



What percentage of people adhere to vegetarian and vegan diets in Germany?

An exploration of the research situation

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Abstract

Studies reporting on the percentage of people adhering to vegetarian and vegan diets in Germany have produced figures that differ markedly in some cases. To investigate the reasons for this, relevant representative studies in adults conducted in the period from 2005–2022 were analyzed. In the 38 studies identified, the percentages ranged from 0.96% to 11.2% for people adhering to a vegetarian diet and from 0% to 3.2% for people adhering to a vegan diet, with an increasing trend over time. Higher percentages of people adhering to a vegetarian diet were found in particular when data were not accurately distinguished from people adhering to a pescetarian or flexitarian diet. In order to ensure that data are robust and comparable, future studies should be designed in such a way that diets are assessed in an accurate manner using clearly defined response options, and using control questions on consumption to allow the correction of self-assignments to vegetarian diets.

Keywords: vegetarian diet, vegan diet, pescetarian diet, flexitarian diet, percentage of people adhering to plant-based diets in Germany, plant-based

Introduction

Plant-based diets are widely recommended for health and environmental, but also for social and economic reasons, and are increasingly in demand, especially in the context of the climate debate [1–4]. For example, the report of the International Panel on Climate Change [2] identifies a balanced diet consisting mainly of plant-based foods as very promising to mitigate climate change. Plant-based diets cover a broad spectrum, ranging from diets that include occasional consumption of meat and fish (often referred to as flexitarian), to diets that avoid meat products (pescetarian), diets that avoid meat and fish products (vegetarian), and diets that avoid all animal-based products (vegan; a form of vegetarian diet) [5, 6]. To date, there are no legally binding threshold values for when a diet should be classified as flexitarian or generally plant-based.

The above diets are associated with different health and environmental impacts due to the differences in food choice patterns [7]. Studies reporting on the percentage of people adhering to vegetarian and vegan diets in Germany have produced figures that differ markedly in some cases. This article aims to provide an overview of the relevant representative studies conducted since 2005 and to identify the background to possible differences.

Method

Search strategy and study selection

Studies were to be identified in which the percentage of people adhering to a vegetarian or vegan diet in Germany was determined in a representative manner. The year 2005 was selected as the start of the study period as this was the year in which the German National

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Scientific databases, websites of scientific institutions, scientific journals
PubMed, Scopus, Web of Science (<i>search by title, abstract and keywords</i>)
• (prevalence OR popularity) AND (vegetarian OR vegan OR plant-based) AND Germany
• (vegetarian OR vegan OR plant-based) AND diet AND Germany
• (use OR consumption OR purchase OR intake) AND (meat substitute OR plant-based meat substitute OR plant-based protein OR plant-based meat alternative) AND Germany
Open Agrar, Robert Koch Institute (RKI), Federal Research Institute of Nutrition and Food (Max Rubner-Institut [MRI]), professional associations (German Nutrition Society [DGE], ProVeg), ERNÄHRUNGS UMSCHAU (<i>search by keywords</i>)
• vegetarianism; veganism; vegetarian/vegan diet; frequency of vegetarian/vegan; flexitarian; meat substitutes/meat substitute products
Internet search
Google, Google Scholar (<i>first three pages of results taken into account in each case</i>)
• prevalence of vegetarian/vegan diets in Germany
• study on vegetarian/vegan diet in Germany
• German Vegetarian Society (<i>Deutsche Vegetarische Gesellschaft</i>)
• [market research institute] frequency of vegetarian/vegan (Germany)
• frequency of vegetarian/vegan
• [market research institute] vegetarian/vegan diet
• frequency of consumption/use of meat substitute products
• purchase of plant-based protein or meat substitutes
Statista (<i>search by keywords</i>)
• (percentage) vegetarian/vegan; vegetarian/vegan diet; (consumption) meat substitutes/meat substitute products; soy products; alternative milk products

Tab. 1: Databases and websites included in the search for studies on the percentage of people adhering to a vegetarian or vegan diet in Germany with the search terms used in each case

Nutrition Survey (*Nationale Verzehrsstudie, NVS*) II – the last large-scale survey with data on this topic – started.

A systematic literature search was conducted in scientific databases, supplemented by a systematic Internet search. The search terms were adjusted for the database in question in each case (♦ Table 1).

Search results were then selected based on a set of inclusion and exclusion criteria (♦ Table 2). In the case of Statista, the primary sources were checked using Google or the websites of the market research institutes.

Inclusion criteria
• data provided for the percentage of people adhering to a vegetarian or vegan diet
• representative of the adult population in Germany aged 18 and over, but if applicable also including adolescents (aged 14 and over)
• study conducted and/or published between 2005 and July 2022
Exclusion criteria
• no information on representativeness available or studies explicitly described as being non-representative
• percentages not reported for the population as a whole, but only separately by gender or by household

Tab. 2: Inclusion and exclusion criteria for studies on the percentage of people adhering to a vegetarian or vegan diet in Germany

Processing of the studies

In the present study, plant-based diets were categorized and differentiated from each other according to the definitions in ♦ Table 3.

The studies that were included were categorized as either cross-sectional studies (one-time data collection in a sample) or longitudinal studies (repeated data collection by the same institution with identical questions). The latter category included studies with a largely identical panel as well as those with a changing study population. If the questioning was changed significantly, the studies were then treated as cross-sectional studies. For each study, the reference point for assigning a percentage to a year was the data collection period, not the date of publication of the results. If data collection spanned several years (for example, the German National Nutrition Survey II lasted from 2005 to 2007), the most recent year of data collection was chosen (in the case of the German National Nutrition Survey II, this was 2007).

The percentages for each diet were put into relation with various factors characterizing the data collection procedure. The factors studied included:



	Designation	Definition
Plant-based diets	vegetarian	lacto-ovo vegetarian = avoidance of meat and meat products and of fish and fish products
		lacto vegetarian = avoidance of meat and meat products, fish and fish products, and egg and egg products
		ovo vegetarian = avoidance of meat and meat products, fish and fish products and milk and milk products
	vegan	avoidance of all types of animal-based foods
		<i>Although a vegan diet is a type of vegetarian diet, it will hereinafter be considered separately from a vegetarian diet according to the above-mentioned definition.</i>
	pescetarian	avoidance of meat and meat products but fish and fish products are consumed
	flexitarian	occasional consumption of meat and meat products and of fish and fish products
(quantities consumed/frequency not universally defined; often described as infrequent, low, or minimal consumption of meat [and fish])		

Tab. 3: Plant-based diets and their respective definitions, incl. an approach for distinguishing them from one another (modified according to [5, 6])

- the context of the data collection or the topic of the study: a distinction was made between studies with a direct thematic relation to nutrition/vegetarian diets or food and multi-topic studies with different areas of focus or industry analyses (collectively referred to as studies without a direct relation to nutrition)
- the institutional context/who was responsible for designing the study: a distinction was made between studies designed by institutions within the scientific community (e.g., scientific institutes) and studies designed by institutions outside the scientific community (market research institutes commissioned by non-governmental organizations [NGOs] or interest groups, or in-house design and realization)
- the data collection period
- the size of the study population: a distinction was made between studies with more than 3,000 respondents and studies with fewer than 3,000 respondents
- data on representativeness
- the age of the respondents: a distinction was made between studies including people aged 18 and over and studies including under 18 year olds (adolescents).
- the accuracy of the questions and response options used to assess the diets: a distinction was made between percentages derived from an accurate or inaccurate assessment (♦ Table 4)

Where the relevant data were available, the percentages were also stratified by age group and gender. The percentages are expressed to the same number of decimal places given in the respective publications.

A classification scheme (♦ Table 4) was devised to examine the potential relationship of the reported percentages with the heterogeneous questions and response options. A key question here was the extent to which the percentages of vegetarian and vegan diets were accurately distinguished from each other and from pescetarian and flexitarian diets during assessment. The studies were categorized using the classification scheme and the four-eyes principle.

If the wording of the questions and response options was not provided, the authors of the study were consulted. However, it was not possible to ascertain the wording in all cases. In these cases, it was assumed that the wording of the description in the publication largely corresponded to that of the questions and responses in the study.

Accurately assessed percentages of people adhering to vegetarian or vegan diets	At assessment, the percentages are accurately distinguished from each other and with respect to pescetarian and flexitarian diets. This is based on either: <ul style="list-style-type: none"> • definitions in accordance with ♦ Table 3^a or • where there are no definitions, based on response options that distinguish the different diets from each other (e.g., no definitions are given for the diets, but in addition to the vegetarian and vegan response options, flexitarian and pescetarian are also available as options)
Inaccurately assessed percentages of people adhering to vegetarian or vegan diets	At assessment, the percentages are inaccurately distinguished from each other or with respect to pescetarian and flexitarian diets. This is based on either: <ul style="list-style-type: none"> • definitions that differ from those in ♦ Table 3 (e.g., use of terms such as “predominantly”) or • no definitions and no response options that distinguish the different diets from each other are provided (e.g., vegetarian and vegan are not defined and pescetarian and flexitarian are not included as response options)

Tab. 4: Classification scheme for determining the accuracy with which the percentages of people adhering to a vegetarian or vegan diet were assessed based on the questions and response options in the studies investigated

^a Minimal deviations from the definition (e.g., not mentioning honey as a food that is avoided in a vegan diet) were disregarded, provided that the rest was consistent.



After applying the classification scheme, the second step was to check in which cases the percentages of vegetarian and vegan diets were aggregated under the category “vegetarian” instead of being published separately.

The percentages were recorded in an Excel spreadsheet together with the factors studied and the respective classification for each case. The spreadsheet was used to descriptively compare the percentages between studies with the same type of classification (accurate vs. inaccurate) or with the same quality of factor present (e.g., studies in which the topic was diet or vegetarian diets vs. studies with no direct relation to nutrition). To test for associations between the percentages and the factors

studied, a two-tailed t-test (or in the case of directional hypotheses, a one-tailed t-test) was performed for two independent samples using Excel (version 1808). In each case, the factors were dichotomized for this purpose (see above). For all results, a p-value of ≤ 0.05 was defined as statistically significant.

Results

The literature search yielded 27 studies on the percentage of people adhering to a vegetarian or vegan diet in Germany. 24 of these were cross-sectional studies and three were longitudinal studies with two, four, and eight data collection time points, respectively (♦ Table 5). The following results refer to the combined total of all of the above: 38 data collection time points in total. For the period

Year(s) of data collection	Published/commissioned by	Context of data collection; information about representativeness ^a	Number of study participants	Age span in years (mean) ^b	Wording of the respective question about diet ^c with regard to vegetarian and vegan diets, as well as response options regarding pescetarian and flexitarian diets (specified in parentheses) that are relevant for applying the classification scheme	Percentage ^{b, d} vegetarian	vegan
2005–2007	MRI [8–10]	German National Nutrition Survey II (NVS II); representative (German-speaking population; weighted for factors including region, gender, age and school-leaving qualification)	19,276	14–80	“Which of the following diets do you adhere to?” <ul style="list-style-type: none"> • “ovo-lacto-vegetarian diet, diet consists of plant-based foods, eggs and milk/milk products; • lacto-vegetarian diet, diet consists of plant-based foods and milk/milk products; • ovo-vegetarian diet, diet consists of plant-based foods and eggs; • diet composed exclusively of plants (vegan diet), contains no animal-based foods whatsoever (vegans). This also includes vegans who additionally abstain from honey; • (ovo-lacto-vegetarian diet with fish)” 	0.96% [11]	
2008–2011	Mensink et al. (RKI) [6]	national health monitoring (DEGS study); representative sample of the resident population	6,933	18–79	“Do you usually eat vegetarian?” <ul style="list-style-type: none"> • “yes” 	4.3%	
2013	Cordts et al. [12]	study on meat consumption; representative (age, gender, income and region of residence)	1,174	from 18	<i>(Wording could not be found)</i> “Based on questions about meat consumption, the study participants were divided into the groups [...] of ‘flexitarians’[...] and [...] vegetarians [...] including 3 vegans. [...] Among the vegetarians, around half eat meat.”	3.7% + pescetarian	
2010–2011	MRI [13]	longitudinal study NEMONIT (Panel of NVS II participants)	1,686 (2010/11)	18–80	“Which of the following diets do you adhere to?”; for definitions see NVS II <ul style="list-style-type: none"> • “ovo-lacto-vegetarian diet; • lacto-vegetarian diet; • ovo-vegetarian diet; • vegan diet; • (ovo-lacto-vegetarian diet with fish)” 	1.02% (2011)	
2012–2013			1,847 (2012/13)			1.92% (2013) [11]	
2012–2014	Lavallee et al. [14]	Bochum Optimism and Mental Health (BOOM) Study; representative (gender, age, education)	2,007	(51,95)	“Are you currently a vegetarian?” <ul style="list-style-type: none"> • “yes: no meat, no fish; • yes: vegan; • (yes: no meat but do eat fish)” 	6.4% + pescetarian	
2014	Pfeiler und Egloff [15]	multidisciplinary panel study (SOEP); representative of the entire German population	4,496	17–96 (51,84)	“Are you vegetarian or vegan?” <ul style="list-style-type: none"> • “Yes, I am a vegetarian; vegetarians are people who do not eat meat and also avoid fish.” • “Yes, I am vegan. Vegans do not eat any animal-based products.” 	2.45%	0.29%
2014	YouGov [16, 17]	industry analysis (food preferences and favorite brands for target group analysis); representative of the population	4,000	from 16	<i>Information from personal communication</i> [18]: “Based on your typical dietary habits, how would you most likely categorize your diet?” <ul style="list-style-type: none"> • “ovo-lacto-vegetarian (includes egg and milk products); • lacto-vegetarian (no egg, but includes milk products); • ovo-vegetarian (includes egg but no milk products); • ovo-lacto-pesco-vegetarian (includes fish, egg and milk products); • raw vegetarian; raw vegan; • vegan” control question “[...] how often meat [...] [or] [...] whether meat, fish, eggs or milk can be included [...].”	4.3%	0.7%



2015	Pfeiler und Egloff [15]	multidisciplinary panel study (SOEP); representative of the entire German population	5,125	17–96 (52,42)	“Do you eat a predominantly or exclusively vegetarian or vegan diet?” • “yes, vegetarian; • yes, vegan”	5.42%	0.55%
2015	<i>Verbraucherzentrale Bundesverband e. V. (vzbv)</i> [19]	opinions on food labeling; representative	1,003	from 14	(<i>Wording could not be found</i>) “They eat... • ...no meat, so they are vegetarian • ...no meat nor any animal-based products, so they are vegan • (...generally eat little meat and refrain from eating meat often)”	4%	1%
2015	Zühlsdorf et al. on behalf of the <i>Verbraucherzentrale Bundesverband e. V. (vzbv)</i> [20]	study on animal welfare; representative of the population	1,024	from 16 (46,74)	“People eat varying amounts of meat and meat products. Please specify which of the following answers best applies to you.” • “I am a vegetarian and I also do not eat fish; • I am a vegan and do not eat animal-based products at all; • (I eat very little meat and/or meat products; I do not eat meat or meat products, but I do eat fish)”	1.8%	0.9%
2015/2016	Luck-Sikorski et al. [21]	study on various aspects of health (orthorexia); representative (weighted for age, gender, region, education).	1,007	(50,6)	<i>Information from personal communication</i> [22]: “Now I would like to find out from you whether you eat a vegetarian, vegan or other specific diet” • “yes, vegetarian; • yes, vegan” “There were [...] no vegans in the sample (explicitly asked, none mentioned).”	5.9%	0%
2016	Pfeiler und Egloff [23]	multidisciplinary panel study (German SOEP); representative for private households and individuals in Germany	12,905	21–102 (56,21)	“Do you eat a predominantly vegetarian or vegan diet?” • “yes, vegetarian; • yes, vegan”	4.6%	0.56%
2016	Skopos, on behalf of the <i>Vegane Gesellschaft Deutschland e. V.</i> [24]	study on vegan diet; representative	1,000	none specification	<i>Information from personal communication</i> [25]: “How often do you eat the following foods?” including “meat, meat products; fish; other animal-based foods such as eggs or milk products” investigators assigned to categories • “vegetarian: No meat, no fish, but do consume gelatin and other animal-based foods [or no gelatin, but do consume other animal-based foods]; • vegans: No animal-based foods [...] [partly also no animal-based products used for purposes other than food]; • ([...] pescetarian)”	2.4%	1.6%
2018	Innofact [26]	multiclient study Veggie; representative of the population	1,019	18–69	“How would you describe your diet a year ago, and how would you describe it now?” • “Vegetarian: I consistently avoid meat, fish and poultry. • Vegan: I consistently avoid all animal-based products and eat only plant-based foods. • (partially vegetarian [...]; meat no, fish yes [...])”	6%	3%
2018	Ipsos [27]	study on the perception of brands (<i>Handelsmarkenmonitor</i>); representative (age, gender, federal state within Germany)	1,000	from 18	<i>Information from personal communication</i> [28]: “Vegetarian products means all products that do not contain any animal-based substances, with the exception of milk, eggs, honey, etc. Vegan products means those that do not contain any animal-based ingredients at all. First, please specify whether you agree or disagree with the following statements.” • “I eat a vegetarian diet; • I eat a vegan diet; • ([...] flexitarian)”	4%	2%
2018	Paslakis et al. (2020) [29]	study on physical and mental well-being; representative (age, gender, level of educational attainment)	2,449	18–91 (49,6)	“Have you been consciously eating a vegetarian diet for at least two weeks?” or “Have you been consciously eating a vegan diet for at least two weeks?” • “yes”; “Respondents were informed that vegetarian means abstaining from meat but consuming plants and milk, and vegan means abstaining from all foods of animal origin.”	5.4%	
2019	acatech (<i>Dt. Akademie der Technikwissenschaften</i>), <i>Körper-Stiftung</i> [30, 31]	<i>TechnikRadar Schwerpunkt Bioökonomie</i> (focus on bioeconomy); representative, population resident in Germany	2,006	from 16 (49,7)	“I’m going to read you some statements about food consumption. They are about eating or not eating meat and/or meat products. Please choose the statement that best applies to you” • “I eat a vegetarian diet; • I eat a vegan diet; • (I rarely eat meat/meat products)”	5.8%	1.0%
2019	Bryant, van Nek und Rolland [32]	study on diets and perceptions of cultured meat; representative (age, gender)	1,000	18–65	“[...] How would you describe yourself?” • “vegetarian (does not eat meat or fish/seafood, but does eat eggs and dairy products); • vegan (does not eat any meat, fish/seafood, milk or eggs); • (flexitarian [...]; pescetarian [...])”	4.6%	1.9%
2019	Michel, Hartmann und Siegrist [33]	study on topics including acceptance of meat and meat alternatives; gender-balanced (comparable with German population)	1,039	20–69 (45)	<i>Information from personal communication</i> [34]: “Which of the following terms best describes your diet?” • “vegetarian (I do not eat meat or fish); • vegan (I do not eat animal-based products at all); • (flexitarian [...]; pescetarian [...])”	3%	1.5%



2020	Appinio [35]	Study on Fast Moving Consumer Goods (FMCG); representative (age, gender)	2,000	16–65	“Which of the following types of diet best fits your current diet?” • “vegetarian; • vegan; • (flexitarian; pescetarian)”	6%	2%
2020	PHW-Gruppe [36]	“veggie study”; representative (weighted for region, age, gender).	1,003	18–75	Information from personal communication [37]: “Thinking about your own diet for a moment: Which of the following statements (best) applies to you?” • “I eat a “vegetarian” diet, i.e., I do not eat meat, fish or products made from meat or fish. • I eat a “vegan” diet, i.e., I do not eat any animal-based products – so no meat, no fish, no milk or milk products, no eggs, no gelatin, and no honey; • [...] “flexitarian” [...]”	8%	1%
2020	Veganz Group AG [38]	European nutrition report; representative (age, gender)	561	15–64	“What kind of diet do you eat?” • “vegetarian; • vegan; • (flexitarian; pescetarian)”	4.4%	3.2%
2018	Bundesministerium für Ernährung und Landwirtschaft (BMEL) [39–45]	annual nutrition reports; representative	1,000 and 1,001 respectively	from 14	“Do you eat a vegetarian diet, meaning you do not eat meat or fish or products made from them, such as sausage, but do eat products that come from live animals, such as eggs, dairy products and honey?” or “Do you eat a vegan diet, meaning you do not eat any animal-based products – i.e., no meat, no fish, no milk or milk products, no eggs, no gelatin, no honey (and no products made from any of these)?” • “yes”	6% (2018)	1% (2018)
2019/2020						7% (2022)	1% (2022)
2021							
2022							
2021	PHW-Gruppe [36]	“cultivated meat study”; representative (weighted for region, age, gender)	1,011	18–75	Information from personal communication [37]: “Thinking about your own diet for a moment: Which of the following statements (best) applies to you?” • I eat a “vegetarian” diet, which means that I do not eat meat or fish or products made from them; • I eat a “vegan” diet, which means that I do not eat any animal-based products – i.e., no meat, no fish, no milk or milk products, no eggs, no gelatin and no honey; • [...] “flexitarian” [...]”	5%	1%
2021	SPLENDID RESEARCH GmbH [46]	sustainable eating monitor, survey including current (environmental) attitudes, eating and shopping behavior; representative (age and gender-balanced)	1,440	18–69	Information from personal communication [47]: Investigators assigned respondents to a particular diet based on questions about their purchasing behavior with regard to certain food product groups, including meat and meat products, and about which food groups they never purchase. According to Splendid, “[...] [pescetarians] are not included in this cluster.”	11%	
seit 2015–2022	Institut für Demoskopie Allensbach [48–51]	annual multi-topic survey Allensbacher Markt- und Werbeträgeranalyse (AWA) [Allensbach Media Market Analysis]; German-speaking population resident in Germany in private households	25,140 (2015)	from 14	“On this list are various groups of people. In which case would you say overall: This could apply to me” • “vegetarians or people who mostly abstain from meat; • vegans or people who mostly abstain from animal-based products”	7.7% (2015)	1.2% (2015)
			23,015 (2022)			11.2% (2022)	2.2% (2022)
2022	Statista [52]	statista global consumer survey; representative (balanced for age, gender and region)	4,524	18–64	“Do you adhere to one or more of the following diets?” • “vegetarian (no meat and no fish); • vegan (no animal-based products at all); • (flexitarian [...]; pescetarian [...])”	6%	3%

Tab. 5: Overview of representative cross-sectional and longitudinal studies on the percentage of people adhering to a vegetarian or vegan diet in Germany (2005–2022)

^a Representativeness specified according to the wording of the publication; in some cases, minor changes were made for the sake of uniformity.

^b The percentages are expressed to the same number of decimal places given in the respective publications.

^c If it was not possible to find the wording of the questions, the quotation from the respective publication is given.

^d If vegetarian and vegan diets were asked about separately but only reported as an aggregated total, the columns are linked; if the percentage also includes the pescetarian diet, this is indicated accordingly. If only one value is given for the percentage of people adhering to a vegetarian diet, the percentage of people adhering to a vegan diet was not queried separately.

^e Here, longitudinal studies are limited to the first relevant study and the most recent one. For values from interim years see • Figure 1 and • Figure 2.

DEGS: study on adult health in Germany (*Studie zur Gesundheit Erwachsener in Deutschland*); MRI: Max Rubner-Institute (Federal Research Institute of Nutrition and Food); RKI: Robert Koch Institute; SOEP: Socio-Economic Panel

Color legend: box = longitudinal studies, percentage categorized as accurately assessed based on the classification scheme, percentage categorized as inaccurately assessed based on the classification scheme



from 2005 to 2017, 17 studies were identified and a further 21 studies for the period between 2018 and 2022.

There were studies designed by scientific institutions, market research institutes, companies, political bodies and non-governmental organizations (NGOs). Furthermore, the spectrum of studies included nutritional and health surveys (including those related to psychological factors) and surveys on opinions, attitudes or consumption habits (♦ Table 5). Out of all 38 studies, 15 were designed by institutions within the scientific community, and 22 were thematically related to nutrition/vegetarian diets or food. 15 of the studies had sample sizes of more than 3,000 participants. The German National Nutrition Survey II with almost 20,000 participants [9] and the *Allensbacher Markt- und Werbeträgeranalyse* (AWA) [Allensbach Media Market Analysis] with up to approx. 25,000 participants per year [48] were by far the largest studies. In 21 studies, adolescents were surveyed as well as adults. In these studies, the percentages of adolescents were included in the total percentages of diets. With regard to representativeness, one study reported being representative only for gender [33 and 34], and 15 studies reported at least gender and age, 5 of which also reported level of education [9, 13, 14, 29]. The remaining 22 studies were described as being representative/representative of the population, or similar, without further specifying the criteria (♦ Table 5).

The percentages of the population adhering to a vegetarian diet in the studies ranged from 0.96% to 11.2%, and the percentages of those adhering to a vegan diet ranged from 0% to 3.2% (♦ Table 5). A vegetarian diet was more common than a vegan diet. The percentage of people adhering to a vegetarian diet was at least twice that of a vegan diet in almost all studies in which the two diets were considered separately. In the first half of the period studied (2005–2014), it was particularly common for the vegetarian and vegan percentages to be aggregated.

Assessment of the diets

In 20 cases, the assessment of the percentages of people adhering to a vegetarian diet was classified as being *accurate* based on the given definition or the response options that distinguished these percentages from those for pescetarian, flexitarian, and vegan diets (hereinafter, these percentages will be referred to as *accurately assessed percentages*). Based on the classification scheme, assessment in the other 18 studies was judged to be *inaccurate*

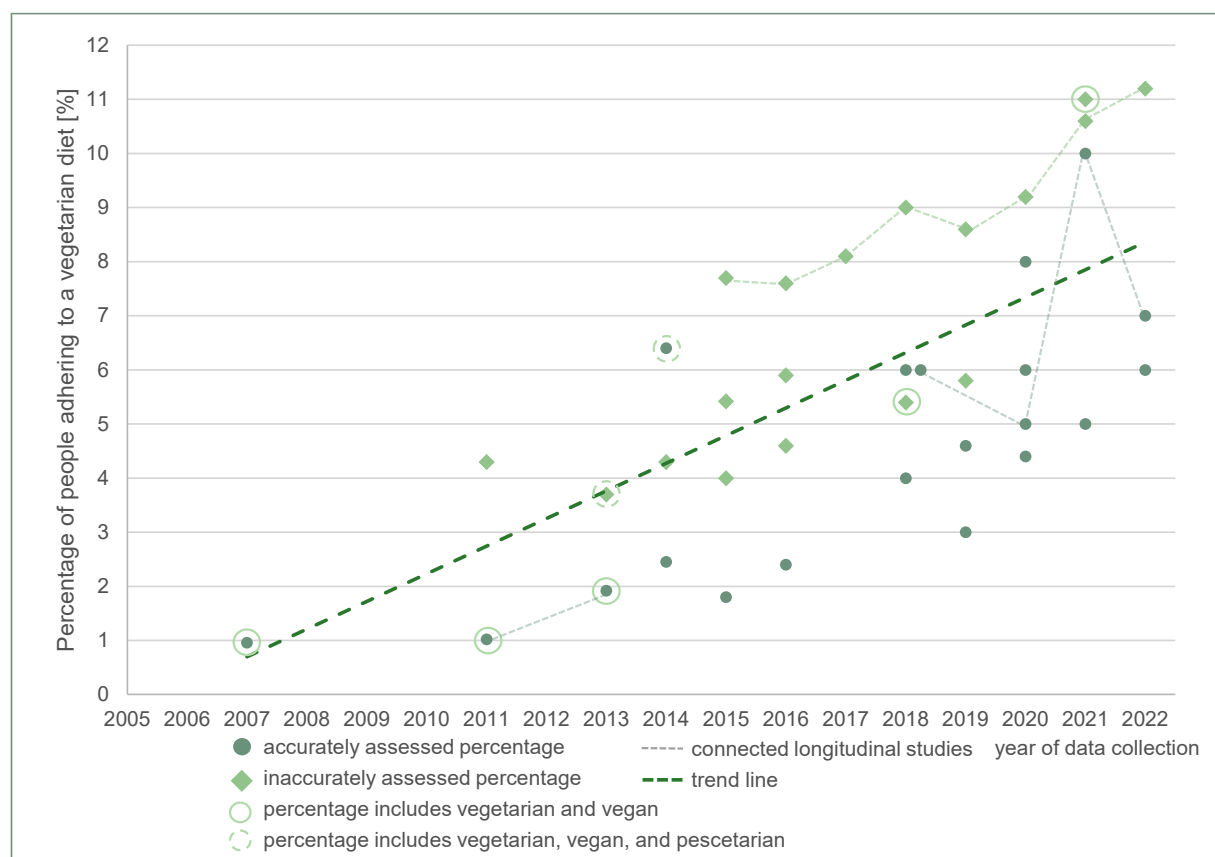


Fig. 1: Cross-sectional and longitudinal studies on the percentage of people adhering to a vegetarian diet in Germany from 2005 to 2022

Differentiated according to the accuracy of classification for the percentages compared to flexitarian and pescetarian diets and highlighting the studies in which percentages of people adhering to a vegetarian and vegan diet (and additionally pescetarian diet) were published as an aggregated total.

Trend line of mean values per year



(hereinafter, these percentages will be referred to as *inaccurately assessed percentages*). The accurately assessed percentages (●) were significantly lower ($p = 0.002$) and were in a lower range (0.96–10%) than the inaccurately assessed percentages (◆; 3.7–11.2%). The accurately assessed percentages were lower in almost every single year studied (◆ Table 5, ◆ Figure 1).

In 4 of the 20 studies with accurately assessed percentages [8, 13, 14] and in 3 of the 18 studies with inaccurately assessed percentages [12, 29, 46], the percentages were published as an aggregated total. This means that in these cases, vegans, and in two cases [12, 14] also pescetarians, were included in the percentages for a vegetarian diet. For studies with aggregated percentages, there was no overall statistical difference in how high the percentages were compared to studies in 2011, 2014, 2018, and 2021, in which the percentages for a vegetarian diet were reported separately from a vegan diet ($p = 0.13$). However, for two studies it was striking that the percentages of people adhering to a vegetarian

diet were not only aggregated with those for a vegan diet, but also with those for a pescetarian diet. These two studies accounted for the highest values in both 2013 and 2014 [14, 46].

Since 2014, 30 studies have reported on a vegan diet separately. In 20 of these studies, the percentages were assessed accurately, but in the other 10 studies, the percentages were categorized as being assessed inaccurately due to the use of terms such as “predominantly” or “mostly” vegan (◆ Table 5). The inaccurately assessed percentages (◆; 0.55–2.2%) were within the range of the studies with accurately assessed percentages (●; 0–3.2%) and were not significantly different from them ($p = 0.09$). The pattern of higher values for inaccurately assessed percentages observed for the vegetarian diet therefore did not occur here (◆ Figure 2).

In 34 of the 38 total studies, respondents self-reported on their diet. In the 4 remaining studies, the investigators assigned respondents to one of the diets. In 3 cases, this was based on questions about the frequency of consumption of animal products [12, 17, 24], and in 1 case, it was based on the foods commonly purchased and not purchased [46]. Compared to the percentages for self-reported vegetarian diets, no clear picture emerged with regard to the height of the percentages. However, these 4 studies were studies in which the percentages were published as an aggregated total and/or assessed inaccurately.

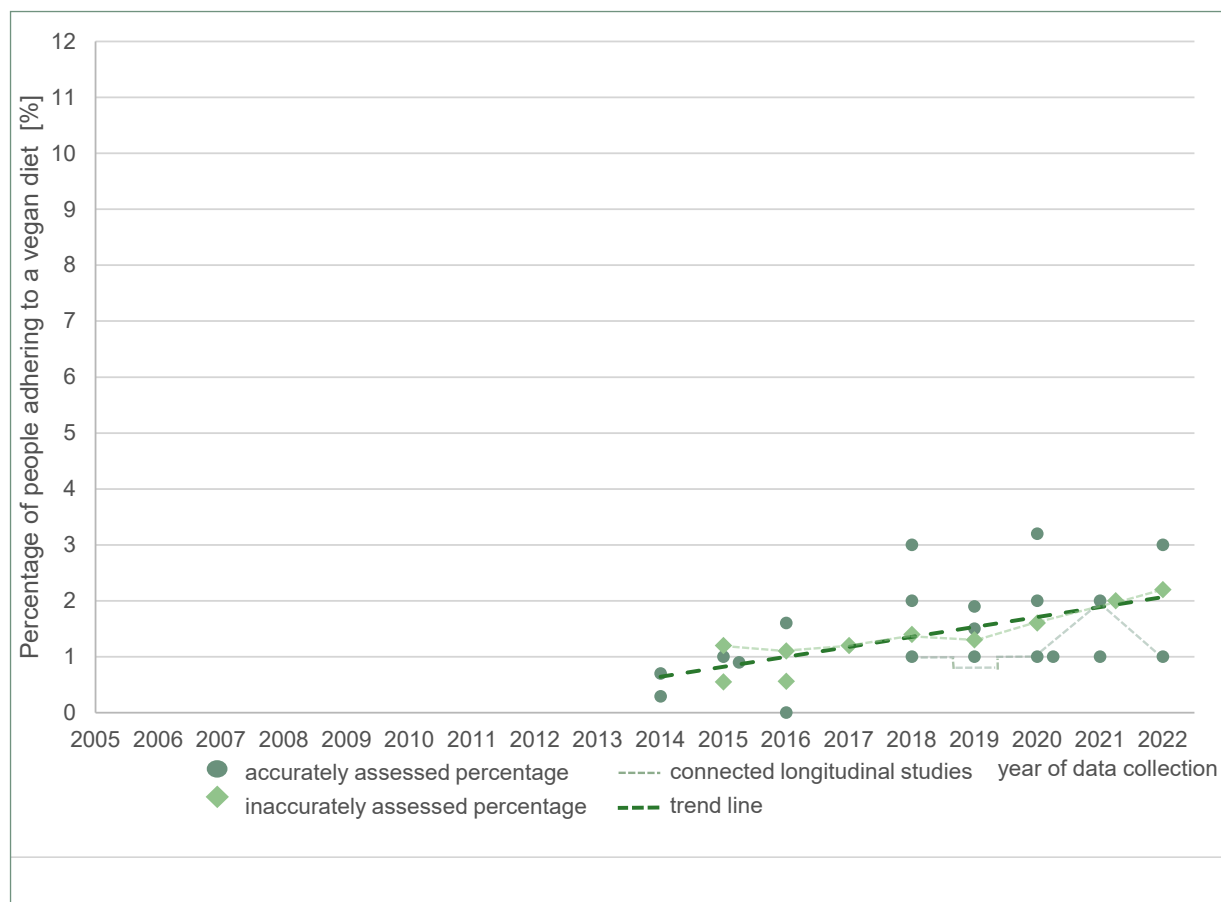


Fig. 2: Cross-sectional and longitudinal studies on the percentage of people adhering to a vegan diet in Germany from 2014 to 2022

Differentiated according to the accuracy of classification for the percentages compared to flexitarian and pescetarian diets. Trend line of mean values per year



Context of data collection/study population

With regard to the context of data collection or the topic of the study (whether the topic of the study was related to nutrition or vegetarian diets), as well as whether the study was designed by institutions within the scientific community or outside of it, differences were found for the percentages of people adhering to a vegetarian diet, but not a vegan diet. Percentages assessed in studies thematically related to nutrition or vegetarian diets were significantly lower ($p = 0.01$). These were also more frequently assessed accurately (15 out of 22; 70%) than the percentages of studies not directly related to nutrition (5 out of 16; 30%). Percentages from studies designed with the participation of a scientific institution were also significantly lower ($p < 0.001$) than percentages in studies designed by non-scientific institutions. With regard to study size (less than 3,000 vs. more than 3,000 respondents), no association with the percentages of people adhering to a vegetarian or vegan diet was found ($p = 0.09$ and $p = 0.6$, respectively).

Of all 38 studies, 14 analyzed the percentage by age, and 20 by gender. In 9 of the 14 studies, percentages were given for different age groups, and in 15 of the 20 studies, percentages were given for women and men (results not shown). Here, higher percentages of people adhering to a vegetarian diet were found for the youngest reported age group (up to 30 or 35 years) compared to the oldest reported age group (older than 55 or 60 years) and for women compared to men ($p < 0.001$ or $p = 0.005$; e.g., [45] 14–29 years 14% vs. ≥ 60 years 4%; female 9% vs. male 5%). Studies that reported percentages of people adhering to a vegetarian diet in the adult population along with percentages of adolescents adhering to a vegetarian diet were not significantly different from studies of percentages in the adult population alone ($p = 0.07$). There were too few studies that broke down the percentages by educational level to allow for an analysis of this factor. In addition, for the majority of the studies, no information was available on which criteria were used to measure representativeness, which meant that no analyses could be carried out in this regard either.

Trend

The longitudinal studies showed a trend of increasing percentages of people adhering to vegetarian and vegan diets over time (♦ Figure 1, ♦ Figure 2). For example, the NEMONIT study found that the percentage of people adhering to a vegetarian diet nearly doubled between 2010/11 and 2012/13, to almost 2% [13]. In the nutrition report by the German Federal Ministry of Food and Agriculture (BMEL), the percentage of people adhering to a vegetarian diet fluctuated between 5% and 10% over the period 2018–2022, with the latest figure being 7% in 2022. In contrast, the percentage of people adhering to a vegan diet in these studies remained constant at 1% over the same period, with the exception of an increase to 2% in 2021 [44, 45]. The AWA showed a steady increase over the 2015–2022 period: just over one-third for a vegetarian diet and two-thirds for a vegan diet [48]. A continuous increase over time was also observed throughout the cross-sectional studies, and this was more pronounced for the percentage of people adhering to a vegetarian diet than for the percentage of people adhering to a vegan diet. Based on the slope of the trend line, the percentage of people adhering to a vegetarian diet increased by 0.5% annually

(2007–2022) and the percentage of people adhering to a vegan diet increased by 0.2% annually (2014–2022) (♦ Figure 1, ♦ Figure 2). However, for a vegetarian diet in particular, there are large discrepancies between the lowest and highest values found within a study year (e.g., 6–11.2% in 2022).

Discussion

In order to provide an overview of representative studies on the percentage of people adhering to a vegetarian or vegan diet in Germany since 2005, 27 studies with 38 data collection time points were identified. These studies differed, sometimes greatly, in terms of both methodology and results. Regardless of how the diets were assessed and regardless of the type of study (longitudinal or cross-sectional), the percentage of people adhering to a vegetarian or vegan diet in Germany increased over the study period. The increasing importance of vegetarian and vegan diets is reflected by the increase in the number of studies on this topic, especially since 2018. Over half of the studies analyzed in the present study were conducted in the period from 2018 to 2022. In addition, the percentages of people adhering to a vegetarian diet were also increasingly assessed in studies that were not directly related to nutrition and were designed without the participation of scientific institutions.

Among all the factors investigated, the accuracy with which the diets were assessed was the factor most closely associated with the percentages of people adhering to a vegetarian diet. For example, higher percentages were found in studies in which the diet was assessed inaccurately (especially with regard to pescetarian and flexitarian diets) than in studies in which the diet was assessed accurately. Pfeiler and Egloff previously demonstrated this relationship in two studies using data from the German SOEP Panel (German Socio-Economic Panel). When the question on the diet was worded accurately, the resulting percentage was lower than that obtained with an inaccurately worded question used in the following year [15]. On the whole, this difference was not observed for the percentages of people adhering to a vegan diet. In this case, the inaccurately assessed percentages were in a similar range to the accurately assessed percentages. The reason for this could be that vegans' understanding of their own diet is



fundamentally more uniform and unambiguous than that of vegetarians due to the stricter dietary practice of completely avoiding all animal-based products.

In several studies, the percentage of people adhering to a vegan diet was included in the percentage of people adhering to a vegetarian diet. Although in some studies the assessment of the diets themselves was judged to be accurate, presenting both types of diet together as an aggregated percentage creates a certain degree of imprecision. However, with regard to the vegetarian diet, these percentages were not significantly higher than in studies that published separate percentages for vegetarian and vegan diets. Before 2014, it can be assumed that the percentage of people adhering to a vegan diet was too low to justify its own category, as no representative study of the population reported this percentage separately at that time. Even after 2014, this could still have been the reason for combined percentages in isolated cases: after all, some studies found minima of around 1% over the years. However, it is also feasible that in some cases the vegan diet could not be methodically separated from the vegetarian diet and was therefore merged with it. However, as the percentages of people adhering to a vegan diet increase, combining them with the percentages of people adhering to a vegetarian diet could skew the percentage of people adhering to a vegetarian diet (in the sense of a lacto-ovo-vegetarian diet) upward. Another upward bias is introduced by additionally aggregating the pescetarian diet with the vegetarian diet, as shown by the significantly higher percentages in the studies that do this compared with other studies from the same years. This is further corroborated by the statistically significantly higher percentages of people adhering to a vegetarian diet when they are inaccurately distinguished during assessment, i.e. from a pescetarian diet.

In almost all of the studies, the percentages were based on respondents' self-reported diets. Regardless of how accurately the questions were worded, there could be a difference between responses and actual behavior. There are also references to this in the literature. Studies in which actual intake was recorded in addition to self-reported diets showed that the percentage of people adhering to vegetarian diets was greater when only self-reported diets were used. For example, in the German National Nutrition Survey II, participants' classification of themselves as being vegetarian, vegan, or pescetarian was checked on

the basis of actual intake, determined using two 24-h dietary recalls, and they were categorized as "not eating meat" if applicable. The resulting percentages were approximately 14% lower than the percentages derived from self-reporting [53, 54]. Based on a comparison with actual intake data, Studies from Finland, the Netherlands, and the United States calculated, that 50–80% of people who classified themselves as vegetarians actually consumed meat and fish [55–57]. This assumption is supported by the YouGov study [16], which is included in the present review. In this study, participants were asked control questions regarding any animal products they avoided in addition to being asked whether they identify as vegetarian or vegan. Based on self-reporting, the percentage of people adhering to a "mostly vegetarian" diet was 11%, and the percentage derived from the additional control questions on the avoidance of meat products was 4.3% (or 1.1% vs. 0.7% for a vegan diet) [16]. As posited by Rosenfeld and Tomiyama [58], the participants may find it more important to feel that they belong to the vegetarian group and perceive themselves as vegetarians than to actually practice a vegetarian diet consistently. In addition, there may be differences in attitude between vegetarians and vegans with regard to dietary strictness, i.e., whether or not they allow themselves to make exceptions [59, 60]. People who avoid meat/fish or animal-based foods for ethical reasons may be stricter about their diet and less accepting of exceptions in consumption than people who eat a vegetarian or vegan diet for health reasons, for example [61]. The various publications suggest that a study based solely on self-reporting may lead to an overestimation of the percentage of people adhering to vegetarian and vegan diets. It can be assumed that additional control questions on the consumption of animal-based products could eliminate the false-positive cases and thus result in lower percentages than would result from self-reporting alone (so far there has been no indication that percentages of people adhering to a vegetarian diet would have to be corrected upwards due to false-negative cases). The same can be assumed if the respondents are objectively assigned to the corresponding diet directly by the investigators themselves on the basis of questions on consumption of animal-based products. However, these assumptions could not be verified because there have been so few studies of this type. The analyses showed that the percentages in studies designed with the participation of a scientific institution were lower than percentages in studies designed by institutions outside the scientific community. The majority of the studies designed with the involvement of scientific institutions had a topic directly related to nutrition, vegetarian diet, food, or health. Percentages from studies in which the topic was related to nutrition were also lower than those from studies in which the topic was not directly related to nutrition/diet. These effects could be due to methodological differences associated with the objectives of the studies. Studies on diet could be designed to achieve detailed differentiation of sub-populations with distinguishable diets in order to identify and quantify influences and interactions affecting health-related variables. Studies designed by institutions outside the scientific community were often conducted as multi-topic surveys. It is possible that in these studies, diet was mainly asked about as just another sociodemographic variable used for general characterization of the study population in the context of market and target group



analyses. Therefore, the objective of the study may have had an overall effect on the study design and thus on the accuracy with which participants were asked about their diet. However, when the percentages from studies conducted by scientific institutions were examined, it was apparent that they were not only assessed accurately, but were also collected at an early point in time (at the beginning of the study period). However, accurately assessed percentages were also lower, as were percentages from studies conducted at earlier data collection dates. It was not possible to statistically control for this in the analyses. Therefore, the extent to which the combination of factors influenced the determined percentages could not be investigated.

Various studies described individual sociodemographic characteristics, including age, gender, and level of education, as relevant factors affecting the practice of vegetarian and vegan diets. For example, young people, women, and people with a high level of education are more likely to adhere to a vegetarian or vegan diet [15, 29, 62, 63]. The present study also found this to be the case. The percentages of people adhering to a vegetarian diet were higher among female participants compared to male participants and among the youngest age groups compared to the oldest age groups. However, studies in which percentages included adolescents under the age of 18, and thus included a subpopulation with a tendency towards higher percentages, did not exhibit higher percentages overall. Therefore, the detailed differences in the percentages of people adhering to a vegetarian diet among subpopulations (age groups) were presumably compensated by the population-representative distribution. This finding suggests that the level of education should also be recorded representatively, as studies in which this was the case determined that individuals with higher levels of education were significantly more likely to say that they adhered to a vegetarian or vegan diet than those with lower levels of education [6, 15, 20, 29]. In the present study, it was not possible to examine the extent to which the level of education not being recorded representatively in the study population may have influenced the determined percentages.

In addition, there may be other factors that have an impact on responses and thus on the percentage, or that could cause bias. One example is how long the respondents have been adhering to the diet, or whether they have made exceptions, and if so, for what reasons. Such aspects were generally not taken into account in the studies, so no analysis was possible in this regard.

Limitations

The relationship between the study questions and response options on the one hand and the percentages of people adhering to vegetarian and vegan diets on the other was investigated by classifying the assessment of diets as accurate and inaccurate. This classification scheme required some assumptions to be made, which inherently entailed some imprecision. For example, the definition of a vegan diet was assumed to be accurate even if honey was not listed as one of the foods to be avoided. In order to make paired comparisons, the factors studied had to be expressed in a dichotomized manner, which meant that the variation in the expression of a factor could no longer be reflected in detail (e.g., studies were categorized by the size of the study population as fewer or more than 3,000 respondents, but the range was between ap-

proximately 500 and 25,000 respondents). In addition, due to the small number of studies available, it was not possible to test combinations of factors, which meant that it was not possible to determine the extent to which any effects identified might have been due to the inaccurate or accurate assessment of the percentages or the timing of the data collection.

Only representative studies were included in the review, but there was no consideration of the factors to which the representativeness referred, as no information on this was available for the majority of studies. Consequently, one study was included that was representative in terms of gender distribution only, while the sample was selected to have an equal distribution across all age groups and other factors were not taken into account (information from personal communication [34]). As a result, relevant factors could be overrepresented or underrepresented. If, for example, people with a high level of education were overrepresented in a study population and no weighting was carried out, the resulting percentages of people adhering to a vegetarian/vegan diet could be skewed upwards.

Furthermore, it was not taken into account if multiple responses were possible. The resulting percentages may therefore have been inflated if individuals assigned themselves to more than one diet. In most cases no information on this was available, so this could not be investigated further. In addition, no estimates could be made regarding the effects of other potential factors such as the preceding questions or the context of the questions. For example, the percentages of people adhering to a vegetarian or vegan diet could be overestimated, if the assessment followed questions on the consumption of fruit, vegetables or meat substitutes. Information on recruitment processes was also lacking. For instance, the composition of a study population could be influenced by information on the content of a study being available in advance, or by the recruitment channels used. If more or fewer people adhering to a vegetarian or vegan diet were drawn to a study as a result of these factors, then regardless of representativeness, this would also influence the percentages.



Concluding remarks

The present review showed a general increase in the percentages of people adhering to vegetarian and vegan diets in Germany in the period 2005–2022. However, estimating exactly how high the current percentages are in Germany is aggravated by the major methodological differences in how the diets were assessed. These methodological differences in design could be explained by the different contexts in which the data were collected (topic of the study/objective, who was responsible for the design). Among the methodological factors examined, inaccurate assessment of diets in particular can lead to overestimation of the percentages of people adhering to a vegetarian or vegan diet. The high proportion of studies with inaccurate assessment partly made it difficult to interpret the factors that could influence the height of the percentages. This means that the present study can only provide indications that the respondents' self-reporting of their diet may contribute to higher percentages.

The factors that emerged as having an impact on the percentages suggest that studies should meet certain criteria. One of the most important criteria is accurate assessment of the diet. There have also been publications suggesting that self-reporting should be compared with control questions on consumption of animal-based products. In addition, the sample should be representative in terms of socio-demographic characteristics, including age, gender, and level of education, which are important factors in determining which dietary practices people adhere to.

As far as can be determined from the available information, none of the studies included in the present study fulfill all of the above criteria. Among the more recent studies (2018–2022), at least 12 studies come close to meeting two of the criteria: accurate assessment of diets and representative recording of at least age and gender. However, all 12 of these studies are based on respondents' self-reporting, and none of them provide clear details about which sociodemographic characteristics have been recorded representatively. The values range from 4% to 10%. These studies do not provide more current percentages based on questions on consumption of animal-based products and on corresponding objective classifications by the investigators.

The factors identified in this review as having an influence on the height of the percentages

should be considered in future studies on the percentages of people adhering to vegetarian and vegan diets. In this context, clearly defined response options will continue to gain importance as the relevance of plant-based diets increases and they become more differentiated. For example, new forms of vegan diets – such as pescovegan and flexitarian diet [65] – should be taken into account to ensure accurate classification. To mitigate the problem posed by self-reported categorization, it would be desirable to design studies in such a way that the percentages of vegetarian and vegan diets could be corrected using control questions on consumption or that the classification is based on validated dietary assessment methods. This would improve the comparability of the studies, generate more robust data on the percentages of people adhering to vegetarian and vegan diets, and provide additional information on trends.

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Conflict of Interest

The authors declare no conflict of interest.

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