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The willingness to transition to a more plant-based diet among omnivores: Determinants and socioeconomic differences

Judith Lehmann [a,*], Miriam Trübner [a,b], Alexander Patzina [a,c], Michael Jeitler [d,e], Rasmus Hoffmann [a,1], Christian S. Kessler [d,e,1]

[a] Institute for Sociology, Otto-Friedrich-University Bamberg, Bamberg, Germany
[b] Institute for Sociology, Johannes-Gutenberg-University Mainz, Mainz, Germany
[c] Institute for Employment Research (IAB), Nuremberg, Germany
[d] Institute of Social Medicine, Epidemiology and Health Economics, Charité – Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany
[e] Department of Internal Medicine and Nature-Based Therapies, Immanuel Hospital Berlin, Berlin, Germany

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ABSTRACT

Plant-based diets benefit individual health and the environment, yet most people eat omnivorous diets. We aim to (1) assess the role of multiple determinants for transitioning to more plant-based diets in a sample of omnivorous respondents, such as recommendations from doctors, scientists and politicians; lower costs; and increased availability, and to (2) identify which subpopulations are most receptive to which determinants. Using data from a survey on the use and acceptance of Traditional, Complementary and Integrative Medicine in Germany (N = 4065; N omnivorous = 3419; 84%), we find that the overall willingness to change to a more plant-based diet is low (mean = 2.25 on a scale of 1–4). Respondents are most willing based on doctors' recommendations (mean = 2.61), and if prices for plant-based products were lower (mean = 2.55), and least willing based on scientists' and politicians' recommendations (mean = 1.86). Regression analyses reveal that men, the baby boomer cohort, and respondents with lower levels of education have a significantly lower willingness to transition to more plant-based diets. Further, recommendations from doctors, scientists, and politicians appear to be promising interventions for addressing the dietary behavior of men and older cohorts. Interventions by doctors and lower prices for plant-based products have the highest potential to induce dietary change even among the reluctant, reducing health inequalities and promoting environmentally friendly behavior.

1. Introduction

Combating climate change is one of humankind's most pressing challenges. In this context, nutrition is seen as a major contributor to individuals' ecological footprints, a measure commonly used to quantify the harmful CO_2 emissions responsible for global warming (Wackernagel & Beyers, 2019). For example, 15.3% of an average German's CO_2 footprint (totaling 10.4 million tons per year) is generated by food alone (Umweltbundesamt, 2024), making a plant-based diet – characterized by plant-based whole foods with very few animal products – a sustainable form of nutrition and a key driver of decarbonization (Scarborough et al., 2023; Wynes et al., 2018). In addition to these positive environmental effects, a shift to a plant-based diet correlates with substantial health benefits, including reduced mortality and cardiovascular risk (Huang et al., 2020; Satija & Hu, 2018), lower blood pressure and weight loss (Ivanova et al., 2021; Zhu et al., 2021), and reduced risk of chronic diseases (Hemler & Hu, 2019; Rouhani et al., 2014). At the same time, red and processed meat consumption is related to increased risks of several chronic diseases (Wolk, 2017). At the societal level, improved individual health also has the potential to relieve pressure on the healthcare sector, which has itself been identified as a major contributor to environmental emissions (Eckelman et al., 2020).

Recognizing the importance of dietary change, numerous studies have investigated the multifaceted motivations of people who have

* Corresponding author. Otto-Friedrich-Universität Bamberg, Feldkirchenstr. 21, 96052, Bamberg, Germany.
E-mail addresses: judith.lehmann@uni-bamberg.de (J. Lehmann), truebner@uni-mainz.de (M. Trübner), alexander.patzina@uni-bamberg.de (A. Patzina), michael.jeitler@charite.de (M. Jeitler), rasmus.hoffmann@uni-bamberg.de (R. Hoffmann), christian.kessler@immanuelalbertinen.de (C.S. Kessler).
[1] Rasmus Hoffmann and Christian S. Kessler share last authorship and have contributed equally.

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adopted plant-based diets, i.e., vegetarians and vegans (Janssen et al., 2016; Rosenfeld, 2018; Ruby, 2012). However, little is known about the willingness of people who do not restrict their meat consumption, usually referred to as omnivores, to switch to a more plant-based diet (Valli et al., 2019), even though this group has the greatest potential to reduce their consumption of meat and animal products. Recent research focuses on the motivations, attitudes, and beliefs of people who eat meat that relate to their willingness to eat more plant based (Dillon-Murray et al., 2024; Kemper et al., 2023; Roozen and Raedts, 2023). While encouraging people to eat more plant-based foods is paramount for individual health and the environment, changing people's eating habits is challenging because they are shaped by multiple determinants such as familiarity, tradition, religion, social context, and taste preferences (Grundy et al., 2022; Sanchez-Sabate & Sabaté, 2019; Valli et al., 2019). Thus, the key question is: *How can people who do not yet eat a plant-based diet be motivated to change their dietary behavior*?

Theories on health behavior change identify key factors such as the difficulty of performing the behavior or perceived benefits and barriers (Ajzen, 1991; Rosenstock, 1974). One major perceived benefit of a plant-based diet identified in the literature are the positive health effects; perceived barriers include for example enjoyment of eating meat and food neophobia, lack of knowledge and skills in preparing plant-based meals, nutrition doubts and health concerns, and inconvenience when eating out (Fehér et al., 2020; Graça et al., 2019; Hielkema & Lund, 2021; Perez-Cueto et al., 2022; Rosenfeld, 2018; Ruby, 2012). Experimental studies are investigating how to address these barriers and change dietary behavior to include more plant-based foods. Various interventions such as providing information on health, animal welfare, and the environmental impacts of meat consumption, offering meat alternatives, and 'nudging' in cafeteria settings have been successful in reducing meat consumption and promoting plant-based diets (Grundy et al., 2022). However, the effects of these interventions are often small, and it is unclear how persistent the achieved dietary changes are (Grundy et al., 2022). While studies identify the motives for and barriers to dietary change and the effectiveness of different interventions in experimental settings, it is still unclear which subpopulations are receptive to which determinants in changing to a more plant-based diet.

We will expand upon existing research in three ways. We *first* identify which subpopulations of omnivores are especially willing or unwilling to switch to a more plant-based diet. Studies have investigated the characteristics of vegetarians and vegans, i.e., gender, educational level, or personality traits (Brunin et al., 2022; Cramer et al., 2017; Holler et al., 2021; Lehto et al., 2022), but it is unclear whether the same characteristics are also associated with a higher willingness to change diet among omnivores. Recent studies focus on the motivations, attitudes, and beliefs that relate to omnivores' willingness to eat more plant based, however, they rarely investigate sociodemographic characteristics (Dillon-Murray et al., 2024; Kemper et al., 2023; Roozen and Raedts, 2023). Some studies show initial indications that sociodemographic characteristics like gender, education, religion, and rural vs urban residence may correlate with the willingness to change to a more plant-based diet (Dillon-Murray et al., 2024; Henn et al., 2022; Perez-Cueto et al., 2022; Hielkema & Lund, 2021; Milfont et al., 2021; Graça et al., 2019).

Second, we assess the role of a variety of determinants – including financial aspects, social acceptance, practicality, and social and medical recommendations – in dietary change. The current literature usually focuses on a limited number of interventions or nudges that are applied in the same setting (Grundy et al., 2022). Therefore, studies rarely compare the effectiveness of different types of interventions, such as information campaigns, changes in prices and taxes, or changes in what is offered in cafeterias, restaurants, or supermarkets on the respondents' perceptions of these determinants.

Third, we examine how the willingness differs for different determinants across various subpopulations to gain insights into who is receptive to which determinants. Research suggests that motives for food selection vary by sociodemographic characteristics, which may also affect the effectiveness of incentives and interventions for different subpopulations (Konttinen et al., 2021; Trübner et al., 2022). Despite the advantage of higher internal validity, experimental studies are rarely able to analyze differences in the impact of interventions based on sociodemographic or socioeconomic variables, even though there is some evidence that dietary interventions are more successful in specific societal groups such as the highly educated (McGill et al., 2015). This corresponds to broader calls in the behavioral sciences for a heterogeneity revolution, with the argument going that more attention should be paid to moderating characteristics for intervention effects (Bryan et al., 2021). It is important to be able to compare determinants, and which subpopulations are receptive to which types of determinants, in order to inform policy and large-scale societal interventions for dietary change.

To fill this research gap, we utilize a module on plant-based diets as part of a survey on the use and acceptance of Traditional, Complementary and Integrative Medicine (TCIM) in Germany (N = 4065) conducted in the fall of 2022; we analyze a variety of self-rated determinants for people not yet following a plant-based or otherwise restricted diet (e.g., gluten-free or low carb) (N = 3,419, 84% of the sample) between the ages of 18 and 75. This study is the first to our knowledge to collect information on individuals' willingness to change their diets due to different determinants, allowing for a different perspective on the question as to which conditions for dietary change are considered influential by the respondents. Germany is a particularly interesting case because vegans and vegetarians make up only 8% of the German population (Bundesministerium für Ernährung und Landwirtschaft, 2022; Mensink et al., 2016). Thus, in the German context great potential for further change in dietary behavior exists.

2. Theoretical background and existing research

We focus on two theoretical strands of the literature on health behavior change: the Health Belief Model (HBM; Rosenstock, 1974) and the Theory of Planned Behavior (TPB; Ajzen, 1991). Recent studies have used both of these models in the context of plant-based diets and meat reduction (i.e., Wang & Scrimgeour, 2021; Pandey et al., 2021; Gifford et al., 2024; Chen, 2024; Seffen & Dohle, 2023; Shin et al., 2024; Urbanovich & Bevan, 2020) with TPB being the dominant theoretical framework (Bourke et al., 2024). In contrast to these studies which test the underlying assumptions of the models, our goal is to interrogate these theoretical models to form assumptions concerning our research questions, especially regarding the differences in willingness for each determinant and the associations with socioeconomic and demographic variables.

The HBM (Rosenstock, 1974) is a theory of behavioral change developed specifically in the context of health behavior. The theory states that certain individual beliefs influence health behavior: perceptions of one's individual risk for a disease (susceptibility), of the seriousness of the disease (severity), and of the potentially positive outcomes (benefits) and material and immaterial costs (barriers) of an action that reduces the threat of the disease. Later, Bandura's (1997) concept of self-efficacy was added to the model, describing the belief that one can successfully perform the advised behavior to achieve the desired outcome. The model also includes cues to action that trigger an appropriate behavior, such as media campaigns or illness in family or friends, and sociodemographic characteristics such as age and gender as modifying factors (Champion & Skinner, 2008; Green et al., 2020).

Another commonly used theoretical framework for behavioral decision-making in the context of nutrition and health is the TPB (Ajzen, 1991), which builds upon the Theory of Reasoned Action (Ajzen & Fishbein, 1980). TPB predicts human behavior through individuals' intentions, which capture motivational factors related to behavior. The central idea is that stronger intentions to engage in a behavior lead to a higher likelihood of its performance, as long as the action is within the individual's control (Ajzen, 1991). Three interconnected factors shape

intentions: attitudes toward the behavior, subjective norms, and perceived behavioral control. Favorable attitudes and subjective norms towards a behavior, as well as high perceived control, should lead to strong intentions to perform that behavior. However, the relative importance of these factors for intentions may vary across behaviors and situations (Ajzen, 1991). Sociodemographic characteristics such as income, education, gender, and age are considered background factors in TPB, with these factors not held to have a direct effect on behavior, but instead an indirect influence on behavior through attitudes, subjective norms, and perceived behavioral control (Ajzen & Schmidt, 2020). In a variation of the TPB, the Attitude-Social Influence-Efficacy model (ASE) expands the social dimension of the behavioral model. While social norms are one type of social influence in ASE, perceived behaviors of others and direct pressure to perform a behavior are the other relevant aspects of this framework (Brug et al., 1995; Vries & Mudde, 1998).

In conclusion, several determinants may influence dietary choices. According to HBM, people evaluate their dietary patterns in relation to their health and potential diseases. Existing research identifies the positive health effects as a central benefit of plant-based diets (Fehér et al., 2020; Reuzé et al., 2023; Rosenfeld, 2018; Ruby, 2012; Urbanovich & Bevan, 2020) and these may be foregrounded particularly through doctors' recommendations. ASE and TPB theorize the effect of social influence, i.e., perceived behavior of others, and subjective norms on behavior change. Building on TPB, the model of Severijns et al. (2023) assumes an indirect effect of social contacts on dietary decisions. Studies show that people without vegetarian friends and families face a substantial barrier to adopting a plant-based diet (Pohjolainen et al., 2015). Living in a household with others who consume meat is also a relevant factor for individuals' own meat consumption (Lea et al., 2006; Lea & Worsley, 2003). There is a correlation between having vegetarian household members, friends and family and reductions in a person's meat consumption (Vandermoere et al., 2019). Social networks can play a crucial role when it comes to dietary change especially for the initial decision to eat less meat (Lund & Halkier, 2024). Therefore, the share of people who adopt a plant-based diet within an actor's social network and within society in general may affect dietary choices through actors' perceptions of the behavior of others, and eventually lead to the formation of new social norms regarding meat consumption. Further, societal recommendations can influence eating behavior by creating social pressure. For example, research shows that a majority of the population in many countries adhere to national dietary guidelines; however, consumption of meat often exceeds the recommendations (Leme et al., 2021). Hence, recommendations from scientists and politicians may create pressure to change to a more plant-based diet.

Both HBM and ASE consider barriers to be an important independent factor in behavior change. These barriers include the individual's food environment and infrastructure, such as the food products offered at their workplace cafeteria, or in supermarkets and restaurants. Accordingly, studies show that omnivores often worry that plant-based diets are inconvenient when eating out (Rosenfeld & Tomiyama, 2020). Experimental studies set in cafeterias, restaurants, and supermarkets show the potential of these settings to induce dietary change (Bianchi et al., 2018; Harguess et al., 2020; Hartmann-Boyce et al., 2018; Nielsen et al., 2017; Taufik et al., 2019). Increasing the availability of plant-based meals and foods in these settings may facilitate dietary change. Another barrier is the price of plant-based meals and foods. Lower prices and subsidies can also influence dietary choices towards a more plant-based diet, according to previous studies (An, 2013; Hartmann-Boyce et al., 2018). Therefore, we expect costs to influence the willingness to eat a more plant-based diet. However, research is still inconclusive when it comes to the effects of prices and taxes on food (Caraher & Cowburn, 2005; Epstein et al., 2012; Garnett et al., 2021; Niebylski et al., 2015). Experimental studies show that changes in the price of plant-based foods have small effects on the consumption of plant-based alternatives to meat (Carlsson et al., 2022; Jahn et al., 2024; Tonsor et al., 2023; van Loo et al., 2020).

The theories themselves do not specify the relationships among these factors, nor do they hypothesize a hierarchy of the factors in terms of their effect on intentions or behaviors. However, empirical research suggests differences in the effects of individual determinants on behavior change. For example, studies find that perceived barriers are the strongest single predictor of behavior change within the HBM framework (Carpenter, 2010; Janz & Becker, 1984). Perceived benefits also strongly predict health behavior. However, the respondents' perceptions of their own susceptibility to a disease and the severity of it are the weakest predictors of preventive behavior and overall behavior change (Carpenter, 2010; Janz & Becker, 1984; Shin et al., 2024). Within the TPB framework, subjective norms have been identified as the weakest predictor of dietary behavior (McDermott et al., 2015; Pandey et al., 2021; Riebl et al., 2015; Wang & Scrimgeour, 2021). Similarly, for ASE, social influence does not show a consistent effect on dietary choices (Brug et al., 1995; Martens et al., 2005). Therefore, we expect that reducing barriers – by offering plant-based meal options in workplace cafeterias, supermarkets, and restaurants, or reducing prices for plant-based foods – will particularly affect people's willingness to change their diets. Similarly, we expect that highlighting the health benefits through doctors' recommendations will increase the willingness to make dietary changes. In contrast, we expect that the proportion of people who have adopted a plant-based diet in individuals' own networks and in society in general will have little effect on dietary choices.

Both HBM and TPB consider sociodemographic characteristics to be moderating background variables. Based on these characteristics, we can distinguish subpopulations with differing levels of willingness to alter dietary behavior. While existing research indicates that overall willingness to change to a more plant-based diet is low among omnivores (Sanchez-Sabate & Sabaté, 2019), with one German study showing that about 12% of their sample were willing to eat less meat (Cordts et al., 2014), we expect some subpopulations to be more willing to adopt a plant-based diet than others. For example, we expect women to be more willing to change their diet than men, due to gendered views on meat consumption (Roozen and Raedts, 2023; Perez-Cueto et al., 2022; Hielkema & Lund, 2021; Milfont et al., 2021; Malek et al., 2019; Graça et al., 2015; Rosenfeld, 2018; Ruby, 2012). We also hypothesize that older cohorts are less willing to change their diets than younger cohorts because younger generations are more concerned about the environmental impact of food production and animal rights[2] (Nawrotzki & Pampel, 2013). Due to the cross-sectional nature of our data, we are not able to separate cohort effects and age effects regarding the openness to new experiences (Fitzenberger et al., 2022), which may influence dietary choices. Age variables have previously been shown to correlate with the willingness to eat more plant based (Carlsson et al., 2022; Hielkema & Lund, 2021; Malek et al., 2019).

Low levels of education may also be associated with lower willingness to change one's diet as, for example, a lack of knowledge about plant-based foods and how to prepare plant-based meals may be a greater barrier for this group (Carlsson et al., 2022; Dillon-Murray et al., 2024; Perez-Cueto et al., 2022; Rosenfeld, 2018). Respondents in rural areas may perceive more barriers to eating plant-based diets (Hielkema & Lund, 2021; Perez-Cueto et al., 2022; Pohjolainen et al., 2015). Respondents with impaired health may have a higher motivation to engage in behaviors that will restore their health or prevent it from worsening, making them more willing to change to a more plant-based diet than healthy respondents (Carpenter, 2010; Milfont et al., 2021; Satia et al., 2001). Respondents who perceive a healthy diet as very important may have recognized the negative consequences of meat consumption for themselves because they are more engaged with information about healthy eating. Religion correlates with willingness to eat more plant based according to Dillon-Murray et al. (2024), and since many religions

[2] However, it is still an open question whether younger generations are more concerned about the environment than older ones (see Gray et al., 2019).

impose dietary restrictions on their members to varying degrees, with Christian religions typically imposing no dietary rules regarding the preparation and consumption of meat (Chouraqui et al., 2021), we expect atheists and Christians to be less willing to change their diet than non-Christian religious people. There is very little evidence on the differential effects of individual behavioral determinants in different subpopulations. Research suggests that sociodemographic and socioeconomic characteristics relate to motives for food choices such as convenience, price, and familiarity of food (Konttinen et al., 2021; Trübner et al., 2022), so some expectations seem plausible. For example, we expect the price of plant-based foods to be particularly important for lower-income households, who may not be able to choose their diets freely due to income constraints (McGill et al., 2015). Plant-based options in the workplace cafeteria may be especially relevant to the dietary choices of full-time or part-time workers and students who may rely on the cafeteria for at least one meal per day.

3. Data and methods

3.1. Data and sample

To analyze who would change to a more plant-based diet under which conditions, we used data from a survey on the use and acceptance of TCIM in Germany. Conducted from September to October 2022, the survey covers various aspects of TCIM and related medical approaches, including knowledge, experience, attitudes, and application of these approaches (see Jeitler et al., 2024 for an overview of the data and descriptive results of the study). It also included a module on dietary practices and attitudes, as well as questions on the willingness to change one's diet, which will be the focus of this study, alongside general attitudes, health status, medical history, and sociodemographic information. The data are available from the corresponding author upon reasonable request.

The survey was conducted via an online access panel with quota sampling by the commissioned research institute Respondi in collaboration with Conversio and the SINUS survey institute. The panel is certified under ISO 26362, which monitors the quality of online sampling. This includes quality procedures that continuously check response behavior. To adhere as closely as possible to the requirements of a representative sample, Respondi requires double opt-in registration, with experts monitoring and managing the panel. The study was approved by the Charité University ethics committee (ClinicalTrials.gov NCT05530720), and participants gave informed consent before taking part. Initially 8821 respondents started the survey, leading to a response rate of 21.5%. Due to lack of consent or age information, 453 cases (5.1%) were excluded. Further, 2845 respondents (32.3%) were excluded due to full quotas, and 313 (3.5%) due to failed internal quality checks. 1000 (11.3%) individuals did not complete the survey and were therefore excluded. Our final sample comprises 4065 respondents aged between 18 and 75.

The literature critically discusses the methodological pitfalls of online access panels, particularly due to non-probability sampling and potential non-response biases (Kohler & Post, 2023; Mercer & Lau, 2023). Consequently, we compared our sample distributions to findings based on probability-based random samples, confirming consistency in diet distributions with previous representative data for Germany (Bundesministerium für Ernährung und Landwirtschaft, 2022; Mensink et al., 2016). Furthermore, online panels offer high data quality, especially for complex questions, due to experienced participants (Zhang et al., 2020; Matthijsse et al., 2015; Hillygus et al., 2014; Chang & Krosnick, 2009) and the self-administered online mode encourages less socially desirable responses, crucial in sensitive areas like health (Rickwood & Coleman-Rose, 2023; Gnambs & Kaspar, 2015; Krumpal, 2013).

We limit our analytical sample to omnivores. Respondents received short descriptions and synonyms to facilitate the responses regarding their diet. For example, plant-based diets were described as "almost without animal products (max. 5%)". Respondents were asked to self-identify their diet: More than half (55%) identified as omnivorous, and 29% as omnivorous but reducing meat; these two groups were combined for analysis. We also conducted robustness checks using only fully omnivorous respondents. Additionally, 2.7% already followed a predominantly plant-based diet, 4% were vegetarian, and 1.5% vegan. Besides omnivorous and plant-based diets, 2.4% report a pescetarian diet and .8% describe other dietary patterns[3] that do not fit under these umbrella terms. Around 4.5% of the respondents do not know how to classify their diet. Overall, our analytic sample includes 3419 self-identified omnivores.

3.2. Outcome variables

All respondents rated their willingness to change to a more plant-based diet based on seven determinants: if their doctor recommended it, if scientists and politicians recommended it, if there were better options at their workplace cafeteria, if more people around them ate a plant-based diet, if plant-based products were cheaper, if plant-based diets were more common in society, and if there were better options in supermarkets and restaurants.[4] These determinants, derived from previous research, represent a wide array of possible incentives and barriers for a plant-based diet. This list is not exhaustive, and other determinants could have been included, however, we aimed to prioritize determinants with broad applicability across various demographic groups. This study is the first to our knowledge to collect information on individuals' willingness to change their diet due to different determinants. The combination of different determinants influencing the willingness to change to a more plant-based diet allows for a different perspective on the question as to which conditions are considered influential by the respondents, since we can analyze not only which determinants may affect respondents to adopt a healthier diet, but also rank the anticipated impact of these determinants.

The question was phrased: "Would you eat more plant based if in particular …", followed by the listed determinants. Respondents selected from four options for each determinant: "does not apply at all" (1), "not really applicable" (2), "quite applicable" (3), "applies fully" (4). The seven ratings were used to create a scale measuring overall willingness to adopt a more plant-based diet, with high internal consistency (Cronbach's alpha = .9). This overall willingness scale ranged from 1 (no willingness) to 4 (very high willingness), averaging 2.3 (5.2% missing, 141 cases[5]). Based on this scale, we created three categories: "low willingness" (ratings up to 2 points on the scale), "moderate willingness" (between 2 and 3 points), and "high willingness" (over 3 points).

Using the willingness ratings for each determinant and the overall willingness, we calculate the relative importance of each determinant by dividing its willingness rating by the overall willingness scale, following Konttinen et al. (2021). The relative importance of the determinants ranges from .84 to 1.19, where 1 indicates that the determinant's willingness rating is equal to the overall willingness. This method helps to assess which determinants are related to an above or below average willingness to change one's diet, and to establish whether the relative importance of each determinant varies systematically by sociodemographic characteristics. For example, on the scale from 1 to 4, male and female respondents averaged 2.57 and 2.63, respectively, in their

[3] Wherever possible, open answers in the "other" category were recoded, for example "I eat everything" and "normal" as omnivorous, or "vegetarian with milk but without eggs" as vegetarian.

[4] The determinants were presented in this order in the questionnaire. See table A1 in the appendix for the module as presented in the questionnaire.

[5] The average global willingness was calculated ignoring missing values. Only cases with no valid values on any of the determinants were set as missing on the global willingness scale.

willingness to change their diet based on doctors' recommendations, which suggests that this determinant is equally important for dietary choices for men and women. However, given the overall lower willingness among men, the relative importance of doctors' recommendations on their dietary choices is greater on average (1.21) than for women (1.16).

3.3. Covariates

We use various covariates in multivariate models to identify correlates of willingness to change to a more plant-based diet and its determinants. The covariates in the regression models are sociodemographic and socioeconomic variables, as well as variables concerning health, spirituality, and religion. Sociodemographic variables include gender, birth cohort, German natives vs. migrants, marital status, and urban vs rural area. Socioeconomic characteristics are level of education, employment status, monthly household net equivalized income categories, and respondents' parents' occupational status. We also included self-rated health and the importance respondents ascribe to a healthy diet, as well as religious affiliation and spirituality. All covariates are categorical, the categories of which have been combined, when possible, for easier interpretation and sufficient number of cases per category. Covariates not systematically correlating with the dependent variables (migration background, marital status, urban vs. rural, social origin) are omitted from the tables. We also do not show results for the diverse gender category because the coefficients are unreliable due to the very small number of cases. Information on the covariates is summarized in Table 1.

3.4. Data analysis

We use multinomial logistic regression analysis to identify correlates of high and low willingness to change to a more plant-based diet, aiming to identify groups of respondents who are more or less likely to adopt a plant-based diet. For easier interpretation of the regression coefficients, we compute average marginal effects (AME), the average effect of any independent metric variable x on the probability of the dependent variable y being 1 (Mood, 2010). To assess how different groups rate their willingness for each determinant that could facilitate a more plant-based diet, we use logistic regression models, including only cases with valid ratings on all seven determinants (26% missings, 896 cases). The willingness rating for each determinant is dichotomized (1 "applicable", 0 "not applicable"). We use the same set of covariates in these models and present AMEs to interpret the regression coefficients. These analyses show how willingness for each of the determinants is distributed in society. Finally, we use linear regression models to analyze the relative importance of each determinant to see which groups rated which of the determinants as above or below average in their decision making.[6] These analyses reveal the differences in willingness between groups that are hidden behind the differences in overall willingness.

4. Results

Focusing on respondents with an omnivorous diet, we evaluate their willingness to change to a more plant-based diet, both in general and based on different motivating determinants for changing to such a diet. The overall willingness – averaging the willingness for all seven determinants – ranges from 1 to 4 and is not very high in the subgroup of respondents with an omnivorous diet (mean 2.25). Of the omnivore respondents, 8.9% report no willingness to switch to a more plant-based diet at all, while 1.5% report the highest possible willingness.

To identify groups who might be more easily convinced to transition to a more plant-based diet, we use regression analyses to see which characteristics correlate with a higher willingness. Table 2 presents two models with covariates. Model 1 controls for sociodemographic and socioeconomic variables as the base model. In model 2, we added variables for social origin, urban vs rural residence, health and healthy diet, spirituality, and religion to investigate whether these variables could account for the sociodemographic and socioeconomic differences we find. We see that respondents with a higher level of education are significantly less likely to have a low willingness and significantly more

Table 1
Descriptive statistics for the covariates.

	N	Frequency	Min.	Max.
Education				
low education	969	0.30	0	1
intermediate education	947	0.29	0	1
high education	1362	0.42	0	1
Net equivalent income				
up to €1.000	574	0.18	0	1
€1.001–1.500	764	0.23	0	1
€1.501–2.000	725	0.22	0	1
€2.001–2.500	648	0.10	0	1
more than €2.500	551	0.17	0	1
missing	16	0.01	0	1
Employment status				
retired	959	0.29	0	1
full time	1361	0.42	0	1
part time	470	0.14	0	1
in school/training	183	0.06	0	1
unemployed	109	0.03	0	1
not in workforce/parental leave	196	0.06	0	1
Social origin (parental occupation)				
never employed	574	0.18	0	1
laborers or lower-level employees	992	0.30	0	1
self-employed or medium/higher-level employees	1712	0.52	0	1
Migration background				
German natives	2866	0.87	0	1
migrants	323	0.10	0	1
missing	89	0.03	0	1
Gender				
female	1625	0.50	0	1
male	1640	0.50	0	1
diverse	13	0.01	0	1
Birth cohort				
1947–1964	1276	0.39	0	1
1965–1979	943	0.29	0	1
1980–1995	789	0.24	0	1
1996–2004	270	0.08	0	1
Marital status				
unmarried	1195	0.36	0	1
married	1453	0.44	0	1
widowed/divorced	630	0.19	0	1
Urban vs. rural				
urban	1609	0.49	0	1
rural	1669	0.51	0	1
Health status				
not good/bad	756	0.23	0	1
good	1499	0.46	0	1
very good/excellent	1023	0.31	0	1
Importance of a healthy diet				
not important	303	0.09	0	1
neutral	915	0.28	0	1
important	2060	0.63	0	1
Spirituality				
not spiritual	2019	0.62	0	1
neutral	545	0.17	0	1
spiritual	714	0.22	0	1
Religion				
Christian religion	1572	0.48	0	1
non-Christian religion	117	0.04	0	1
no religious affiliation	1589	0.48	0	1

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany, only for omnivorous respondents who have valid values for willingness (N = 3278).

[6] We use robust standard errors due to heteroskedasticity (MacKinnon, 2013).

Table 2
Multinomial logistic regression of the willingness to change to a more plant-based diet (AMEs).

	Model 1			Model 2		
	Low willingness	Moderate willingness	High willingness	Low willingness	Moderate willingness	High willingness
Level of educ. (ref.: *low*)						
intermediate	.005	.019	.014	.003	.019	.021
high	.108***	.055*	.053**	.082***	.050*	.032
Net equivalent income (ref.: *up to €1000*)						
€1001–1500	.026	.025	.000	.014	.020	.006
€1501–2000	.003	.036	.033	.002	.028	.026
€2001–2500	.015	.059	.045	.003	.046	.042
more than €2500	.008	.040	.048	.015	.024	.039
missing	.114	.124	.010	.079	.117	.038
Employment status (ref.: *retired*)						
full time	.048	.005	.053*	.049	.000	.048*
part time	.059	.015	.044	.057	.020	.038
in school/training	.135*	.031	.104*	.126*	.037	.089*
unemployed	.031	.025	.005	.028	.034	.005
not in the workforce/parental leave	.025	.031	.006	.035	.038	.003
Gender (ref.: *female*)						
male	.064***	.030	.033*	.030	.020	.011
Birth cohort (ref.: *1947–1964*)						
1965–1979	.015	.001	.013	.024	.006	.017
1980–1995	.108***	.044	.064*	.125***	.047	.077**
1996–2004	.181***	.125**	.056	.188***	.122*	.066
Health status (ref.: *not good/bad*)						
good				.006	.013	.007
very good/excellent				.027	.007	.019
Import. of healthy diet (ref: *not important*)						
neutral				.156***	.113***	.044*
important				.338***	.169***	.169***
Spirituality (ref: *not spiritual*)						
neutral				.055*	.031	.086***
spiritual				.076***	.033	.109***
Religion (ref.: *Christian)*						
non-Christian				.025	.089	.114**
no religious affiliation				.036*	.032	.004
N		3278			3278	

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: net equ. income = net equivalized household income; also controlling for gender: diverse, migration background, marital status, social origin, urban vs. rural; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

likely to have a moderate or high willingness to eat a more plant-based diet compared to respondents with a lower level of education. However, their higher likelihood of having a high willingness to change their diet is not statistically significant in model 2 because it is explained by differences assigned to the importance of a healthy diet and the level of spirituality. Income is not related to the willingness to change one's diet; however, we find that full-time employees and students have a higher willingness compared to respondents who are retired (reference group). According to model 1, men are more likely to have a low willingness and less likely to have a high willingness to consume a more plant-based diet than women. This association is no longer statistically significant in model 2 because it is explained by differences assigned to the importance of a healthy diet and the level of spirituality. Compared to the baby boomer generation (born between 1947 and 1964), millennials (born between 1980 and 1995) and generation Z (born between 1996 and 2004) are less likely to have a low willingness to change to a more plant-based diet. In sum, respondents with a high level of education, women, and respondents from younger birth cohorts show a higher willingness to transition to a more plant-based diet. In contrast, respondents with a low to intermediate level of education, men, and respondents from older birth cohorts might not be easily swayed to change their diet.

In a second step, we assess respondents' willingness to adopt a plant-based diet for each of the seven determinants. The willingness to switch to a more plant-based diet varied between 1.85 on average if scientists and politicians promoted a more plant-based diet and 2.61 if respondents' doctors suggested it (Fig. 1). The highest rated determinants are if doctors recommended a plant-based diet, if the costs of a plant-based diet were lower, if supermarkets and restaurants offered more plant-based options, and if the workplace cafeteria offered more plant-based options. On average, respondents rated their willingness based on these determinants higher than their overall willingness. However, their willingness would be less affected if plant-based diets were more common in society, if more people around them followed a plant-based diet, and if scientists and politicians advocated it (Fig. 1).

Next, we use the willingness for each of these determinants separately in logistic regression models to investigate the associations with the covariates. In Table 3, there is one model for each of the seven determinants. Of the groups that we have identified as being more open to dietary change in the first step of our analysis, first, respondents with a high level of education report a significantly higher willingness than respondents with a low level of education for all determinants, except if more people in their network or in society in general ate a plant-based

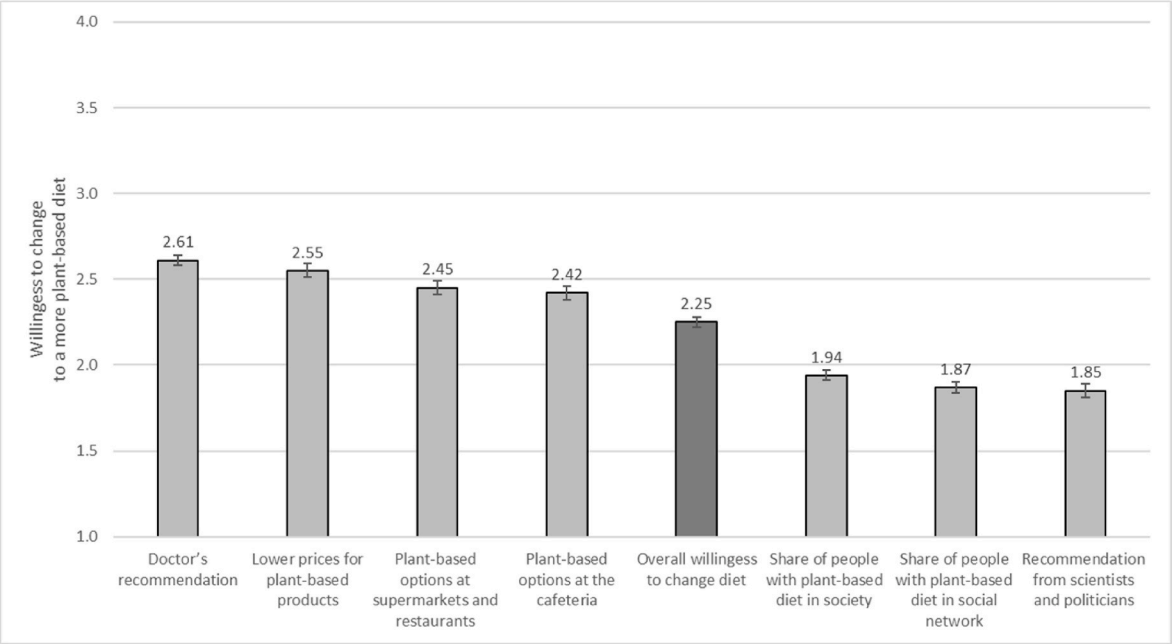

Fig. 1. Mean of overall and determinant-specific willingness to change to a more plant-based diet (with 95% confidence intervals).

diet. Second, women are less willing than men to change their diet if scientists and politicians recommended it. However, they are more likely than men to adopt a plant-based diet if their workplace cafeterias or supermarkets and restaurants offered better plant-based options, or if plant-based products were cheaper. Third, in terms of birth cohort, younger cohorts would be more likely than the baby boomer cohort to change their diet if more people around them or in society in general followed a plant-based diet, if plant-based products were cheaper, or if supermarkets and restaurants offered better plant-based options. Hence, we conclude that these groups show differences in their willingness based on the seven determinants.

Some other findings are worth noting. Lower prices for plant-based products are associated with a lower likelihood of dietary change among respondents with a net household income of more than 2000 euros per month compared to those with less than 1000 euros. Respondents who work part-time, are students, or are unemployed are more likely to change to a more plant-based diet if there are better options at the cafeteria than retired respondents. Students are also more sensitive to lower prices and doctors' recommendations. Ascribing greater importance to a healthy diet and spirituality correlate with higher willingness for all the determinants. Respondents with a non-Christian religious affiliation rate their willingness higher than Christians if plant-based options improve in their workplace cafeteria, supermarkets, and restaurants, and if more people in society adopt a plant-based diet. Respondents with no religious affiliation have a lower willingness than their religious counterparts if doctors recommend a plant-based diet. In conclusion, while we find no differences in willingness by determinant for the importance of a healthy diet and spirituality, and very few for education, willingness differs by determinant for gender, birth cohort, employment status, and household income. These findings suggest that willingness based on the determinants differs by socioeconomic and demographic characteristics, which we will explore further in the next step.

In a third step, we analyze the relative importance of each of the determinants of respondents' dietary choices. Controlling for the differences in overall willingness to change to a more plant-based diet, we can see which determinants are more or less important to respondents. For example, in Table 3, respondents with a higher level of education have a higher willingness regarding most of the seven determinants because they have a higher overall willingness to change their diet than those with lower levels of education. If we control for this general difference in willingness between educational groups, we identify the determinants that are particularly relevant for their dietary choices. Table 4 shows that respondents with higher levels of education are more likely to be influenced by recommendations from scientists and politicians and by better plant-based options in their workplace cafeterias. However, if more people in their social network or in society in general adopt a more plant-based diet, respondents with a high level of education will be less affected than respondents with a low level of education.

While Table 3 already showed that for men, recommendations by scientists and politicians have more influence than for women, and better options at workplace cafeterias or at supermarkets and restaurants and lower prices for plant-based products are less important for them, Table 4 indicates that, considering men's lower overall willingness, they are also more receptive to doctors' recommendations than women. The baby boomer cohort, compared to younger ones, also has a lower overall willingness and therefore lower willingness ratings for many of the seven determinants. However, the baby boomer cohort is particularly receptive to doctors' recommendations, while they consider the proportion of people around them who consume a plant-based diet and lower prices for plant-based products as less important than other birth cohorts. Millennials rate recommendations from scientists and politicians as less important than the baby boomer cohort.

These findings are complementary to the findings on level differences across different determinants and show the relative importance of the seven determinants. In conclusion, they reveal that recommendations from doctors and from scientists and politicians are promising interventions in convincing hard to reach groups such as men and the baby boomer birth cohort to adopt a more plant-based diet, but the recommendations of scientists and politicians are also an important factor for the highly educated. Lower prices for plant-based products will particularly motivate women and households with incomes below 2000 euros per month. If the number of people in society who adopt a plant-based diet increases, this may specifically influence the dietary choices of respondents with lower levels of education.

Table 3
Logistic regression models of the willingness to change to a more plant-based diet, by determinant influencing dietary choices (AMEs).

	doctor's recomm.	recomm. from scientists and politicians	pb options at the cafeteria	pb diet in social network	lower prices for pb products	people with pb diet in society	pb options at s.markets and restaurants
Level of education (ref.: *low*)							
intermediate	.029	.004	.021	.036	.008	.059*	.007
high	.105***	.060*	.089***	.009	.096***	.024	.068*
Net equ. income (ref.: *up to €1000*)							
€1001–1500	.013	.014	.028	.000	.022	.007	.047
€1501–2000	.010	.038	.002	.014	.056	.003	.064
€2001–2500	.017	.031	.034	.013	.103**	.002	.059
more than €2500	.024	.023	.032	.028	.127***	.026	.073*
missing	.037	.045	.016	.045	.184	.022	.258*
Employment status (ref.: *retired*)							
full time	.051	.054	.070*	.053	.028	.027	.040
part time	.053	.030	.124***	.003	.042	.023	.057
in school/training	.120*	.086	.201***	.049	.124*	.088	.111
unemployed	.007	.030	.130*	.005	.042	.036	.021
not in workforce/parental leave	.022	.024	.069	.021	.047	.020	.100*
Gender Ref.: *female*)							
male	.007	.047**	.081***	.025	.054**	.001	.076***
Birth cohort (ref.: *1947–1964*)							
1965–1979	.008	.009	.030	.056*	.085**	.059*	.026
1980–1995	.062	.063*	.080*	.185***	.151***	.158***	.120***
1996–2004	.118*	.089	.061	.239***	.153**	.159**	.158**
Health status (ref.: *not good/bad*)							
good	.021	.027	.024	.047*	.023	.046	.008
very good/excellent	.015	.022	.003	.027	.080**	.019	.070*
Import. of healthy diet (ref: *not important*)							
neutral	.136***	.055*	.080*	.044	.097**	.055*	.117***
important	.342***	.169***	.269***	.173***	.268***	.214***	.308***
Spirituality (ref: *not spiritual*)							
neutral	.006	.105***	.030	.109***	.035	.063*	.007
spiritual	.078**	.107***	.106***	.126***	.089***	.091***	.044
Religion (Ref.: *Christian*)							
non-Christian	.014	.012	.162**	.053	.081	.110*	.154**
no rel. affiliation	.038*	.012	.011	.014	.012	.013	.012
N	2523	2523	2523	2523	2523	2523	2523

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: recomm. recommendations, pb plant-based, s.markets supermarkets, net equ. income net equivalized household income, rel. religious; also controlling for gender: diverse, migration background, marital status, social origin, urban vs. rural; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

4.1. Robustness checks

To strengthen our results, we repeated the analyses using only respondents who self-identified as omnivores, excluding respondents who described themselves as omnivores but with a reduced meat consumption. Previous research shows that omnivores and vegetarians differ in many characteristics (Brunin et al., 2022; Cramer et al., 2017; Holler et al., 2021; Lehto et al., 2022) and the same is true for omnivores who do not restrict their diet and those who reduce their meat consumption (Dagevos, 2021; Kemper et al., 2023; Malek & Umberger, 2021), which in turn may influence our results. For overall willingness to change to a more plant-based diet, we no longer find differences between men and women (see table A2 in the appendix). Women are overrepresented in the 'omnivorous but reduced meat consumption' category (61% compared to 52% in the full sample), and the women in this category seem to drive the gender difference in the overall willingness. Otherwise, no substantial differences in the results appear.

Analyzing the willingness for the individual determinants, there are very few differences in the results (see table A3 in the appendix). The differences in willingness to change diet if prices for plant-based products were lower by household income are less pronounced. Only the highest income group rates this determinant significantly lower than the reference group. This might be due to fewer cases in each income category. For gender and birth cohorts, the overall patterns stay the same, while coefficients vary slightly. However, there are some differences in the relative evaluations of the individual determinants (see table A4 in the appendix). We do not find the gender difference in the evaluation of doctors' recommendations when only analyzing

Table 4
Linear regression models of the relative evaluation of each determinant influencing dietary choices.

	doctor's recomm.	recomm. from scientists and politicians	pb options at the cafeteria	pb diet in social network	lower prices for pb products	people with pb diet in society	pb options at s.markets and restaurants
Level of education (ref.: *low*)							
intermediate	.037	.009	.039*	.024	.005	.037**	.019
high	.018	.039**	.035*	.036**	.011	.046***	.022
Net equ. income (ref.: *up to €1000*)							
€1001–1500	.020	.009	.039*	.006	.019	.002	.028
€1501–2000	.011	.023	.055**	.012	.012	.003	.046**
€2001–2500	.035	.002	.063**	.005	.057**	.007	.041*
more than €2500	.057*	.011	.073**	.008	.071**	.011	.029
missing	.039	.009	.097	.046	.070	.020	.140*
Employment status (ref.: *retired*)							
full time	.012	.022	.029	.006	.012	.007	.006
part time	.008	.036	.059**	.018	.003	.010	.010
in school/training	.019	.012	.076*	.025	.004	.001	.014
unemployed	.021	.043	.052	.021	.072	.022	.018
not in workforce/parental leave	.044	.035	.049	.009	.015	.016	.039
Gender (Ref.: *female*)							
male	.042**	.064***	.047***	.012	.030*	.012	.053***
Birth cohort (ref.: *1947–1964*)							
1965–1979	.065**	.017	.006	.018	.050**	.000	.007
1980–1995	.111***	.043*	.014	.056***	.059**	.020	.034
1996–2004	.104**	.035	.026	.069**	.040	.014	.042
Health status (ref.: *not good/bad*)							
good	.006	.005	.009	.029*	.037*	.025*	.025
very good/excellent	.008	.029	.010	.036**	.063***	.027	.046**
Import. of healthy diet (ref: *not important*)							
neutral	.005	.001	.011	.024	.014	.014	.007
important	.000	.020	.009	.030	.015	.012	.037*
Spirituality (ref: *not spiritual*)							
neutral	.047*	.047***	.015	.037**	.014	.014	.022
spiritual	.021	.004	.028	.021	.001	.001	.027*
Religion (Ref.: *Christian*)							
non-Christian	.100*	.075*	.041	.014	.009	.068*	.090**
no rel. affiliation	.022	.009	.003	.012	.023	.017	.016
N	2523	2523	2523	2523	2523	2523	2523
R^2	.040	.041	.038	.032	.042	.024	.038

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: recomm. recommendations, pb plant-based, s.markets supermarkets, net equ. income net equivalized household income, rel. religious; also controlling for gender: diverse, migration background, marital status, social origin, urban vs. rural; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

omnivorous respondents. This difference seems to originate in the lower evaluation of doctors' recommendations by omnivorous women with a reduced meat intake. Within the birth cohorts, only millennials see doctors' recommendations as significantly less important for their diet than the reference group. This difference may be due to fewer cases especially in the youngest birth cohort. Similarly, there is no difference in the evaluation of recommendations from scientists and politicians by birth cohort. However, we find that employment status relates to the evaluation of recommendations from scientists and politicians, with all categories but students rating this determinant significantly lower than retired respondents (reference group). Among retired respondents, 85% are from the baby boomer generation, which might explain the lack of differences by birth cohort. Again, we find no difference in the relative importance of lower prices by household income. Overall, there are fewer sociodemographic differences in the importance of the individual determinants when limiting the sample to omnivore respondents. This may be a statistical artefact or reflect that omnivorous respondents are more homogenous in their willingness to change to a more plant-based diet than when including those omnivorous respondents with reduced meat consumption.

5. Discussion

Reducing the consumption of meat and animal products in general by promoting plant-based diets is a key strategy to decrease CO_2 emissions and thereby combat climate change and global warming. It can

also improve general health and decrease the risk of many serious diseases. Therefore, we focus on the question of how the willingness to change to a more plant-based diet varies between sociodemographic groups and which determinants to motivate dietary change are promising in which subpopulations. We find that individuals with high levels of education, women, and the millennial and gen Z cohorts have a high willingness to adopt a more plant-based diet and may be swayed to change their dietary habits. Conversely, those with low to intermediate levels of education, men, and the baby boomer cohort may prove less amenable to dietary change. The findings are consistent with our expectations derived from the theoretical context. However, contrary to our assumptions, health status and religion do not impact willingness. Further, our results show that doctors' recommendations, lower prices for plant-based foods, and more plant-based options in workplace cafeterias, supermarkets, and restaurants are the most promising determinants for facilitating a more plant-based diet. In general, the proportion of contemporaries who eat a plant-based diet and recommendations from scientists and politicians are less important in influencing respondents' dietary choices, which is also in line with our expectations. Moreover, we identify which subpopulations can be reached by which determinants. Doctors' recommendations – as the most promising determinant overall – receive the most favorable ratings regarding willingness for dietary change, while our subgroup analysis shows that this determinant may be particularly likely to reach men and the baby boomer cohort.

We have mentioned the dual benefits of a plant-based diet for the environment and for personal health. For the environment, it does not matter how dietary habits are distributed in society, as long as the overall damage to nature due to excessive meat consumption decreases. But with regard to the impact of dietary change on individual health, it is important to consider the socioeconomic distribution of current dietary habits and the effect of potential changes on this distribution. This is important because dietary habits, as one of many factors, contribute to overall health inequalities, which may be exacerbated further by increasing environmental problems, and their reduction is a key public health concern, alongside the environment and the average health status of a population.

Our analysis also allows us to draw conclusions about the potential impact of dietary changes on health inequalities between social groups. While some of the determinants we analyzed were rated more favorably by social groups with a high willingness to change to a more plant-based diet in general, others appealed more to groups with a low overall willingness. On the one hand, focusing on the former has the potential to increase healthy and sustainable diets in general but could also widen the gap between social groups and thus increase dietary inequalities. For example, the highly educated have a higher willingness to change their diet than other educational subgroups, and they are especially receptive to plant-based options in their workplace cafeterias and to recommendations from scientists and politicians. Therefore, these measures may increase differences in dietary choices between educational groups. On the other hand, determinants that appeal to groups with low overall willingness may reduce dietary inequalities but may not quickly decrease consumption of animal products in general. For example, doctors' recommendations appeal particularly to men and the baby boomer cohort, hence potentially reducing the gap in plant-based diets between men and women and between younger and older birth cohorts. Other determinants that may reduce dietary health inequalities include recommendations from scientists and politicians, which are important for men and older birth cohorts; lower prices for plant-based products, which are particularly relevant for low-income households; and an increasing number of people in society who adopt a plant-based diet, which specifically affects the willingness for dietary change of people with low to intermediate levels of education. Future research should focus more on the differing effects of different barriers and determinants by socioeconomic and demographic characteristics because they may influence social and health inequalities which is also reflected in current debates about the heterogenous effects of interventions and nudges that offer unique perspectives in behavioral research (Bryan et al., 2021).

Our finding that doctors' recommendations have the greatest potential to increase plant-based diets among currently omnivorous people is consistent with research that highlights the importance of health as a motivation for plant-based diets (Rosenfeld, 2018; Ruby, 2012). However, there is a lack of studies focusing on the effects of doctors' recommendations on change towards a more plant-based diet, particularly with experimental designs. Most of the related studies assess patients' compliance with nutritional advice for specific groups such as people with lifestyle-related chronic diseases (i.e., Ball et al., 2013), or for specific behaviors such as infant feeding (i.e., Chouraqui et al., 2019). There is evidence that individuals prefer to receive nutritional information from their general practitioners because they consider them trustworthy and familiar (Ball et al., 2014). Therefore, we need more studies that focus on the specific circumstances that make doctors' recommendations successful in encouraging omnivores to switch to more plant-based diets on a large scale. Simultaneously, we need more studies that further our understanding of the barriers and challenges that doctors face regarding nutritional advice for their patients (Adamski et al., 2018).

According to our results, the availability of plant-based foods and food infrastructure are also an important determinant of dietary change. Previous research provides some evidence that price-related interventions reduce inequalities in healthy diets (McGill et al., 2015); however, more research is needed. By phrasing the question to ask whether the respondents would change to a more plant-based diet if it were cheaper, we capture their general perception of cost as a barrier. However, there is evidence that a meat-free diet is cheaper than a diet with meat (Lusk & Norwood, 2016; Pais et al., 2022). Experimental studies provide first estimates of how much cheaper plant-based alternatives would have to be compared to meat for consumers to buy them (Carlsson et al., 2022; Jahn et al., 2024; Tonsor et al., 2023; van Loo et al., 2020). Future research may differentiate between different kinds of plant-based foods, such as processed meat alternatives and natural ingredients like legumes as they vary in price and other qualities that may be relevant for dietary behavior.

Much of the experimental research focusing on plant-based options in specific settings, such as cafeterias or supermarkets, mostly targets specific subpopulations, such as the highly educated or employees, risking the exacerbation of dietary health inequalities (Bianchi et al., 2018; Harguess et al., 2020; Hartmann-Boyce et al., 2018; Nielsen et al., 2017; Taufik et al., 2019). For example, many experimental studies take place in university cafeterias (i.e., Rosenfeld et al., 2022; Garnett et al., 2019, 2021; Kurz, 2018; Visschers & Siegrist, 2015) and promote plant-based diets to the highly educated, targeting a group with high willingness. A scoping review of literature on nudges shows that the majority of studies used a specific setting with a convenience sample (Szaszi et al., 2018). However, intervention studies conducted in multiple diverse settings show that effects vary by socioeconomic status of the costumers, with effects often greater in areas with lower socioeconomic status and lower consumption of plant-based products before the intervention (Luick et al., 2024; Piernas et al., 2021; Trewern et al., 2022). Future experimental studies concerning food environment and prices should investigate differences in their success in changing dietary behavior for different subpopulations and should not be confined to single stores or restaurants if possible.

Respondents in our study rated the impact on diet of the proportion of their contemporaries eating plant-based diets in their own networks and in society in general as low. This is at odds with the finding that living with people who eat meat and not knowing people who eat a plant-based diet are significant barriers for omnivores to eating a more plant-based diet (Lea et al., 2006; Lea & Worsley, 2003; Rosenfeld, 2018) and that having vegetarians among one's family and friends and getting support from one's social network are crucial for dietary change (Lund & Halkier, 2024; Vandermoere et al., 2019). If more people ate

plant-based diets, this might eventually shift dietary norms and make meat-eaters the exception, which could lead to their stigmatization. Studies find that anticipated stigma can be a barrier to dietary change (Markowski & Roxburgh, 2019). However, other studies find that anticipated stigma is a less important barrier than health and taste concerns when considering switching to a vegetarian diet (Rosenfeld & Tomiyama, 2020). Gifford et al. (2024) find a negative correlation between social norms and the intention to move toward a plant-based diet. Perhaps the impact of peer pressure is harder to assess for people who conform to a norm, so they perceive social norms and their influence as less relevant to their decision making. While Severijns et al. (2023) show that social norms did not impact animal protein consumption, social contacts influenced diet through attitudes, information, and perceived behavioral control. However, respondents may not anticipate these indirect effects of their peers on their diet choices.

Respondents report the lowest willingness for recommendations from scientists and politicians. While there is evidence that health communication campaigns about nutrition can be successful (Hornik & Kelly, 2007; Snyder, 2007), our results encourage scientific evaluations of their effects, especially considering the high costs of these interventions. Since our results indicate that these recommendations can particularly reach men and older birth cohorts, we advocate further experimental research into the different effects of interventions by gender and age. Also, in the German case, there is a strong connection between scientific and political advocacy for dietary behavior (Bundesministerium für Ernährung und Landwirtschaft, 2024). However, future research should analyze scientists' and politicians' recommendations separately, as studies show that some political actors deny scientific evidence (Hornsey & Lewandowsky, 2022).

For our analyses, we chose different covariates to highlight the associations between the willingness to change to a more plant-based diet and its determinants on the one hand, and different socioeconomic and demographic variables on the other hand. However, we decided not to present results concerning the political preferences of the respondents and their willingness for dietary change because theoretical and causal links between the two concepts are complex and the inclusion of political preferences in the models did not align with our research questions. While our data includes information on political preferences, the addition of this variable does not change the results we reported. Still, the associations between political preferences and dietary attitudes in our data were in line with recent research showing that preference for environmentally conscious parties correlates with greater willingness to eat more plant base, and preference for right-wing parties is associated with lower willingness (i.e., de Boer & Aiking, 2022; Milfont et al., 2021; Hielkema & Lund, 2021).

While our study makes important contributions to existing literature on the transition to plant-based diets, it is not without limitations. First, the data we use is cross-sectional, and while we can identify subpopulations that are willing to change to a more plant-based diet, we are not able to analyze causal pathways that lead to differences in the willingness and perception of determinants dietary change. Second, although our data stems from an online access panel with quota sampling, we do not expect this to affect our results concerning who is willing to change their diet and how different determinants are perceived. However, descriptive results based on the share of omnivorous and plant-based diets and the distribution of willingness to change to a more plant-based diet in our sample must be interpreted carefully. Nevertheless, the share of omnivores in our study is comparable to existing research using representative data for Germany (Bundesministerium für Ernährung und Landwirtschaft, 2022; Mensink et al., 2016). Future research should employ longitudinal data with probability sampling to assess how both the willingness to change dietary behavior and the perception of determinants vary over time, and what affects these changes.

Third, medical experts designed the questionnaire in an iterative process in cooperation with a wider circle of academic experts. However, the design process did not include pretests with non-academic participants. Fourth, our questionnaire assessed willingness to change to a more plant-based diet based only on the specific determinants mentioned here. Hence, willingness and the determinants are conceptually intertwined, and we were not able to analyze them separately. Future studies would be advised to include a general rating on respondents' willingness to change their dietary behavior, independent of determinants, in order to establish a baseline estimate of willingness regardless of specific incentives and barriers. The seven determinants analyzed in this study are not exhaustive, and future research can include other barriers such as a perceived lack of knowledge regarding how to prepare plant-based meals. Also, respondents only received a short description of what plant-based diet means. Therefore, interpretations of the specifics of a plant-based diet may be different for respondents. Similarly, respondents self-identified their current diet, and it was not measured through actual dietary behavior. Research shows that some people who identify as vegetarian may still consume meat at least occasionally (Ruby, 2012), so there may be a disconnect between dietary behavior and identity.

Fifth, the rather small R^2 of our analyses also hints to the fact that there might be other covariates that are crucial for people's decision to switch to a more plant-based diet. We used sociodemographic and socioeconomic variables, as well as variables concerning health, spirituality, and religion for our analyses to investigate how these more traditional covariates relate to diet. Future research could investigate other covariates such as different health behaviors. Lastly, the evaluations of the determinants of adopting a more plant-based diet in our study are hypothetical. We do not know if the suggested changes will actually influence respondents' behavior in the way they indicated. Therefore, we propose areas in which future studies, particularly with experimental designs, may generate further knowledge on how to promote plant-based diets in society.

Our results demonstrate that individuals differ in their willingness to change to a more plant-based diet and that motives for dietary change will have differing effects depending on individuals' socioeconomic and sociodemographic backgrounds. Future studies should further investigate which determinants and interventions have the greatest potential to sway people to change to a more plant-based diet and which ones will particularly affect subpopulations with a low willingness, both to promote sustainable eating behaviors and reduce dietary health inequalities. Future studies should also focus more on the factors that help maintain a plant-based diet once it has been adopted, so that dietary changes are persistent.

CRediT authorship contribution statement

Judith Lehmann: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Miriam Trübner:** Writing – review & editing, Methodology, Conceptualization. **Alexander Patzina:** Writing – review & editing, Methodology. **Michael Jeitler:** Writing – review & editing, Project administration, Investigation, Funding acquisition. **Rasmus Hoffmann:** Writing – review & editing, Supervision, Project administration, Funding acquisition. **Christian S. Kessler:** Writing – review & editing, Supervision, Project administration, Investigation, Funding acquisition.

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Ethics statement

The study involving humans was approved by Charité University ethics committee (registered with ClinicalTrails.gov NCT05530720). The study was conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Declaration of competing interest

MT reports grants from the Karl and Veronica Carstens Foundation. MJ reports grants from the Karl and Veronica Carstens Foundation. CK reports grants from the Karl and Veronica Carstens Foundation for conducting this study. He is a member of the scientific advisory board of the company Bruno Zimmer, board member of the German Medical Doctors' Association for Ayurveda-Medicine (DÄGAM e.V.) and receives honoraria for lecturing Ayurveda at Sonne und Mond, Berlin. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix

Table A1
Module on individuals' willingness to change to a plant-based diet due to different determinants as presented in the questionnaire and the English translation

German version	**Würden Sie sich vermehrt pflanzlich ernähren, wenn vor allem …**	Trifft voll und ganz zu	Trifft eher zu	Trifft eher nicht zu	Trifft überhaupt nicht zu	Weiβ nicht
	Ihr(e) Arzt/Ärztin es Ihnen empfehlen würde?	O	O	O	O	O
	Wissenschaft und Politik es gesamtgesellschaftlich empfehlen würde?	O	O	O	O	O
	es in der Kantine/Mensa Ihrer Arbeitsstelle mehr leckere pflanzliche Gerichte geben würde?	O	O	O	O	O
	sich in Ihrer Umgebung mehr Leute pflanzlich ernähren würden?	O	O	O	O	O
	hochwertige pflanzliche Lebensmittel billiger wären?	O	O	O	O	O
	eine pflanzliche Ernährungsweise gesellschaftlich verbreiteter wäre?	O	O	O	O	O
	es bessere Angebote in Supermärkten und Gaststätten geben würde?	O	O	O	O	O
English version	**Would you eat more plant based if in particular …**	Applies fully	Quite applicable	Not really applicable	Does not apply at all	I don't know
	your doctor would recommend it to you?	O	O	O	O	O
	scientists and politicians would recommend it for society as a whole?	O	O	O	O	O
	there would be more delicious plant-based dishes in the canteen at your workplace?	O	O	O	O	O
	more people around you would eat a plant-based diet?	O	O	O	O	O
	high-quality plant-based foods would be cheaper?	O	O	O	O	O
	a plant-based diet would be more common in society?	O	O	O	O	O
	there would be better options in supermarkets and restaurants?	O	O	O	O	O

Table A2
Multinomial logistic regression of the willingness to change to a more plant-based diet (AMEs) only for omnivorous respondents

	Model 1			Model 2		
	Low willingness	Moderate willingness	High willingness	Low willingness	Moderate willingness	High willingness
Level of educ. (ref.: *low*)						
intermediate	.005	.0231	.018	.004	.023	.019
high	.090**	.0717**	.019	.072*	.061*	.011
Net equivalent income (ref.: *up to €1000*)						
€1001–1500	.071*	.060	.012	.064	.058	.006
€1501–2000	.047	.057	.009	.050	.057	.007
€2001–2500	.054	.077*	.023	.047	.070	.023
more than €2500	.021	.042	.021	.021	.037	.015
missing	.078	.015	.063	.036	.017	.053
Employment status (ref.: *retired*)						
full time	.059	.039	.020	.066	.047	.019
part time	.048	.039	.010	.052	.043	.009
in school/training	.135	.035	.100	.138	.053	.085
unemployed	.104	.111	.007	.106	.116	.010
not in the workforce/parental leave	.041	.046	.004	.054	.055	.002

(*continued on next page*)

Table A2 (*continued*)

	Model 1			Model 2		
	Low willingness	Moderate willingness	High willingness	Low willingness	Moderate willingness	High willingness
Gender (ref.: *female*)						
male	.028	.016	.012	.000	.002	.002
Birth cohort (ref.: *1947–1964*)						
1965–1979	.045	.009	.036	.052	.016	.036
1980–1995	.134***	.065	.069**	.151***	.078*	.073**
1996–2004	.218***	.200***	.019	.219***	.200***	.019
Health status (ref.: *not good/bad*)						
good				.014	.004	.010
very good/excellent				.046	.036	.010
Import. of healthy diet (ref: not important)						
Neutral				.139***	.107***	.032
important				.291***	.185***	.105***
Spirituality (ref: not spiritual)						
neutral				.097***	.003	.095***
spiritual				.094**	.016	.078***
Religion (ref.: *Christian)*						
non-Christian				.034	.108	.074
no religious affiliation				.031	.025	.006
N		2151			2151	

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: net equ. income net equivalized household income; also controlling for gender: diverse, migration background, marital status, social origin, urban vs. rural; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

Table A3
Logistic regression models of the willingness to change to a more plant-based diet, by determinant influencing dietary choices (AMEs) only for omnivorous respondents

	doctor's recomm.	recomm. from scientists and politicians	pb options at the cafeteria	pb diet in social network	lower prices for pb products	people with pb diet in society	pb options at s.markets and restaurants
Level of education (ref.: *low*)							
Intermediate	.053	.001	.041	.013	.015	.057*	.004
high	.115***	.051*	.086**	.020	.109***	.027	.065*
Net equ. income (ref.: *up to €1000*)							
€1001–1500	.046	.003	.048	.016	.026	.023	.000
€1501–2000	.003	.040	.004	.011	.050	.015	.029
€2001–2500	.034	.028	.032	.006	.068	.006	.000
more than €2500	.052	.040	.028	.031	.108*	.042	.049
missing	.058	.100	.008	.097	.130	.004	.249*
Employment status (ref.: *retired*)							
full time	.061	.035	.113**	.059	.020	.053	.061
part time	.037	.025	.110*	.003	.022	.014	.065
in school/training	.082	.093	.240**	.025	.114	.069	.144
unemployed	.107	.023	.259***	.002	.100	.042	.161*
not in workforce/parental leave	.023	.017	.110	.030	.049	.008	.159**
Gender (Ref.: *female*)							
male	.008	.056**	.056*	.017	.036	.019	.057*
Birth cohort (ref.: *1947–1964*)							
1965–1979	.041	.017	.024	.046	.105**	.056*	.029
1980–1995	.077	.076*	.079	.173***	.200***	.149***	.135***
1996–2004	.164*	.056	.090	.194***	.183**	.106	.167*
Health status (ref.: *not good/bad*)							
good	.060	.038	.038	.008	.002	.018	.002
very good/excellent	.003	.013	.024	.024	.086*	.008	.082*
Import. of healthy diet (ref: not important)							
neutral	.131***	.038	.073*	.025	.072*	.043	.092**
important	.300***	.114***	.222***	.125***	.219***	.167***	.255***
Spirituality (ref: not spiritual)							
neutral	.029	.147***	.069*	.112***	.053	.077**	.016
spiritual	.103**	.102***	.153***	.108***	.086**	.076**	.067*
Religion (Ref.: *Christian*)							
non-Christian	.096	.077*	.109	.004	.036	.018	.122
no rel. affiliation	.055*	.013	.020	.020	.011	.017	.011
N	1658	1658	1658	1658	1658	1658	1658

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: recomm. recommendations, pb plant-based, s.markets supermarkets, net equ. income net equivalized household income, rel. religious; also controlling for gender: diverse, migration background, marital status, social origin, urban vs. rural; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

Table A4
Linear regression models of the relative evaluation of each determinant influencing dietary choices only for omnivorous respondents

	doctor's recomm.	recomm. from scientists and politicians	pb options at the cafeteria	pb diet in social network	lower prices for pb products	people with pb diet in society	pb options at s. markets and restaurants
Level of education (ref.: *low*)							
intermediate	.034	.009	.033	.021	.003	.040**	.019
high	.017	.037*	.022	.029	.028	.051**	.023
Net equ. income (ref.: *up to €1000*)							
€1001–1500	.010	.014	.038	.014	.009	.014	.016
€1501–2000	.006	.032	.061*	.000	.001	.007	.029
€2001–2500	.025	.019	.051*	.011	.033	.005	.019
more than €2500	.078*	.032	.089**	.028	.048	.032	.027
missing	.091	.004	.130	.009	.043	.007	.181*
Employment status (ref.: *retired*)							
full time	.002	.056**	.047*	.005	.010	.007	.020
part time	.011	.075**	.053*	.019	.025	.010	.036
in school/training	.068	.020	.108*	.065	.018	.013	.041
unemployed	.047	.096*	.089*	.066	.089*	.050	.081*
not in workforce/parental leave	.062	.077**	.058	.035	.033	.005	.088**
Gender (Ref.: *female*)							
male	.036	.065***	.035*	.007	.019	.007	.047***
Birth cohort (ref.: *1947–1964*)							
1965–1979	.042	.004	.007	.019	.041	.005	.001
1980–1995	.108***	.034	.022	.050**	.064*	.019	.032
1996–2004	.064	.055	.005	.054	.035	.001	.034
Health status (ref.: *not good/bad*)							
good	.015	.006	.004	.018	.018	.000	.024
very good/excellent	.028	.027	.003	.026	.046*	.007	.044*
Import. of healthy diet (ref: not important)							
neutral	.012	.004	.014	.023	.009	.013	.004
important	.017	.031	.005	.035*	.017	.008	.034
Spirituality (ref: not spiritual)							
neutral	.059*	.060***	.004	.036*	.025	.006	.022
spiritual	.017	.005	.052**	.017	.008	.015	.023
Religion (Ref.: *Christian*)							
non-Christian	.104	.101*	.057	.004	.005	.041	.117**
no rel. affiliation	.035	.015	.011	.006	.006	.014	.023
N	1658	1658	1658	1658	1658	1658	1658
R^2	.047	.062	.048	.028	.034	.027	.046

Note. Own calculations, data from a survey on the acceptance and use of TCIM in Germany; abbreviations: recomm. recommendations, pb plant-based, s.markets supermarkets, net equ. income net equivalized household income, rel. religious; also controlling for gender: diverse, migration background, marital status; *** significant at $p < 0.001$, ** significant at $p < 0.01$, * significant at $p < 0.05$.

Data availability

The data that support the findings of this study are available from the corresponding author, JL, upon reasonable request.

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