairy market (6,7). At the same time, dairy milk consumption per person in the U.S. has decreased by almost 50% since 1975 (8), and the percentage of households purchasing dairy milk at all continues to decline (9). Consumers report choosing PB alternatives over dairy for a variety of reasons, including allergy or intolerance (10,11), environmental concerns (5,12), animal welfare concerns (5), and health-related factors (5,11,12).

The U.S. Dietary Guidelines still recommend daily dairy consumption, although over 80% of the U.S. population is not meeting the recommended intake of three servings daily (13). Dairy milk is a top source of carbohydrates, fats, protein, and important micronutrients like calcium, vitamins A and D, and potassium (12,14). However, dairy has received media scrutiny surrounding potential adverse health effects (15–17). Dairy is a top source of saturated fat (18), a nutrient Americans are encouraged to reduce in their diets for the prevention of cardiovascular disease (13,19). However, many studies have not found a direct association between dairy fat consumption and increased cardiovascular disease risk (20–22). Studies have also found an inverse association between dairy fat consumption and risk of hyperglycemia (22) and type 2 diabetes (23–25). Evidence suggests an association between dairy consumption and increased prostate cancer risk (26–29), but also between dairy

consumption and reduced risk of other types of cancers, like colorectal cancer (21,30) and breast cancer (21,31). Despite promotion of dairy milk for bone health, research over the past two decades has not found significant evidence supporting calcium intake or milk intake for bone mineral density or reduced fracture risk (21,32–35) in adults, although intake does appear important during childhood and adolescence (21,34). Conclusions on the associations between dairy and certain health conditions have not yet been reached, yet U.S. consumers continue to reduce their dairy milk intake (8,9).

Although the value of PB milk has been debated (17,36,37), these products do have desirable attributes. Most non-dairy milks contain little or no saturated fat (14), and some are high in polyunsaturated fat (12,38), which may improve cardiovascular disease risk (20,39). Non-dairy milks also tend to be lower in calories, supporting weight maintenance, and higher in vitamin E, supporting protection against cancer-promoting free radicals (38). Still, concerns remain about the nutritional adequacy of diets that replace dairy foods with PB alternatives (38,40,41). Other than soymilk, most PB milks contain little protein (12,14,42), and fortified soymilk remains the only PB milk identified as a nutritionally adequate substitute for dairy in the Dietary Guidelines for Americans (13). PB milks are often fortified with the same micronutrients as those found in dairy, although it is unclear if these fortified micronutrients have the same bioavailability (14,38). Bioavailability may be reduced by certain plant compounds known as “anti-nutrients”, such as phytic acid, found in some PB products that can bind to minerals and disrupt their absorption (38). It is important for consumers of PB dairy alternatives to replace missing nutrients in other areas of their diet (12), but many may not be aware of this.

A limited body of research has examined consumer perceptions towards PB dietary patterns and PB milk products (43–47), revealing that many view PB diets positively, but misconceptions exist about the nutritional properties of dairy milk and PB alternatives. As demand for PB dairy alternatives increases, ensuring accurate consumer understanding of the nutritional differences is important (12,48,49). Members of the dairy industry and some nutrition experts have raised concern that labeling PB products with dairy food names like milk, cheese, and yogurt is leading consumers to believe they contain the same nutrient content as dairy (38,50–52). They argue PB products should not be allowed to be labeled in this way, as they do not meet the U.S. Food and Drug Administration's (FDA) standards of identity for milk products (53). In January 2017 the National Milk Producers Federation helped introduce The DAIRY PRIDE Act to Congress, which called to prohibit PB products from using dairy terms in their packaging (50). In part prompted by this, in September 2018, the FDA requested public comment on issues related to the current labeling of PB substitute products, to gather information on consumer understanding about the differences between dairy and PB dairy alternatives (54).

As PB dietary patterns grow, it is important to understand what health professionals – particularly those who directly counsel patients – understand and believe about PB products. Yet, to date, there is limited documentation of this. In a study investigating beliefs influencing dairy versus PB dairy alternative consumption using focus groups with 161 Canadian adults, healthcare provider approval or disapproval was stated as a major influence of milk and cheese product consumption by several participants (55). Research conducted in the U.S. has found a high level of

support from RDNs for PB protein consumption (56), and most RDNs and dietetics students support PB dietary patterns (57,58). A survey of medical doctors found that the majority believed PB diets were health-promoting, while only one-third reported a willingness to recommend a PB diet to their patients (59). In another study of nutrition beliefs among health professionals, nearly two-thirds agreed that PB diets were beneficial to health, and over half felt that overconsuming dairy was harmful to health, although many also agreed that dairy was an important source of calcium (60). A small study including 15 physicians found mixed beliefs on dairy fat recommendations for children (61). However, no studies to date have examined health professionals' perceptions of dairy compared to PB alternatives. Likewise, no studies have examined Federal Register comments submitted specifically by healthcare professionals on a health debate.

Given that they are key sources of nutrition information for the U.S. consumer, and their advice may directly influence consumer food choice, health professionals' views regarding PB alternatives are important to assess. In this cross-sectional study, we examined health professionals' knowledge and perceptions of PB dairy alternatives and their labeling in the U.S., and examined knowledge differences between dietetics professionals and all other health professionals. The study sample consisted of (1) health professionals who participated in the FDA's request for comment on the labeling of PB products with dairy food names such as "milk," "cultured milk," "yogurt," and "cheese" (54) (83 FR 49103 2018), and (2) a national sample of health professionals who completed an online survey on this topic.

2.3. Methods

2.3.1. Federal Register Comments

The Federal Register is a U.S. government daily publication of Federal agency rules, proposed rules, and public notices. Documents posted in the Federal Register are open to public comment (62). In response to the FDA's request for comment on PB labeling posted on September 28th, 2018, a total of 11,906 comments were submitted to the Federal Register before the deadline on January 28th, 2019. All comments submitted by the deadline were obtained from the FDA through a Freedom of Information Act request. Comments and commenters' self-identified characteristics were imported into the NVivo qualitative data analysis software (version 12). Duplicate submissions (including petitions) with no unique text were identified and only one of each duplicate was retained for analysis. Off-topic and unusable submissions, as well as submissions from minors, were removed from the dataset. Following the removal process, 8,052 comments remained for analysis (Additional File 1).

As part of the standard process, submitters were asked to select their country and state or province of residence, as well as their submission category. Submission category options included individual consumer, food industry, health professional, and private industry, among others. We combined the categories to create six groupings: individual consumers (including consumer group representatives and international public citizens), representatives of a food industry or association (food industry, food association, international food association), government representatives (federal, state, local, international, and other), health professionals, members of academia, and representatives of another industry or association (including any other U.S. or

international industry or association listed). Within their comment, some submitters also self-identified as health professionals, by listing their degree qualifications or indicating that they are a health professional. We identified 191 commenters as a health professional from the body of their comment (n = 71) and/or if they chose the "health professional" category during submission (n = 154) (Additional File 1).

2.3.2. Survey

We designed a web-based (Qualtrics, Provo, UT) survey to measure health professionals' knowledge and opinions of dairy products and PB alternatives. To be eligible, individuals had to be age 18 years or older; live in the U.S. since at least January 2020; and currently be an RDN, medical doctor (MD), doctor of osteopathy (DO), physician assistant (PA), dentist, dental hygienist, licensed practical nurse (LPN), registered nurse (RN), nurse practitioner (NP), or a student currently enrolled in a degree program for one of those professions holding Junior undergraduate standing or above. These specific categories of health professionals were targeted as likely to have the most direct contact and opportunity to provide nutrition advice to patients. We used three methods for non-probability convenience sampling to recruit respondents: (1) paid digital ads via Facebook to reach a national sample; (2) targeted postings to relevant national LinkedIn and Facebook group pages; and (3) postings on academic, professional, and community listservs in Vermont as well as nationally. The survey was open from November 19, 2020 until February 4, 2021. All respondents who passed the eligibility screener and completed all or part of the survey were included in analyses. A total of 417 survey responses were retained for analysis. Respondents were entered in a

gift card drawing. This study was determined to be exempt by the Institutional Review Board at the University of Vermont.

The survey asked respondents' age, gender identity, race, ethnicity, state of residence, and type of health profession or professional degree program. The survey also measured respondents' perceptions of the nutrition and labeling of dairy and PB alternatives (Table 1). These questions were developed based on those asked by the FDA in their request for comments (54). Specifically, it asked which products, dairy or PB alternatives, if either, they believe are nutritionally superior over the other, and why, and which nutrients may be below adequate intake in individuals who consume PB alternatives in place of dairy, and why. It also asked respondents' opinions on consumers' reasons for choosing PB alternatives, if consumers understand the nutrition of PB dairy alternatives, if the labeling of these products affects consumer understanding, and whether the FDA should permit PB products to be labeled with names that include the names of dairy foods. Additionally, the questionnaire asked respondents if they had ever submitted a comment to the Federal Register, and if so, if they had submitted a comment to this request from the FDA. Lastly, it asked respondents if there was anything else they would like to share about the labeling of PB dairy alternatives.

Table 1. PB dairy alternative survey questions.

Variable name	Question	Response options	Post-collection recoding
Submitted to Federal Register	Have you ever submitted a comment to the U.S. Federal Register?	Yes No Don't remember	
Submitted to FDA request	Did you participate in in the Food and Drug Administration's request for comments regarding the labeling of plant-based products with names that include	Yes No Don't remember	

	the names of dairy foods such as "milk," "cultured milk," "yogurt," and "cheese"? [a]		
Consumer reasons	What do you believe are consumers' reasons for purchasing and consuming plant-based milk products (milk products not from animal origin) that are labeled with the names of dairy foods such as "milk," "cultured milk," "yogurt," and "cheese"? Please select all that apply.	Nutrition and health concerns Animal welfare concerns Environmental concerns Dairy allergy or intolerance Food safety concerns Hormone and/or antibiotic concerns Taste preferences Other	All response options were recoded to binary variables for analyses: 0=did not select response option 1=selected response option
Nutritionally superior product	Which product (plant-based milk or dairy milk products), if either, do you believe is nutritionally superior to the other?	I believe dairy products are nutritionally superior to plant-based milk products I believe plant-based milk products are nutritionally superior to dairy products I believe neither is nutritionally superior to the other I am unsure	'I believe neither is nutritionally superior to the other' and 'I am unsure' response options were combined for analyses
Why nutritionally superior product	Please explain the reasons why you believe [dairy OR plant-based OR neither] products are nutritionally superior. [b]	Open-ended	
Nutrients of concern	Do you believe that the diets of people who consume mostly plant-based milk products are lacking in any of the following nutrients compared to the diets of people who consume mostly dairy products? Please select all that apply.	Calcium Potassium Protein Vitamin A	All response options were recoded to binary variables for analyses: 0=did not select response option 1=selected response option

		Vitamin D None of these are nutrients of concern Other
Why nutrients of concern	Please explain why you selected your answer(s) above.	Open-ended
Consumer understanding	Do you believe consumers understand the nutritional differences between plant-based products and their dairy counterparts?	Yes No Unsure
PB label effect	Do you think the use of dairy names such as "milk," "cultured milk," "yogurt," and "cheese" on plant-based product labels affects consumers' perceptions and understanding of these products?	Yes No Unsure
Allow dairy terms on PB labels	Do you think that the Food and Drug Administration should permit plant-based products to be labeled with names that include the names of dairy foods such as "milk," "cultured milk," "yogurt," and "cheese"?	Yes No Unsure
Other milk comments	Is there anything else that you would like to share about the labeling of plant-based milk products?	Open-ended

[a] Only asked if respondent selected yes to previous question. [b] Not asked to respondents who selected 'I am unsure' to nutritionally superior product question.

2.3.3. Coding

We used the template analysis approach (63,64) to develop a codebook including a priori codes and codes that reflected emergent themes. The coding team iteratively applied the template to subsets of the public comment data in June 2019 and met to resolve differences in interpretation and revise the template. The final template consisted of two categories of codes: characteristic codes (relevant to the Federal Register comments only) and content codes. Characteristic codes captured self-described characteristics of commenters, including their affiliation (e.g., representative

of an organization), their preference for dairy products or PB alternatives, and their position on the labeling of PB products with dairy terms. Content codes captured main themes in the data, including discussion of nutrition and health topics. See Additional File 2 for codes relevant to this work. An eight-person team coded the full public comment dataset. Coding consistency for a sample of data was checked between each coder and the first author prior to full coding. Open-ended survey responses were coded using the same codebook and methods. After coding was complete, our research team checked each code for accuracy and consistency in use. Coding anomalies were discussed and corrected.

2.3.4. Data Analysis

2.3.4.1. Federal Register Analysis

Federal Register comments from health professionals were analyzed using thematic analysis, a method used to identify, organize, and describe key findings from a qualitative data set (65). Frequencies of all relevant codes (Additional File 2) were tabulated and reviewed. Key themes were summarized in code memos, which were reviewed and refined by the research group. For qualitative analysis, the frequency of codes and themes discussed by participants from both samples is reported using the following: "almost all" indicates ≥ 90%; "most" means more than two-thirds; "many" indicates between half and two-thirds; "about half" means about 50%; a "substantial minority" indicates at least one-third yet less than half; "some" means less than a third; and "few" or "a small number" means ≤ 10% of submissions (66). A chi-square test was used to examine differences in positions on the labeling of PB products with dairy

terms between health professional and non-health professional commenters. The test was statistically significant if $p<0.05$.

2.3.4.2. Survey Analysis

Open-ended survey responses were thematically analyzed using the same methods described above for analysis of Federal Register comments. Matrix coding queries were used to consider responses to open-ended questions between dietetics professionals (including dietetics students) and all other health professionals (including other health professional students). Quantitative survey data was analyzed with IBM SPSS Statistics (version 27). During analysis, variables for race and ethnicity were merged and recoded to a binary variable "Black, Indigenous, or person of color (BIPOC)" and "not BIPOC". State of residence was recoded to a binary variable that indicated whether it was a "dairy state". U.S. "dairy states" were determined based on being among the 10 states with the highest percentage of total farm sales coming from milk sales in 2017 (VT, NM, NY, WI, ID, NH, PA, AZ, MI, and ME) (67). Also, the nutritionally superior product variable was recoded to combine the responses "I believe neither is nutritionally superior to the other" and "I am unsure". Univariate descriptive statistics were generated for all relevant variables. Chi-square tests were used to examine bivariate associations of dairy and PB dairy alternative perceptions between dietetics professionals and other health professionals. Using multivariate logistic regression models, we examined whether health profession (dietetics professionals versus other health professionals) was associated with respondents' beliefs on which product was nutritionally superior, nutrients of concern, consumer understanding, PB label effect, and allowing dairy terms in PB labeling. Demographic factors including age,

race/ethnicity, and whether or not the respondent lived in a dairy state were included in all models. Tests were statistically significant if $p<0.05$.

2.4. Results

Of the 8,052 original comments received by the FDA in response to this request for comment, less than 2.5% (n=191) were submitted by health professionals (Table 2). A little more than half of health professional commenters (55.5%) reported living in the U.S., with the majority also specifying their state of residence. Nearly one in ten (9.4%) of these health professional commenters reported residing in a "dairy state". The remainder did not report their location (44.0%) or reported a location outside of the U.S. (0.5%).

Half of all commenters (49.7%) and 42.4% of health professional commenters described a preference for PB dairy alternatives. Only 7.4% of all commenters and 11.0% of health professionals indicated a preference for dairy products. A substantial portion of all commenters (41.3%) and health professional commenters (46.6%) did not indicate a preference for dairy vs. dairy alternatives. Compared to non-health professional commenters, a smaller proportion of health professionals supported the use of dairy terms in PB product labels (68.9% vs. 64.9%; $X^2=27.53$, $p<0.001$; data not shown).

Table 2: Characteristics of Federal Register commenters.

Variable	Total commenters		Health professionals	
	n	%	n	%
Location				
United States	3779	46.9	106	55.5
Dairy State	776	20.5	10	9.4
Other State	2623	69.4	83	78.3

Did not specify	380	10.1	13	12.3
Other country	150	1.9	1	0.5
Did not specify	4123	51.2	84	44.0
Product preference				
Prefer dairy products	599	7.4	21	11.0
Prefer PB products	4000	49.7	81	42.4
Unclear or neutral preference	3453	42.9	89	46.6
Position on labeling				
Support use of dairy terms in PB labeling	5674	70.4	124	64.9
Oppose use of dairy terms in PB labeling	1021	12.7	47	24.6
Unclear or neutral position on PB labeling	1357	16.9	20	10.5

Note. N = 8052, n = 191 for health professionals.

Most survey respondents were female (91.5%), non-Hispanic white (87.5%), and under age 55 (82.2%) (Table 3). Forty-six percent were from a "dairy state", reflecting the additional recruitment conducted in Vermont. The sample consisted of 350 practicing health professionals and 67 students hereafter collectively referred to as "health professionals". RDNs and dietetics students made up 44.4% of the sample, and other health professionals or students made up the remainder. Nurses or nursing students comprised the largest population of other health professionals (74.1%; data not shown).

Table 3: Characteristics of survey respondents.

Variable	n	%
Age		
18-34	181	43.4
35-54	161	38.6
Over 55	75	18.0
Female	301	91.8
Non-Hispanic white [a]	275	87.9
Location		
Dairy state	150	46.0
Other state	176	54.0

Health profession		
Dietetics professional or student	185	44.4
Other health professional or student	232	56.6

Note. N = 417. Totals for gender identity (n=328), race/ethnicity (n=313), and location (n=326) are smaller because response to these questions was optional.
[a] The small number of BIPOC respondents inhibited the disaggregation of analyses by race/ethnicity.

2.4.1. Key Nutrition and Health Themes of Dairy and PB Alternatives Discussed in Federal Register Comments and Open-Ended Survey Responses.

2.4.1.1. Federal Register Comments

Sixty-four percent of health professionals who commented on the Federal Register (n=123) mentioned nutrition and health aspects of dairy and/or PB dairy alternatives within their comment, either describing the nutritional merits or demerits of PB dairy alternatives. Interestingly, of health professionals who supported the use of dairy terms on PB labels, 57% commented on their nutrition and health aspects, compared to 87% of those who opposed the use of dairy terms on PB labels. In order, the most common nutrition and health topics mentioned by health professionals were the general nutrition or healthfulness of either product; micronutrient content, including mentions of calcium, vitamin D, and potassium; protein content; other nutrition or health aspects, such as chronic disease; allergy; and digestion. Additionally, a substantial minority of health professionals mentioned that they believe consumers are confused about the nutritional differences between products, and some mentioned that they believe current labeling is contributing to this confusion. Illustrative quotes for each theme and subtheme are presented in Table 4.

Among those who mentioned nutrition and health, 62% of health professionals discussed the nutritional merits of PB dairy alternatives, and 35% of health professionals discussed the nutritional demerits of PB dairy alternatives (Table 4). A

small remainder were neutral. Those who discussed the nutritional merits believed these products can be part of a healthy diet. About half of those who discussed their nutritional merits argued that PB dairy alternatives are nutritionally adequate replacements for dairy for certain individuals, such as those with an allergy, intolerance, or elevated risk for cardiovascular disease, and about half stated they are nutritionally superior to dairy. Some of these health professionals also believed that dairy is harmful to human health, contributing to chronic disease risk. Health professionals who discussed the nutritional demerits of PB dairy alternatives believed that they are not nutritionally equal and/or that dairy products are superior nutrient sources, especially in relation to protein. Few mentioned bioavailability differences.

Table 4: Key themes discussed in comments submitted to the FDA.

Theme	Subtheme	Example quotes
Nutritional merits of PB dairy alternatives	1. PB dairy alternatives are a healthy choice.	*"These are healthy alternatives with superior nutritional quality."* *"The general public has finally been educated about plant-based milk being healthier for humans…"*
	2. PB dairy alternatives provide an adequate source of essential micronutrients for individualized dietary needs.	*"Its still a great calcium source, and its useful for those (especially kids) who cant tolerate or dont like cows milk."* *"Take any one of my patients with high cholesterol; I will tell them to choose some dairy alternatives, fortified with those essential nutrients, including vitamins and minerals…"*
	3. Dairy is harmful to human health.	*"Animal products are directly linked with hypercholesterolemia, a major contributor to cardio-vascular disease, morbidity and mortality."* *"Healthcare professionals like myself are making strong inroads into convincing the public of the deleterious health effects of the ingestion of any form of animal products…"*
Nutritional demerits of PB dairy alternatives	1. Dairy and PB alternatives do not have equal nutritional	*"Every week, patients tell me they are using almond milk or some other nut milk as an alternative to dairy, with no clue that these*

	profiles.	*are not nutritionally equivalent products."* *"There is a substantial difference in the nutritional content of these two products, and consumers are understandably confused by the name "milk" on non-dairy products."*
2.	Dairy provides a superior source of essential micronutrients.	*"We know from extensive research on the benefits of dairy milk including calcium, potassium, and vitamin D, in addition to many other important micronutrients."* *"I have cared for too many patients that have fractures that could have been prevented by a higher calcium intake from dairy products. The plant based beverages do not contain naturally occurring calcium…"*
3.	The protein content in dairy is superior to PB alternatives.	*"As a dietitian it saddens me to see parents giving rice or coconut milk to children... less than 1 gm protein."* *"The nutritional value of nut milk isn't the same as cows milk, and the biggest difference is in the protein content. Most nut milks are not a good source of protein, and people think they are getting the same amount of protein that they would in cows milk."*

2.4.1.1. Survey Responses

The most common nutrition and health topic mentioned by survey respondents was nutrient value, specifically protein and calcium. Other top nutrition and health aspects discussed include the general nutrition or healthfulness of either product and other nutrition and health issues such as chronic disease and inflammation. Table 5 presents representative quotes for each theme. Many comments discussed the high nutrient value of dairy, most mentioning that dairy has a higher nutrient content and/or quality when compared to PB alternatives (Table 5). Almost all comments on protein described dairy as a good source of protein, with many stating dairy's protein quality is superior to PB alternatives. Many comments that mentioned calcium stated that dairy provides more calcium than PB alternatives, some stating that calcium from PB sources

is less bioavailable. Less than one-third of comments discussed the nutritional merits of PB alternatives in terms of protein, calcium, and overall nutrient content, often referencing the fortification of PB products. Few comments stated that dairy consumption is associated with disease risk.

Regarding general nutrition and healthfulness, many health professionals commented that neither product can be deemed nutritionally superior to the other, saying both have advantages and disadvantages. Of note, some respondents shared that achieving nutrient adequacy is dependent on more than just dairy product consumption, discussing that nutrients can be obtained from many other sources with a balanced diet. No major differences were identified in themes discussed by dietetics professionals compared to other health professionals.

Table 5: Key themes discussed among survey respondents.

Theme	Example quotes
Dairy has a superior overall nutrient value compared to PB dairy alternatives.	*"cows milk has a standard of identity and assures the same nutrient content regardless of brand, city, state it was produced in; plant based beverages nutrient content varies by brand and only certain brands of soy beverages come close in matching the nutrient content of cows milk"* *"I think that even fortified plant-based products don't contain the same amount of calcium as dairy products and because dairy products are also naturally high in 8 other essential nutrients."*
The protein content and quality in dairy products is superior to PB dairy alternatives.	*"Most plant-based beverages are very low in protein as well (for example, almond milk) which is important for children and elderly as it is common for these age groups to struggle with protein intake. Cow's milk has more of the building block proteins that humans need in their diet."* *"Dairy products tend to be a higher source of quality protein…"*
Both products have nutritional advantages and disadvantages.	*"They both have nutritional benefits and deficits. I think the determining factor is the specific patients dietary needs/restrictions"*

	"I think each have different nutrition facts. Broadly grouping them makes it hard to say they are superior. They all provide nutrients."
Nutritional adequacy is dependent upon the whole diet.	*"Cows milk is not the sole source of vitamins and minerals. Eating a balanced diet including fruits, vegetables and whole grains will satisfy your dietary needs."* *"With a healthy diet a person can get most of the nutrients needed. Plant based or not."*

Note. Themes were not separated between those discussing the nutritional merits vs. demerits of PB alternatives due to the small number of total comments discussing nutritional merits of PB alternatives.

2.4.2. Survey Respondents' Perceptions and Concerns about Nutrition Quality of Dairy and PB Alternatives

Top reasons identified by health professionals for why some consumers choose PB dairy alternatives over dairy were nutrition and health concerns (85.0%), dairy allergy or intolerance (82.4%), and animal welfare concerns (64.9%) (Table 6). About one-third (32.8%) believed dairy products were nutritionally superior to PB dairy alternatives, and 14.2% believed PB dairy alternatives were nutritionally superior to dairy products. About half (53.0%) did not believe that either was nutritionally superior. Most (77.2%) believed that consumers do not understand the nutritional differences between dairy products and PB alternatives, and many (65.4%) also believed the use of dairy names on PB product labels affects consumers' understanding of these products. Just one survey respondent reported submitting a comment to the FDA's request on this topic. Responses were split on if the FDA should permit PB dairy alternatives to be labeled with the names of dairy foods, with 39.7% saying yes, 36.4% saying no, and 23.9% remaining unsure.

Table 6: Survey responses to PB dairy alternative questions.

Variable	n	%
Consumer reasons [a]		
Nutrition and health concerns	324	85.0

Animal welfare concerns	244	64.9
Environmental concerns	194	50.9
Dairy allergy or intolerance	314	82.4
Food safety concerns	32	8.4
Hormone and/or antibiotic concerns	205	53.8
Taste	131	34.4
Other	25	6.6
Nutritionally superior products		
Dairy products	122	32.8
PB products	53	14.2
Neither or unsure	197	53.0
Consumer understanding		
Yes	23	6.8
No	260	77.2
Unsure	54	16.0
PB label effect		
Yes	225	65.4
No	70	20.3
Unsure	49	14.2
Allow dairy terms on PB labels		
Yes	136	39.7
No	125	36.4
Unsure	82	23.9

Note. Consumer reason n=381; Nutritionally superior product n=372; Consumer understanding n=337; PB label effect n=344; Allow dairy terms in PB labeling n=343.
[a] Reflects frequency of respondents who selected this reason.

In response to the question about nutrients of concern in diets that replace dairy with PB alternatives, 40.1% of health professionals believed calcium intake may be a concern, and about one-third believed vitamin D and protein intake may be of concern (Figure 1). Conversely, 35% of health professionals believed none of the nutrients listed were of concern in diets replacing dairy with PB alternatives.

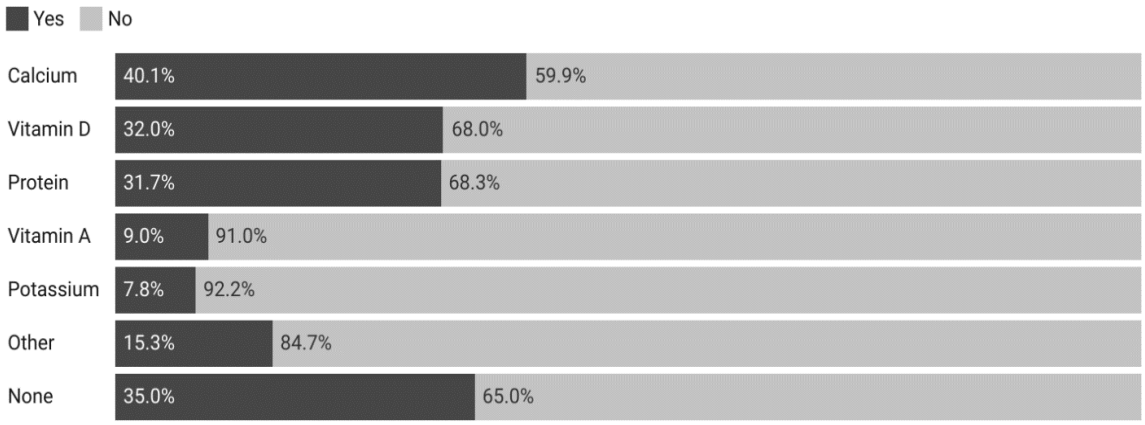

Figure 1: Do you believe that the diets of people who consume mostly PB milk products are lacking in any of the following nutrients? (n=334)

2.4.3. Perceptions of Dairy and PB Alternatives by Health Professional Category and Demographics

Multivariate logistic regression analyses examined demographic and professional factors associated with the belief that dairy or PB dairy alternatives are nutritionally superior (Table 7). As compared to respondents aged 18-24 years, those aged 55 years and older were more likely to believe dairy products were nutritionally superior to PB dairy alternatives (OR 2.99; 95% CI 1.44-6.21, p=0.003). Those from a dairy state were less likely to believe PB dairy alternatives are nutritionally superior to dairy (OR 0.26; 95% CI 0.11-0.59, p=0.001). Dietetics professionals were more likely than other health professionals to believe dairy is nutritionally superior to PB dairy alternatives (OR 2.27; 95% CI 1.33-3.87, p=0.003), and less likely to believe PB dairy alternatives are nutritionally superior to dairy (OR 0.19; 95% CI 0.08-0.50, p=0.001).

Table 7: Factors associated with the belief that dairy or PB dairy alternatives are nutritionally superior (n=302).

Variables	b	SE	OR	CI	p value
Dairy products are nutritionally superior to PB milk products					

Age (ref=18-34)					
35-54	0.51	0.30	1.67	0.93-2.99	0.085
Over 55	1.10	0.37	2.99	1.44-6.21	**0.003**
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.26	0.43	0.77	0.33-1.78	0.539
Location (ref=Not Dairy State)					
Dairy state	-0.05	0.27	0.95	0.56-1.61	0.861
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.82	0.27	2.27	1.33-3.87	**0.003**
<u>PB milk products are nutritionally superior to dairy products</u>					
Age (ref=18-34)					
35-54	-0.01	0.43	0.99	0.42-2.30	0.976
Over 55	0.53	0.52	1.71	0.62-4.73	0.305
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.51	0.52	1.67	0.60-4.63	0.328
Location (ref=Not Dairy State)					
Dairy state	-1.35	0.42	0.26	0.11-0.59	**0.001**
Health professional type (ref=non-dietetics professional)					
Dietetics professional	-1.64	0.49	0.19	0.08-0.50	**0.001**

Note. Adjusted logistic regression models are presented. The models used "neither or unsure" as the reference category of the dependent variable.

Multivariate logistic regression analyses also were used to identify demographic and professional factors associated with the belief that the diets of consumers of PB alternatives are lacking in specific nutrients (Table 8). Respondents aged 55 years and older were more likely than those aged 18-34 years to believe vitamin A would be a nutrient of concern for individuals that replace dairy with PB alternatives (OR 5.23; 95% CI 1.81–15.06, p=0.002). Dietetics professionals were more likely than other health professionals to believe protein (OR 2.02 95% CI 1.22–3.34, p=0.006), vitamin

D (OR 2.46; 95% CI 1.48-4.09, p=0.001), and potassium (OR 7.18; 95% CI 2.35–21.95, p=0.001) would be a nutrient of concern for individuals that replace dairy with PB alternatives. Conversely, they were less likely than other health professionals to believe that none of the nutrients were of concern for these individuals (OR 0.49; 95% CI 0.29-0.81, p=0.005).

Table 8: Factors associated with the belief that diets of PB dairy alternative consumers lack specific nutrients (n=299).

Nutrient of concern	b	SE	OR	CI	p value
Calcium					
Age (ref=18-34)					
35-54	0.32	0.27	1.38	0.81-2.33	0.235
Over 55	0.28	0.34	1.33	0.69-2.57	0.397
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.28	0.38	0.76	0.36-1.58	0.456
Location (ref=Not Dairy State)					
Dairy state	0.05	0.24	1.05	0.66-1.70	0.830
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.41	0.24	1.513	0.95-2.43	0.085
Potassium					
Age (ref=18-34)					
35-54	0.50	0.52	1.65	0.60-4.53	0.334
Over 55	1.08	0.60	2.95	0.91-9.61	0.072
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.96	0.55	2.62	0.90-7.65	0.078
Location (ref=Not Dairy State)					
Dairy state	-0.21	0.46	0.81	0.33-2.00	0.650
Health professional type (ref=non-dietetics professional)					
Dietetics professional	1.97	0.57	7.18	2.35-21.95	**0.001**
Protein					

Age (ref=18-34)					
35-54	0.19	0.29	1.21	0.69-2.13	0.508
Over 55	0.56	0.35	1.75	0.88-3.46	0.111
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.40	0.42	0.67	0.30-1.52	0.339
Location (ref=Not Dairy State)					
Dairy state	0.17	0.26	1.18	0.72-1.96	0.513
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.70	0.26	2.02	1.22-3.34	**0.001**
<u>Vitamin A</u>					
Age (ref=18-34)					
35-54	0.92	0.50	2.50	0.93-4.76	0.070
Over 55	1.65	0.54	5.23	1.81–15.06	**0.002**
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.28	0.60	1.32	0.41-4.27	0.639
Location (ref=Not Dairy State)					
Dairy state	0.41	0.41	1.50	0.68-3.34	0.318
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.75	0.41	2.13	0.96-4.76	0.067
<u>Vitamin D</u>					
Age (ref=18-34)					
35-54	0.08	0.29	1.08	0.61-1.91	0.788
Over 55	0.58	0.36	1.79	0.89-3.59	0.101
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.17	0.39	1.19	0.56-2.54	0.656
Location (ref=Not Dairy State)					
Dairy state	-0.39	0.26	0.68	0.41-1.13	0.135
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.90	0.26	2.46	1.48-4.09	**0.001**

None					
Age (ref=18-34)					
35-54	-0.42	0.28	0.66	0.38-1.14	0.137
Over 55	-0.41	0.35	0.66	0.33-1.33	0.25
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.15	0.40	0.86	0.40-1.86	0.698
Location (ref=Not Dairy State)					
Dairy state	-0.23	0.26	0.79	0.48-1.31	0.368
Health professional type (ref=non-dietetics professional)					
Dietetics professional	-0.72	0.26	0.49	0.29-0.81	**0.005**

Note. Adjusted logistic regression models are presented above. The models used not selecting that nutrient/response as the reference category of the dependent variable.

Multivariate logistic regression analyses also identified factors associated with the belief that consumers understand the nutritional differences between PB products and their dairy counterparts (Table 9). Those from a dairy state were less likely to agree (OR 0.30; 95% CI 0.10-0.86; p=0.025) or disagree (OR 0.39; 95% CI 0.19-0.77; p=0.007) that consumers understand the nutritional differences between the products and were more likely to remain unsure. Compared to other health professionals, dietetics professionals were more likely to say that consumers do not understand the nutritional differences between dairy products and their PB counterparts (OR 3.44; 95% CI 1.65-7.21; p=0.001). Multivariate analyses examining factors associated with beliefs on whether the use of dairy terms in PB labeling affects consumer understanding and whether the FDA should permit PB products to use dairy names in their labeling can be found in Additional File 3.

Table 9: Factors associated with the belief that consumers understand the nutritional differences between products (n=299).

Consumer understanding	b	SE	OR	CI	p value
Yes					

Age (ref=18-34)					
35-54	-0.30	0.61	0.74	0.22-2.45	0.620
Over 55	0.12	0.69	1.13	0.29-4.38	0.865
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.79	0.78	2.19	0.48-10.10	0.313
Location (ref=Not Dairy State)					
Dairy state	-1.22	0.06	0.30	0.10-0.86	**0.025**
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.25	0.58	1.29	0.41-4.03	0.663
No					
Age (ref=18-34)					
35-54	0.17	0.39	1.18	0.56-2.52	0.660
Over 55	0.08	0.46	1.09	0.44-2.69	0.858
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.20	0.59	1.22	0.39-3.86	0.733
Location (ref=Not Dairy State)					
Dairy state	-0.95	0.36	0.38	0.19-0.77	**0.007**
Health professional type (ref=non-dietetics professional)					
Dietetics professional	1.24	0.38	3.44	1.65-7.21	**0.001**

Note. Adjusted logistic regression models are presented above. The models used "unsure" as the reference category of the dependent variable.

2.5. Discussion

This paper was the first to examine healthcare professionals' perceptions on the nutritional value and labeling of PB dairy alternatives, and the first to use the U.S. Federal Register to examine health professionals' opinions on a national issue. Sales of PB products are rising in the U.S. (6,7,68), and national and international dietary recommendations emphasize the health and environmental benefits of transitioning to a more PB diet (69,70). Increasingly, U.S. consumers are replacing dairy with non-dairy alternatives. However, fully omitting dairy foods can present nutritional issues (38),

which many consumers may not be aware of (43–47). Health professionals are trusted sources of nutrition information and the nutrition advice they give is likely to influence consumer food choices (4,55). This study found that many health professionals took a neutral stance on the nutritional sufficiency of both products, specifically stating that although dairy is a better source of nutrients, neither product is nutritionally superior to the other. Many health professionals believed that consumers are confused about the nutritional differences between dairy products and their PB counterparts. However, dietetics professionals had a greater understanding of the nutrient adequacy of both products and believed more consumer confusion exists than other healthcare professionals. There appeared to be differences between the perceptions of health professionals who participated in the FDA's request for comments and the survey sample of health professionals, suggesting beliefs among those participating in the federal rulemaking process may not reflect the beliefs of diverse health professionals in the U.S.

Aligning with prior research, we found that many U.S. health professionals recognized the beneficial nutrition qualities of dairy in one's diet, in terms of essential nutrients, especially protein, calcium, and vitamin D (12,14,38), but also understood that PB alternatives have their own nutritional properties (10–12,38) that may suit individual nutritional needs. About half of survey respondents reported that neither product was nutritionally superior. However, their open-ended responses reflected the belief that the dairy is a better source of essential nutrients. Although a greater proportion of Federal Register comments discussed the nutritional merits of PB dairy alternatives, about half of these only suggested that they are an *adequate* alternative for

individuals who cannot or choose not to consume dairy, not necessarily stating that they are superior. For example, many Federal Register comments discussed that PB products may be beneficial for individuals with a dairy allergy or intolerance, or for those needing to reduce their saturated fat intake. Survey respondents also cited dairy allergy or intolerance as a top reason that consumers may select a PB alternative. This aligns with literature showing that allergy, lactose intolerance and other digestive issues are a primary reason that consumers choose PB dairy alternatives (10,12). It may be that while health professionals see the positive aspects of PB alternatives, they would still recommend dairy as a first option if appropriate.

Over three-fourths of survey respondents were in agreement with dairy industry stakeholders (51,52) that consumers do not understand the nutritional differences between dairy and PB alternatives, and two thirds agreed that the current labeling, which allows PB products to use dairy terms like “milk”, “cheese”, and “yogurt” in their packaging, is contributing to this misunderstanding. A substantial minority of health professionals who submitted comments to the FDA and mentioned nutrition and health aspects also directly discussed consumer misunderstanding of the nutritional differences between the products, with some attributing this confusion to the current labeling regulations. Among all health professionals studied, we saw less strong opinions on the proposed labeling regulation change. Still, this adds to the limited evidence showing misconceptions about the nutritional properties of dairy and PB alternatives (43–47).

From the survey, significantly more non-dietetics professionals reported PB dairy alternatives to be nutritionally superior to dairy as compared to dietetics professionals.

Dietetics professionals were more likely to believe that protein, vitamin D, and potassium may be lacking in the diets of individuals who do not consume dairy, and less likely to believe that no nutrients would be lacking. Many health professionals reported that diet is dependent on more than one food source, and that omitting dairy from the diet will not necessarily lead to nutrient inadequacies. However, 77% of health professionals also believed consumers do not understand the different nutritional aspects of both products, indicating that they may not know to consume other foods high in these nutrients. Likewise, data on the standard American diet (13) shows that dairy is a top food source for nutrients of concern like calcium, vitamin D and potassium, and most Americans are not consuming enough fruits, vegetables or seafood to be obtaining these nutrients through other sources. Still, fewer non-dietetics professionals actually believed there is consumer confusion on the nutritional differences between products. These findings suggest that dietetics professionals may have a greater understanding of the role dairy has in the context of the American diet. As previous literature suggests (71–76), nutrition training in many healthcare disciplines remains limited. Registered dietitians receive extensive training in nutritional sciences and nutrition care, and may serve as important additions to interprofessional healthcare teams (74).

We also identified notable differences between health professionals from the survey sample and the Federal Register sample. A greater proportion (about one-third) of Federal Register participants discussed PB dairy alternatives being a nutritionally superior choice compared to less than 15% of survey respondents. Also, a much smaller proportion of health professionals who commented on the Federal Register believed

consumers are confused about the nutritional differences, and/or that the use of the dairy terms in PB product labels is an issue. Likewise, almost two-thirds of health professionals who commented did not support a labeling regulation change, compared to less than 40% of health professionals from the survey. This may indicate that those who participated in this federal rulemaking process have more polarized opinions on the topic as compared to the general population of U.S. healthcare professionals.

This study had several imitations. First, there was an uneven distribution of health professional types within the survey sample, as the majority were dietetics and nursing professionals. However, having approximately half of respondents made up of dietetics professionals allowed us a large enough sub-sample to make a comparison of dietetics professionals to other health professionals with less nutrition training. Second, a large minority of the sample (32%) came from Vermont. This allowed the novel and important inclusion of an independent variable to evaluate living in a state with a prominent dairy industry in our analyses. Third, the majority of the sample was female and non-Hispanic white, and nearly 85% were dietetics or nursing professionals. This reflects our additional recruitment activities targeted towards RDNs and nurses, and extended recruitment in Vermont. Over 90% of RDNs and nurses in the U.S. are female (77,78) and less than 10% of the population of Vermont identify with a race or ethnicity other than non-Hispanic white (79). Fourth, the use of qualitative data allowed us to capture more detailed and individualized responses from health professionals. These data were coded using standard techniques for team-based research and it is possible that certain comments were interpreted incorrectly. However, all coders performed

several rounds of preliminary practice to ensure agreement among coding and all codes were checked and discussed with at least one other person on the team.

2.6. Conclusions

We found that many health professionals believe that consumers are confused about the nutritional differences between dairy and PB alternatives, and some believe that prohibiting the use of dairy terms in PB packaging may help reduce confusion. Our findings also indicate important knowledge gaps among non-dietetics health professionals around the nutrional adequacy of PB dairy alternatives, and the nutrional value dairy may have in the standard American diet. PB diets can be beneficial to health and longevity, but completely eliminating food groups can present nutritional challenges. Improved nutrition education and training focusing specifically on the nutritional needs of patients who follow PB dietary patterns may be necessary, to ensure health providers are equipped to help consumers make informed health decisions. Lastly, our findings suggest that stakeholders who submit comments to the Federal Register, which are then taken into account in the rulemaking process, may represent over-polarized views on nutrition issues.

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CHAPTER 3: PERSONAL BIAS IN NUTRITION ADVICE: A SURVEY OF HEALTHCARE PROFESSIONALS' RECOMMENDATIONS REGARDING DAIRY AND PLANT-BASED DAIRY ALTERNATIVES

3.1. Abstract

3.1.1. Objective

To examine the relationship between health professionals' personal dietary preferences and their professional nutrition advice to patients on dairy and plant-based dairy alternatives.

3.1.2. Design

Cross sectional web-based survey. Survey examined health professionals' personal dietary preferences, including milk preference (plant-based or dairy milk), dietary pattern (vegetarian or omnivore), and if they followed a "plant-based" diet, and examined if they would advise patients to consume dairy and/or plant-based dairy alternatives. Adjusted and unadjusted logistic regression models examined if health professionals' personal dietary preferences were associated with their professional advice to patients on either product.

3.1.3. Setting

Sample of U.S. health professionals.

3.1.4. Participants

Non-probability convenience sampling recruited registered dietitian nutritionists, physicians, physician assistants, nurse practitioners, registered nurses, licensed practical nurses, dentists, dental hygienists, and students in any of these degree programs holding

Junior standing and above. Three hundred and thirty-one respondents completed relevant survey questions and were included in analyses.

3.1.5. Results

Most respondents would recommend both dairy (81%) and dairy alternatives (72%) to their patients. Leading reasons for recommending dairy were for maintenance of good health, a nutrient deficiency, or a nut or soy allergy or intolerance. Most respondents would recommend dairy alternatives for a dairy allergy or intolerance. Half (49%) reported a preference for plant-based milk, and about 40% identified as having a dietary pattern that reduces animal product intake. About 40% reported following a plant-based dietary pattern. In adjusted models, plant-based milk preference (OR 4.52; 95% CI 2.31-8.82, $p<0.001$) and following a vegetarian dietary pattern (OR 1.91; 95% CI 1.11-3.27, $p=0.019$) were associated with greater odds of recommending dairy alternatives to a patient. Plant-based milk preference (OR 0.16; 95% CI 0.07-0.35, $p<0.001$), following a vegetarian dietary pattern (OR 0.45; 95% CI 0.25-0.82, $p=0.009$), and following a plant-based dietary pattern (OR 0.41; 95% CI 0.22-0.76, $p=0.005$) were associated with lower odds of recommending dairy to a patient. In all adjusted models, dietetics professionals were more likely than all other health professionals to say they would recommend both dairy and plant-based dairy alternatives to patients.

3.1.6. Conclusions

Healthcare professionals' nutrition recommendations on dairy appear to reflect their personal nutrition habits, despite dairy being an important source of essential nutrients for patients who are willing and able to consume it. Improved nutrition

training focusing on evidence-based nutrition recommendations, reducing personal bias in practice, and routinely including registered dietitians on interprofessional healthcare teams may improve the quality of nutrition advice given to U.S. consumers.

3.2. Introduction

Americans consider health professionals among the most trustworthy sources of health and nutrition information (1–3). Healthcare professionals are often called upon to advise patients on dietary choices, and they are expected to provide sound nutrition recommendations using the most up to date evidence (4–6). Unfortunately, many health degree programs other than dietetics programs lack adequate nutrition education (4,6–9), making it difficult for health providers outside of registered dietitian nutritionists (RDN) to accurately and confidently provide nutrition advice (6,8,10). Prior research also shows that health professionals' personal health behaviors may influence the health advice they give to patients (11–18), and evidence suggests they are more confident in counseling patients on health and nutrition behaviors they practice themselves (19). Work examining this relationship has found that physical activity habits among health professionals and health professional degree students are likely to influence how much physical activity advice they provide (14,16–18). Likewise, in a study of U.S. female physicians from the Woman Physicians' Health Study, those who were more concerned with their own eating habits or identified as a vegetarian were more likely to advise patients on nutrition (15). A study of Canadian physicians found those who consumed more fruits and vegetables advised patients on nutrition more often (14).

Health professionals may be asked by patients for advice on diets that consist mainly of plant-based (PB) foods. In recent years, many Americans have reported reducing their intake of animal-source foods (20,21). National and international reports have begun to highlight evidence showing the potential long-term health benefits of diets that emphasize vegetables, fruits, and whole grains, and limit intake of animal-source foods (22,23). Growing evidence demonstrates that PB dietary patterns are protective against multiple non-communicable diseases, including cardiovascular disease (24–28), type 2 diabetes (24,25,28), obesity (24,26,28), and certain cancers (24–26,28).

As Americans are reducing their animal product intake, sales of substitute products for popular animal-based foods have increased (29,30). Among the most popular are dairy alternatives, including PB milk, cheese, and yogurt products (29,30). PB dairy alternatives can be useful for individuals who have an allergy or intolerance to dairy (31,32), or who choose not to consume dairy for ethical reasons such as concerns for the environment or animal welfare (20). Many consumers also choose dairy alternatives due to perceived health benefits (20,32,33). However, evidence of health benefits from omitting dairy from the diet is inconsistent (34). Some research shows that dairy can have positive health impacts, potentially reducing one's risk of type 2 diabetes (35–37) and certain cancers (34,38,39). A diet of predominately plant foods may be protective against some chronic diseases (24), but the complete exclusion of a certain food groups may not be, and may lead to risk of nutrient inadequacies (25,27,40). Because PB dairy alternatives do not have equal nutrient content to dairy,

especially in terms of protein and micronutrients (33,41,42), consumers who choose these products must ensure they are not missing these key nutrients in their diet.

It is important to assess how healthcare professionals advise patients on dairy and PB dairy alternatives, and if they provide unbiased recommendations based on the evidence of health outcomes associated with intake of these products. Accurate nutrition guidance from healthcare providers can positively impact patient dietary behavior (43). No research to date has examined if a relationship exists between healthcare professionals' personal dietary preferences related to PB diets and their recommendations on dairy and dairy alternative products. The objectives of this study were to examine health professionals' dietary preferences, which milk products (dairy and/or PB) they would recommend to patients and why, and if their personal preferences are associated with their professional advice on either product. We hypothesized that health professionals who follow animal product-reducing or PB dietary patterns or prefer PB milk to dairy milk would be more likely to recommend PB dairy alternatives and less likely to recommend dairy products to patients.

3.3. Methods

3.3.1. Survey

We designed a web-based (Qualtrics, Provo, UT) survey to measure health professionals' personal dietary preferences, and their recommendations on dairy products and PB dairy alternatives. To be eligible, individuals had to be age 18 years or older; live in the U.S. since at least January 2020; and currently be a RDN, medical doctor (MD), doctor of osteopathy (DO), physician assistant (PA), dentist, dental hygienist, licensed practical nurse (LPN), registered nurse (RN), nurse practitioner

(NP), or a student currently enrolled in a degree program for one of those professions holding Junior undergraduate standing or above. These specific categories of health professionals were targeted as likely to have the most direct contact and opportunity to provide nutrition advice to patients.

The survey asked respondents' age, gender identity, race, ethnicity, state of residence, and type of health profession or professional degree program. To measure health professionals' recommendations on dairy and PB alternatives, we included a 4-item instrument modified from two previous studies (44,45), which asked if respondents would recommend dairy foods to a patient and if they would recommend PB dairy alternatives to a patient. Response options for both questions were yes, no, and unsure. If respondents answered affirmatively to either question, they were asked which purpose(s) would lead them to recommend that product: maintenance of good health; prevention of chronic disease; treatment of chronic disease; nutrient deficiency; intolerance or allergy; or other with a space to elaborate.

We used a series of questions to measure health professionals' dietary patterns. First, an instrument adapted from the National Health and Nutrition Examination Survey (NHANES) Dietary Screener Questionnaire (DSQ) (46,47) asked respondents the major type of milk they consume, and the frequency they consume it. Five response options were provided: from cows, from goats or sheep, PB milk, other, or I don't drink milk. Those who responded other could write in the type of milk consumed. We then asked which type of dietary pattern respondents most closely identify with: vegan (not consuming any animal products); vegetarian (not consuming any meat or fish); semi-vegetarian (consuming red meat, poultry or fish no more than once a week); pesco-

vegetarian (consuming no meat but fish); omnivorous (eating meat or fish almost every day); or other with a space to write-in their dietary pattern (48). Lastly, we asked respondents whether they consider their diet to be "plant-based" to which they could respond affirmatively or negatively.

We used three methods for non-probability convenience sampling to recruit respondents: (1) paid digital ads via Facebook to reach a national sample; (2) targeted postings to relevant national LinkedIn and Facebook group pages; and (3) postings on academic, professional, and community listservs in Vermont as well as nationally. The survey was open from November 19th, 2020 until February 4, 2021 and 417 people completed at least part of the survey. For this analysis, we excluded 86 respondents who did not answer both recommendation questions, resulting in a final sample of 331. Respondents were entered in a gift card drawing. This study was determined to be exempt by the Institutional Review Board at the University of Vermont.

3.3.2. Analysis

We analyzed survey data with IBM SPSS Statistics (version 27). During analysis, variables for race and ethnicity were merged and recoded to a binary variable "Black, Indigenous, or person of color (BIPOC)" and "not BIPOC". State of residence was recoded to a binary variable that indicated whether it was a "dairy state". U.S. dairy states were determined based on being among the 10 states with the highest percentage of total farm sales coming from milk sales in 2017 (VT, NM, NY, WI, ID, NH, PA, AZ, MI, and ME) (49). For milk product preference, respondents who reported other and could not be reclassified or reported not drinking milk were excluded from analyses that included this variable, as an aim of this study was to examine preference

for dairy versus PB alternative products. Dietary pattern was recoded to a binary omnivorous/vegetarian variable, with vegetarians representing all respondents who reported a dietary pattern that reduced meat intake. Respondents who selected other as their dietary pattern but described a diet that fit into one of the specified diets were reclassified to that category. Only two respondents could not be reclassified and were excluded from analyses that included this variable.

We generated univariate descriptive statistics for all variables. Using a series of six logistic regression models, we examined whether milk preference, dietary pattern, or considering one's diet to be PB was associated with whether the respondent would recommend (1) dairy foods and (2) PB dairy substitutes. For the models, respondents who selected no or unsure regarding if they would recommend dairy and/or dairy alternatives were combined and compared to respondents who selected yes, they would recommend dairy and/or dairy alternatives. Following the construction of unadjusted models, we adjusted the models for age, whether or not the respondent lived in a dairy state, and health professional type (dietetics professional or student versus other type of health professional or student). Gender identity and race/ethnicity were excluded from the models due to the low number of participants who identified with a gender other than female or with a race other than non-Hispanic white. Health professional type was added to the models because a separate analysis with this dataset found perceptions of dairy and PB alternatives to differ between dietetics professionals/students and other types of healthcare professionals/students (Clark et al., forthcoming). We used listwise deletion to handle missing data. Tests were statistically significant if $p < 0.05$.

3.4. Results

Most survey respondents were female (91.5%), non-Hispanic white (87.5%), and under age 55 (82.2%) (Table 1). Forty-six percent were from a dairy state, reflecting the additional recruitment conducted in Vermont. The sample consisted of 276 practicing health professionals and 55 students hereafter collectively referred to as "health professionals". RDNs and dietetics students made up 45.3% of the sample, and other health professionals or students made up the remainder. Nurses or nursing students comprised the largest population of other health professionals (71.8%; data not shown).

3.4.1. Health Professionals' Recommendations on Dairy and Dairy Alternatives

The majority of health professionals would recommend both dairy (80.7%) and PB dairy alternatives (71.6%) to their patients (Table 1). Top reasons health professionals would recommend dairy foods to a patient included maintenance of good health (79.8%), a nutrient deficiency (73.7%), or a nut or soy allergy or intolerance (69.8%) (Figure 1). Dairy allergy or intolerance far outweighed all other reasons health professionals would recommend PB dairy alternatives to a patient, with almost all (95.3%) citing this reason (Figure 2). Of the 19.9% who stated "other" for why they would recommend dairy alternatives, almost half said the patient's personal preference.

3.4.2. Health Professionals' Dietary Patterns

Almost half of respondents (48.4%) consume PB milk alternatives over dairy milk (Table 1). A little over half (57.7%) drink dairy or PB milk infrequently (less than once a day), and 42.3% drink milk frequently (once a day or more). About 60% of respondents reported following an omnivorous dietary pattern and about 40% reported

following some form of a vegetarian diet. Likewise, about 40% of respondents considered their diet to be PB.

Table 1: Characteristics of survey respondents.

Variable	n	%
Age		
18-34	146	44.1
35-54	126	38.1
Over 55	59	17.8
Female	290	91.5
Non-Hispanic white [a]	266	87.5
Location		
Dairy state	146	46.3
Other state	169	53.7
Health profession		
Dietetics professional or student	150	45.3
Other health professional or student	181	54.7
Would recommend dairy foods to a patient		
Yes	267	80.7
No	24	7.3
Unsure	40	12.1
Would recommend PB dairy alternatives to a patient		
Yes	237	71.6
No	29	8.8
Unsure	65	19.6
Milk product preference		
Dairy milk	145	51.6
Plant-based milk	136	48.4
Frequency of milk consumption		
< Once per day	161	57.7
≥ Once per day	118	42.3
Dietary pattern		
Omnivore	193	59.6
Vegetarian	131	40.4
Follow a plant-based diet		
Yes	132	41.5
No	186	58.5

Note. N = 331. Totals for gender identity (n=317), race/ethnicity (n=304), location (n=315), milk preference (n=281), frequency of milk consumption (n=279), dietary pattern (n=324), and following a PB diet (n=318) are smaller because response to these questions was optional.

[a] The small number of Black, Indigenous, and people of color (BIPOC) respondents inhibited the disaggregation of analyses by race/ethnicity.

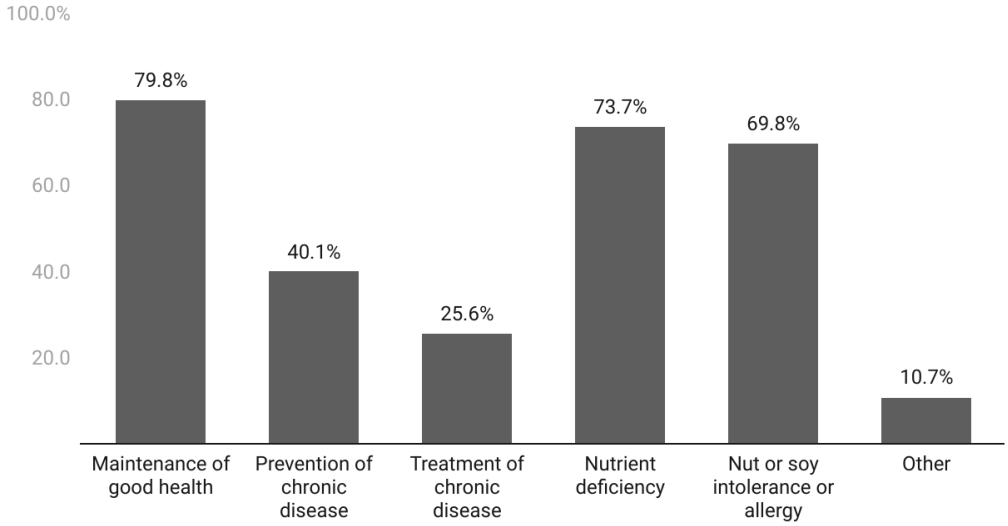

Figure 1: Reasons for recommending dairy foods to a patient (n=262).

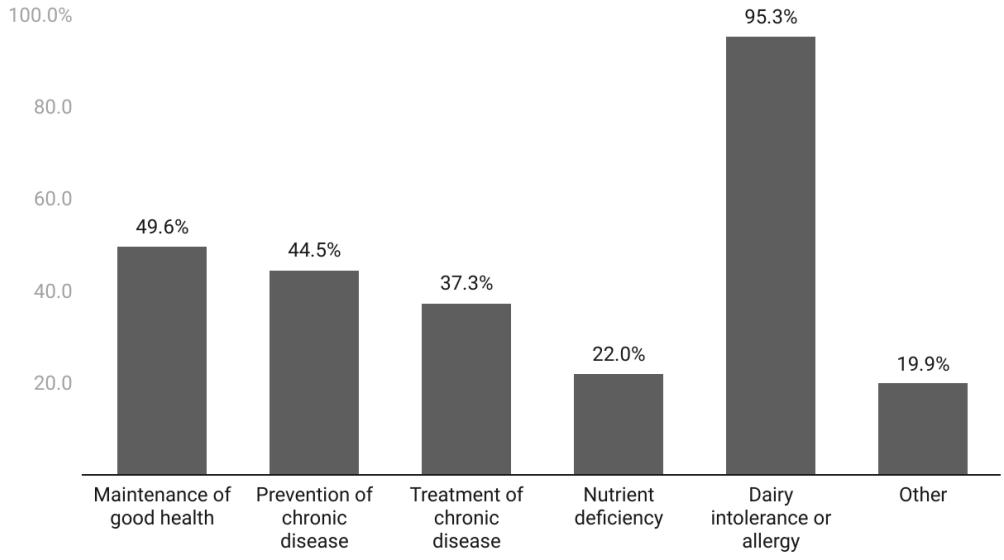

Figure 2: Reasons for recommending PB dairy alternatives to a patient (n=236).

3.4.3. Health Professionals' Milk Product Recommendations by Personal Dietary Pattern

In unadjusted regression models, preference for PB milk (OR 0.14; 95% CI 0.06-0.30, p<0.001) and identifying as vegetarian (OR 0.53; 95% CI 0.30-0.92, p=0.025) were significantly associated with lessor odds of recommending dairy foods to patients. Preference for PB milk (OR 3.76; 95% CI 2.09-6.79, p<0.001), identifying as a vegetarian (OR 2.05; 95% CI 1.22-3.46, p=0.007), and following a PB diet (OR 1.90; 95% CI 1.14-3.19, p=0.015) were significantly associated with greater odds of recommending dairy alternatives to patients (Table 2).

Table 2: Unadjusted regression models examining whether respondents would recommend dairy and PB dairy alternative products to their patients from personal preferences and dietary pattern.

Model	Variable	Would recommend dairy products to a patient				
		b	SE	OR	CI	p value
1	Milk preference (ref=milk from animals)					
	Plant-based milk	-1.98	0.39	0.14	0.06-0.30	**< 0.001**
2	Dietary pattern (ref=omnivore)					
	Vegetarian	-0.64	0.29	0.53	0.30-0.92	**0.025**
3	Follow a plant-based diet (ref=no)					
	Yes	-0.55	0.29	0.58	0.33-1.02	0.058
		Would recommend dairy alternatives to a patient				
		b	SE	OR	CI	p value
4	Milk preference (ref=milk from animals)					
	Plant-based milk	1.33	0.30	3.76	2.09-6.79	**< 0.001**
5	Dietary pattern (ref=omnivore)					
	Vegetarian	0.72	0.27	2.05	1.22-3.46	**0.007**
6	Follow a plant-based diet (ref=no)					
	Yes	0.64	0.26	1.90	1.14-3.19	**0.015**

Note. The logistic regression models presented above used "no or unsure" as the reference category of the dependent variables. Milk preference n=281; Dietary pattern n=324; Follow a PB diet n=318.

In adjusted regression models, dietary preferences and health profession were associated with respondents' willingness to recommend dairy and PB dairy alternatives to patients. In the first adjusted model examining milk preference (Table 3), health professionals who prefer PB milk were significantly less likely to say they would recommend dairy products to a patient (OR 0.16; 95% CI 0.07-0.35, p<0.001) and

more likely to say they would recommend dairy alternatives to patient (OR 4.52; 95% CI 2.31-8.82, p<0.001). Frequent milk product drinkers were significantly less likely to say they would recommend dairy alternatives to a patient (OR 0.47; 95% CI 0.26-0.86, p=0.014). As compared to non-dietetics professionals, dietetics professionals were significantly more likely to say they would recommend both dairy (OR 2.85; 95% CI 1.36-5.95, p=0.005) and dairy alternatives (OR 2.79; 95% CI 1.49-5.25, p=0.001) to a patient.

Table 3: Adjusted regression examining if respondents who prefer PB milk over dairy would recommend dairy and PB dairy alternative products to their patients (n=272).

Variable	Would recommend dairy products to a patient					Would recommend dairy alternatives to a patient				
	b	SE	OR	CI	p value	b	SE	OR	CI	p value
Age (ref=18-34)										
35-54	-0.16	0.40	0.85	0.39-1.86	0.684	0.35	0.35	1.41	0.71-2.82	0.328
Over 55	-0.80	0.52	0.92	0.33-2.58	0.878	0.03	0.42	1.03	0.46-2.32	0.948
Location (ref=Not Dairy State)										
Dairy state	0.33	0.36	1.39	0.68-2.81	0.365	-0.24	0.30	0.79	0.44-1.43	0.436
Health professional type (ref=non-dietetics professional)										
Dietetics professional	1.05	0.38	2.85	1.36-5.95	**0.005**	1.03	0.32	2.79	1.49-5.25	**0.001**
Milk frequency (ref= < once per day)										
≥ once per day	-0.01	0.35	0.99	0.50-1.94	0.971	-0.75	0.31	0.47	0.26-0.86	**0.014**
Milk preference (ref=milk from animals)										
Plant-based milk	-1.85	0.41	0.16	0.07-0.35	**< 0.001**	1.51	0.34	4.52	2.31-8.82	**< 0.001**

Note. The multivariate logistic regression models presented above used "no or unsure" as the reference category of the dependent variables.

The second adjusted model (Table 4), examining recommendations by dietary pattern, indicated that health professionals who identified as vegetarian were significantly less likely to say they would recommend dairy products to a patient (OR 0.45; 95% CI 0.25-0.82, p=0.009), and more likely to say they would recommend dairy alternatives to a patient (OR 1.91; 95% CI 1.11-3.27, p=0.019) as compared to health professionals who identified as omnivorous. Dietetics professionals were again significantly more likely to say they would recommend both dairy (OR 1.40; 95% CI 2.03-8.03, p<0.001) and dairy alternatives (OR 2.01; 95% CI 1.18-3.43, p=0.010) to a patient.

Table 4: Adjusted regression examining if respondents who follow a vegetarian diet would recommend dairy and PB dairy alternative products to their patients (n=314).

Variable	Would recommend dairy products to a patient					Would recommend dairy alternatives to a patient				
	b	SE	OR	CI	p value	b	SE	OR	CI	p value
Age (ref=18-34)										
35-54	0.26	0.34	1.30	0.66-2.55	0.447	0.08	0.30	1.09	0.60-1.96	0.784
Over 55	0.45	0.44	1.57	0.66-3.75	0.311	-0.38	0.35	0.68	0.34-1.36	0.276
Location (ref=Not Dairy State)										
Dairy state	0.54	0.32	1.72	0.92-3.23	0.089	-0.43	0.27	0.65	0.39-1.10	0.108
Health professional type (ref=non-dietetics professional)										
Dietetics professional	1.40	0.35	4.03	2.03-8.03	< **0.001**	0.70	0.27	2.01	1.18-3.43	**0.010**
Dietary pattern (ref= Omnivore										
Vegetarian	-0.80	0.31	0.45	0.25-0.82	**0.009**	0.64	0.28	1.91	1.11-3.27	**0.019**

Note. The multivariate logistic regression models presented above used "no or unsure" as the reference category of the dependent variables.

The third adjusted model (Table 5) found respondents who reported that their diet was PB were significantly less likely to say they would recommend dairy products to a patient (OR 0.41; 95% CI 0.22-0.76, p=0.005). Dietetics professionals were significantly more likely to say they would recommend both dairy (OR 4.65; 95% CI 2.29-2.45, p<0.001) and dairy alternatives (OR 1.82; 95% CI 1.06-3.12, p=0.031) to a patient.

Table 5: Adjusted regression examining if respondents who consider their diet to be PB would recommend dairy and PB dairy alternative products to their patients (n=309).

Variable	Would you recommend dairy products to a patient					Would you recommend dairy alternatives to a patient				
	b	SE	OR	CI	p value	b	SE	OR	CI	p value
Age (ref=18-34)										
35-54	0.17	0.35	1.19	0.60-2.36	0.618	0.14	0.30	1.15	0.63-2.07	0.653
Over 55	0.43	0.44	1.54	0.64-3.67	0.334	-0.42	0.35	0.66	0.33-1.32	0.240
Location (ref=Not Dairy State)										
Dairy state	0.53	0.32	1.70	0.91-3.21	.099	-0.41	0.27	0.66	0.39-1.11	0.120
Health professional type (ref=non-dietetics professional)										
Dietetics professional	1.54	0.36	4.65	2.29-9.45	**< 0.001**	0.60	0.28	1.82	1.06-3.12	**0.031**
Follow a plant-based diet (ref= No)										
Yes	-0.90	0.32	0.41	0.22-0.76	**0.005**	0.51	0.28	1.67	0.97-2.89	0.067

Note. The multivariate logistic regression models presented above used "no or unsure" as the reference category of the dependent variables.

3.5. Discussion

To our knowledge this is the first paper to explore health professionals' nutrition recommendations on dairy and PB dairy alternatives, and the first to examine if personal preferences for PB versus dairy milk or dietary pattern are associated with recommendations health professionals provide to consumers. As the consumption of PB dairy alternatives increases (29,51), it is important to understand if health professionals are providing accurate and unbiased nutrition advice about these products to their patients. Most health professionals sampled would recommend both dairy and dairy alternative products to patients, although their health reasons for recommending each product differed. Almost half of respondents preferred PB milk over dairy milk, and about 40% identified as vegetarian or described their diet as PB. Personal dietary preferences were associated with health professionals' likelihood of recommending dairy and dairy alternatives. Health professionals who preferred PB milk or followed PB dietary patterns were more likely to recommend dairy alternatives and less likely to recommend dairy.

Maintenance of good health, nutrient deficiency, and nut or soy allergy or intolerance were major reasons health professionals would recommend dairy to a patient, while dairy allergy or intolerance far exceeded all other reasons for health professionals recommending PB dairy alternatives. Our findings agree with prior research indicating dairy allergy or intolerance is a top reason consumers choose PB alternatives (31,32). Aligning with current U.S. dietary recommendations (52), a much greater proportion would recommend dairy (compared to PB alternatives) for maintenance of good health. Few health professionals would recommend PB dairy

alternatives to combat a nutrient deficiency and less than 50% said they would recommend dairy or a PB product for prevention and/or treatment of chronic disease. This may indicate that many health professionals don't feel that milk products have a large influence on disease risk. Current literature (34) suggests dairy intake is neither the superfood nor the dietary villain that different stakeholders make it out to be (53,54).

The proportion of health professionals who indicated that they prefer to drink PB milk alternatives (48.4%) is higher than the estimated 23% of U.S. households that consume mostly non-dairy milks, as found in a recent representative study of 995 U.S. households (55). It is interesting that almost half prefer PB milk, as almost half of the sample came from a dairy state where dairy milk consumption may be expected to be higher. This high proportion is also interesting because most of the sample was made up of non-Hispanic white respondents, and this population is more likely to meet U.S. dairy intake recommendations (56). About 40% of health professionals identified as following a dietary pattern that reduces animal product intake to some extent, and about 40% consider their diets to be PB. Although only about 3-5% of Americans identify as vegetarian or vegan (57–59), over 40% report trying to consume more PB foods (57). Prior work has shown mixed results regarding whether the dietary behaviors of health professionals differ from the general public (9,60–62). Globally, less than 40% of physicians appear to consume more than two servings of fruits and vegetables per day, although over three-fourths appear to consume meat and dairy daily (9). Another study found that although U.S. female nurses do not consume the recommended amount of fruits and vegetables per day, their intake is higher than women in the general

population (61). Further research may be required to determine the degree that health professionals and all Americans are fully or partially replacing animal-based foods with plant sources.

Health professionals who personally prefer PB milk or identify as vegetarian were more likely to say they would recommend PB dairy alternatives to patients, and less likely to say they would recommend dairy. Health professionals who consider their diet to be PB were also less likely to say they would recommend dairy. In unadjusted models, health professionals with PB diets were also more likely to recommend PB dairy alternatives, although when models were adjusted, this association was no longer significant. Our findings agree with the literature that personal nutrition behaviors are associated with health professionals' nutrition recommendations (14,15). Although most respondents did report that they would recommend both dairy and PB dairy alternatives to patients, our findings suggest bias in nutrition advising. Whether dairy or a PB dairy alternative is appropriate for a given patient often depends on that patient's individual dietary needs and preferences (20,31,32). While the associations between dairy intake and some health outcomes remain unclear (34), dairy is a top food source of many nutrients of concern (51), and advising a patient to choose a PB alternative in place of dairy if there is no personal or health-related need could lead to nutrition risks (25,27,40). The nutrition education provided in many health degree programs remains limited (4,7-9). Improved access to information regarding the nutritional characteristics of both dairy and PB alternatives may increase health professionals' knowledge on this topic regardless of their own dietary practices. The greater propensity of RDNs to recommend either product as compared to other health professionals, suggests that their

specialized training in nutrition and nutrition counseling may buffer some of the influence of personal preferences. Previous work has highlighted a need to increase interprofessional teamwork between different health professionals (4). Given the high rates of diet-related non-communicable diseases in the U.S. (63,64) and the high demand for nutrition information by consumers (65,66), RDNs represent critical members of interprofessional healthcare teams. Future work may focus on education models centered on collaboration between RDNs and other healthcare disciplines.

This study has several limitations. First, the relatively small sample size did not allow for certain statistical comparisons, such as the milk product recommendations between vegetarians, vegans, and other meat-reducing dietary patterns separately. However, this may be adequate, given that dietary pattern reporting is often imprecise (67). Second, few respondents reported that they would not recommend dairy or PB alternatives to their patient, hindering our ability to examine factors that associated with reluctance to recommend these products. Third, health professionals' dietary patterns and preferences were based on self-reported data, which are subject to response bias (68). What was defined as a PB diet was also left to the respondents' interpretation. Future research on this topic may consider more robust or objective measures of dietary patterns, such as dietary recalls or biomarkers. Fourth, the majority of the sample was female and non-Hispanic white, and nearly 85% were dietetics or nursing professionals. This reflects the additional recruitment activities targeted towards RDNs and nurses, and the extended recruitment in Vermont. Over 90% of RDNs and nurses in the U.S. are female (69,70) and less than 10% of the population of Vermont identify with a race or ethnicity other than non-Hispanic white (71). Most prior research examining

associations between personal beliefs and behaviors and professional counseling practices has focused on physicians and medical students (11,14,15,18). This study was novel in that it examined counseling bias among other types of health professionals, and among those with and without formal dietetics training, which has not been examined previously.

Our findings indicate that personal milk preferences and dietary patterns among U.S. health professionals appear to be associated with willingness to recommend dairy and PB dairy alternatives to patients. Health professionals are expected to base their nutrition recommendations on up-to-date nutrition literature. While PB dairy alternative products are important substitutes for individuals who cannot or will not consume dairy, the needs of the patient should drive nutrition recommendations rather than health professionals' personal beliefs. Future work should focus on strategies for improving nutrition training for healthcare professionals. Specifically, training could focus on use of evidence-based nutrition recommendations, reducing personal bias in nutrition advice, and the importance of referring patients with nutrition questions and concerns to RDNs and including RDNs on healthcare teams. This may help improve the quality of nutrition advice given to U.S. consumers.

3.6. References

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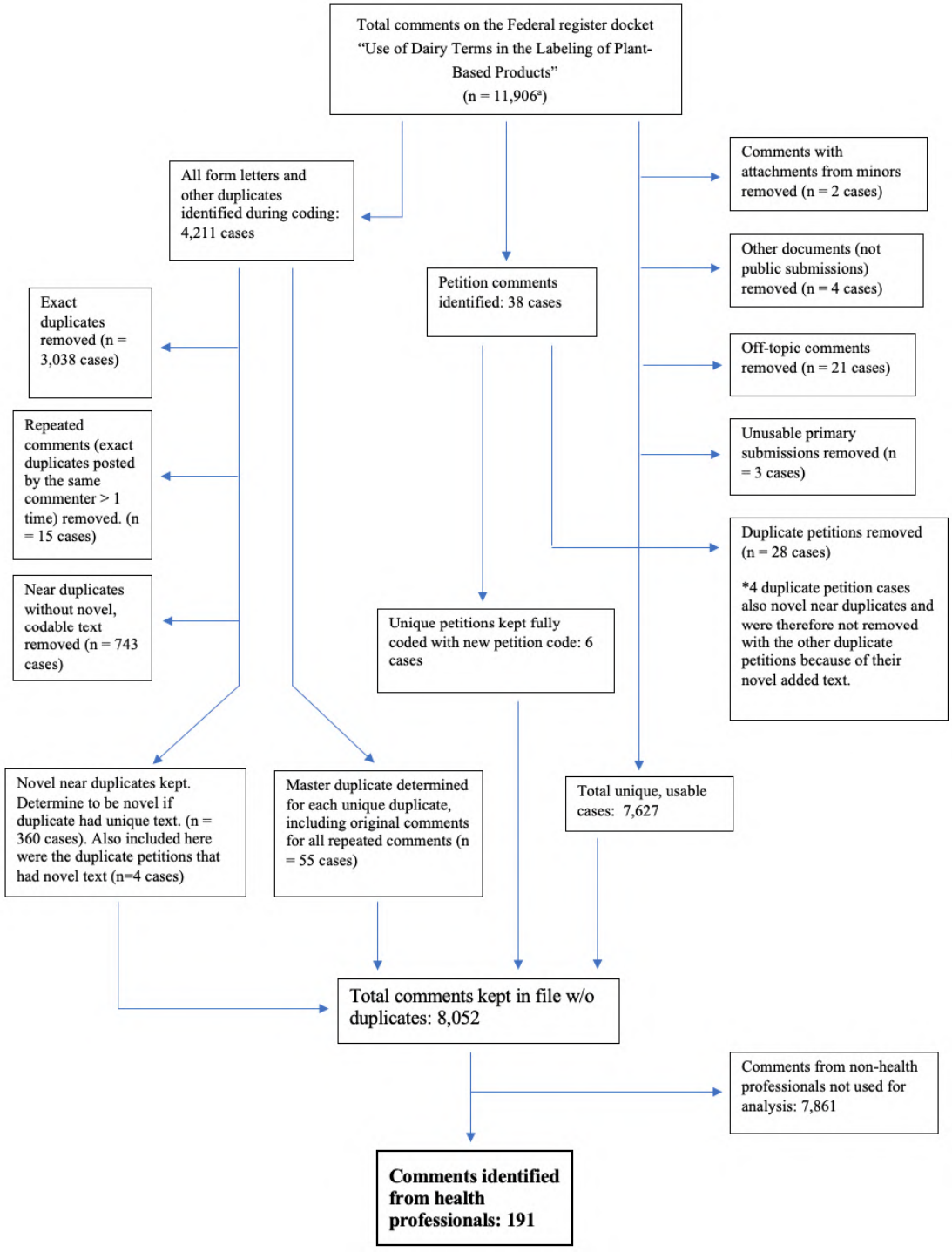
ADDITIONAL FILES

1. Removal Process for Comment Submissions Not Included in Analysis



[a] Originally 11,907; comment 11899 withdrawn by FR (late comment)

2. Relevant Codebook Codes

Code	Definition	When to use / When not to use	Examples	Source
COMMENT CHARACTERISTICS				
4 – POSITION ON LABELING		Do not use. One or more of the child codes MUST be applied to all comments.		
4.1 – SUPPORT MILK IN PB LABELING	Explicit support for labeling PB products with terms typically used to denote dairy products	Apply to full comment (select all).	"Totally fine, not confusing." "Yes, consumers are not stupid--we know what we're buying!" "I do not believe that public is confused by the use of the word Milk in non dairy drinks." "I support the continued labeling of plant-based products with names that include milk, cultured milk, yogurt, and cheese." "I Want Milk From Plants, Not Abused Cows"	Original
4.2 – OPPOSE MILK IN PB LABELING	Explicit opposition for labeling PB products with terms typically used to denote dairy products	Apply to full comment (select all).	"As a dairy farmer it is important to me that labeling and packaging of these alternative products is advertised truthfully. The ONLY way to accomplish this is to not use the term "milk" or "dairy" or any other terms referencing real dairy products when labeling these alternative products." "I believe that FDA needs to verify and enforce the these existing standards, and not permit plant-based beverages to be labeled as their dairy counterpart." "I am not a dairy farmer, but I am opposed to misleading labels."	Original
4.3 – UNCLEAR OR NEUTRAL POSITION ON PB LABELING	No explicit support or opposition for labeling PB products with terms typically used to denote dairy products	Apply to full comment (select all).		Original
4.4 - SUPPORT OR OPPOSE DAIRY LABELING	Explicit support or opposition for labeling dairy products with special labels that would differentiate dairy products from PB products (e.g. "cow's milk").	Apply to full comment (select all).	"...if we're going to be petty why don't we demand that milk be labeled Cow Breast Milk." "...I do think that cows milk should carry a warning - like that on cigarettes - saying how much suffering has been caused by the manufacturing of the product and that it is a hazard to human health." "Labels on plant-based products aren't the problem the label on cow's milk is." "The liquid from a cow should properly be labeled "Mammary Discharge."" "All the dairy industry has to do to avoid any confusion to consumers is to	Original

			label milk-based products as such - for example "This product is made from cows' milk".”	
COMMENT CONTENT				
1 – NUTRITION AND HEALTH ASPECTS		Do not use.		
1.1 - CALCIUM	Calcium content of dairy or products is noted as plant-based and/or the health implications of calcium consumption are noted	Apply to relevant text.	“If you look at what nutritional value of whole milk it is low in fat, high in protein and contains high levels of needed nutritional ingredients such as calcium…” “While many consumers know that dairy products provide nine key nutrients necessary for healthy child development and adult health…”	Original
1.2 - VITAMIN D	Vitamin D content of dairy or plant-based products is noted and/or the health implications of Vit D consumption are noted	Apply to relevant text.	“...vitamin A &D that plant based milk has to be added to come close to dairy milk.” “While many consumers know that dairy products provide nine key nutrients necessary for healthy child development and adult health…”	Original
1.3 - PROTEIN	The protein content of dairy or plant-based products is noted and/or the health implications of protein intake are noted	Apply to relevant text.	“In a recent survey, 73% of consumers believed that almond based drinks had as much or more protein per serving than milk,even though milk has 8 times as much protein.” “If you look at what nutritional value of whole milk it is low in fat, high in protein and contains high levels of needed nutritional ingredients such as calcium…” “While many consumers know that dairy products provide nine key nutrients necessary for healthy child development and adult health…”	Original
1.4 - SUGAR	The sugar content of dairy or plant-based products is noted and/or the health implications of sugar intake are noted	Apply to relevant text.		Original
1.5 - OTHER ESSENTIAL NUTRIENTS	Other macro or micro nutrients of dairy or plant-based products are mentioned and/or the health implications of other essential nutrients are noted The general mention of PB or dairy products being rich in “nutrients” This includes the mention of fiber General mentions of the amount of fat and/or cholesterol, or the comparison of these amounts in PB or dairy products	Apply to relevant text.	“The vitamins, minerals, fat, and protein levels are different, which some consumers might not realize.” “If you look at what nutritional value of whole milk it is low in fat, high in protein and contains high levels of needed nutritional ingredients such as calcium…” “While many consumers know that dairy products provide nine key nutrients necessary for healthy child development and adult health…”	Original

1.6 – OBESITY	Weight, BMI, or obesity	Apply to relevant text. Use for references to weight implications or weight-loss implications of consuming dairy or plant-based products.		Original
1.7 – DIGESTION	Breaking down or absorbing nutrients	Apply to relevant text. Use for references to difficulty digesting dairy or plant-based products such as lactose intolerance, IBS, or generally not feeling well after consuming dairy or plant-based products.	"Dairy milk can cause a lot of gas in me, so I like having the option of using almond or rice milk, and I certainly don't confuse the two when I buy them or use them at home" "People shouldn't be drinking cows milk. we do not need to drink dairy. We are unable to digest it after a certain age."	Original
1.8 – ALLERGY	Dairy or plant-based product allergies	Apply to relevant text. Use for references to allergies to dairy or plant-based products. Do NOT use for references to lactose intolerance.	"In fact, I am disappointed that some plant based "dairy" products (like "cheese") have casein in them. For me, that defeats my purpose" "I think its just fine to call plant based milks - alternative milk. It makes it easier to find especially with those of us who have dairy allergies."	Original
1.9 – PRODUCT HEALTHFULNESS	General comments on how "healthy" or "unhealthy" PB products or dairy products are, about the superior health characteristics of either PB products or dairy products or when the nutritional differences between PB products and dairy are compared Comments mentioning calories in PB or dairy milk or the comparison between the two	Apply to relevant text.	"The public is choosing delicious, healthy plant-based milk" "Almond, Soy or other plant product Are healthier that's no confusion about it" "I am glad that the plant based "dairy" products do not have the same nutritional profile as animal dairy products do, since, from my reading, regular consumption of animal milks are not healthy." "... I do think that cows milk should carry a warning - like that on cigarettes - saying how much suffering has been caused by the manufacturing of the product and that it is a hazard to human health" "Dairy products are critical to the healthy diet of children and adults." "However, I feel that many may not realize or recognize the nutritional differences between dairy milk and these milk substitutes" "This is clearly an effort by the dairy industry to protect their profits, as they face competition from healthier, more sustainable, and cruelty free plant-based dairy alternatives."	
1.10 – HORMONES AND ANTIBIOTICS	Reference to use of growth hormones (e.g. rBST) or antibiotics			

1.11 – OTHER NUTR AND HEALTH	Reference to other nutrition or health conditions like diabetes, metabolic syndrome, infections, bone development (without mention of calcium or other nutrients), skin conditions, cancer, and heart disease References to avoidance of saturated fat and/or cholesterol, unhealthfulness or negative health consequences of saturated fat and/or cholesterol, such as the mention of chronic disease related to their consumption	Apply to relevant text. Do NOT use for general references to dairy or PB products being "healthy" or "healthier" than the other is. See 1.9 – PB PRODUCT HEALTHFULNESS and 1.10 – DAIRY PRODUCT HEALTHFULNESS.		Original

3. Additional Multivariate Logistic Regression Analyses

Multivariate regression analyses examined factors associated with the belief that the use of dairy terms in PB labeling is affecting consumer understanding, and the belief that the FDA should permit PB products to use dairy terms in their labeling. Respondents aged 35-54 years were more likely than respondents aged 18-34 years to believe PB labeling is affecting consumer understanding (OR 2.12; 95% CI 1.02-4.42; p=0.046) (Table 10). Respondents from a dairy state were also more likely to believe PB labeling is affecting consumer understanding (OR 2.49; 95% CI 1.25-4.98; p=0.010). Respondents aged 55 years and older were also more likely than those aged 18-34 years to say that the FDA should not permit PB products to use dairy names in their labeling (OR 3.85; 95% CI 1.53-9.71; p=.004) (Table 11).

Table 10: Factors associated with beliefs on if PB product labeling is affecting consumer understanding (n=306).

PB label effect	b	SE	OR	CI	p value
Yes					
Age (ref=18-34)					
35-54	0.75	0.38	2.12	1.02-4.42	**0.046**
Over 55	1.04	0.54	2.82	0.98-8.09	0.054
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.10	0.51	0.91	0.34-2.45	0.852
Location (ref=Not Dairy State)					
Dairy state	0.91	0.35	2.49	1.25-4.98	**0.010**
Health professional type (ref=non-dietetics professional)					
Dietetics professional	-0.39	0.34	0.68	0.35-1.31	0.249
No					
Age (ref=18-34)					
35-54	0.14	0.44	1.14	0.48-2.72	0.761
Over 55	0.56	0.62	1.75	0.52-5.85	0.365
Race/ethnicity (ref=Not BIPOC)					

BIPOC	0.22	0.57	1.24	0.40-3.81	0.705
Location (ref=Not Dairy State)					
Dairy state	0.05	0.42	1.05	0.46-2.39	0.904
Health professional type (ref=non-dietetics professional)					
Dietetics professional	-0.14	0.40	0.87	0.40-1.88	0.718

Note. An adjusted logistic regression model is presented. The model used "unsure" as the reference category of the dependent variable.

Table 11: Factors associated with beliefs on if PB products should be permitted to use dairy terms (n=305).

Allow dairy terms in PB labeling	b	SE	OR	CI	p value
Yes					
Age (ref=18-34)					
35-54	-0.41	0.33	0.67	0.35-1.26	0.210
Over 55	0.21	0.48	1.23	0.48-3.18	0.665
Race/ethnicity (ref=Not BIPOC)					
BIPOC	0.65	0.45	1.91	0.78-4.64	0.155
Location (ref=Not Dairy State)					
Dairy state	0.14	0.30	1.15	0.63-2.08	0.650
Health professional type (ref=non-dietetics professional)					
Dietetics professional	-0.21	0.30	0.81	0.45-1.45	0.476
No					
Age (ref=18-34)					
35-54	0.30	0.34	1.35	0.70-2.64	0.373
Over 55	1.35	0.47	3.85	1.53-9.71	**0.004**
Race/ethnicity (ref=Not BIPOC)					
BIPOC	-0.38	0.55	0.68	0.23-2.02	0.491
Location (ref=Not Dairy State)					
Dairy state	0.40	0.31	1.49	0.81-2.75	0.205
Health professional type (ref=non-dietetics professional)					
Dietetics professional	0.28	0.31	1.32	0.72-2.43	0.365

Note. An adjusted logistic regression model is presented. The model used "unsure" as the reference category of the dependent variable.