Using Evidence Mapping to Examine Motivations for Following Plant-Based Diets

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Abbreviations used

FCQ: Food Choice Questionnaire; NHANES: National Health and Nutrition Examination Survey; PICO: population, intervention, comparator, outcomes
Abstract
Motivations to adopt plant-based diets are of great public health interest. We used evidence mapping to identify methods that capture motivations to follow plant-based diets and summarize demographic trends in dietary motivations. We identified 56 publications that described 90 samples of plant-based diet followers and their dietary motivations. We categorized the samples by type of plant-based diet: vegan (19%), vegetarian (33%), semi vegetarian (24%), and other, unspecified plant-based diet followers (23%). Of 90 studies examined, 31% administered multiple choice questions to capture motivations, followed by rate items (23%), Food Choice Questionnaire (17%), free response (9%), and rank choices (10%). Commonly reported motivations were health, sensory/taste/disgust, animal welfare, environmental concern, and weight loss. The methodological variation highlights the importance of using a structured questionnaire to investigate dietary motivations in epidemiological studies. Motivations among plant-based diet followers appear distinct, but evidence on the association between age and motivations appears limited.

Keywords: vegetarian, vegan, flexitarian, plant-based diets, motivations, Food Choice Questionnaire, evidence mapping

Introduction
The term “plant-based diet” is typically used to describe dietary patterns primarily limited to foods derived from plants (i.e., fruits, vegetables, legumes, whole grains, nuts, and seeds), but that may include various types and amounts of animal products (i.e., honey, eggs, dairy, meat, and fish) (1). Followers of plant-based diets can adapt their dietary patterns to personal
preference, resulting in a spectrum of abstention from animal products that ranges from strict veganism (no animal products) to semi-vegetarianism (occasional inclusion of meat) (2,3).

Diet-related chronic diseases have been a major focus of public health efforts (4). However, progress is still slow as the prevalence of these diseases remains high. In the U.S. about 40% of adults and 19% of youth are classified as obese (5). Additionally, approximately 12% of adults have diabetes (6) and 12% have heart disease (7). In light of the growing burden of chronic illnesses, plant-based diets are a growing area of interest in public health because there is some evidence that they offer a healthier (2,8,9) and more sustainable (10–12) alternative to the typical Western diet consumed in the U.S. (13–15). In particular, meta-analyses of observational studies found that plant-based diets were associated with reduced risks of ischemic heart disease (16), cancer (16), and type 2 diabetes (17).

Despite these potential benefits, consumption of plant-based diets remains low. Less than 10% of Americans reported following a vegetarian or vegan diet (18,19), and an analysis on the National Health and Nutrition Examination Survey (NHANES) 2007-2012 found that less than 2% of American adults were non-meat eaters (20). At the same time, however, interest in reducing meat consumption is growing: a Nielsen survey in 2017 found that 39% of Americans strived to eat more plant-based foods (18). This interest is expected to continue increasing and, thus, an examination of the motivations for adopting a plant-based diet may offer insight into the current appeal of these dietary patterns and inform strategies that empower individuals to decrease meat consumption and increase fruit and vegetable intake.

There are various reasons for choosing and customizing a plant-based diet, including to improve health, promote animal welfare, and/or curb the environmental impact of meat and dairy production (21). In recent decades, motivations to adopt plant-based diets have been widely
studied in the fields of sociology, psychology, and nutrition. For instance, researchers have investigated possible relationships between dietary motivation for choosing plant-based diets and: dietary restraint (22–37), personality (26,38,39), disgust sensitivity (32,40–42), attitudes toward animals and pets (41,43–47), dietary intake (34,40,48–51), physical activity (23,29,33,34,49–51), and other potential attributes related to psychological traits and health behavior (23,50–53).

However, the methods of capturing dietary motivations are diverse, making it difficult to organize and assess across the literature. Methods range from the Food Choice Questionnaire (25,26,31,54–58), which asks participants to rate their level of agreement (on a Likert scale) with 36 statements related to determinants of their food choices, to questionnaires that list motivations for selection (27,28,33,34,38,40,43,45–47,49,50,52,59–61) or provide a free response option (35,44,48,62–65). Given the heterogeneity of these methods, evidence mapping would be appropriate for summarizing the available evidence on motivations to adopt plant-based diets.

Evidence mapping is an emerging technique in nutritional epidemiology and has been used to review and summarize published research in a variety of investigative fields (66–73). Evidence mapping is a type of mapping review (74), and its process often consists of a systematic search for publications on a broad topic, a presentation of the results (such as a table or diagram), and the identification of the gaps in the knowledge (75). Unlike systematic reviews, evidence mapping does not typically focus on a specific research question or analyze data on study results (69,70,76). Rather, as a more comprehensive approach, evidence mapping aims to capture the overview of the existing research on the topic, especially the trajectory of investigation and variations in methodology (70). Typically, PICO (population, intervention, comparator, outcomes) information is captured (76).
We used evidence mapping to summarize the existing research on motivations to adopt a plant-based diet. Specifically, the diversity in research questions and methods of examining dietary motivations warrants a comprehensive picture of the current evidence on motivations to follow a plant-based diet. Thus, our first objective was to determine how methods of capturing motivations to adopt plant-based diets have evolved over time. Our second objective was to identify key motivations for following plant-based diets and determine which populations – namely, age groups and types of plant-based diet followers – require further investigation. Our final objective was to determine whether dietary motivation is related to age. This aim expands our work beyond the typical scope of an evidence map and includes an assessment of results with the purpose of summarizing the trends in dietary motivations in the context of age and type of plant-based diet with the available evidence. Our evidence maps identified gaps in the research and recommended strategies for future studies that would help elucidate the demographic trends in dietary motivations.

**Methods**

We followed the three main steps of evidence mapping outlined by previous studies employing this technique (69,70,72,73,76). First, we (A.J.M. and N.M.M.) specified our topics of investigation, which were (1) the evolving methods of capturing dietary motivations of plant-based diet followers and (2) the possible association between age and motivation to adopt a plant-based diet.

As the second step, one investigator (A.J.M.) systematically searched and screened relevant publications based on established criteria. Finally, data was extracted from these studies and reported on variables of interest in two comprehensive “maps” of evidence from existing
research, one describing the evolution of methods to capture plant-based diets and another showing possible associations among dietary motivation, type of plant-based diet, and age.

**Search Strategy**

Our aim was to obtain all observational studies that investigated the dietary motivations of plant-based diet followers. Two systematic and reproducible searches were conducted in each of these databases: MEDLINE, CINAHL, and PsycINFO. For the first search (MEDLINE 8/25/2018, CINAHL 10/27/2018, and PsycINFO 10/27/2018), keywords related to motivations and plant-based diets were used. Possible relationships between motivations for adopting a vegetarian diet and risks of eating disorders had been widely studied (22–36,77), so for the second search (MEDLINE 8/26/2018, CINAHL 11/26/2018, and PsycINFO 11/18/2018), keywords related to eating disorders and plant-based diets were also used. However, studies on populations with diagnosed eating disorders were excluded. The search terms are listed in Supplementary Table 1. These terms were searched in all fields including title, abstract, subject heading words, and keyword heading words. The searches extended from the inception of each database (1946 for MEDLINE, 1967 for PsycINFO, and 1981 for CINAHL).

**Abstract screening and hand search**

The publications collected from the six searches (two searches per database) were screened in two phases using a priori selection criteria. For the first phase, the abstracts of the publications identified in the databases were screened. A low threshold of inclusion was used in order to consider all potentially relevant publications. For a publication to be selected at this phase, its study (or studies) must (i) be published in English; (ii) be observational; (iii) investigate a sample of healthy plant-based diet followers (i.e. not having any diagnosed conditions such as eating disorder); and (iv) report quantitative data on dietary motivations. Qualitative studies were
excluded because their objectives were primarily to investigate the complexities of dietary motivations (i.e., personal experiences that motivate an individual’s decision to adopt a plant-based diet; how an individual modifies his or her motivations over time) through in-depth interviews and not necessarily to assess the dietary motivations in large samples. Bibliographies, reviews, case reports, letters, animal studies, and clinical studies were excluded. The inclusion and exclusion criteria of abstract and full text screenings are listed in Supplementary Table 2.

We examined the reference list of each publication selected in the abstract screening. If a title included a word related to plant-based diets or motivations, we screened the corresponding abstract based on the same selection criteria.

**Full text screening**

Full-text manuscripts of the results from abstract screening were obtained, and additional inclusion criteria were applied to further restrict the results to studies that investigated multiple motivations and reported sufficient data for analysis. For a publication to be selected at this phase, its study (or studies) must report data on (i) motivations of plant-based diet followers; and (ii) at least one health motivation and at least one ethical motivation.

**Data extraction**

We examined the eligible publications and extracted data on publication year, demographic profile of the sample, categories of plant-based diet followers, methods of capturing data on dietary motivations, and categories of dietary motivations. For four of the identified publications with analyses on dietary motivations, we retrieved information about the research methods and demographic profile of participants from previous publications (49,60,78–83).
Identification of plant-based dietary patterns

For each publication, we documented the terms and their definitions that each publication used to describe followers of plant-based diets. These were grouped into four broad categories: vegan (excludes all animal products), vegetarian (excludes all animal flesh, including red meat, poultry, and seafood but may or may not include dairy and/or eggs), semi vegetarian (limits animal flesh to an extent), and plant-based diet followers (data available only on mixed samples of vegan, vegetarian, and semi vegetarian).

Categorizing methods of capturing dietary motivation

We extracted the method reported to capture dietary motivations and grouped the methods into six categories – free response, multiple choice, rank choices, rate items, Food Choice Questionnaire (FCQ), and not reported.

Determining and categorizing the most prevalent motivations

We determined the most prevalent motivation for adopting a plant-based diet in each category of plant-based diet followers (vegan, vegetarian, semi vegetarian, or plant-based diet followers). Data on the motivations were presented differently across publications. For studies that reported the distribution of responses, the motivation with the highest frequency of endorsement was determined as the most prevalent. For studies that prompted participants to assign a value (often on a Likert scale) to each motivation, data was then reported as the mean value in the sample, and the motivation with the most favorable mean value was determined as the most prevalent. For studies that prompted participants to assign a value to each motivation and, subsequently, performed a regression analysis that predicted choice of dietary pattern, the motivation with the greatest significant effect was determined as the most prevalent. We grouped the most prevalent
motivation observed in each sample into three broad categories: ethical, health, or other (which included a diverse group of motivators such as sensory factors, politics, finances or cost, social influences, familiarity, habit, mood, convenience, natural content, etc. that were investigated in a limited number of studies). There was insufficient data to isolate and group the specific other motivations that were less prevalent or not investigated as part of the questionnaire administered to participants. Furthermore, several studies reported data on these broad health versus ethical categories without providing a breakdown of specific motivations (28,29,41,45–48,51,61). By grouping motivations into three categories (health, ethical, and other), we allowed the inclusion of the maximum number of studies.

Describing the age profile of each sample

For each sample of plant-based diet followers, the reported mean or median age (year) was recorded. If the age range of the sample was reported to be 5 years or less, the midpoint was recorded and presented as the estimated median age. Some publications provided the demographics separately by dietary pattern, while others reported the combined demographics of both plant-based diet followers and omnivores. Wherever possible, the mean or median age of the plant-based diet followers was recorded (n = 46). Otherwise, the combined age of plant-based diet followers and omnivores was recorded because in these studies, age was presented for the overall sample (n = 35). Publications that did not report a mean age, median age, or an age range within 5 years were excluded from analyses examining age (35,43,50,52,84).

Constructing evidence maps

Forms of evidence mapping include descriptive (66) or visual (69,70,72) representations of data compiled from the literature. For the present study, two weighted-scatter plots were constructed in Microsoft Excel, and they convey data in four dimensions (x-axis, y-axis, bubble color, and
bubble size). In both plots, each bubble represents a sample of plant-based diet followers. Bubble color conveys the type of plant-based diet (vegan, vegetarian, semi vegetarian, or plant-based diet follower), and bubble size conveys sample size. One weighted scatter plot depicts the publication year on the x-axis and the method of capturing dietary motivation on the y-axis, and the other plot depicts age on the x-axis and the most prevalent motivation on the y-axis.

Results

Literature Search and Screening

Figure 1 shows the results of systematic searches for publications on quantitative and observational studies on motivations to adopt plant-based diets (1946 to November 2018). The searches in MEDLINE, CINAHL, and PsycINFO identified 631, 331, and 545 publications, respectively, resulting in a total of 1,507 publications. This total number includes publications that were extracted from more than one database and hence does not represent the number of unique publications. The 1,507 abstracts were screened, yielding 45 potentially relevant publications. An additional 25 potentially relevant publications were identified via hand search. The 70 (45+25) publications were reviewed at the full text level, and 56 were identified as meeting the defined inclusion criteria.

Characteristics of Samples

The 56 identified publications included 90 samples of plant-based diet followers, as certain publications provided data on more than one plant-based diet population. All observational studies were cross-sectional. Several publications grouped participants by type of plant-based diet (36%, n = 20). In some analyses on motivations, participants were grouped by gender (32), age (34), or ethnicity (59). Other studies recruited plant-based diet followers at two different points in time (37,55,84). Regardless of how participants were recruited and grouped for
analyses, each separate group with reported data on motivations was considered as a “sample.” As a result, 25 publications (44%) contained multiple samples. The studies were classified into three target populations based on age range and/or recruitment: adolescents, college students, and those recruited from the general population that included both adolescents and adults. Two studies combined data on adolescents and young adults (11 to 20 years of age) (33,48). Five samples were recruited from middle schools and high schools (31,33,36,48,85), and three samples were recruited by mailing questionnaires (34,64). In all, eight samples consisted of primarily adolescents. Nineteen samples were recruited from university students (22,25–27,30,32,34,35,37,43,62,86). The age range was not reported in 13 (68%) of these samples, but we estimated the age range of this category to be about 18 – 23 years. Sixty-three samples were recruited from the general population. The estimated age range was 13 – 99 years with missing information about the age range in 34 samples (54%). Table 1 summarizes the characteristics (sample size, % female, and region) of all 90 samples organized by the target population (adolescents, college students, and general population). We defined “small” sample sizes as n’s below 100, “medium” as n’s between 200 and 400, and “large” as n’s greater than 400. The education profile (% with bachelor’s degree or higher) is also reported for samples of the general population. Mean BMI was omitted, as it was reported for only 27% (n = 24) of the samples.

**Plant-Based Dietary Patterns**

Different approaches were used to categorize followers of plant-based diets in observational studies. For instance, studies asked participants to self-identify their dietary pattern (22,24,27,29,30,34,35,38,41,46,47,49,50,53,55,56,61,64,85–89), to indicate the animal-based foods that they consumed or avoided (32,39,40,45,51,52,62,84,90,91), or to complete a
questionnaire about their frequency of meat consumption (26,60,65,92,93). Other studies applied a combination of the above (25,28,33,36,37,43,44,54,57,59,79,82,94).

The studies used various terms to describe plant-based diet followers. The publications, terms, definitions, and categories are listed in Table 2. The definition of the term vegan was consistent across studies and was defined as a dietary pattern that excludes all animal products, including red meat, poultry, seafood, dairy, and eggs. Only one study made the distinction between strict vegan and moderate vegan (90). All samples that were labeled with the term vegan were compiled under one category. Nineteen percent (n = 17) of the samples were categorized as vegan.

Discrepancies in the definition of the term vegetarian were observed. For the purpose of this review, vegetarian is a dietary pattern that completely excludes all animal flesh, including red meat, poultry, and seafood but may include dairy and/or eggs (31,37,43,52,56,57,59,62,82,92). Hoffman et al. (2013) noted that “[a]ll vegans are vegetarians but not all vegetarians are vegans” (52). Using the commonly accepted definition of vegetarian, the aforementioned studies included individuals abstaining from meat, some of whom might have been vegan. Some studies had samples that included vegetarians but excluded vegans (37,39,41,43,45–47,54,61,82), while others combined vegetarians and vegans for analyses (24,26,33,52,65,77,78,84). Some studies used other terms to describe what we classify as vegetarian, such as strict vegetarian (45), full vegetarian (24), restricted vegetarian (33), lacto-/ovo-/lacto-ovo-vegetarian (26,39,54,65,84), meat avoider (32) and meat abstainer (93). Regardless of the term used, if a sample of plant-based diet followers was described to be completely abstaining from all types of animal flesh (and may or may not be following a vegan
diet), the sample was included in the category of vegetarian. Thirty-three percent (n = 30) of the samples were vegetarian.

Compared with vegan and vegetarian, semi vegetarian is the least stringent and the most diverse family of plant-based diets. In this study, we defined semi vegetarian as a plant-based dietary pattern that allows intake of animal flesh to a limited extent. Semi vegetarian diets have variation in the permitted types of animal flesh: fish and/or poultry (24,26,33,77), fish only (24,26), and specific type(s) of meat chosen by the individual (37,45,62). Semi vegetarian can also refer to diets that limit the overall intake of meat and do not necessarily restrict a certain type of meat (92). Other studies used various terms to describe limited intake of meat: flexitarian (26,95), low meat eater (59), and reduce meat consumption (88). We included a sample in the category of semi vegetarian if the described dietary pattern (1) excludes or restricts red meat; (2) includes fish and/or chicken as the permitted type of meat; (3) avoids a certain type of meat; or (4) restricts intake of meat in general. Twenty-four percent (n = 22) of the samples were categorized as semi vegetarian.

Data on the remaining samples extracted from the publications were collapsed into the general category of plant-based diet followers, because the recruitment strategies and/or statistical analyses did not distinguish among vegan, vegetarian, and semi vegetarians (n = 9) and hence combined them into one sample (25,27,30,35,36,55,64,86). Other studies defined vegetarian as a group of plant-based diets with a spectrum of abstention from animal products ranging from vegan to semi vegetarian and labeled the samples with this general term (n = 6) (22,34,38,40,42). Lea et al. (2006) described their sample as followers of “plant-based diets” (94). The remaining studies used “vegetarian” to describe their samples without defining the term (n = 5) (53,57,63,85,87). Twenty-three percent (n = 21) of the samples were placed in the
general category of plant-based diet followers. In their analyses of motivations, these studies did not differentiate among types of plant-based diet followers, and thus this category represents a broad range of diets.

**Methods of Capturing Motivations to Adopt Plant-Based Diets**

We examined the methods used to capture data on motivations to adopt plant-based diets. As described in Table 3, we classified the methods into five categories: free response, multiple choice, rank choices, rate items, and the Food Choice Questionnaire (FCQ). Most studies administered multiple choice (31%, n = 28), followed by rate items (23%, n = 21), FCQ (17%, n = 15), free response (9%, n = 8), and rank choices (10%, n = 9). The method was not reported for 10% (n = 9) of the samples. The formats of reporting data on motivations were frequency (64%, n = 58), mean values (32%, n = 29), and regression (3%, n = 3). Figure 2 is a weighted scatter plot that displays the samples (n = 90) by the method of capturing dietary motivation and publication year. Each bubble represents a single sample, and the color indicates the type of plant-based dietary pattern.

**Most Prevalent Motivation by Age**

For this present review, we categorized each motivation as ethical, health, or other. We categorized a motivation as ethical if a study described it as one of the following: ethical, moral, ideological, animal welfare, environmental concern, ecological, religion, spiritual belief, world hunger, or social justice. We categorized a motivation as health if a study described it as a motivation to improve some aspect of health or to lose weight. We categorized a motivation as other if it was related to sensory factors, political, finances/cost, social influences, familiarity/habit, mood, convenience, or natural content (i.e., absence of artificial ingredients). Table 4 lists the motivations that have been investigated and their designations (ethical, health
or other). Figure 3 shows the distribution of samples of studies that have investigated each type of motivation. The most commonly measured motivations were health (100%, n = 90), sensory/taste/disgust (69%, n = 62), animal welfare (58%, n = 52), environmental concern (59%, n = 53), weight loss (53%, n = 48), and unspecified ethics (41%, n = 37).

Figure 4 is a weighted scatter plot that displays the samples (n = 81) by the most prevalent motivation and mean or median age of the sample. The reported mean age is displayed for 93% (n = 75) of the samples, and the reported median is displayed for 4% (n = 3) of the samples. The median estimated from the reported age range is displayed for 4% (n = 3) of the samples. Demographic data on plant-based diet followers were extracted for 57% (n = 46) of the samples. For studies that did not report demographic data on plant-based diet followers, the combined data on plant-based diet followers and omnivores were extracted (43%, n = 35). Samples of vegan and strict vegetarian tended to endorse ethical motivations, while samples of semi vegetarian tended to endorse health motivations. We observed many large samples with a mean age between 30 and 40 years, while samples with younger and older populations tended to be smaller.

Discussion
We used evidence mapping to summarize the complex and growing literature on motivations to adopt plant-based diets. We observed heterogeneity in methods to capture dietary motivations and possible differences in dietary motivations across types of plant-based diets and age groups. In addition, we identified populations that require further investigation and observed variation in how plant-based diet followers were identified.

As previously noted, definitions of vegetarian and semi vegetarian have been largely inconsistent (21,96). Plant-based diets exist as a spectrum of abstention from animal products,
and self-chosen labels such as flexitarian and eating practices are often not based on discrete categories. Despite these limitations, however, classifying plant-based diet followers for purposes of epidemiological research and understanding dietary motivations can still be useful. Specifically, prompting participants to indicate the animal products that they consume or avoid (32,39,40,45,51,52,62,79,84,90,91), or to complete a questionnaire about their frequency of meat consumption (26,60,65,92,93) may allow researchers to more accurately identify their dietary patterns based on actual intake rather than self-reported eating practices or self-chosen labels. This approach may help address the discrepancies among dietary motivation, aspiration to adopt a plant-based diet, and actual food choices made by individuals. An example of best practice, as illustrated by Asher and colleagues (79), is to employ a multi-step process to identify current vegetarians and vegans, in which the participants indicate the types of meat and/or animal products that they exclude from their diet as well as whether they self-identify as vegetarian, vegan, or neither. This comprehensive methodology minimizes the ambiguities of classifying plant-based diet followers via self-report alone.

**Evolution of Methods and Their Heterogeneity**

Methods of capturing data on dietary motivations to adopt plant-based diets have evolved over time. Starting around 2010, *multiple choice* and *rate items* were prominent question formats compared to *free response* and *rank choices*, especially as online recruitment methods result in large samples (Figure 2) (28,29,39–41,45–47,51,61,78,89,92,93). As suggested by qualitative studies, followers of plant-based diets often have multiple dietary motivations, and these dietary motivations are dynamic as they are modified over time (21,96–99). The *rate items* method is optimal for analyzing the dynamic nature of dietary motivations because it allows participants to
indicate the relative importance of multiple motivations. Moreover, the assignment of values on a Likert scale provides quantitative data that is suitable for statistical analyses.

Using the rate items format, Steptoe & Pollard (1995) developed the Food Choice Questionnaire (FCQ), which measures nine types of dietary motivations: health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity, and ethical concern (which has subscales for political values and environmental welfare) (58). This questionnaire was designed to assess the main determinants of a person’s food choices and capture a wide array of motivations, but its development did not consider ethical motivations specific to plant-based followers. Recognizing this limitation and noting the growing popularity of vegetarianism, Lindeman and Väänänen (2000) created new scales to replace the original ethical concern scale: ecological welfare (which includes subscales for animal welfare and environment protection), political values, and religion (56). This revised FCQ is comprehensive, because it measures the dietary motivations that are the most frequently measured in studies involving plant-based diet followers, though it excludes social influence (Table 4 and Figure 3). Furthermore, depending on the objectives of the study, new scales can be added to the FCQ (100–102). The FCQ is a reliable and versatile tool for measuring motivations for adopting plant-based diets, but it has not been widely used in research studies on plant-based diet followers. Among studies that recruited plant-based diet followers, two studies used the original FCQ (26,57), and five studies used the revised FCQ by Lindeman & Väänänen (25,31,54–56).

Trends in types of plant-based diets, dietary motivations, and age

Despite the observed heterogeneity in methodology, our evidence map on prevalent motivations versus age shows noteworthy trends (Figure 4). Literature reviews have noted the widespread use of the ethical-health framework of understanding motivations to adopt plant-based diets (21,103).
Based on this framework, we saw that *vegans* and *vegetarians* tended to endorse ethical motivations, while *semi vegetarians* tended to endorse health motivations. Notably, Kessler and colleagues (2016) found that vegetarians and vegans gave the most favorable ratings for *Love of animals* and *Global importance for humanity* as initial motivators, suggesting a possible relationship between strict plant-based diets and ethical motivations (39). On the other hand, Tobler and colleagues (2011) found that individuals who were reducing meat consumption tended to give favorable ratings to *Reducing meat consumption is healthier* as a motivation (88). These findings suggest potential distinctions among the dietary motivations of *vegan*, *vegetarian*, and *semi vegetarian* diet followers. This observation demonstrates the importance of accurate identification of dietary patterns when analyzing motivations.

Regarding the link between age and motivation to adopt a plant-based diet, the evidence remains inconclusive due to limited data captured from relatively few studies, small sample sizes, and underrepresentation of certain types of plant-based diet followers. The most robust evidence is available for people in their 30s and 40s, and several studies on this age group included *vegans* or *vegetarians* (Figure 4). Many sample sizes for this age group were medium to large scale. Several of these studies recruited participants online (28,29,39,40,41,45,46,51,61,78,89,92,93), and this method has been helpful for recruiting followers of stringent plant-based diets, who are an extreme minority (18,19).

There are numerous studies on younger plant-based diet followers (samples with a mean age that is below 30 years), but the samples tended to be small or combine different types of plant-based diet followers into one group for analyses. Many of these samples were recruited in middle schools (33,34,36,85), high schools (31,33,34,48), and universities (22,25–27,30,32,35,37,43,62,86), and restricting the target population to such settings resulted in small
sample sizes. Notably, Parviainen et al. (2017) recruited young participants by mailing questionnaires to households throughout Finland, which allowed them to obtain large sample sizes (64). Instead of restricting the target population to students of select schools, future studies could mail questionnaires nationwide or post online surveys to recruit large samples of adolescents and college students who follow plant-based diets, as online research has been shown to be successful among followers of plant-based diets (104).

The effect of family influence on motivation to adopt plant-based diets appears to be minimal among secondary school students, because studies estimated that only between 3 and 14% of adolescent vegetarians lived with at least one vegetarian family member (33,34,36). For comparison, Robinson-O’Brien et al. (2009) found that among 19 to 23-year-old vegetarians, 13% reported that a family member was vegetarian (34). Data with respect to family influence on dietary motivation among young adults (between 18 and 23 years old) are limited, but researchers speculated that living away from home allowed more freedom for young adults to prepare their own meals and experiment with vegetarianism (35,62). Studies on young plant-based diet followers often investigated associations among vegetarianism, weight concerns, and disordered eating (22,24–27,30–37), which may be motivated by the perceived link between vegetarianism and unhealthy lifestyle behaviors among adolescents and young adults. However, the American Academy of Pediatrics and the Academy of Nutrition and Dietetics confirmed that well-planned vegetarian and vegan diets are nutritionally adequate for infants, children, and adolescents (105,106).

As for older age groups (samples with a mean age that is over 40 years), there are only a few studies, but they have medium to large scale samples that are predominantly semi-vegetarian followers. Considering the possible health benefits (2,8,9) and environmental sustainability (10–
12) of reduced meat consumption, several of these studies took consumer- and population-oriented approaches to investigating motivations to adopt plant-based diets (60,88,91,93,94). These studies recruited individuals who had been reducing their meat consumption but did not necessarily identify themselves as vegans or vegetarians, and, thus, they were classified as semi vegetarian. In contrast to studies on younger plant-based diet followers, these studies aimed to understand the reputation of plant-based diets and consumer awareness of their potential benefits.

**Strengths and Limitations**

As visual representations, our evidence maps summarize the evolving research on motivations to adopt plant-based diets. The evidence map illustrating methods of capturing dietary motivation versus publication year (Figure 2) shows how methods have evolved over time. The evidence map on the most prevalent motivation versus age (Figure 4) shows trends in dietary motivations and highlights gaps in the research. Together, these evidence maps inform strategies for future investigations and provide guidance for systematic reviews and meta-analyses.

There are four main limitations to the evidence map for the most prevalent motivation versus age (Figure 4). The first limitation is the representation of age. Information about the age profile of exclusively plant-based diet followers was available for only forty-six samples (57%). The remaining studies reported the combined demographic profile of plant-based diet followers and omnivores (43%, n = 35). For studies that recruited adolescents and young adults, the demographic profiles of plant-based diet followers and the overall sample were highly similar. For studies that recruited individuals from the general population and reported only the combined demographic profile, however, the evidence map may not be a completely accurate representation of the age profiles of plant-based diet followers. Furthermore, only the mean or
median age of the samples are represented, so information about the spread of the age distribution is not conveyed, which would be useful to consider particularly for large samples.

As for the second limitation, we did not examine the possible effects of gender and socioeconomic status on motivations to adopt plant-based diets. Notably, vegetarians in Western societies tend to be women and well-educated (107,108). In our review, almost three-fifths of the samples were more than 75% female (Table 1). Women, both vegetarian and omnivorous, are more likely than men to agree that reduced meat consumption is healthy, helps protect the environment, and minimizes animal suffering (87,109,110). Furthermore, perceived gender norms surrounding meat consumption may discourage men from adopting vegetarianism (111). Men may face greater barriers to adopting plant-based diets and, hence, alternative reasons (i.e. those unrelated to health or ethics) may be more likely to convince them to adopt a plant-based diet. For example, some may find having vegetarian friends to be a more powerful motivator than the potential health and environmental benefits of plant-based diets (112). Since our analyzed samples were largely women, our evidence map likely did not reflect possible trends in motivations that were neither health nor ethical.

Given that only a few studies reported education level and income, we could not determine the socioeconomic profiles. People with higher levels of education likely have elevated awareness of the potential health and sustainability benefits of plant-based diets. Further, higher quality dietary patterns are shown to be more expensive (113). Interestingly, however, we found one study that reported finances/cost as a significant motivator to reduce meat consumption (59). The affordability of plant-based diets and consumer behavior are complex research topics that are beyond the scope of this paper, and we could not summarize their possible effects on dietary motivations based on the limited data.
In regard to the third limitation, there is no consensus in the literature with respect to consistently categorizing motivations, and some researchers may disagree with the broad *ethical* and *health* motivation categories that we created. For example, some studies have classified ethical motivations as only concern for animal welfare (22,23,36,42,62,65,77,92) and others have classified both animal welfare and environmental protection as ethical motivations (24,31,32,38,45,52,54,59,93). Many studies have considered health and weight concerns as separate motivations, especially those that investigated dietary restraint among plant-based diet followers (24,26,27,30–32,34–37). Overall, studies investigated different combinations of motivations (Figure 3), and many studies reported data on broad health and ethical (or ideological) motivations without providing the breakdown of specific motivations (24,26–29,37,45–48,51,53,57,64,65,77,84). Accordingly, we found that broad *ethical* and *health* motivation categories were the most effective way to synthesize results for the purpose of this review. Researchers conducting future studies should consider either investigating a wide variety of specific motivations (as opposed to broad health and ethical motivations) or using questionnaires such as the FCQ, which would result in better synthesis of study results.

Finally, while our evidence map shows research interest in motivations to adopt plant-based diets since the 1980s (Figure 2), this is still an emerging field of study and there are only a few studies with large sample sizes. Notably, the Adventist Health Studies recruited thousands of vegetarians and studied their health outcomes but did not investigate their dietary motivations (114,115). We expect this limitation of few studies with large sample sizes to be overcome in the coming years especially with the emergence of online surveys that can facilitate large scale recruitment of participants (39,104).
**Conclusions**

We created two evidence maps summarizing the literature on motivations to adopt plant-based diets, which is growing and becoming more complex. As increasing use of online recruitment results in larger samples, the *rate items* method may be effective for obtaining quantitative data. To facilitate comparisons in epidemiological studies, we recommend using a structured questionnaire such as the *FCQ*. Followers of more stringent diets, such as *vegans* and *vegetarians*, tended to endorse ethical motivations, while those seeking to simply reduce meat consumption (*semi vegetarians*) tended to endorse health motivations. Given these distinct motivations, distinguishing among self-identified *vegans*, *vegetarians*, and *semi vegetarians* will likely result in meaningful and interpretable data. Evidence on the association between age and motivations to adopt a plant-based diet remains inconclusive due to few studies, small sample sizes, and underrepresentation of certain demographic groups. Many studies on adolescents and young adults had small sample sizes and combined different types of plant-based diets. Those on middle-aged adults often had medium to large scale samples that were predominantly vegetarians and vegans. Studies that recruited older adults had large samples of mostly semi vegetarians. For future investigations, larger sample sizes that isolate specific types of plant-based diets will be conducive to obtaining robust evidence on dietary motivations as predictors of eating pathology and on incentives to reduce meat consumption and integrate more plant foods in diet.

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Figure 1. Flow diagram of literature search and screening results.
Figure 2. Weighted scatter plot of method of capturing dietary motivation vs. publication year. Each bubble represents a single sample of plant-based diet followers, and its size corresponds to the sample size. The sample bubbles (n = 90) are colored by plant-based dietary pattern (vegan, vegetarian, semi vegetarian, and plant-based diet followers), and they are separated by the reported method of capturing data on dietary motivation.
Figure 3. Measured motivations by percentage of samples. Studies captured data on various combinations of motivations. This graph shows the breakdown of studies that measured broad motivations (health, ethical, and other) and specific motivations (weight, animal welfare, environmental concern, etc.) of plant-based diet followers.
Figure 4. Weighted scatter plot of most prevalent motivation vs. age. Each bubble represents a single sample of plant-based diet followers, and its size corresponds to the sample size. The sample bubbles (n = 81) are colored by plant-based dietary pattern (vegan, strict vegetarian, semi-vegetarian, and plant-based dietary followers), and they are separated by the most prevalent motivation. “Other” motivations included sensory appeal, taste, and preference for eating a variety of foods. The mean age is displayed for 93% (n = 75) of the samples, and the median is displayed for 4% (n = 3) of the samples. The median estimated from the reported age range is displayed for 4% (n = 3) of the samples. Demographic data on plant-based diet followers were extracted for 57% (n = 46) of the samples. For studies that did not report demographic data on
plant-based diet followers, the combined data on plant-based diet followers and omnivores were extracted (43%, n = 35).
Table 1. Characteristics of study participants in research samples of plant-based diet followers

| Characteristic                  | Total (n = 90) | Adolescents (n = 8) | College Students (n = 19) | General Population (n = 63) |
|---------------------------------|---------------|---------------------|--------------------------|----------------------------|
| **Sample size, n (%)**          |               |                     |                          |                            |
| ≤ 50                            | 35 (39)       | 3 (38)              | 13 (68)                  | 19 (30)                    |
| 51-300                          | 40 (44)       | 4 (50)              | 5 (26)                   | 31 (49)                    |
| 301-600                         | 7 (8)         | 0 (0)               | 0 (0)                    | 7 (11)                     |
| 601-900                         | 4 (4)         | 1 (13)              | 0 (0)                    | 3 (5)                      |
| > 900                           | 4 (4)         | 0 (0)               | 1 (5)                    | 3 (5)                      |
| **% female, n (%)**             |               |                     |                          |                            |
| ≤ 25%                           | 1 (1)         | 0 (0)               | 1 (5)                    | 0 (0)                      |
| 26-50%                          | 2 (2)         | 1 (13)              | 0 (0)                    | 1 (2)                      |
| 51-75%                          | 19 (21)       | 2 (25)              | 5 (26)                   | 12 (19)                    |
| 76-100%                         | 53 (59)       | 5 (63)              | 13 (68)                  | 35 (56)                    |
| **% with bachelor’s degree or higher, n (%)** |               |                     |                          |                            |
| ≤ 40%                           | --            | --                  | --                       | 6 (10)                     |
| 41-60%                          | --            | --                  | --                       | 6 (10)                     |
| 61-80%                          | --            | --                  | --                       | 10 (16)                    |
| **Region, n (%)**               |               |                     |                          |                            |
| North America                   | 51 (57)       | 3 (38)              | 12 (63)                  | 36 (57)                    |
| Europe                          | 31 (34)       | 4 (50)              | 3 (17)                   | 24 (38)                    |
| Australia/New Zealand           | 4 (4)         | 1 (13)              | 0 (0)                    | 3 (5)                      |
| Middle East                     | 1 (1)         | 0 (0)               | 1 (6)                    | 0 (0)                      |
| Multiple                        | 3 (3)         | 0 (0)               | 3 (17)                   | 0 (0)                      |

a Thirteen studies did not report the sex proportion of the plant-based diet followers or the overall sample.
b Five studies reported the sex proportion of plant-based diet followers. Other studies reported the sex proportion of the overall sample combining omnivores and plant-based diet followers. This table reports the sex proportion of plant-based diet followers wherever data is available. If unavailable, the sex proportion of the overall sample is reported.
Nineteen studies reported the education level of the recruited participants. This table excludes information on three studies that reported mean education level in years and two studies with ambiguous descriptions of education level.

d Ten studies reported the education level of plant-based diet followers, and the remaining four studies reported the education level of the overall sample combining omnivores and plant-based diet followers.
| Dietary groups (determined for present study) | Definitions | Terms used in publications | Study with relevant sample |
|---------------------------------------------|-------------|---------------------------|----------------------------|
| Vegan                                       | Excludes all animal products. | Vegan                      | Heiss et al. (2018)         |
|                                             |             |                           | Heiss et al. (2017)         |
|                                             |             |                           | Janssen et al. (2016)       |
|                                             |             |                           | Kessler et al. (2016)       |
|                                             |             |                           | Kerschke-Risch (2015)       |
|                                             |             |                           | Radnitz et al. (2015)       |
|                                             |             |                           | Rothgerber (2015)           |
|                                             |             |                           | Rothgerber (2014b)          |
|                                             |             |                           | Rothgerber (2014c)          |
|                                             |             |                           | Rothgerber (2013a)          |
|                                             |             |                           | Dyett et al. (2013)*        |
|                                             |             |                           | Hoffman et al. (2013)*      |
|                                             |             |                           | Haverstock & Forgays (2012) |
|                                             |             |                           | Timko et al. (2012)         |
|                                             |             |                           | Izmirli & Phillips (2011)*  |
|                                             |             |                           | Waldmann et al. (2003)      |
|                                             |             |                           | Larsson & Johansson (2002)  |
| Vegetarian                                  | Excludes all red meat, poultry, and seafood. Includes dairy and/or eggs (i.e., not follow a vegan diet). | Vegetarian                  | Kessler et al. (2016)       |
|                                             |             |                          | Rothgerber (2015)           |
|                                             |             |                          | Rothgerber (2014a)          |
|                                             |             |                          | Rothgerber (2014b)          |
|                                             |             |                          | Rothgerber (2014c)          |
|                                             |             |                          | Rothgerber (2013a)          |
|                                             |             |                          | Haverstock & Forgays (2012) |
|                                             |             |                          | Timko et al. (2012)         |
|                                             |             |                          | Izmirli & Phillips (2011)*  |
|                                             | Excludes all red meat, poultry, and seafood. May or may not include dairy and/or eggs (i.e., may or may not follow a vegan diet). | Vegetarian                  | Lentz et al. (2018)         |
|                                             |             |                          | de Boer et al. (2017)       |
|                                             |             |                          | Asher et al. (2014)*        |
|                                             |             |                          | Brinkman et al. (2014)      |
|                                             |             |                          | de Backer & Hudders (2014)  |
|                                             |             |                          | Hoffman et al. (2013)*      |
|                                             |             |                          | Forrestell et al. (2012)    |
|                                             |             |                          | Spencer et al. (2007)*      |
|                                             |             |                          | Curtis & Comer (2006)       |
|                                             |             |                          | Mooney & Walbourn (2001)    |
|                                             |             |                          | Perry et al. (2001)         |
|                                             |             |                          | Lindeman & Väänänen (2000)  |
| Diet Type                      | Description                                                                 | References                                                                                           |
|-------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| Semi vegetarian               | Excludes or restricts red meat. Includes fish and/or chicken.                | Lindeman et al. (2000) Kim et al. (1999)* White et al. (1999)* Santos & Booth (1996) Janelle & Barr (1995) |
|                               | Avoids a certain type of meat                                              | Brinkman et al. (2014) Forestell et al. (2012) Haverstock & Forgays (2012) Latvala et al. (2012) Curtis & Comer (2006) Perry et al. (2001) Pollard et al. (1998) |
|                               | Restricts amount of meat                                                   | Rothgerber (2014a) Timko (2012) Izmirli & Phillips (2011)* Santos & Booth (1996)                    |
|                               | Low in red meat                                                            | Lentz et al. (2018) de Boer et al. (2017) de Backer & Hudders (2014) Schösler et al. (2014)*       |
|                               | Less beef and pork, more chicken and vegetables                            | Latvala et al. (2012) Forestell et al. (2012) Tobler et al. (2011)                                   |
|                               | Pescatarian                                                               |                                                                                                       |
|                               | Pesco-vegetarian                                                           |                                                                                                       |
|                               | Less beef and pork, more chicken and vegetables                            |                                                                                                       |
|                               | Semi vegetarian                                                           |                                                                                                       |
|                               | Some meats avoided                                                        |                                                                                                       |
|                               | Partial meat avoider                                                      |                                                                                                       |
|                               | Flexitarian                                                               |                                                                                                       |
|                               | Meat reducer                                                              |                                                                                                       |
|                               | Reduce meat consumption                                                   |                                                                                                       |
|                               | Less all meat, more vegetables                                           |                                                                                                       |
|                               | Low meat-eater                                                            |                                                                                                       |
|                               | Low frequency of eating meat                                              |                                                                                                       |
| Plant-based diet followers    | Describes samples that combine multiple types of plant-based diet followers in analyses | Parviainen et al. (2017) Trautmann et al. (2008)* Fisak et al. (2006) Klopp et al. (2003) Lindeman & Sirelius (2001) Smith et al. (2000) Gilbody et al. (1999) Worsley & Skrzypiec (1997) Bobić et al. (2012) Robinson-O’Brien et al. (2009) Lea et al. (2006) Baş et al. (2005) Fessler et al. (2003) |
|                               | Uses a definition of “vegetarian” or “plant-based” that can encompass      |                                                                                                       |
various dietary patterns
Uses term “vegetarian” without defining it

| Rozin (1997) |
|-------------|
| Ogden et al. (2007) |
| Kalof et al. (1999) |
| Pollard et al. (1998) |
| Ryan (1997) |
| Cooper et al. (1985) |

+ Indicates publications with analyses on dietary motivations that had descriptions of research methods and demographic profiles in previous publications submitted by the same research team.

* Indicates studies that were included in the Method vs. Publication Year map but excluded from the Motivation vs. Age map because of incomplete demographic data.
Table 3. Common methods of capturing motivations of plant-based diet followers.

| Method                        | Description                                                                 |
|-------------------------------|-----------------------------------------------------------------------------|
| Free Response                 | Asks the participant to list their motivations for following their diet.  |
| Multiple Choice               | Lists the common motivations for following a diet and asks the participant to choose one or more of the applicable options. |
| Rank Choices                  | Lists the common motivations for following a diet and asks the participant to rank order each motivation. |
| Rate Items                    | Lists motivations or statements related to motivations and asks the participant to indicate their level of agreement with each item, usually on a Likert scale. |
| Food Choice Questionnaire (FCQ) | This questionnaire, which was developed by Steptoe et. al 1995, has the format of “Rate Items.” |
| Motivation Group | Motivations                      |
|------------------|----------------------------------|
| Ethical          | Ethical                          |
|                  | Moral                            |
|                  | Ideological                      |
|                  | Animal welfare                   |
|                  | Environmental concern            |
|                  | Ecological                       |
|                  | Religion                         |
|                  | Spiritual belief                 |
|                  | World hunger                     |
|                  | Social justice                   |
| Health           | Health                           |
|                  | Weight                           |
| Other            | Other                            |
|                  | Sensory                          |
|                  | Taste                            |
|                  | Disgust                          |
|                  | Political                        |
|                  | Finances                         |
|                  | Social Influence                 |
|                  | Familiarity                      |
|                  | Habit                            |
|                  | Mood                             |
|                  | Convenience                      |
|                  | Natural content                  |