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Removing barriers to plant-based diets: Assisting doctors with vegan patients

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ABSTRACT

Shifting to plant-based diets can alleviate many of the externalities associated with the current food system. Spontaneous shifts in diet are often hindered by consumers' imperfect knowledge about the health risks and benefits, which leads them to seek advice from their doctors. However, doctors have often had only limited nutrition training, and often express negative opinions of plant-based diets, even though recent evidence suggests that they confer substantial health benefits. We here explore whether providing doctors (general practitioners) with information about the risks and benefits of plant-based diets significantly changes their attitudes and medical practices. We run a survey experiment on a representative sample of French doctors and assess the impact of an information campaign developed by doctors to inform their colleagues about plant-based nutrition through case studies. Our confirmatory analysis shows that our information campaign effectively changes doctors' views about plant-based diets (Cohen's d : 0.71). To a smaller extent, we find a positive but not statistically nor economically significant effect of the intervention on the doctors' (hypothetical) medical practice with patients who follow a plant-based diet (Cohen's d : 0.22).

1. Introduction

Dietary changes are expected to play a growing role in climate-change mitigation over the coming years. The global food system generates a variety of greenhouse gases (CO₂, CH₄, N₂O) from multiple sources, including deforestation, fertilizer use, and enteric fermentation and manure from livestock. Agriculture currently accounts for about 40 % of global land use (Foley et al., 2005), with food production generating up to 30 % of global greenhouse gas emissions (Vermeulen et al., 2012) and representing 70 % of freshwater consumption (Molden, 2013; Steffen et al., 2015). Limiting the increase in global temperature to 1.5° or 2° above pre-industrial levels requires substantial shifts in dietary habits in addition to efforts to reduce fuel emissions (Clark et al., 2020).

More globally, accumulating evidence has shown considerable heterogeneity of types of diet with respect to their contribution to climate change (Theurl et al., 2020). Animal-based foods are shown to emit more GHG and to use more land (Poore & Nemecek, 2018), while vegetarian and vegan diets have the lowest environmental footprint

together with the lowest mortality rates (Springmann et al., 2016; Clark & Tilman, 2017; Clark et al., 2019; Springmann et al., 2020). Recently, the Eat-Lancet Commission issued new guidelines in an attempt to define the contours of healthy and sustainable diets and urged for a reduction in animal-based foods (Willett et al., 2019). Similarly, the 2019 IPCC special report on GHG and land use emphasized the importance of dietary changes to mitigate climate change.

Pushing consumers towards plant-rich diets is therefore a key element in limiting global warming (Rust et al., 2020). The limited acceptability of coercive policies (Espinosa & Nassar, 2021) such as meat taxation (Douenne & Fabre, 2020) has encouraged governments to support individual spontaneous changes in diet. NGOs (Espinosa & Treich, 2021) and public authorities (Espinosa & Stoop, 2021) play an important role in informing consumers about the benefits of adopting a plant-based diet. However, some consumers who are willing to adopt such diets may be concerned about their health impact, and are likely to consult their doctor for advice. While the general opinion of doctors is thus a key element for the success of spontaneous shifts towards

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plant-based diets, some may lack information about recent scientific work showing the health benefits of these diets (Springmann et al., 2016; Clark & Tilman, 2017; Clark et al., 2019; Springmann et al., 2020). The outdated or incomplete knowledge of doctors may therefore hinder the global environmental objective of a shift towards plant-based diets.

The objective of our research is to investigate the effectiveness of informing doctors (general practitioners) of the benefits and risks of plant-based diets in their recommendations to their patients who wish to adopt such diets and their associated health monitoring. More specifically, we test the impact of an information campaign that consists of a booklet and an online platform (*Vegecliv*) developed by French doctors to help their colleagues inform vegetarian and vegan patients. This platform was developed in a similar way to platforms on other medical issues such as the use of antibiotics (*Antibioclic*) or the monitoring of pregnancy (*Gestacliv*). It offers general recommendations for patients who have adopted a plant-based diet for a large set of nutrients (proteins, vitamins B12 and D, iodine, omega-3, calcium, iron, and zinc) and allows doctors to obtain detailed information for specific patient profiles (infants, young children, pregnant or breastfeeding women, and the elderly). It provides guidelines to achieve a balanced plant-based diet including supplements, based on the most recent scientific findings. The booklet, developed for the experiment, comprises the most relevant information from *Vegecliv* about the risks and benefits of plant-based diets (see the Supplementary Materials).

To assess the impact of a plant-based nutrition information campaign on doctors' views, we run a survey experiment. We expose a representative sample of 200 French doctors to the booklet and its associated platform and compare their attitudes to a representative control group of 200 additional French doctors. We develop three indicators to evaluate the impact of the information campaign. The *Veganism Disapproval Index* (VDI) captures the doctors' general opinion towards plant-based diets, the *Proper Medical Practice Index* (PMPI) reflects the doctors' medical practice quality (i.e., prescribing the relevant tests and avoiding the non-relevant tests), and the *Veganism Promotion Index* (VPI) measures the doctors' active promotion of a well-balanced plant-based diet and its expected health benefits (i.e., variation of the charity giving game).

Our results show positive effects of our information intervention. Our confirmatory analysis shows indeed that the exposition to the booklet is very effective in improving doctors' views about plant-based diets. However, the impact on expected medical practice (i.e., biological tests prescribed to the patients) is much more limited: while we cannot rule out the possibility of a positive treatment effect, the information intervention is below our smallest effect size of interest and is not statistically larger than zero in our most conservative estimations. We do not analyze the impact of the information campaign on the VPI because the associated statistical test does not have sufficient statistical power (outcome-neutral test). Our exploratory analysis does not suggest any heterogeneous effect of the intervention. One exception is the fact that the treatment effects seem to be larger for doctors who spent more time reading the booklet. However, our setup is not capable of distinguishing whether this results from a selection effect (i.e., doctors who are the most adverse to plant-based diets spent less time reading the booklet) or from an attention effect (i.e., doctors who spent less time reading the booklet learned fewer things). Descriptive statistics of the questionnaire indicate that doctors are aware of the adverse effects of their negative opinions about plant-based diets on patients and tend to overestimate their knowledge of nutrition. Overall, our study shows that informing or/and training doctors through simple booklets is an effective strategy that could lead to better relationships with patients who follow a plant-based diet and could, in the long run, encourage the development of more sustainable diets. However, more intensive actions, like better training at the university, might be required to effectively improve the supervision of patients adopting a plant-based diet by doctors.

The remainder of the paper is organized as follows. First, we provide

background on the role of doctors with vegetarian and vegan patients and the importance of information campaigns in the context of plant-based diets. Second, we present our methods. We detail our experimental design and our sampling and analysis plans. Third, we show the results of the survey experiment. Last, we discuss the implications of our findings.

2. Background

2.1. Doctors' role with vegetarian and vegan patients

Doctors are an easily available source of information and frequently give nutritional advice to their patients to improve their health (Anis et al., 2004). Some studies have demonstrated that doctors might positively influence dietary changes through counseling (Rousset et al., 2003), specifically the reduction of red meat consumption (McIntosh et al., 1995), and switches to vegetarianism or veganism (Cramer et al., 2017). Doctors might also negatively influence their patients' dietary choices. Qualitative research in France has shown that some doctors try to prevent their patients from adopting plant-based diets (Villette, 2019; Boyadjian, 2018) and promote animal-based food (Borel, 2017). Doctors show increasing concerns the greater the share of plant-based food in the diet (Borel, 2017), and are more likely to look for dietary deficiencies in vegetarian or vegan patients (Villette, 2019; Boyadjian, 2018; Passetlergue, 2018). This aversion towards plant-based diets has been shown to be detrimental to the doctor-patient relationship (Vittoriani, 2021; Hardouin, 2018). Previous work estimates that one in four French vegetarians / vegans does not inform their doctor about their diet, and one in three has thought about changing their doctor because of their views about vegetarianism (Demange, 2017). Doctors' disapproval of their patients' diets can then harm the therapeutic relationship, lead patients to not reveal information about their behaviour or symptoms (Vittoriani, 2021; Demange, 2017; Rughoo, 2019), produce mistrust of medical authority (Hardouin, 2018; Farella et al., 2020; Lahmer, 2018) that can in turn lead to a shift to alternative forms of medicine (Hardouin, 2018; Rughoo, 2019) and the use of other sources of medical information such as the internet (Rughoo, 2019; Lahmer, 2018). In addition, vegetarian and vegan patients frequently report that their doctor lacks information and provides inadequate advice about plant-based diets (Vittoriani, 2021; Hardouin, 2018; Demange, 2017; Rughoo, 2019; Lahmer, 2018; Baldassarre et al., 2020; Jarson & Maginot, 2020).

Doctors' inability to provide effective guidance on vegetarianism may weaken the commitment of vegetarian and vegan patients to their diet, by leading them to question its healthiness and suitability. In particular, Demange (2017) shows that French patients who have adopted a plant-based diet for two years or less are more likely to ask their doctors for advice, as compared to those who have been vegetarian or vegan for longer. The study also shows that the proportion of vegetarian or vegan patients who hesitate to report symptoms to their doctor is significantly higher when the latter had advised them to eat meat. Doctors' imperfect knowledge of plant-based diets has been shown to result from a lack of training in nutrition (and especially plant-based

nutrition) in their curriculum (Chung et al., 2014; Crowley et al., 2019). Some qualitative studies suggest that doctors themselves do not feel sufficiently trained on nutrition in general or/and do not remember being trained at school on this topic (Franceschini, 2021). They further indicate that less than half of the doctors feel competent to advise vegetarian patients, and about one out of four for vegan patients (Bonnet, 2021). A 2009 report for the Ministry of Health reached similar conclusions and pointed out that only a few hours are devoted to nutritional training in the curriculum of doctors.

A number of countries and groups of researchers have sought to address this issue by creating educational platforms¹ and tools for medical professionals and patients (Baroni et al., 2019). In France, initiatives to convey information on plant-based diets to doctors, such as the *Vegeclis* platform and an information booklet designed by Blanchet-Mazuel & Wissocq (2018), were the first attempts to improve the therapeutic relationship. However, the diffusion and efficiency of these kinds of tools remain to be established. In particular, we do not know the extent to which doctors are willing, even passively, to become informed.

2.2. Information campaigns

Information campaigns could be a useful mechanism to help doctors better advise patients regarding more sustainable diets. Information campaigns have indeed been shown to be effective tools to educate, update beliefs and induce behavioural changes, may it be in politics (Kendall et al., 2015), environmental behaviors (Carlsson et al., 2021) or health (Noar, 2006; Perloff, 2017). Specifically, health information campaigns have been proven successful to educate the general population on topics such as nutrition (Snyder, 2007), HIV (Dupas, 2009) strokes, (Haesebaert et al., 2020) vaccines, (Nyhan & Reifler, 2015) and more recently guidelines during the COVID-19 pandemic (Barari et al., 2020). Additionally, informing professionals about the latest scientific advances and methods, in particular doctors, can lead to better practices and updated knowledge (Friis et al., 1989).

However, informing doctors about the risks and benefits of plant-based diets may have only a limited impact on their practices, for behavioural and environmental reasons. First, previous work has shown that individuals generally have a tendency to reject contradictory information (cognitive dissonance, (Rothgerber, 2014; Rothgerber, 2020) social norms, (Higgs, 2015; Cheah et al., 2020) confirmation bias, (Lord et al., 1979; Nickerson, 1998; Piazza et al., 2015; Dickinson & Kakoschke, 2021) and information avoidance (Loewenstein, 2006; Golman et al., 2017; Sharot & Sunstein, 2020; Ho et al., 2021)), including information related to plant-based or animal-based diets. Espinosa & Stoop (2021) Doctors are also subject to imperfect information acquisition (Grol & Grimshaw, 2003; Francke et al., 2008) and may therefore interpret the new evidence via their own beliefs and diet, thus preventing the success of any information campaign. Second, most doctors are practitioners who may lack the time to keep up with the scientific literature and may prefer to rely on dietary guidelines issued by national institutions (e.g., the ANSES in France). In their eyes, these guidelines are more informative than single scientific articles used in information campaigns, as they are based on reviews of the existing

¹ Italy has a dedicated platform on which patients and medical professionals can find information on plant-based diets (www.famigliaveg.it). The NHS in the UK has dedicated health pages for vegetarian and vegan diets (www.nhs.uk/live-well/eat-well/the-vegan-diet, www.nhs.uk/live-well/eat-well/the-vegetarian-diet). The USDA also provides dedicated resources for vegetarian diets (www.nutrition.gov/topics/basic-nutrition/eating-vegetarian). In France, the main source of information for patients is the government's nutritional recommendations (PNNS - www.mangerbouger.fr/Les-recommandations). This recommends the consumption of 500 grams of meat per week and encourages vegetarians and vegans to seek information on possible deficiencies directly with their doctor.

literature and should be, in this respect, more robust. However, these recommendations vary greatly across countries, (Springmann et al., 2020) and often result from a trade-off between political (including economic) and scientific considerations. In addition, these recommendations are issued for several years (e.g., 5 years for France), which can create a delay between the production of scientific knowledge and its incorporation into dietary guidelines. Overall, doctors who prefer to stick to the national dietary guidelines might overlook recent scientific evidence and may thus be relatively insensitive to information campaigns.

3. Methods

3.1. Registered report at PCI-RR

This paper originates from a Registered Report² (RR) that was submitted to Peer-community in Registered Reports (PCI RR).³ PCI-RR is a researcher-run, non-profit, and non-commercial platform that reviews and recommends pre-print RRs. The process divides peer-review into two stages. First, researchers submit a Stage-1, which contains the introduction, research question, hypotheses, methods, analysis plan, and pilot data. After a first round (or several rounds) of peer-review, the paper can receive an IPA (In-Principle Acceptance) by a recommender before the data collection. Second, after the data have been collected and analyzed, the paper goes through another round of peer-review and can be granted a Stage-2 recommendation by the recommender if they consider that the authors have proceeded to data collection and analyses as they committed to. The current work has gone through this two-stage procedure at PCI-RR under the supervision of Zoltan Dienes and was then submitted to the Journal of Behavioral and Experimental Economics where it underwent standard peer-review.

3.2. Ethics information

This work received the approval of the ethics committee of the Centre de Recherche en Économie et Management in June 2021 (IRB approval number: 010721-01). It complies with all relevant ethical regulations. Participants in the study were recruited and compensated by the polling institute BVA. The participants were selected from the institute's database of doctor participants.⁴ They were randomly allocated to one of the two conditions (control vs. treatment), and received a fixed amount of money (€18) determined by the standard practice of the polling institute.

3.3. Design

Survey. The experiment is a survey experiment with one control and one treatment condition. In the control condition, a representative sample of French doctors is contacted via the polling institute to answer a short questionnaire about their perception and views of plant-based diets (see Supplementary Material S1 for the entire survey). The two first screens contain case studies, and their answers constitute our primary outcomes. In the first case study, we seek to elicit what doctors

² For more details on Registered Reports in economics please see Arpinon and Espinosa (2023).⁷⁷

³ Peer-community in Registered Reports is a non-profit platform gathering researchers who provide Registered Reports peer-reviews. More information can be found on rr.peercommunityin.org/about. IPA can be accessed here: <https://rr.peercommunityin.org/articles/rec?id=92>. The second-stage recommendation can be accessed here: <https://rr.peercommunityin.org/articles/rec?id=307>.

⁴ The institute has access to a pool of French doctors who regularly take part in surveys. The participants in our experiment were recruited from this pool and were blind to the study's objective.

Table 1

List of biological tests prescribed to an asymptomatic patient after four years of veganism.

	Test name	Objective of the test
T1	Methylmalonic acid urine test	To measure the level of Methylmalonic acid, which reflects vitamin B12 deficiency.
T2	Phosphate, calcium, and PTH (parathromon) test	To measure levels of phosphate and calcium, important for bones, muscles, and tiredness.
T3	Vitamin B9 (folic acid test)	To measure the presence of vitamin B9, important for neuronal development, the immune system, the production of DNA, and red blood cells.
T4	Zinc test	To measure the level of zinc, which is important for cell growth, cell division, the immune system, and the breakdown of carbohydrates.
T5	Albuminemia	To measure the level of albumin. Used to detect undernutrition.
T6	Ferritinemia	To measure the level of ferritin, which is a protein that stores iron, to detect iron deficiencies.
T7	25-hydroxy vitamin D test	To measure the level of vitamin D, which is transformed to 25-OH-D by the liver. The vitamin is useful for bone mineralization and neuromuscular activity.
T8	Thyroid-stimulating-hormone	To measure the presence of TSH, which reflects the activity of the thyroid.
T9	Vitamin B12 blood test	To measure the level of vitamin B12 and analogs in the blood.
T10	Complete Blood Count, Platelets	To measure hemoglobin level, which serves for anemia diagnosis.

usually tell their patients when the latter desire to adopt a plant-based diet. The first case study reads as follows:

A 27-year-old man, presenting no symptoms or previous illness history, comes to you for a consultation. He currently consumes animal-based products regularly but wishes to become vegan (no red meat, no white meat, no fish, no dairy products, no eggs). He asks your opinion on the potential health risks associated with this diet.

Doctors are asked to report, on 0 %-to-100 % scales, how likely they would tell this patient that (i) they strongly advise against such a diet (Q1), (ii) it creates important deficiency risks (Q2), (iii) there is no problem if the diet is diversified and the patient takes food supplements (Q3), (iv) it is a bad decision that can have negative long-term consequences (Q4), and (v) it can be beneficial for his health (Q5). The items are displayed in a random order, and we ask doctors to answer as truthfully as possible to reflect what they would do in their office. We decided to consider a young male as this type of patient has the lowest risk of deficiencies. Female patients are more likely to suffer from iron deficiencies and might need specific treatment if they plan to become pregnant.

On the next screen, doctors are presented with a second case study, which is a follow-up of the first scenario:

The same patient returns after four years as a vegan (no consumption of animal-based products – meat, fish, eggs, dairy products, etc.) with no supplements and asks if he should have a blood test to look for any deficiencies. He reports eating fruit, vegetables, pulses, seaweed, and grains regularly. He does not have any symptoms.

Doctors are asked whether they would prescribe biological tests. If they answer “Yes”, they are presented with the list of ten tests displayed in Table 1. The tests are displayed in a random order, and doctors select the tests that they would prescribe. Of this list, only the first test is relevant for an asymptomatic vegan patient who does not take food supplements, i.e., the methylmalonic acid urine test. Vitamin B12 is indeed the only nutrient that cannot be found in a well-diversified plant-based diet so that a strictly vegan patient should suffer from deficiencies in this vitamin if they do not take supplements. The blood test for vitamin B12 has limited relevance given that the patient eats seaweed regularly, which contains B12-analogs that distort the results of the

blood test. Regarding the other items, a vegan patient with a diversified diet should not have any greater risk of deficiency than the general population. While prescribing T1 is a sign of good medical practice, the prescription of T2 to T8 is unnecessary and indicates a limited knowledge of plant-based diets.⁵ Tests T9 and T10 cannot be seen as good or bad medical practice and are included here only to provide the usual list of tests that doctors may be willing to prescribe.

On the third screen, doctors are introduced with a variation of the charity giving game. Participants receive €2 and can decide to give some of this earning to fund an information campaign developed by a research agency (CNRS) aimed at informing the general population about the importance of a well-balanced vegan diet and its expected health benefits. Doctors can give money in increments of €0.20. Any unallocated money is theirs to keep.

Treatment. In the treatment condition, participants are exposed to an information campaign before answering the survey. The information campaign consists of a booklet (see Supplementary Material S2) created by the research team (including two doctors) and is inspired by the information available on the *Vegecliv* website that summarizes the latest scientific recommendations for doctors regarding plant-based diets. The booklet contains five pages of information: one page about vegetarianism and veganism in France, two pages about essential nutrients and the risks of deficiencies for vegetarian / vegan patients, one page about the recommendations for specific populations, and one page about the health benefits of plant-based diets. At the end of the booklet, the doctors are invited to visit the *Vegecliv* website for more information and detailed case studies. Last, we show the list of scientific references that were used to generate the booklet. Participants are told that they have 10 min to read the booklet and consult the *Vegecliv* website. We record the time spent on the information campaign and whether the participants consult the website.

Methodological details. The study is a between-subject survey experiment that randomizes treatment allocation at the individual level. Data collection was performed independently for the two conditions up to 200 observations in each condition. It occurred between June 1st, 2022, and July 1st, 2022, for each condition. The two groups of participants are representative samples of the population of French doctors regarding gender, age, and area of practice. Participants were anonymous and received monetary compensation for their participation in the survey. The collection of data was carried out by the polling institute.

Data analysis was conducted by the research team and was therefore not blinded. While we committed to excluding from the data analysis participants from the two conditions who spent less than one and a half minutes on the survey, no participant met this exclusion criterion in the sample.

Outcome variables. We consider three outcome variables to assess the effect of the campaign on doctors. We first define a score that reflects the respondents’ general opinion about plant-based diets. We consider answers to the first case study (i.e., questions Q1 to Q5) and define a *Veganism Disapproval Index* (VDI) as follows:

$$\text{Veganism disapproval Index} = \frac{Q1 + Q2 - Q3 + Q4 - Q5 + 20}{50} \in [0; 1]$$

The answers to questions Q1 to Q5 take on values between 0 % and

⁵ Alles et al. (2017) (Allès et al., 2017) report the average daily nutrient intakes of the largest French cohort (Nutrinet) and compare them with the French national nutrition recommendations (ANSES). Without considering supplements, French vegans have on average a daily intake of 760 mg of calcium (recommendation: 750 mg/day), 481 µg of Vitamin B9 per (250µg/day), 10mg of Zinc per day (9.3 mg/day), 18.6 µg of iron per day (6 µg/day), and 248.8 µg of Iodine per day (150µg/day). As far as vitamin D is concerned, the deficiency risks are similar for vegans as for the general population, as sun exposure is the main source, and intakes through nutrition are very limited. However, vegans have a daily intake of 2.7 µg of Vitamin B12 per day, below the recommended intake of 4 µg/day.

Table 2
Design table.

Question	Hypothesis	Sampling plan (e.g. power analysis)	Analysis Plan	Rationale for deciding the sensitivity of the test confirming or disconfirming the hypothesis	Interpretation given to different outcomes	Theory that could be shown wrong by the outcomes
Does providing information to doctors decrease their aversion towards plant-based diets?	Tests on VDI: $H_0^1 : \beta \geq \pi; H_1^1 : \beta < \pi$ $H_0^2 : \beta \leq \pi; H_1^2 : \beta > \pi$ $H_0^3 : \beta \geq 0; H_1^3 : \beta < 0$ $H_0^4 : \beta \leq 0; H_1^4 : \beta > 0$	200 observations in each condition. Alpha=1.67 % (Benchmark of 5 % with Bonferroni correction for three hypotheses.) Smallest effect size of interest of 0.1 or above.	Outcome neutral tests: based on data of the control group, we can estimate an effect size of 0.1 with probability 80 % or larger. Tobit model estimation if observations at the upper or lower bound of the scale (i.e., at 0 or 1); OLS estimation otherwise. Unilateral tests. Exclusion rule: participants who spend less than 1min30sec on the survey in both conditions.	Simulations based on pilot data (S = 2000) demonstrate that the smallest effect size of interest of 0.1 can be detected with a probability of 99.6 %.	If H_0^1 rejected: successful campaign. If H_0^1 not rejected, H_0^2 and H_0^3 rejected: failure. If H_0^1 and H_0^3 not rejected, H_0^2 and H_0^4 rejected: weakly successful. If H_0^1, H_0^2 and H_0^4 not rejected, H_0^3 rejected: failure or weakly successful. If H_0^1, H_0^2 and H_0^3 not rejected: inconclusive. If H_0^1 and H_0^2 not rejected, H_0^3 rejected: weakly or fully successful.	Non-applicable
Does providing information to doctors modify their medical practices with vegan patients?	Test on PMPI: $H_0^1 : \beta \leq \pi; H_1^1 : \beta > \pi$ $H_0^2 : \beta \geq \pi; H_1^2 : \beta < \pi$ $H_0^3 : \beta \leq 0; H_1^3 : \beta > 0$ $H_0^4 : \beta \geq 0; H_1^4 : \beta < 0$	200 observations in each condition. Alpha=1.67 % (Benchmark of 5 % with Bonferroni correction for three hypotheses.) Smallest effect size of interest of 0.125 or above.	Outcome neutral tests: based on data of the control group, we can estimate an effect size of 0.125 with probability 80 % or larger. Tobit model estimation if observations at the upper or lower bound of the scale (i.e., at 0 or 1); OLS estimation otherwise. Unilateral test. Exclusion rule: participants who spend less than 1min30sec on the survey in both conditions.	Simulations based on pilot data (S = 2000) demonstrate that the smallest effect size of interest of 0.125 can be detected with a probability of 100 %.	If H_0^1 rejected: successful campaign. If H_0^1 not rejected, H_0^2 and H_0^3 rejected: failure. If H_0^1 and H_0^3 not rejected, H_0^2 and H_0^4 rejected: weakly successful. If H_0^1, H_0^2 and H_0^4 not rejected, H_0^3 rejected: failure or weakly successful. If H_0^1, H_0^2 and H_0^3 not rejected: inconclusive. If H_0^1 and H_0^2 not rejected, H_0^3 rejected: weakly or fully successful.	
Does providing information to doctors increase their willingness to promote plant-based diets?	Test on VPI: $H_0^1 : \beta \leq \pi; H_1^1 : \beta > \pi$ $H_0^2 : \beta \geq \pi; H_1^2 : \beta < \pi$ $H_0^3 : \beta \leq 0; H_1^3 : \beta > 0$ $H_0^4 : \beta \geq 0; H_1^4 : \beta < 0$	200 observations in each condition. Alpha=1.67 % (Benchmark of 5 % with Bonferroni correction for three hypotheses.) Smallest effect size of interest of 0.12 or above.	Outcome neutral tests: based on data of the control group, we can estimate an effect size of 0.12 with probability 80 % or larger. Tobit model estimation if observations at the upper or lower bound of the scale (i.e., at 0 or 1); OLS estimation otherwise. Unilateral test. Exclusion rule: participants who spend less than 1min30sec on the survey in both conditions.	Simulations based on pilot data (S = 2000) demonstrate that the smallest effect size of interest of 0.12 can be detected with a probability of 15.7 %.	If H_0^1 rejected: successful campaign. If H_0^1 not rejected, H_0^2 and H_0^3 rejected: failure. If H_0^1 and H_0^3 not rejected, H_0^2 and H_0^4 rejected: weakly successful. If H_0^1, H_0^2 and H_0^4 not rejected, H_0^3 rejected: failure or weakly successful. If H_0^1, H_0^2 and H_0^3 not rejected: inconclusive. If H_0^1 and H_0^2 not rejected, H_0^3 rejected: weakly or fully successful.	

100 % in increments of 10 percentage points. The VDI, once normalized, ranges between 0 and 1. The lower the VDI score, the more positive a doctor’s opinion about the healthiness and appropriateness of plant-based diets.

Second, we aim to test whether our intervention has the potential to successfully improve medical practice with patients who have adopted a plant-based diet. To do so, we construct a score of good medical practice for our case study. In the case of a patient who has adopted a diversified plant-based diet, does not take supplements, and exhibits no clinical

symptoms, the only relevant test is the methylmalonic acid urine test. Tests T2 to T8 are unnecessary as the patient has no greater deficiency risk than someone who consumes animal-based foods. Tests T9⁶ and T10 are not relevant. The *Proper Medical Practice Index* (PMPI) therefore assigns a positive point for the urine test (T1) and negative points for the remaining tests T2 to T8. It is defined as:

$$\text{Proper Medical Practice Index} = \frac{T1 - \sum_{i=2}^8 T_i + 7}{8}$$

⁶ Testing for the presence of Vitamin B12 with a blood test is uninformative as the patient eats seaweed.

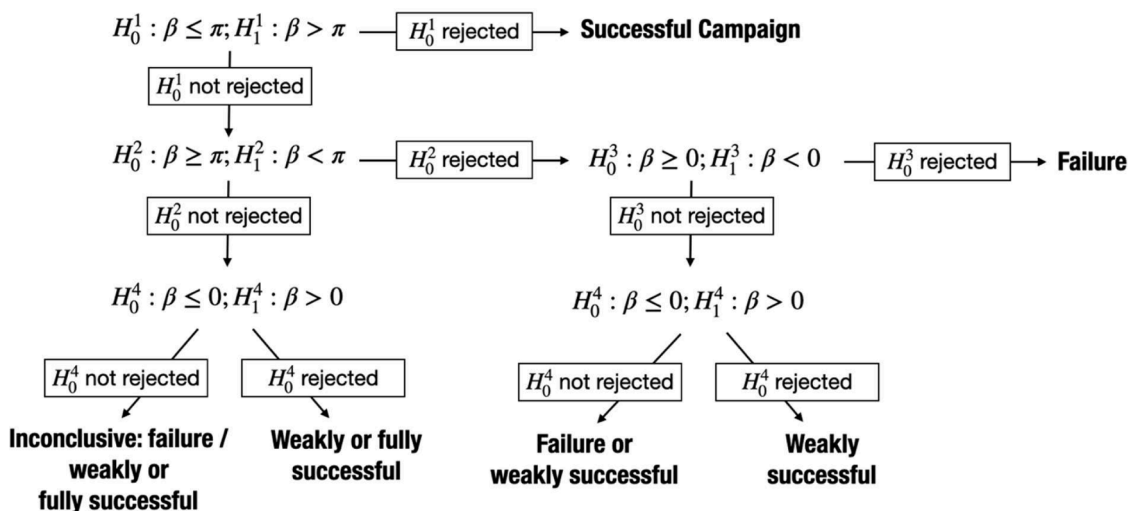


Fig. 1. Hypothesis testing for the VPI and PMPI and interpretation of possible results. Unilateral hypothesis testing using the marginal effects estimates β from the regression and π the smallest effect size of interest. The hypothesis testing is set up for the PMPI and VPI for which we expect the information campaign to increase the scores. The hypothesis testing for the VDI, for which we expect the information campaign to decrease the score, is reverted. In this case, π is negative.

The PMPI takes on values between 0 and 1. Higher scores on the PMPI indicate better medical practices.

Third, we analyze the doctors’ decision to give funds to the information campaign. We refer to the share of funds that doctors give to the project as the *Veganism Promotion Index* (VPI). Unlike the VDI, the VPI is incentivized and is thus more likely to reflect a more active involvement in the promotion of information about plant-based diets. The VPI, once normalized, ranges between 0 and 1. We ran a pilot session in October 2021 with students at the University of Nantes and obtained good consistency measures for the above outcome variables (see Table 2 in Supplementary Material S3).

3.4. Sampling plan

Power analysis. The sample consists of 400 observations (200 in the control group, and 200 in the treatment group). The key element for our data analysis is to define the smallest effect size of interest (SESOI), (Lakens et al., 2018; Dienes, 2020; Dienes, 2021) i.e., the smallest effect below which the campaign is not seen as sufficiently effective to be worthy of interest for policy-making. We rely on previous literature to define the SESOI. For the VDI, we use previous research by Espinosa & Stoop (2021), who found a 20 percentage-point increase in the share of correct responses following a short information campaign on nutrition with short responses. The intervention in our study is longer and more complex, and we thus consider that a policy with half of this effect size (i.e., 10 percentage points) would be worth considering for policymakers. For the VPI, we rely on results comparing the impact of NGOs’ discourses on donations in a charity-giving game by Espinosa and Treich (2021). The authors found a 6 percentage-point increase in donations when individuals are exposed to a two-paragraph welfarist discourse. Given that the information campaign we develop is more complex and would generate larger costs than a simple exposure to a two-paragraph discourse, we consider that a SESOI at least twice higher (i.e., 12 percentage points) would be worth considering for policymakers. For the PMPI, there is no existing literature that explores the effect of a plant-based diet information campaign on doctors’ practices to our knowledge. We consider that an improvement by at least one additional test in doctors’ prescriptions (either a useless test is abandoned, or an additional useful test is prescribed) would have the potential to successfully improve medical practices and would be worth considering for policymakers. We define the SESOI for the PMPI as $1/n$, where n represents the total number of tests available. The SESOI is $1/8 = 0.125$ (i.e., 12.5 percentage points). In our power analysis, we estimate the

probability of rejecting the null hypothesis (i.e., no effect or negative effect of the information campaign) for the SESOI. Our power analysis (see Supplementary Material SM4) calibrated on the pilot data yielded satisfactory statistical powers for the VDI and PMPI with probabilities to estimate the SESOI equal to 99.6 % for the VDI and 100 % for the PMPI. The statistical power is low for the VPI (15.7 %).

3.5. Analysis plan

The three outcomes of interest (VDI, PMPI, VPI) were generated using the two formulae set out previously. Under both conditions (control and treatment), participants who cannot see images (i.e., those who wrongfully answer the image question on screen 2) were not able to participate in the rest of the experiment and were not included in the final 400 observations.⁷ Note that no participant fell under the preregistered exclusion rule. We committed to estimating the effect of the information campaign on the three outcome variables using a Tobit model to take into account the possible inflation of observations at the lower and upper limits of the scales. In case there were no such observations, we committed to estimating the treatment effect using OLS. We use a significance threshold of 0.05 but we apply a Bonferroni correction for multiple hypothesis testing and retain $p = 0.0167$ as a significance threshold (three outcome variables, $\alpha=0.05$).

We set up outcome-neutral tests to anticipate potential ceiling or floor effects. Prior to hypothesis testing, we committed to running the above power analysis again using data from the control group. We committed to analysing only the outcome variables for which we are able to estimate the SESOI with a probability of 80 percentage points or higher (see Sampling Plan).

We committed to perform hypothesis testing for the PMPI and VPI as presented in Fig. 1 (for which we expect an increase in the scores). Hypothesis testing for the VDI is reverted (for which we expect the campaign to decrease the score). Using the estimates of the Tobit (or OLS) estimation, we perform unilateral hypothesis testing to determine the impact of the information campaign. First, we test whether the treatment effect is smaller than the SESOI (i.e., $H_0^1 : \beta \leq \pi$). If we reject H_0^1 , we conclude that the information campaign is successful ($\beta > \pi$). If we are unable to reject H_0^1 , we test the reverse hypothesis, i.e., whether

⁷ This exclusion condition was added after the Stage 1 manuscript was accepted but was approved by the recommender before data collection.

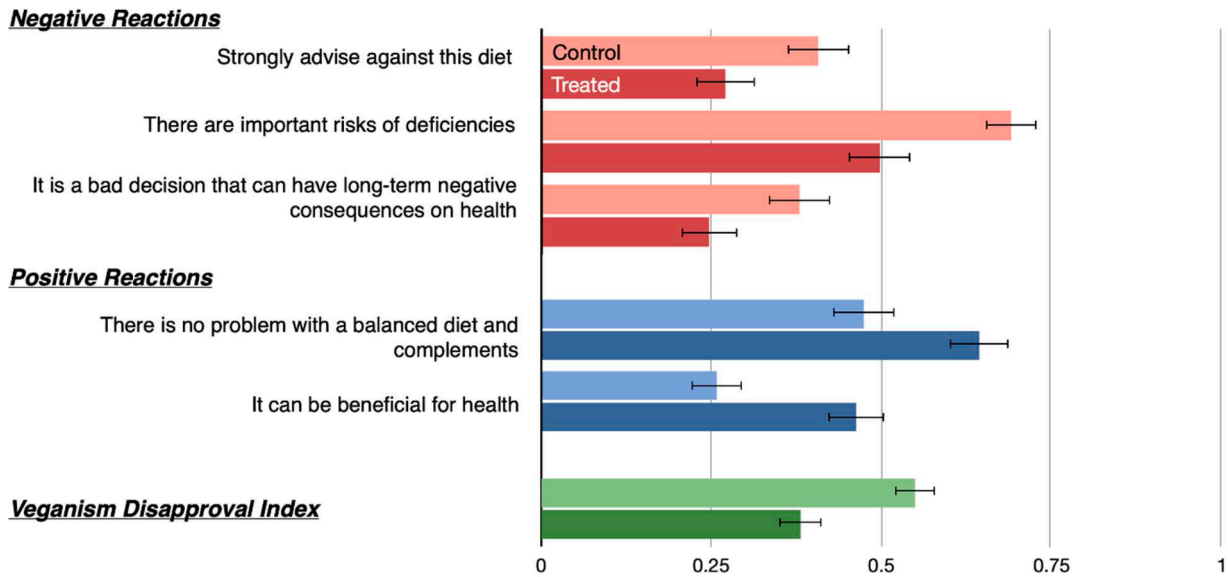


Fig. 2. Differences in the advice given to a 27 years-old male patient willing to adopt a plant-based diet. Bars represent averages, and spikes represent 95 % confidence intervals. $N = 200$ in the control condition, $N = 200$ in the treatment condition.

the treatment effect is larger than the SESOI (i.e., $H_0^2 : \beta \geq \pi$).
 On the one hand, if we reject H_0^2 , we have confirmation that the treatment effect is smaller than the SESOI ($\beta < \pi$). We then test whether the treatment effect is greater than zero (i.e., $H_0^3 : \beta \geq 0$). If we reject H_0^3 , we conclude that the information campaign is a failure as the treatment effect is negative ($\beta < 0$). If we are not able to reject H_0^3 , we test the reverse hypothesis, i.e., whether the treatment effect is lower than zero (i.e., $H_0^4 : \beta \leq 0$). If we reject H_0^4 , we conclude that the information campaign is weakly successful as the treatment effect is located between zero and the SESOI ($\pi > \beta > 0$). If we are unable to reject H_0^4 , we are not able to distinguish between a failure and a weakly successful

information campaign as the treatment effect is lower than the SESOI but could be positive or negative.

On the other hand, if we are unable to reject H_0^2 , we are not able to conclude whether the treatment effect is greater or lower than the SESOI ($\beta \leq \pi$ or $\beta \geq \pi$). We then test whether the treatment effect is negative (i.e., $H_0^4 : \beta \leq 0$). If we reject H_0^4 , we conclude that the information campaign is either weakly or fully successful as the treatment effect is positive but could be greater or lower than the SESOI ($\beta > 0$ but $\beta \leq \pi$ or $\beta \geq \pi$). If we are unable to reject H_0^4 , our results are inconclusive as the treatment effect could be positive or negative, greater or smaller than the SESOI ($\beta \leq 0$ or $\beta \geq 0$ and $\beta \leq \pi$ or $\beta \geq \pi$).

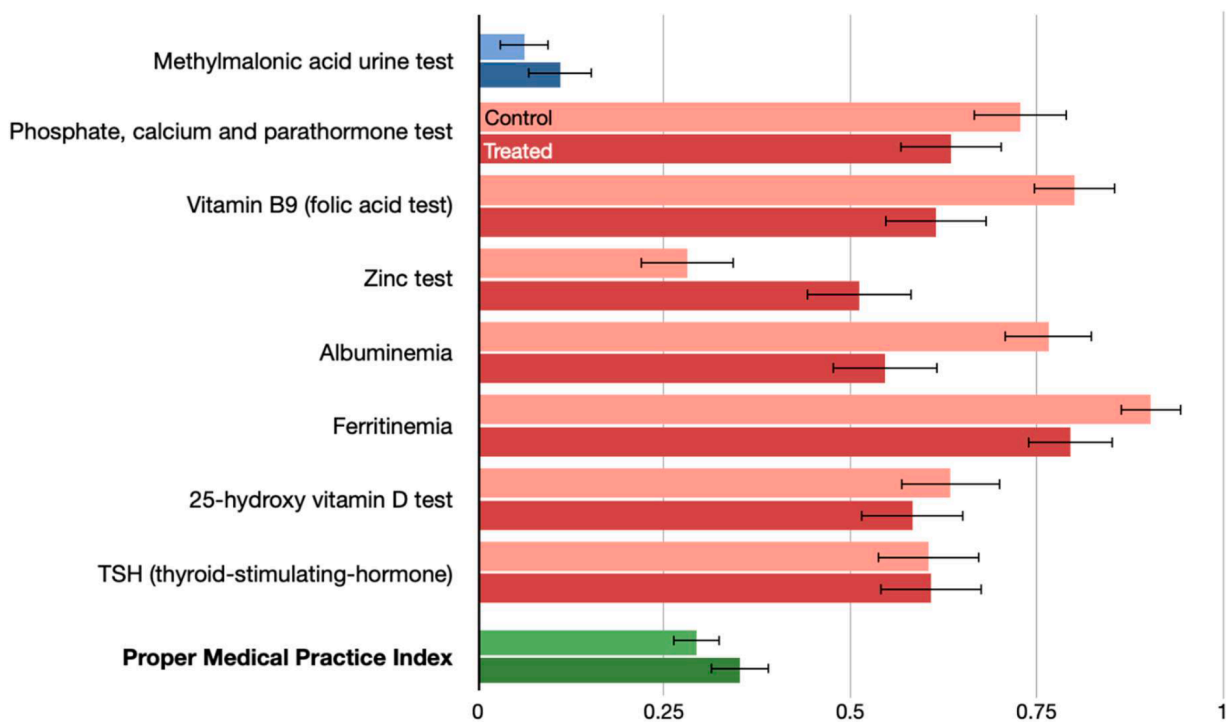


Fig. 3. Differences in biological tests doctors would prescribe to a 31 years-old male patient who has been vegan for four years without taking supplements and who has no symptoms. Bars represent averages, and spikes represent 95 % confidence intervals. $N = 200$ in the control condition, $N = 200$ in the treatment condition.

Table 3
Mean, standard deviation and marginal effects for the VDI and PMPI.

	Control group		Treated group		Marginal effects		p-values
	Mean	SD	Mean	SD	Estimate	SE	
VDI total	0.550	0.214	0.382	0.226	-0.166	0.021	<0.001
VDI 1	0.409	0.328	0.269	0.308	-0.142	0.032	<0.001
VDI2	0.691	0.273	0.501	0.325	-0.185	0.030	<0.001
VDI 3	0.382	0.326	0.247	0.297	-0.125	0.031	<0.001
VDI 4	0.473	0.330	0.644	0.306	0.174	0.032	<0.001
VDI 5	0.259	0.271	0.464	0.301	0.213	0.029	<0.001
PMPI total	0.293	0.228	0.348	0.273	0.044	0.024	0.069
T1	0.060	0.238	0.110	0.315	0.050	0.028	0.073
T2	0.730	0.445	0.645	0.480	-0.085	0.046	0.067
T3	0.800	0.401	0.625	0.485	-0.175	0.044	<0.001
T4	0.280	0.450	0.500	0.501	0.220	0.048	<0.001
T5	0.765	0.425	0.560	0.498	-0.205	0.046	<0.001
T6	0.900	0.301	0.800	0.401	-0.100	0.035	0.005
T7	0.635	0.483	0.590	0.493	-0.045	0.049	0.357
T8	0.605	0.490	0.610	0.489	0.005	0.049	0.919
PMPI no zinc	0.232	0.242	0.326	0.282	0.096	0.026	<0.001

The marginal effects for the VDI total, VDI items 1 through 5, PMPI total, and PMPI no zinc are estimated using a Tobit regression. The marginal effects for T1 through T8 are estimated using an OLS regression. The p-values correspond to a two-sided test where the null hypothesis is that the marginal effect is equal to zero.

4. Results

The experiment took place in June and July 2022. Data collection happened as originally planned with no deviation from the pre-registration. In total, 400 doctors took part in the experiment (200 in the control group, 200 in the treatment condition). All participants spent more than 90 s on the survey. Among the 400 doctors included in the data analysis, 87 % are private practitioners (87.5 % in the control group vs. 86.5 % in the treated group), 44.3 % are female (44% vs. 45.5 %), and 50 % live in an urban area with 100,000 inhabitants or more (55% vs. 44.5 %). About 27 % of the participants are below 40 years old (27% vs. 27 %), and 32.8 % are 60 years old or older (34% vs. 31.5 %).

As planned, we reproduced the power analysis using the control group data rather than the pilot data. We obtain a 99.7 % chance of detecting an effect size equal to the SESOI for the VDI, 100 % for the PMPI, and only 8.1 % for the VPI. Following our pre-registration, we do not analyze the VPI as we lack statistical power due to the large share of zeros (49 % of the decisions in the control group). Although we test only two hypotheses, we did not explicitly mention that we would adapt our Bonferroni adjustment accordingly, so we retain $p = 0.0167$ as a significance threshold ($\alpha=0.05$). Following our pre-registered procedure, we use Tobit estimations for all analyses as we have values at the upper or/and lower bounds of the scales.

4.1. Confirmatory analyses

First, we observe that the treatment significantly affects the advice doctors would give to the patient willing to adopt a plant-based diet. Fig. 2 shows indeed that the treatment significantly decreases veganism disapproval by doctors. The average VDI score reduces from 0.550 (SD=0.214) in the control condition to 0.382 in the treatment group (SD=0.226). The estimated marginal effect of the treatment using a Tobit regression model is equal to -0.166 (SE=0.022), which is significantly smaller than the pre-registered SESOI of -0.10 (one-sided test: $p = 0.001$). According to the pre-registered decision rule, the information intervention can be considered as successful.

Second, we see that the treatment also affects the medical practice, i. e., the biological tests that the doctors would prescribe to the vegan patient. The average PMPI score increases from 0.293 (SD=0.228) in the control group to 0.348 (SD=0.273) in the treatment condition (see Fig. 3). The estimated marginal effect of the treatment is equal to 0.044 (SE=0.024, Tobit model), which is lower than the pre-registered SESOI of 0.125. The treatment effect is not statistically different from zero given our Bonferroni adjustment (one-sided test: $p = 0.0343$). Following our pre-specified decision rule, we can conclude that the information

intervention is either weakly successful or fails at improving medical practice.

4.2. Exploratory analyses

First, our results show that the information intervention successfully impacts doctors' (hypothetical) advice about plant-based diets. We see that the information intervention increases all positive reactions (the diet can be beneficial for health, there is no problem if the diet is well balanced and the patient is supplemented) and mitigate negative reactions (strongly advise against this diet, there are important risks of deficiencies, it is a bad decision with negative long-term consequences on health). Means, standard deviations, marginal effects, standard errors, and p-values for two-sided tests are reported in Table 3 in Appendix.

Second, the information intervention has however a limited or even null impact on (hypothetical) medical prescriptions. Exploratory analyses suggest that the intervention increases the prescription of T1 and decreases the prescription of several other tests (T2, T3, T5, T6). The intervention seems to have limited or no impact on T7 or on T8. More surprisingly, the intervention seems to increase the prescription rate for the Zinc test (T4). In the control group, 28 % of the doctors ask for a Zinc test while 51 % of them do so in the treatment group. It suggests that our booklet can be improved regarding the information provided for Zinc. In the experiment, we mentioned that Zinc concentration levels tend to be smaller for vegan patients than for the general population but that there is no significant clinical impact. Doctors might have retained that Zinc levels can be smaller and might have preferred to test for it. When we drop the Zinc variable, the estimated marginal treatment effect on PMPI (scaled between 0 and 1 in both cases) goes from 0.044 to 0.096. In this case, the one-sided p-value decreases to less than 0.001. This suggests that the lack of results is likely to be due to the Zinc effect.

Additionally, we explore whether modifying the correction level of Multiple Hypothesis Testing (MHT) changes the conclusion for the PMPI. In the confirmatory analysis, even though we do not analyze the VPI, we stick to the pre-registered correction level of three hypotheses and use a Bonferroni correction, which is a conservative approach. We relax this approach in two ways. First, we re-run the analysis using a Holm-Bonferroni correction for three hypotheses, as Holm-Bonferroni is less conservative than the Bonferroni correction while still efficiently correcting for MHT (family-wise error rate). (Eichstaedt et al., 2013) This procedure leaves the results unchanged for the VDI (successful campaign) and the PMPI (weakly successful or failure). Second, we re-run the analysis using a Bonferroni and Holm-Bonferroni correction for two hypotheses, as we only tested two hypotheses in the

Table 4
Heterogenous treatment effects on VDI using a Tobit regression.

	(1)	(2)	(3)	(4)	(5)
Treatment	-0.171*** (0.023)	-0.156*** (0.030)	-0.156*** (0.032)	-0.190*** (0.030)	-0.161*** (0.043)
Female		0.005 (0.032)			0.005 (0.032)
Treatment x female		-0.035 (0.045)			-0.033 (0.045)
Urban area			0.007 (0.032)		0.002 (0.032)
Treatment x urban area			-0.032 (0.045)		-0.030 (0.045)
Age below 49				-0.070* (0.032)	-0.070* (0.032)
Treatment x Age below 49				0.042 (0.045)	0.041 (0.045)
Log Likelihood	13.204	13.643	13.546	16.021	16.806
Num. obs	400	400	400	400	400
Left-censored	5	5	5	5	5
Uncensored	389	389	389	389	389
Right-censored	6	6	6	6	6

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. The figures here are the estimated coefficients, with standard errors in parentheses.

Table 5
Heterogenous treatment effects on PMPI using a Tobit regression.

	(1)	(2)	(3)	(4)	(5)
Treatment	0.052 (0.029)	0.067 (0.038)	0.080* (0.041)	0.054 (0.038)	0.098 (0.055)
Female		0.001 (0.041)			0.003 (0.040)
Treatment x female		-0.033 (0.057)			-0.036 (0.057)
Urban area			0.072 (0.041)		0.074 (0.040)
Treatment x urban area			-0.044 (0.057)		-0.043 (0.057)
Age below 49				0.022 (0.041)	0.027 (0.041)
Treatment x age below 49				-0.003 (0.058)	-0.004 (0.057)
Log likelihood	-111.802	-111.493	-110.004	-111.557	-109.306
Num. obs	400	400	400	400	400
Left-censored	53	53	53	53	53
Uncensored	347	347	347	347	347
Right-censored	0	0	0	0	0

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. The figures here are the estimated coefficients, with standard errors in parentheses.

confirmatory analysis (the VPI failed the outcome neutral test).⁸ Following our decision rule, the results remain unchanged for the VDI but the PMPI goes from weakly successful or failure to weakly successful for both correction procedures.

Third, we then explore whether the treatment has a heterogeneous effect on the doctor population. We run a series of Tobit regressions in which we interact the treatment effect with (i) a dummy variable for female doctors, (ii) a dummy variable for doctors living in urban areas with 100,000 inhabitants or more, or (iii) a dummy variable for doctors who are strictly younger than 50 years old. We also include the dummy variable in the regression. Results are reported in Tables 4 and 5 (see Appendix). We do not detect any significant association for the VDI or for the PMPI scores.

Fourth, the treatment effect might also depend on the attention

⁸ We are unable to use a less conservative approach such as Romano-Wolf or Young's joint correction as we report the result using the Sequential Unilateral Hypothesis Testing (SUHT) procedure.

devoted to the booklet. The median doctor in the treatment group spent 3.6 min looking at the information booklet, while the most rapid doctor devoted only 22 s to our information campaign. To explore the sensitivity of our results to this issue, we run the above statistical analysis by considering only participants who spent at least 90 s on the information booklet in the treatment group (21 observations excluded). In this case, the estimated marginal treatment effects become larger in absolute value both for the VDI (from -0.166 to -0.173) and the PMPI (from 0.044 to 0.054). The conclusions remain the same for the VDI, and the intervention becomes weakly successful for the PMPI if we follow our decision rule. The larger effects obtained by excluding the most rapid participants might either result from larger attention devoted to the information campaign or/and from a selection effect (i.e., doctors who are the least friendly to plant-based diets spend the least time on the booklet). Lastly, we explore whether the time spent on the web-based tool Vegeclis, for which the link was provided in the booklet, correlates with the VDI and PMPI scores.⁹ The median time spent on Vegeclis is 5.58 s and only 12 doctors spent over 30 s on Vegeclis. We believe that any time under 30 s is not enough to explore Vegeclis and grasp additional information that was not included in the booklet. We create a dummy variable equal to 1 for those who spent over 30 s on the page and run a Tobit regression either on the time spent on Végéclis or on the dummy variable (sample of treated doctors). The results show no significant differences, suggesting that visiting Vegeclis does not affect the doctors' VDI and PMPI scores. We thus conjecture that the impact of the information intervention stems mostly from the five-page booklet.

Fifth, our experiment contained the Veganism Promotion Index (VPI), which aimed at capturing more active behaviors in favor of the promotion of a plant-based diet. We did not analyze the treatment effect on the VPI in the confirmatory analysis because it did not pass the associated outcome-neutral test (i.e., low statistical power). The lack of statistical power is mostly driven by the very large share of observations at the lower bound of the scale, e.g., doctors who do not give anything to the information campaign (49 % in the control group, 51 % in the treatment group). The average donation score is the same in both conditions (mean: 38.7 % of endowment). Fig. 4 shows that the distribution is three-modal with peaks at 0 %, 100 %, and 50 % (in decreasing order of prevalence). While the VPI does not seem to be affected by the treatment, we observe however a strong correlation with the VDI. A

⁹ We use the time spent on the penultimate of the booklet (i.e., the page where the link to Vegeclis was provided) as a proxy for the time spent on Vegeclis.

Distribution of donations given to the information campaign

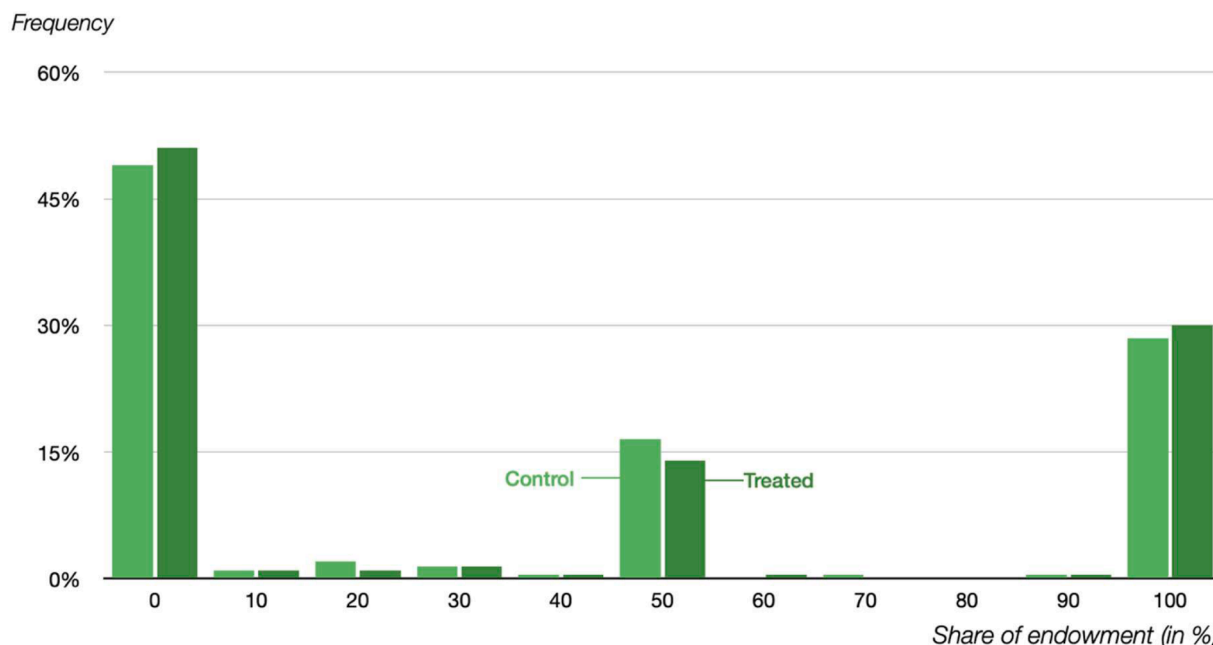


Fig. 4. Differences in VPI scores. Bars represent frequencies in the data. $N = 200$ in the control condition, $N = 200$ in the treatment condition.

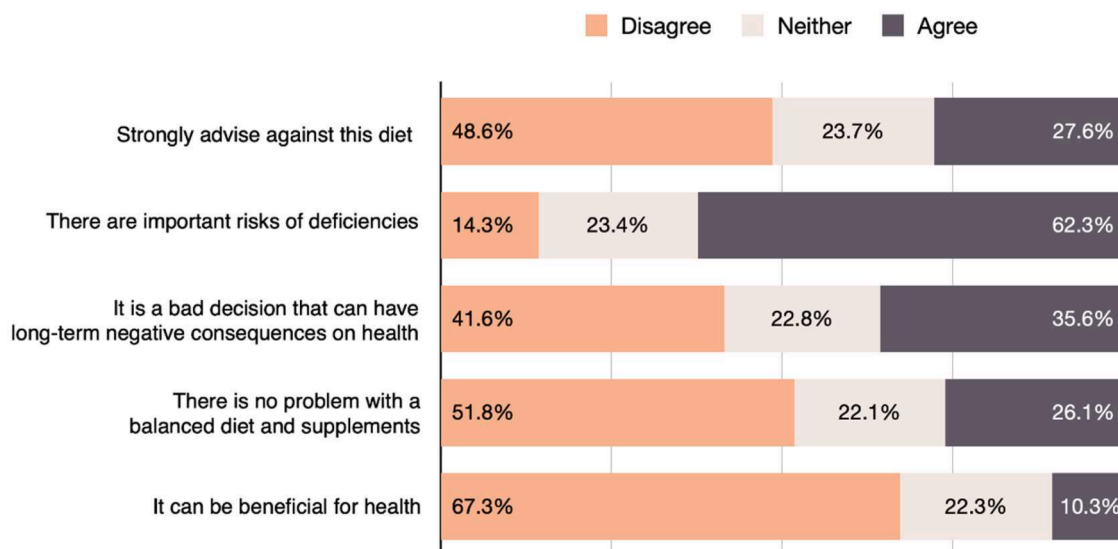


Fig. 5. Advice given to a 27 years-old male patient willing to adopt a plant-based diet. Weighted averages for representativeness. Control group only ($N = 200$).

Tobit regression indicates that going from 0 to 100 % in the VDI score decreases donations by 46.5 percentage points ($p < 0.001$), suggesting that more negative attitudes towards veganism are correlated with lower donations to promote plant-based diets.

Sixth, we document the average view among the general population of doctors about plant-based diets by using data from the control group. We recode the answers to the items of the VDI. We consider that doctors who give scores between 0 and 3 disagree with the statement, and those who give scores between 7 and 10 agree with the statement. We consider that doctors who report answers between 4 and 6 neither agree nor disagree with the statement. We weigh answers to get a representative sample of the doctor population. Fig. 5 reports the VDI-recoded answers for the control group. We observe that most doctors in the population highlight large risks of deficiencies (62.3 %) when the patient tells them

about his plans to go vegan. Doctors are also very unlikely to tell the patient that a vegan diet could be beneficial for health (10.3 %). Only one out of four doctors report that there is no problem with a balanced vegan diet with supplements (26.1 %). However, and surprisingly, only one out of four doctors strongly advise against this diet (27.6 %), which suggests that most doctors would not express all their concerns to the patient.

Last, exploratory analysis of the control group only suggests that doctors are aware of the issues associated with plant-based diets and medical practice. First, Fig. 6 below shows that only 24.5 % of French doctors declare to have good knowledge of plant-based diets. When we ask about *other* doctors, only 11.1 % of the French doctors declare that their colleagues are sufficiently knowledgeable on the topic. This suggests that doctors might have on average an overconfidence bias, i.e.,

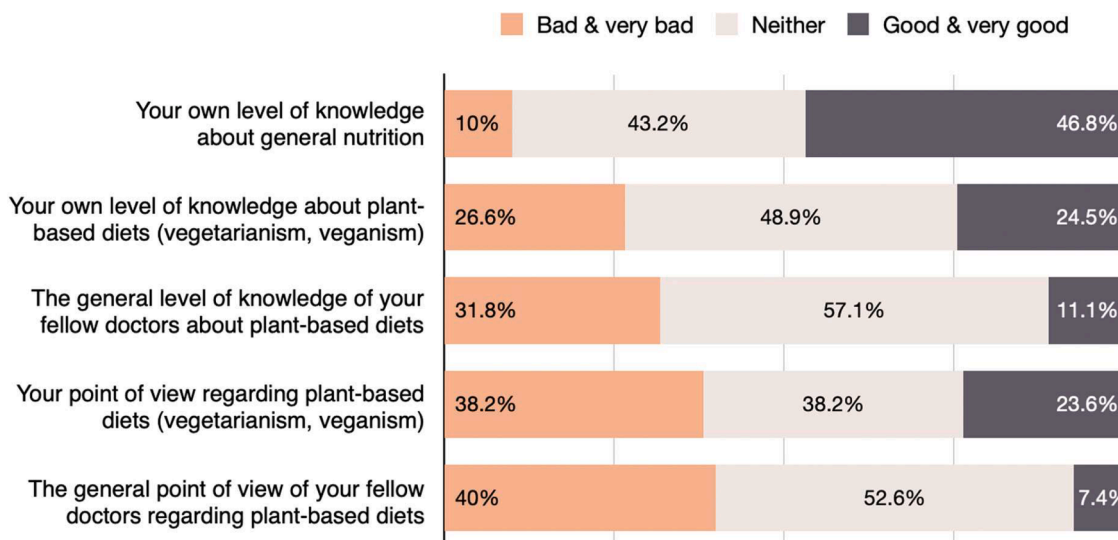


Fig. 6. Self-reported knowledge about diets and plant-based diets by French doctors. Weighted averages for representativeness. Control group only (N = 200).

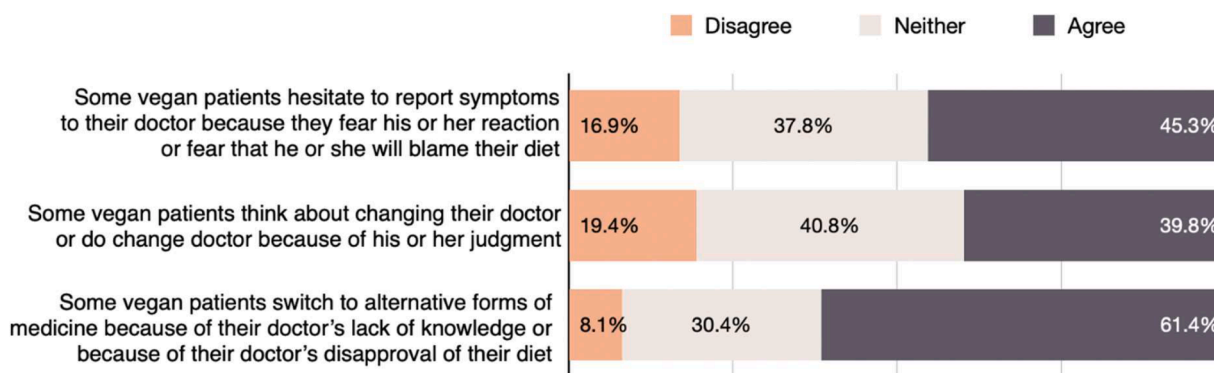


Fig. 7. Doctors' perception of the negative consequences of the doctors' negative views on plant-based diets on the patient-doctor relationship.

considering that they know, on average, more than their colleagues about plant-based diets. In addition, half of the doctors say that they have good knowledge about diets but medical schools in France devote very little time to the topic. So, doctors might either actively get informed on their own initiative on the topic (but they get informed less on plant-based diets), or they might overestimate their knowledge on the issue.

Next, doctors seem aware of the fact that doctors' opinions on plant-based diets might have negative consequences for patients. Fig. 7 shows that most doctors (61.4 %) consider that the doctors' lack of knowledge or disapproval of one's vegan diet might lead patients to switch to alternative forms of medicine. Only a small minority of doctors do not think that a vegan patient could hide their symptoms (16.9 %) or change doctors (19.4 %) because of their reaction to their plant-based diet.

5. Discussion

Our study shows that doctors hold on average negative views about plant-based diets. While recent scientific evidence suggests that vegan diets could substantially decrease mortality rates, only a small share of doctors tend to think that a vegan diet can be beneficial for health. On the contrary, strong opinions against vegan diets persist, especially regarding the risks of deficiencies. More particularly, our results show that doctors are still largely concerned with the potential lack of iron in plant-based diets. These results show that there is room for better informing and training doctors with the latest scientific

recommendations on plant-based diets.

Our information intervention aims to fill this gap by giving precise information about the risks and benefits of plant-based diets. We find strong evidence that our information booklet successfully impacted doctors' views about vegan diets, and the estimated treatment effect resulting from our confirmatory analysis is 66 % larger than the pre-registered SESOI. Doctors feel reassured about the risks of deficiencies, and the long-term consequences on health, and are more likely to see benefits for health. The success of the information intervention suggests that the current opposition to plant-based diets is likely to result from a lack of information rather than a strong bias against this diet.

Nevertheless, we find limited empirical support for the impact of our booklet on doctors' (hypothetical) medical practice with vegan patients (i.e., the estimated effect is positive, but it is below the pre-specified SESOI and is not statistically different than zero). The exploratory analyses suggest that not all tests might have been affected in the same way by our information treatment, as the prescription of Zinc tests increases after exposure to the treatment. However, the exploratory analyses also suggest that the most frequently prescribed tests (Ferritinemia, Vitamin B9, and Albuminemia) are significantly affected by the treatment. Altogether, we believe that these results show that there is some room to improve the doctors' medical practice with patients adopting a plant-based diet, but that it might require more elaborate training than a simple booklet. In our view, it highlights the need for training on plant-based nutrition at the university.

The results of the study are positive and show that the booklet has the

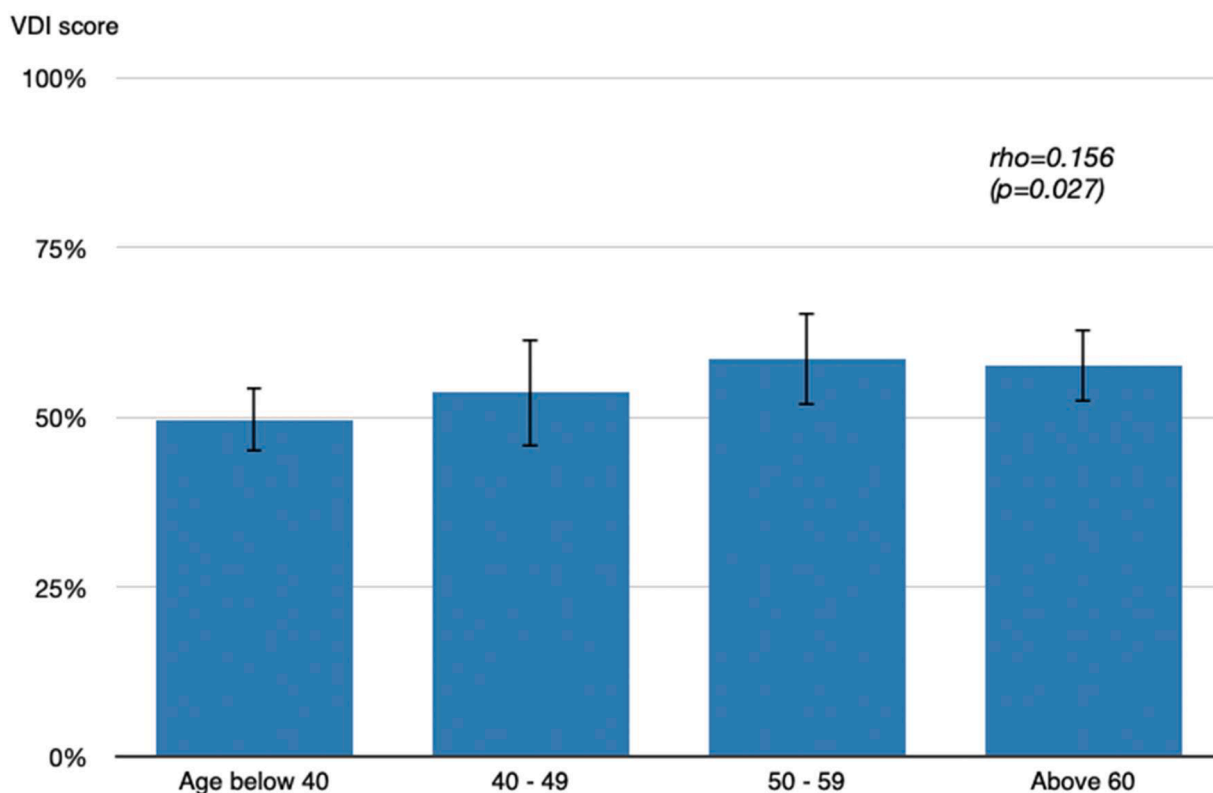


Fig. 8. VDI scores between age groups. The error bars represent the 95 % confidence intervals. Rho represents the Spearman rank correlation score.

potential to improve doctors' opinions and, to a lesser extent, medical practices with vegan patients. Our sample is representative so that the results are generalizable to the entire population of French doctors. Further studies are required to assess the effectiveness of the conveyed information. The study is based on case studies, thus reflecting stated rather than revealed preferences, and may therefore not reflect doctors' actions in real practice. Responding to case studies involves less responsibility for doctors, allowing them to express more sympathetic views and adopt riskier behaviors without consequences. Future studies should focus on the impact of the booklet on real-life cases as well as the long-term effect of the information on medical practices.

Our intervention seems to have an effect on the average of those observed by other studies on medical information campaigns. Giguère et al. (2020) provide a systematic review of the impact of printed educational materials on medical practices and healthcare outcomes. The authors report a mean Cohen's d of 0.41 across a range of studies (Cohen's d ranges from 0.04 to 0.79).¹⁰ We find that our booklet outperforms previous studies on the VDI (Cohen's $d = 0.71$) and performs below average for the PMPI (Cohen's $d = 0.22$; Cohen's $d = 0.35$ when Zinc is removed). Due to the heterogeneity of practitioners, practices, and information, it is difficult to compare effect sizes across studies. Nevertheless, our booklet synthesizes information, requires a minimal cost of time and money for doctors, and is tailored to the specific needs of doctors, which seem to be the most important factors in conveying information in the medical field. (Dawes & Sampson, 2003; Marriott et al., 2000)

Our study suggests that information campaigns can be an efficient but not sufficient way to favor the transition toward a more sustainable food system. On the one side, the booklet significantly improves the

views on plant-based diets with relatively small costs as some doctors and experts already gather scientific evidence about the risks and benefits of plant-based diets on a regular basis. Conveying this information can be an effective way to improve the doctors' reactions to patients willing to adopt a plant-based diet. This, in turn, could reduce the risks of patients hiding symptoms or switching to alternative medicine. On the other side, information campaigns might not be enough to help doctors deal with plant-based diets. While it is true that they yield short-term large benefits (i.e., doctors rapidly change their minds after a simple exposure to the booklet), we observe more modest effects (if any) on medical practice.

The long-term success of the transition towards more plant-based diets highly depends on the capacity to effectively monitor the health of patients willing to switch. In addition, the long-term benefits of the intervention on the doctors' opinions about plant-based diets might be smaller than what we report here due to information decay, although we can also anticipate some form of information spillovers across colleagues which could augment the benefits of such interventions. However, it could also be that the general perspective on plant-based diets becomes more positive among younger generations of doctors leading to a better consideration of patients who adopt such diets. In the control group, an exploratory analysis suggests that younger generations hold more positive views on plant-based diets. We find indeed a negative correlation between the age of doctors and the disapproval of veganism (see Fig. 8 in the Appendix; Spearman's rank correlation: 0.156, $p = 0.027$).

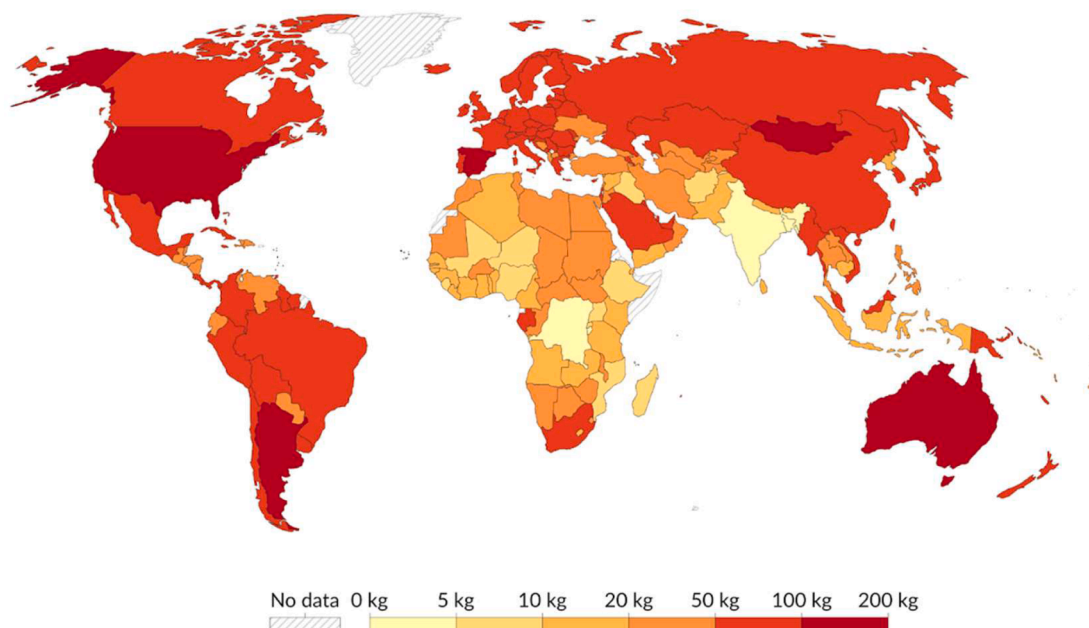
Let us also note that the recipient's trust in the messenger is a key element for the success of such information campaigns. While we can reasonably expect most doctor students to trust their professors during their university training, it might be more difficult to obtain similar levels of trust with booklets. In the current experiment, the booklet included the logo of the French National Institute for Research (CNRS), one of the largest public scientific organizations in France, which benefits from a prestigious image. The participants were therefore likely to trust the information provided in the document. However, the

¹⁰ Their findings only apply to comparisons between printed educational materials versus no intervention. Our intervention slightly differs as we provide a computerized booklet.

Meat supply per person, 2020

Average total meat supply per person measured in kilograms per year.

Our World
in Data



Data source: Food and Agriculture Organization of the United Nations

OurWorldInData.org/meat-production | CC BY

Note: Data excludes fish and other seafood sources. Figures do not correct for waste at the household/consumption level so may not directly reflect the quantity of food finally consumed by a given individual.

Fig. 9. Meat supply per person in 2020. Source: FAO, Our World In Data. .

effectiveness of similar campaigns might be lower for campaigns that have a lower trustworthiness. Furthermore, the effect of the campaign is likely to be heterogeneous depending on the participants' views and the credit they give to the campaign (in addition to other standard behavioral biases such as confirmation bias).

Importantly, we cannot rule out the possibility that the above results are partially due to an experimental demand effect (EDE). (Bardsley, 2005; Bardsley, 2008; Zizzo, 2010) Participants in the experiment reacted to fictional case studies about how to deal with vegan patients just after reading a booklet on the topic. This might encourage them to answer according to the guidelines outlined in the booklet because they feel that they are expected to do so. It is thus possible that the increase in positive views about plant-based diets is due to this EDE. On the other hand, two other elements suggest that the EDE might be limited. First, we do not observe any economically significant impact on donations (although we lack statistical power to conclude). This suggests that, should there be an EDE at stake, it has a limited impact. Second, we observe that doctors are more likely to prescribe a Zinc test to their patients after being exposed to the booklet. The booklet states that Zinc concentration levels tend to be smaller for vegan patients than for the general population but that there is no significant clinical impact. The increase in Zinc test prescriptions might reflect that doctors still adopt a conservative approach to the booklet's claims, limiting the EDE. Still, it is likely that the effect net of the EDE is lower than what we found above and, in this regard, our results should be seen as an upper bound of a potential real effect outside of this narrowly controlled environment.

In recent years, numerous works in economics have sought to

promote the consumption of plant-based diets for environmental, health, and animal welfare reasons.¹¹ A key challenge for economists is to determine the most effective interventions to drive an effective change in consumption. Here, we focused on changing doctors' knowledge and opinion about plant-based diets. An important element to quantify the potential for change is the demand for nutritional advice from patients to their doctors. Recently, Labbé (2016) showed that about 9 out of 10 patients would like to receive nutritional advice from their doctor, suggesting a strong demand. Our intervention has thus the potential to effectively help doctors convince/comfort their patients to adopt a plant-based diet. Overall, the benefits of the adoption could be economically significant. To get an idea of the magnitude of the benefits of such an intervention, let us consider the data of Springmann et al. (2020) who estimate at the country level the number of premature deaths (i.e., people between the ages 30 and 69) that could be avoided by adopting a vegan diet in France. The authors estimate that about 30,500 premature deaths and 65.92 MtCO₂-eq could be avoided yearly should the population adopt a vegan diet. Assuming a Value of Statistical Life of 3 million Euros per life in France (Treich, 2015), the adoption of a vegan diet could imply a yearly social benefit of 91.5 billion Euros due to premature mortality reduction. The environmental benefits (assuming 200 Euros per ton of CO₂-eq) would equal about 13.1 billion Euros per year. If an intervention could help even 1 out of 100 patients adopt or maintain a vegan diet, the social benefit would be larger than a billion Euros. This figure does not consider the reduction in other health externalities (e.g., reduction in health care costs, increase in pensions), other environmental externalities (e.g., water use, biodiversity,

¹¹ Examples of work include promoting through nudges, (Kurz, 2018, Hansen et al., 2021, Zhou et al., 2019) labeling, (Rosenfeld et al., 2022) and framing (Krcan & Houtsman, 2020, Carvalho et al., 2022).^{83,84}

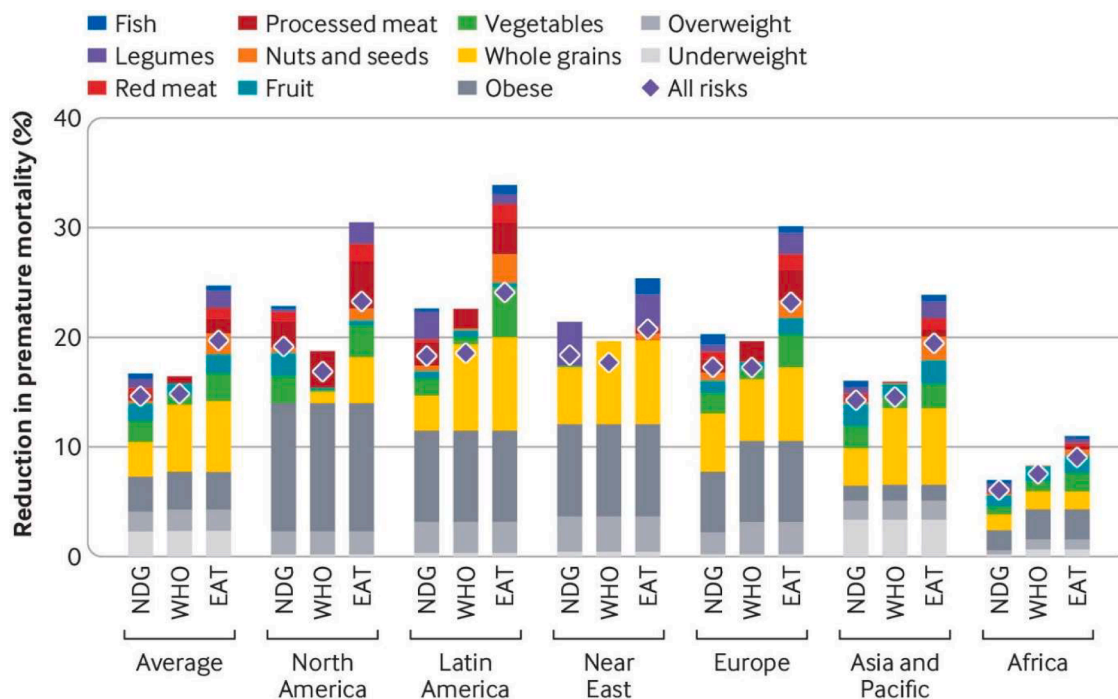


Fig. 10. Reduction in premature mortality following dietary changes. Source: Springmann et al. (2020).

pollution), or externalities on animal welfare.

Beyond France, our strategy to inform doctors about the risks and benefits of adopting plant-based diets could be extended and tested in other high-income and upper-middle-income countries. Data from the FAO displayed in Fig. 9 show indeed that the meat supply per capita exceeds 50 kgs in numerous countries worldwide. Meat supply per capita in France was equal to 79.2 kg in 2020, which is representative of the European Union (78.3 kg) and lies between high-income countries (90.4 kg) and upper-middle-income countries (63.7 kg). The estimates of Springmann et al. (2020) displayed in Fig. 10 in the Appendix show that the benefits for premature mortality of adopting a predominantly plant-based diet (EAT-Lancet diet) are similar for Europe, Latin America, and North America. However, we can note that the social gains in adopting plant-based diets are much smaller in low-income countries where the meat supply is much lower (11.9 kg per capita in 2019). More globally, the adoption of plant-based diets mostly applies to countries with sufficiently high food security, and interventions such as ours should be envisioned for upper-middle-income and high-income countries only. Regarding our treatment, it is possible that doctors in other countries would react differently to an information intervention given the cultural norms (e.g., the role of doctors in society, the cultural attachment to meat) and the medical training.

CRedit authorship contribution statement

Romain Espinosa: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Thibaut Arpinon:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft, Writing – review & editing. **Paco Maginot:** Conceptualization, Resources. **Sébastien Demange:** Conceptualization, Resources. **Florimond Peureux:** Conceptualization, Resources.

Declaration of competing interest

Romain Espinosa is a recommender at PCI Registered Reports.

Thibaut Arpinon declare no competing interests.

Paco Maginot developed the platform *Vegecliv* but derives no financial benefits from it.

Sébastien Demange has had no financial competing interests over the past 5 years but has been an unpaid member of the Board of Directors and the Board of Nutrition Experts of the French Vegetarian Association (AVF) in this time period.

Florimond Peureux has no financial competing interests but is the Director of the *Observatoire National de l'Alimentation Végétale* (ONAV), a non-profit NGO that studies and promotes plant-based diets and provides information about the associated risks and benefits. Paco Maginot and Sébastien Demange are part of the ONAV scientific committee.

Data availability

All data and codes are available here: <https://github.com/EspinosaRomain/DoctorsVeganDiets>.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.socec.2024.102175](https://doi.org/10.1016/j.socec.2024.102175).

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