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Review

Widespread Dietary Patterns (Healthy and Balanced Diet, Western Diet, and Vegan and Vegetarian Diets) Compared for Water Consumption: Which Is the Winner?

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Abstract: An increasing number of people are interested in following a dietary pattern that is environmentally sustainable and water saving. However, consumers are mostly unable to recognize evidence-based information on food and nutrition and efficiently manage their diet. We conducted a narrative review aiming to support professionals to guide their assisted people that decide to follow a dietary pattern chosen for environmental or ethical reasons. We reviewed three scientific databases and Google Scholar, searching for papers that deal with the water consumption of widespread and well known dietary patterns (Healthy and Balanced Diet, Western Diet, and Vegan and Vegetarian diets). Our results suggest that moving toward a low-animal-based diet favors a reduction in water consumption, but current evidence is not sufficient to establish which is the winner in terms of water saving by comparing Vegetarian and Vegan diets.

Keywords: food sustainability; nutritional literacy; plant-based diet; vegan diet; water consumption; healthy diet

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1. Introduction

To date, an increasing number of people are deciding to follow a specific diet for ethical and environmental reasons [1]. In fact, growing scientific evidence suggests that specific kinds of food have different impacts on the environment [2]. Nowadays, despite the large amount of information and the interest in food and diet, people often struggle to efficiently manage their diet and make decisions about it [3]. This challenge calls to mind the concept of food literacy and its role in addressing the so-called "food paradox" [3], which can be summarized as "while people are becoming more interested in food, people are actually becoming more disconnected from it" [4], and confirms the cultural distance between people and the food they consume.

As a sort of confirmation, while television programs regarding food and, more generally, information about foodstuffs have been exploding, the time spent on cooking, growing, or eating food by consumers is steadily falling [4]. The result of this phenomenon is people's alienation in relation to the food they consume and the relative incapacity to manage their diet. Block et al. [3] attributed a central role to food literacy: it can deeply influence human health and well-being through educational food programs and initiatives that inform people and spread individual knowledge, motivation, and ability, in addition to providing the opportunity to apply that knowledge with the aim to use food adequately [3]. A food and nutrition literate community is realized when people can eat food able to provide nutritional health within a sustainable food system [5]. In the previous paper [5], this perspective was described as a multifaceted concept called "food and nutrition literacy", which embraces several aspects regarding individual knowledge and competences, interactive skills, and specific characteristics of the food environment. Other authors [6] emphasized the importance of developing a positive relationship with food and being able

to navigate the complex food system, which involves food skills and practices developed across the lifespan. On the other hand, they focused on individuals' capacity to take health enhancing actions aimed at improving nutritional outcomes and achieving a sustainable food system. The authors of previous papers [5,6] emphasized the potential role of food literacy as a tool to achieve environmental outcomes through specific food choices and decisions about personal diet. Recently, Willet et al. [2] collected evidence that proves that food consumption represents the major connection between human health and the environment [2].

In recent literature, several indicators trying to measure the environmental impact of diets have been identified (i.e., greenhouse gases, acidifying and eutrophying emissions, land use, and water consumption) [7]. In particular, water scarcity and pollution seem to represent the most serious critical issues to be addressed in the immediate future to ensure a healthy environment and the survival of the living beings of our planet [8]. For these reasons, it becomes fundamental to monitor water consumption in every human activity, including the food system.

The water consumption of a product can be calculated by the Water Footprint (WF), which is an indicator that quantifies the volume of water consumed during the production of a food (in liters per kilogram), and it can be distinguished into three components: the blue WF, which represents the use of groundwater and surface water; the green WF, which refers to the use of rainfall; and the grey WF, which is the fresh water required to assimilate the pollutants [9]. From the literature, it emerged that 70% of freshwater is absorbed by agriculture, while 22% is for industry, and the remaining 8% is for domestic purposes [10]. Several authors take into account this parameter to study the water consumption of widespread diets.

The Healthy and Balanced Diet, Western Diet, Vegan and Vegetarian diets are among people's most followed diets [11–13].

Regarding the definitions of these dietary patterns, the Healthy and Balanced Diet has been processed on the basis of the Healthy Eating Plate [14] and composed by a high amount and variety of vegetables and fruits, whole grains, protein foods (mainly from fish, poultry, beans, and nuts), and a moderate amount of healthy plant oils, such as olive and sunflower [13].

Vegan and Vegetarian diets [11] differ by the fact that the Vegan diet is a dietary pattern that excludes any animal food products (including eggs, dairy products, and honey) and it is based on a wide amount of plant foods [11]. On the contrary, the Vegetarian diet includes products such as seafood, dairy products, and eggs in addition to vegetables, fruits, whole grains, legumes, nuts, and seeds [11]. There are different types of Vegetarian diets and these are: the pescatarian diet, lacto-ovo vegetarian diet, ovo-vegetarian diet, and lacto-vegetarian diet [11].

A variant of the Vegetarian diet is the so-called Flexitarian diet that differs from the previous by the fact that it allows the occasional consumption of meat products [2].

Lastly, the Western Diet is characterized by a higher intake of processed meat, red meat, butter, high-fat dairy products, eggs, and refined grains [13,15].

More in detail, the frequencies considered for the second course differ among the four dietary patterns [16]: legumes, 50–60 g (raw) or 150–180 g (cooked)—twice a week (Healthy and Balanced Diet), three times/week (Vegetarian diet or Flexitarian), or four times/week (Vegan diet); fish, 120–150 g—twice a week (Healthy and Balanced Diet), twice a month (Vegetarian diet or Flexitarian); white meat, 100–150 g—once/twice a week (Healthy and Balanced Diet); eggs, 2 or 100 g—once a week or less (Healthy, Vegetarian diet or Flexitarian); red meat, 100 g—once a week or less (Healthy and Balanced Diet); cured meat, 70 g—once per two weeks or less (Healthy and Balanced Diet); cheese, 100 g (cream cheese) or 50 g (matured)—once/twice a week (Healthy and Balanced Diet, Vegetarian diet or Flexitarian); tofu or tempeh, 100 g—once/twice a week (Vegetarian diet or Flexitarian, Vegan diet); seitan, 100 g—once a week (Vegetarian or Flexitarian diets, Vegan diet). Frequencies for the second course of the Western diet could be the

following [16]: white meat, 100 g—more than twice a week; eggs, 2 or 100 g—once a week; red meat, 100 g—more than once a week; cured meat, 70 g—more than once a week; cheese, 100 g (cream cheese) or 50 g (matured)—more than twice a week.

Reducing the environmental impact of personal food choices is one of the most common reasons that drives people to adopt a Vegetarian or Vegan diet [1]. Many persons need to be properly oriented by health professionals when choosing to adhere to a Vegan or Vegetarian dietary pattern to not incur dietetic imbalances, with potential severe consequences for their nutritional health status. It is therefore important that nutrition practitioners and health educators are able to give correct information to people to preserve their health while pursuing environmental sustainability, and identifying the most environmentally friendly dietary choice.

In this perspective, we conducted a narrative review with the aim of classifying the four cited widespread dietary patterns—the Healthy and Balanced Diet, the Vegan diet, the Vegetarian diet, and the Western Diet—in terms of water consumption, from the least to the most impacting. We decided to focus on water consumption, considering the decline of this precious and limited resource, whose potential scarcity poses a danger to living beings in the near future [16,17].

2. Materials and Methods

A narrative review of the literature was performed on PubMed, Embase, Web of Science, and Google Scholar by using the following search string: ((“water footprint” OR “food sustainability” OR “sustainable diets” OR “dietary patterns and environment” OR “diet and climate change” OR “healthy and sustainable diet”) AND (“vegan diet” OR “flexitarian diet” OR “Mediterranean diet” OR “Western diet”)). We searched for documents in English from all geographic areas and without temporal limits. We decided to include editorials, books, and theses in addition to peer-reviewed journals and reports. In line with other authors [6], we scanned the first three pages of Google Scholar, taking into account that Google sorts search results by relevance.

The initial search resulted in n = 508 items (PubMed, n = 52; Web of Science, n = 60; Embase, n = 47; Google Scholar, n = 349). We reviewed titles and abstracts for selection and n = 252 items were considered for the revision of the full text [18]. These papers focus on environmental impact in terms of water consumption, excluding papers focused on other aspects of the environmental impact of diets such as, for instance, Carbon Footprint, cropland use, or nitrogen and phosphorus release.

We only included seven studies in the final synthesis (please see Figure 1) that investigated water consumption by comparing at least two dietary patterns in terms of WF among Healthy and Balanced Diet, Western Diet, and Vegan and Vegetarian diets. The studies included in the final synthesis were: five research articles, one report and one systematic review [18–24].

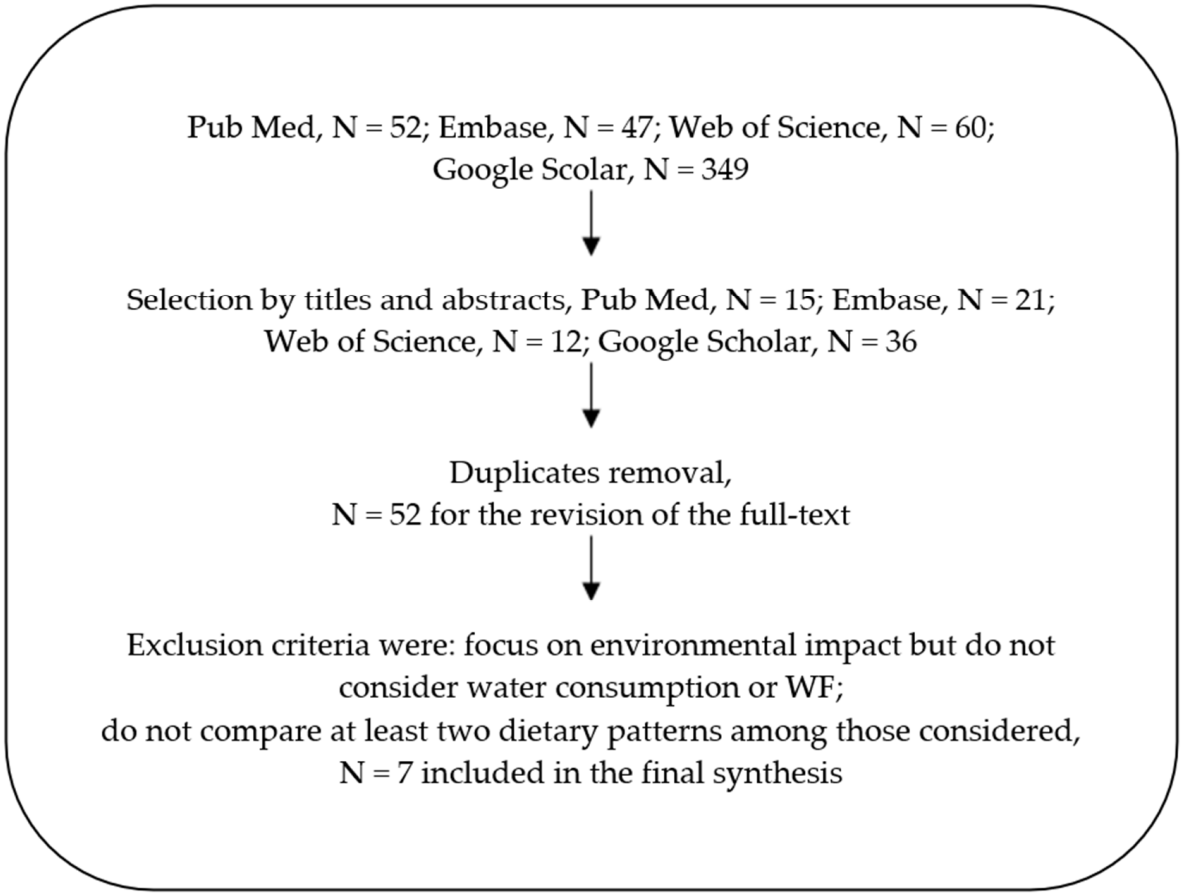

Figure 1. The flow diagram depicting the selection of articles.

3. Results

The results found by exploring the four databases have been collected and synthesized in Table 1.

Table 1. Studies included in the narrative review. Legend of the abbreviations that appear in the table: liters/die (l/d), liters/capital/die (l/cap/d).

Authors, Year of Publication	Article Type	Dietary Patterns	Main Conclusions
Ruini, L.F. et al., 2015 [19]	Report	Vegetarian diet Animal-based diet (USA diet) *	Comparison between two different meals (vegetarian meals and a modified vegetarian meal added with 150 g of red meat per day). The meal option with a higher amount of meat has a higher water consumption. The WF of Vegetarian diets is 1530 per capita l/d l/cap/d and the WF of the Animal-based diet is 4300 l/cap/d.
Harris F. et al., 2020 [21]	Systematic review	Current dietary patterns in Germany * Healthy diet (national dietary guidelines) ° Vegetarian diet Vegan diet ᵛ	Comparison between the four dietary patterns. A reduction in the animal source food content of diets would reduce green WF. Changing to a healthier dietary pattern (Healthy, Vegetarian, and Vegan diets) would result in a median reduction in total dietary WF of 18% per day with respect to current dietary patterns.

Table 1. *Cont.*

Authors, Year of Publication	Article Type	Dietary Patterns	Main Conclusions
Rosi A. et al., 2017 [18]	Research article	Omnivorous diet * Ovo-lacto-vegetarian diet Vegan diet [v]	Calculation of the WF. The omnivorous choice generated a bigger environmental impact and no differences were found for the environmental impacts between ovo-lacto-vegetarian and vegan diets. The WF range of an Omnivorous diet is 3000–3500 l/cap/d, while the WF ranges of Vegetarian and Vegan diets are 2000–2500 l/cap/d.
Saez-Almendros S. et al., 2013 [23]	Research article	Mediterranean diet ° Western diet *	Adherence to a Western diet would increase the indicators of environmental impact with respect to the Mediterranean diet.
			The water consumption of the Mediterranean diet is 824 l/cap/d 13.2 km^3/year, and that of the Western diet is 1374 l/cap/d 22 km^3/year.
Springmann M. et al., 2018 [20]	Research article	Flexitarian diet ^ Vegetarian diet Vegan diet [v]	Moving to a low-meat dietary pattern reduced freshwater use. Replacing animal products with plant-based food (low meat dietary patterns) led to a reduction in fresh water use of 2–11%.
Sobhani S.R. et al., 2019 [22]	Research article	Current diet * Diet based on food dietary pyramid in Iran °	A healthy diet with a greater proportion of energy from fruit and dairy products instead of a diet with a high proportion of energy from meat, fish, poultry, eggs and pasta, rice, and bread can reduce water use. The WF of the current diet is 4.11 m^3 per day 4110 l/cap/d, and the WF of the diet based on the food dietary pyramid is 2170 l/cap/d 2.17 m^3 per day.
Vanham et al., 2013 [24]	Research article	Current diet * Healthy diet ° Vegetarian diet Combination diet ° (Vegetarian and Healthy diets)	The Vegetarian diet results in the lowest WF. Generally, the reduction in meat intake contributes mostly to the WF reduction. The WF of the current diet is 4265 l/cap/d, the WF of the Healthy diet is 3291 l/cap/d, of the Vegetarian diet is 2655 l/cap/d, and of the Combination diet is 2973 l/cap/d.

* The characteristics of these diets provided by the authors [18,19,21,24] correspond to a Western diet [13,15]. Considering an ideal male subject of age between 30 and 59, weight 69 kg, who does not have specific nutritional requirements, it was estimated that the Western diet has an energetical content of 2459 kcal, proteins 97 g, fat 105 g, carbohydrates 303 g. ° These dietary patterns described by the authors [21–24] correspond to the model of the Healthy Eating Plate [14]. Considering an ideal male subject of age between 30 and 59, weight 69 kg, who does not have specific nutritional requirements, it was estimated that the Healthy and Balanced diet has an energetical content of 2184 kcal, proteins 71 g, fat 81 g, carbohydrates 314 g. [V] The characteristics of the Vegan diet referred to the definition provided by the Academy of Nutrition and Dietetics [11]. Considering an ideal male subject of age between 30 and 59, weight 69 kg, who does not have specific nutritional requirements, it was estimated that the Vegan diet has an energetical content of 2200 kcal, proteins 71 g, fat 83 g, carbohydrates 314 g. The characteristics of the Vegetarian diet referred to the definition provided by the Academy of Nutrition and Dietetics [11]. Considering an ideal male subject of age between 30 and 59, weight 69 kg, who does not have specific nutritional requirements, it was estimated that the Vegetarian diet has an energetical content of 2123 kcal, proteins 77 g, fat 64 g, carbohydrates 333 g. ^ A Flexitarian diet is basically a Vegetarian dietary pattern predominantly involving the consumption of vegetal products, but it occasionally permits the consumption of animal-based products and foods derived from animals (milk, cheese, fish, meat, and eggs) [20]. Considering an ideal male subject of age between 30 and 59, weight 69 kg, who does not have specifical nutritional requirements, it was estimated that the Flexitarian diet has an energetical content of 2216 kcal, proteins 70 g, fat 83 g, carbohydrates 317 g.

Rosi et al. [18] evaluated the environmental impact—including the WF—of the diets followed by n = 153 Italian adults (51 omnivores, 51 lacto-ovo-vegetarians, and 51 vegans). These authors calculated the water consumption by considering a manual calculation on the basis of tables, which included a complete list of the water requested by foods and beverages [25]. In particular, the authors observed that the omnivore choice had the highest WF and there were no relevant differences between the other dietary patterns in terms of environmental impact. This conclusion is in line with Springman et al. [20], who observed that adopting dietary patterns with fewer or no animal-based products resulted in a reduction in environmental parameters including freshwater use. The authors of the work mentioned above conducted extensive research based on an integrated health and environmental framework and adopted a multi methodological approach.

Harris et al. [21] conducted an extensive review of the literature and observed that moving from a Western Diet to a Healthy Balanced Diet involves a reduction in the green WF, but they did not find differences for the blue WF.

Sobhani et al. [22] focused their attention on two dietary patterns as well. The first one is represented by a diet of 2920 kcal with the highest proportion of energy intake coming from cereals (39%) (i.e., rice and pasta), the lowest contribution coming from vegetables (16%), and the remaining energetical intake coming from dairy products, meat, eggs, fish, and fats. The second dietary model has the same energetical intake, but the amount of vegetables and fruits increases and, in particular, the vegetable products contribute to 21% of the energy. These authors observed that the vegetal-based dietary model, which satisfies the characteristics of the Healthy Plate [14], can favor a reduction in water consumption. This observation comes from a survey conducted by the authors, which used a food frequency questionnaire [23] and investigated the dietary intake of n = 695 individuals.

Vanham et al. [24] focused their attention on the Spanish population. They compared the Mediterranean diet, which has been defined by the Mediterranean Pyramid [26], and the Western Diet, calculating the WF of the two. They observed that the Western Diet in comparison with the Mediterranean diet would increase all the footprints including water consumption.

In line with this point of view, Vanham et al. [24] observed that a diet characterized by a high energy intake and rich in animal-based products has a higher level of water consumption in comparison with other dietary patterns that include larger amounts of vegetables. These authors calculated the WF of the diets previously described considering the Ecoinvent database [27] and they concluded that reducing the consumption of animal-based products determines the highest contribution to water saving, and for this reason the Vegetarian dietary pattern represents the best choice.

The environmental impact of meat consumption is recognized by other evidence. In fact, adding a portion of 150 g of meat to a vegetarian meal seems to determine an increase of 2770 L of water consumed [19]. The experts of this report [19] compared two different meals: a vegetarian meal and a modified vegetarian meal with a higher amount of meat and higher water consumption.

4. Discussion

Some authors who have focused their attention on the topic of food literacy described today's consumers as confused in their decisions about how to manage their diet [3,4,28]. In fact, people often struggle to recognize evidence-based information and some authors stated that consumers often feel confused, skeptical, and helpless in relation to the meaning of healthy eating [28,29]. To date, an increasing number of people confirm that they would be willing to change their eating habits to gain a more sustainable diet [1]. In spite of this, disoriented consumers have difficulty in recognizing the impact of their food choices on health and on the environment. The environmental sustainability of a diet is in fact a wide and complex topic and includes water consumption: the availability of fresh water on the Earth is strongly influenced by global food production [2].

We conducted a narrative review of the literature investigating which is the most sustainable diet in terms of water consumption within a list of four widespread dietary patterns: Healthy and Balanced Diet [14] (for an ideal subject aged between 30 and 59, weight 69 kg, has an estimated kcal 2184, proteins 71 g, fat 81 g, carbohydrates 314 g) [16]; Western Diet [13,15] (2459 kcal, proteins 97 g, fat 105 g, carbohydrates 303 g) [16]; Vegan diet [11] (2200 kcal, proteins 71 g, fat 83 g, carbohydrates 314 g) [16]; and Vegetarian diet [11] (2123 kcal, proteins 77 g, fat 64 g, carbohydrates 333 g) [16] or Flexitarian diet [20] (2216 kcal, proteins 70 g, fat 83 g, carbohydrates 317 g) [16].

We decided to focus our attention on the water consumption of a diet taking into account that water is an essential resource for life, not endless but limited and exhaustible, and current data show a worrying growing water scarcity worldwide [30,31]. Moreover, in this pandemic era, water availability, as well as water consumption, is alarming more than ever due to the fact that one of the most effective interventions in curbing the spread of COVID-19 is ongoing sanitation and cleaning hands [32,33]. For these reasons, water scarcity is a critical condition to foreground [33].

The authors of the papers and documents included in the present literature review generally agreed on the fact that moving towards less animal-based and more plant-based diets would have a beneficial effect on the environment in terms of water consumption [7,18,24]. In fact, the results discussed in the papers included in our narrative review showed that adherence to a diet rich in vegetal products (Vegan, Vegetarian, and Healthy and Balanced diets) favors a reduction in WF considering the range 1025 l/cap/d [18]–2770 l/cap/d [19]. Springmann M. et al. [20] also suggested that following a Flexitarian diet led to a reduction in fresh water use of 2–11% with respect to adherence to an animal-based diet.

In spite of this general and shared position, there is not an agreement on the comparison between the Vegan and Vegetarian diets regarding water consumption: at present, the available evidence suggests no differences between Vegetarian and Vegan diets [18].

From our narrative literature review, it emerges that the two dietary patterns (Vegetarian and Vegan diets) are similar in terms of water consumption, followed by the Healthy and Balanced diet, while the Western diet places itself in the last position. Regarding the Flexitarian diet, its water consumption has an intermediate value between that of the Healthy and Balanced Diet and Western Diet [20]. More in general, a reduction in meat intake contributes to water preservation [25]. Specifically, data presented in the papers included in our narrative review suggested that the WF from the most water saving diets to the worst are: Vegan diet (2000–2500 l/cap/d [18]), Vegetarian diet (1530–2655 l/cap/d [24,25]), Healthy and Balanced Diet (2170–3291 l/cap/d [22,24]), and Western Diet (3000–4300 l/cap/d [18]). Finally, the water consumption of the Flexitarian diet is included between that of the Healthy and Western diets (3190 l/cap/d).

This information could be adequately spread by professionals in the field of public health and healthcare. In fact, Velardo [28] observed that nutrition practitioners and health educators have a fundamental role in promoting and disseminating reliable information about food and nutrition to the population. In particular, people could be informed by experts that both Vegan and Vegetarian diets could be considered as sustainable diets because they guarantee water preservation while satisfying nutritional needs. In addition to nutritionists, dietitians, or other health professionals, an important information channel is represented by science communicators and journalists, who can reach a larger number of citizens in the dissemination of information for the correct management of diets regarding nutritional as well as environmental health.

People interested in following a sustainable diet should also know that the Vegan diet represents a very strict and hard to follow dietary choice. The Vegan diet requires the entire replacement of animal-based products with foods from plant origins, and it always needs integration with micronutrients (i.e., vitamin B12) that omnivores consume from animal products.

Additionally, in the Vegetarian diet, some intakes need to be carefully monitored (i.e., iron, calcium, vitamin B12, folic acid, vitamin D) [11], even if it represents a more varied dietary choice. However, it represents a less rigid diet, and the human body could compensate for the reduction in the external intake of such micronutrients.

In conclusion, it is important to note that both Vegetarian and Vegan diets guarantee savings in terms of water use and that they can be safe if followed correctly. In fact, both Vegans and Vegetarians (excluding Pescatarians) need to carefully monitor their micronutrient intake and integrate vitamin B12. Ultimately, people interested in following a sustainable diet should know that both Vegan and Vegetarian dietary patterns are appropriate but that they require some measures to be adopted, so that these diets do not compromise the person's health status. In order to protect health in the long run, an important role is played by healthcare professionals and science communicators as they divulge information on a healthy and sustainable diet: healthcare professionals' and science communicators' ability to collect and process information about food and nutrition can exert great importance on people's knowledge on food and dietary choices.

In conclusion, it may be advisable to suggest that people interested in following a sustainable and water saving diet start trying a Vegetarian diet, which is less rigorous with respect to a fully Vegan choice, for a period useful to investigate its acceptability and also to monitor micronutrients that may be prone to deficiency. In case of other reasons, different from the environmental impact and water saving, such as animal well-being, it is fundamental to fully inform people about the health risks represented by a Vegan diet. In this sense, the contribution of healthcare professionals, as well as science communicators, could be the key to avoid negative consequences on people's health, while respecting environmental norms and animal rights, according to the so-called "One Health" approach.

We suggest that future research with the same objective of the present narrative review should expand the search string, including search terms such as "Vegetarian diet*", "Plant-based diet", "Raw-vegan diet", "Animal-based diet", "Omnivorous diet", and "Current diet".

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