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Greenhouse gas emissions, energy demand and land use associated with omnivorous, pesco-vegetarian, vegetarian, and vegan diets accounting for farming practices

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ABSTRACT

In the present context of environmental damages, food systems constitute one of the key burdens on the environment and resources. Dietary patterns emerge as a main leverage to preserve a healthy environment.

The aim is to compare the environmental impacts of different diets with different levels of animal product consumption, while accounting for the type of farming systems (organic or conventional) of the food consumed.

Dietary environmental impacts of the diet of 29,210 NutriNet-Santé participants were estimated using databases developed within the BioNutriNet project. Four diets, differing from their animal-based food proportion, were studied: omnivorous, pesco-vegetarian, vegetarian, and vegan. Three individual environmental indicators were assessed (greenhouse gas emissions, cumulative energy demand and land occupation) and combined in one aggregated partial score (pReCiPe, partial ReCiPe). Means of these indicators adjusted for energy intake were estimated across diet groups using covariance analysis.

About 95% of the study sample was omnivorous. Organic consumption was much higher among non-omnivorous than other groups. The pReCiPe were 64%, 61%, and 69% lower for diet of pesco-vegetarians, vegetarians and vegans respectively, in comparison to the omnivorous diet. Regarding the three individual environmental indicators included in the pReCiPe index, the same trend was observed but trade-offs exist in organic with cumulative energy lowered and land occupation augmented.

A positive link between animal-sourced food consumption and total environmental impact was observed in this large sample of French adults. By far, omnivorous had the highest-level of greenhouse gas emissions, cumulative energy demand and land occupation while vegan diets had the lowest. Further research on environmental indicators distinguishing farming practices is needed to allow a more comprehensive evaluation of the impact.

Keywords: diet-related environmental impacts, animal-based food, farming system, greenhouse gas emissions, cumulative energy demand, land occupation.

1 INTRODUCTION

2 Over the past decades, environmental damage, such as climate disruption, the sixth mass
3 extinction of biodiversity, deforestation, water use and human interference with the nitrogen
4 and phosphorus cycles, has intensified (1–3). This damage is the consequence of the current
5 society's dominant model, specifically that of agriculture and food consumption, causing
6 major pressures on the environment (4,5). If there is no change in the food system by 2050,
7 the increase in greenhouse gas (GHG) emissions, cropland use, freshwater use, and nitrogen
8 and phosphorus application would drive biophysical processes beyond planetary boundaries
9 (2,4,6).

10 There is a growing body of scientific literature dealing with environmental impacts of food
11 production and consumption, with data mainly focusing on agriculture-related greenhouse gas
12 emissions (3,7,8).

13 The food system represents 20 to 30% of the global GHG emissions (9,10). Therefore, at both
14 collective and individual level, food behaviors and food choices represent major levers of
15 action against the ongoing environmental disaster. These emissions could be attenuated by
16 reduction of meat consumption, illustrated by many studies showing that removing entirely
17 meat from a healthy diet will (11) result in a reduction by about one-third of GHG emissions
18 (12), or that diet-related GHG emissions are twice lower for vegans than for meat eaters (13).
19 Livestock, in particular, exhibits significant pressures on the environment including extensive
20 land use and energy demand, biodiversity loss, N surplus and water use. Beyond the
21 ecosystem services of livestock including grasslands for the biodiversity and carbon storage
22 (14,15), Aleksandrowicz et al. showed that diets reducing the amount of animal-based foods
23 had the largest environmental benefits (first vegans, then vegetarians, and pesco-vegetarians),
24 not only in terms of GHG emissions, but also in terms of land use and energy demand (8).

25 Land cropping, especially when intensively cultivated, contributes to greenhouse gases,

26 deforestation, biodiversity loss, water use and pollution through fertilizers and synthetic
27 pesticides as well as soil pollution and erosion (16,17).

28 Although strong positive correlation between organic food consumption and vegetarianism
29 have been observed (18,19) driving by some similar motives, namely ethic and environment
30 preservation, few studies have considered the type of farming practices when studying the
31 environmental impacts of diets (20). These farming models may play an important positive
32 role in terms of environmental impacts. Thus, there is a lack of information regarding organic
33 farming in previous studies that usually consider only the prevailing conventional agriculture.

34 Organic farming is, with respect to many indicators, more environment-friendly than
35 conventional farming (17,21,22). Indeed, organic systems are characterized by higher energy
36 efficiency (17,23), better soil biophysics and biologic quality (21,24) and contribute positively
37 to plant and animal biodiversity (both in cropland and wild life) (9,11,12). Regarding GHG
38 emissions, organic farming performs better than conventional, but only per area (26,27).

39 Indeed, organic farming has lower yield and, as a result, does not reduce significantly the
40 GHG and increases the land use per product unit (23,24,27). At the individual diet level, we
41 previously reported that regular organic food consumers exhibited environmental benefits.

42 Disentangling the role of food patterns (plant-based diet) and farming system (organic or
43 conventional) revealed that organic farming system led to a slight reduction in cumulative
44 energy demand but to a rise of land occupation (28). Thus, the studies investigating
45 environmental impacts related to different diets, in particular vegetarian and vegans, without
46 consider farming practices, may have underestimated some impacts as these consumers are
47 more prone to choose organic food.

48 In that context, the aim of this study is to compare the environmental pressure and impact of
49 diets of participants of the large cohort NutriNet-Santé study across different diets

50 (omnivorous, pesco-vegetarians, vegetarians, and vegan), while distinguishing farming
51 practice (organic or conventional) in the assessment of impacts.

52 **2.METHODS AND DATA**

53 **2.1 NutriNet-Santé Study**

54 The NutriNet-Santé Study (29) is a prospective cohort conducted in French volunteers' adults.
55 Since 2009, data are collected by questionnaires through a secured on-line platform. On a
56 yearly basis, the participants are required to provide information as regards sociodemographic
57 and socioeconomic status, weight, height, smoking status, alcohol consumption, health events,
58 medication use and food consumption. They are also regularly requested to fill-in additional
59 questionnaires focusing on diet-related topics.

60 This study is piloted in line with the Declaration of Helsinki, and all processes were officially
61 accepted by the Institutional Review Board of the French Institute for Health and Medical
62 Research (IRB Inserm 0000388FWA00005831) and the Commission Nationale de
63 l'Informatique et des Libertés (CNIL908). The volunteers completed and signed electronically
64 an informed consent. The NutriNet-Santé Study is registered in ClinicalTrials.gov
65 (NCT03335644).

66 **2.2 Data Collection**

67 **2.2.1 Dietary intake assessment and diet group classification**

68 In 2014, food consumption over the last year was estimated through the Org-FFQ, a self-
69 administered organic food-frequency questionnaire (Org-FFQ) (11) with photographs
70 improving estimation of the portion size. The Org-FFQ was developed from a validated FFQ
71 (30) with additional questions inquiring organic food consumption. Thus, volunteers reported
72 their consumption frequency and the portion consumed for 264 food items grouped in 17
73 groups. Participants also specified the frequency of consumption as organic for 257 food and
74 beverage items (existing with organic label). Then to the question "How often was the product

75 of organic origin?”, the respondents could answer by: never, rarely, half-of-the-time, often or
76 always. Then, each modality was assigned a percentage, respectively 0%, 25%, 50%, 75%
77 and 100% to estimate the organic food consumption (in g) for each food item (28).

78 Daily nutritional intakes were calculated using the NutriNet-Santé food composition table
79 (31).

80 For this study, NutriNet-Santé participants were classified into one of the following diet
81 groups: 1) omnivorous: diet that included meat or fish intake almost every day, 2) pesco-
82 vegetarian: diet that did not include meat (<1g/day), but included dairy products, eggs, fish
83 and seafood, 3) vegetarian: diet that did not include animal flesh (<1g /day) but included dairy
84 products and eggs and 4) vegan: diet that did not include any animal flesh (<1g /day) or any
85 animal products (no eggs or dairy products, <1g/day)).

86 We also calculated the PANDiet (probability of adequate nutrient intake score), a 100-point
87 index reflecting the nutritional quality of the whole diet. PANDiet is the average of a
88 moderation and an adequation subscores which are based on the Probability of Adequate
89 Nutrient intake (32).

90 **2.2.2 Environmental impact assessment**

91 Details of the assessment of the environmental impact, LCA and sources by product and
92 production method have been extensively detailed elsewhere (33). Briefly, diet-related
93 environmental impacts were assessed using a French database (DIALECTE (34)) of
94 environmental measure for raw agricultural products and completed with other published
95 data. Environmental data came from 2,086 farms with different farming practices (46% were
96 organic farms). The Life Cycle Assessment (LCA) methodology was applied to the data
97 pertaining to resources consumption and environmental impacts for about 60 agricultural
98 commodities. Due to a lack of data for organic food system, LCA were calculated at the farm
99 gate only.

100 Three environmental indicators were evaluated: greenhouse gas emissions (GHGe) (kgCO₂
 101 eq/kg), cumulative energy demand (CED) (in MJ/kg) and land occupation (LO) (in m²/kg).
 102 GHG emissions covered the sum of three GHGs (carbon dioxide CO₂, methane CH₄ and
 103 nitrous oxide N₂O). The CED encompassed renewable and unrenovable energy consumption
 104 as (35). The Dia'terre[®] method was used for GHGe and CED (36). The land occupation (LO)
 105 corresponded to the area required to produce agricultural commodities within one year.
 106 Economic and transformation weights were applied to translate commodities to consumption
 107 (33).

108 The environmental impacts of individual diet were estimated by multiplying the
 109 environmental impacts by the food quantity consumed (g/day), while accounting for the
 110 method of food production. The three above-mentioned indicators were combined in a single
 111 indicator to get a more synthetic measure of the overall environmental impacts. To account
 112 for existing trade-offs between environmental pressures, the ReCiPe aggregating several
 113 pressure indicators has been proposed. This approach considers the matching of midpoint-
 114 oriented and endpoint-oriented indicators (37). As GHGe, CED and land occupation represent
 115 about 90% of the total environmental dimension of the ReCiPe, the partial ReCiPe (pReCiPe)
 116 for environmental impact assessment of food product and diet has been defined (38). This
 117 score was computed, as follows:

$$118 \quad \text{pReCiPe} = [0.0459 * \text{GHGe} + 0.0025 * \text{CED} + 0.0439 * \text{LO}]$$

119 Where GHGe is greenhouse gas emissions, in kgCO₂ eq/kg, CED is cumulative energy
 120 demand, in MJ/kg and LO is land occupation, in m²/kg. The highest the pReCiPe index is
 121 high the environmental impact. We also computed the pRecipe index and the three individual
 122 indicators for 100% organic and 100% conventional diet by attributing organic or
 123 conventional environmental value to all the foods consumed.

124 **2.2.3 Covariates**

125 The covariates used were those closest to the filling date of the Org-FFQ (39). The variables
126 were gender, age, living area (rural, i.e. a population below 2,000 inhabitants or urban, i.e. a
127 population above 2,000 inhabitants), education (< school diploma, high school diploma and
128 post-secondary graduate) and monthly income per household unit (<1,200 euros, between
129 1,200 and 1,800 euros, between 1,800 and 2,700 euros, and > 2,700 euros), physical activity,
130 (< 30 min/day, 30 to 60 min/day, and > 60 min/day), tobacco status (former smoker, non-
131 smoker, and current smoker). The daily diet monetary cost (€/day) was estimated for each
132 participant by multiplying the quantities consumed (g/day) by the corresponding item prices
133 (€/g), while accounting for farming practice and place of purchase as previously extensively
134 described (28).

135 **2.3 Statistical analyses**

136 Among the 37,685 NutriNet-Santé participants who completed de Org-FFQ, 8,475 individuals
137 were excluded. Exclusion criteria were: missing covariates (n=380), under- or over-reporters
138 (n=2,109), living overseas (n=743) and no data regarding the place of purchase (n=5,243).

139 Therefore, the final sample included 29,210 participants (**Supplemental Figure 1**).

140 Participants' characteristics were reported as means (SD) or percentages. P-values referred to
141 chi-square test for categorical variables or variance analysis (ANOVA) for continuous
142 variables. ANCOVA (analysis of covariance) models were performed (for other
143 characteristics) to estimate the nutritional and environmental characteristics according to the
144 diets, providing means (95% CI) adjusted for energy intake. For the nutrients, energy
145 adjustment was performed using the residual method (40). P-values were estimated via
146 covariance analysis. For statistical tests, the type I error was set at 5%. Data management and
147 statistical analyses were conducted using SAS 9.4 software (SAS Institute Inc.).

148 **3. RESULTS**

149 **3.1 Socio-demographic characteristics of participants across diets**

150 The sociodemographic characteristics of the study sample are presented in **Table 1**. A total of
151 74.7 % were women and the mean age (SD) was 53.5 (13.99). About 95% of the participants
152 were omnivorous. Pesco-vegetarians (1.59%), vegetarians (1.39%) and vegans (1.02%) were
153 younger, more likely to live in urban area, more often graduated and had more often lower
154 income than omnivorous. They were also more often less physically active and drank on
155 average less alcohol than omnivorous. However, there was no significant difference for
156 tobacco status. Finally, vegetarians had the lowest diet monetary cost and vegans the highest.

157 **3.2 Nutritional characteristics**

158 Nutrient and food group intakes (in g/day) according to each diet group were presented in
159 **Table 2**. The energy intake was higher in the omnivorous than in the 3 other diet groups.
160 Pesco-vegetarians, vegetarians and vegans had higher intake of carbohydrates,
161 polyunsaturated fats, fibers and lower intake of saturated fats than omnivorous. As expected,
162 the ratio of vegetable to total proteins was far higher for vegans (0.95), vegetarians (0.72) and
163 pesco-vegetarians (0.58) than for omnivorous (0.32). Organic food consumption was
164 positively associated with the reduction of animal-based products in the diet, with the highest
165 organic food ratio in the diet observed among vegans (0.67 vs 0.28 among omnivorous).
166 Micronutrient intakes are shown in **Supplemental Table 1**. The PANDiet score was higher
167 among vegans than among omnivorous.

168 **3.3 Environmental impacts**

169 **Table 3** presents the values of the aggregated environmental impact (as expressed by the
170 pReCiPe) as well as the values of three individual indicators reflecting environmental
171 pressures, for each type of diet. The pReCiPe index was the highest for omnivorous, and
172 decreased when shifting toward more plant-based diet. However, the pReCiPe of pesco-
173 vegetarians and vegetarians were not statistically different. Regarding the individual
174 environmental impacts, omnivorous had by far the highest GHG emissions, CED and LO

175 values, whereas vegans showed the lowest ones. Moreover, pesco-vegetarian, vegetarian
176 diets' indicators values were similar and higher than those of vegans. Scenarios referring to a
177 100% conventional diet or 100% organic diet are presented in **Table 4**. While 100%
178 conventional diets exhibited a lower pReCiPe value compared to 100% organic diets,
179 particularly for omnivorous, environmental pressures were differentially affected by farming
180 practices. Thus, GHGe were quite similar for both scenarios. CED was higher for 100%
181 conventional diets while land occupation was higher for 100% organic diets.
182 In addition, differences across the type of diets were less pronounced in 100% conventional
183 diets. However, omnivorous were always those who exhibited the highest environmental
184 pressures. pReCiPe by food groups for each diet type is presented in **Figures 1**. After animal
185 foods, the highest environmental impacts were attributable to the fruit and vegetables, starchy
186 foods, oil and ready meals.

187 **4. DISCUSSION**

188 The present study assessed the environmental impacts of four types of diets (differing by the
189 proportion of animal-based food) in a large sample of French adults, participants from the
190 NutriNet-Santé cohort.

191 We observed significant differences between various types of diets, with respect to each
192 indicator of environmental pressure and with respect to the aggregated index (as assessed by
193 the pReCiPe). The more animal food in the diet, the higher the value of pReCiPe index.
194 However, pesco-vegetarians exhibited a similar pReCiPe value compared to vegetarians
195 although pesco-vegetarians had higher intakes of animal-based food than vegetarians. It is
196 noteworthy that land occupation related to fish and seafood consumption may have been
197 underestimated in the present study. Consequently, diet-related environmental impacts were
198 ranked (in ascending order) as follows: omnivorous, vegetarian, pesco-vegetarian and then
199 vegan. Notably, the omnivorous' diet had by far the highest environmental impacts. Extents

200 of reduction of the aggregated indicator, i.e. the pReCiPe, of environmental impact were 64%,
201 61%, and 69% for pescovegetarians, vegetarians and vegans respectively, compared with the
202 omnivorous. Although the two first reductions were not statistically significantly different.
203 Also, using LCA differentiating farming practices (organic or conventional), we showed that
204 vegans' diet emitted 78% less GHG, required 53% less energy and 67% less land occupation
205 than omnivorous' diet. These results are in line with several recent works documenting
206 associations between dietary patterns and a set of environmental impacts (GHG emissions,
207 land occupation, and water use) in modelled and observed data (8,10,20). Indeed, a reduction
208 in meat consumption is a major leverage for reducing diet-related environmental impacts, and
209 in particular GHG emissions (4,5,23,41,9). Aleksandrowicz et al., in a systematic review
210 focusing on GHG emissions, land occupation, and water use, concluded that the least
211 impacting diets on the environment, compared to omnivorous diets, were in descending
212 sequence the vegan diet, followed by the vegetarian, and then the pescovegetarian (8). In a
213 recent study, in line with our results, based on simulation and covering 140 countries, vegan
214 diets exhibited a reduced per capita GHG footprint by 70% compared to current diets (42). As
215 extensively documented, these results are largely due to higher environmental impacts of
216 animal-based products, especially ruminant meat, compared to plant-based products.
217 Recently, the EAT-Lancet commission on healthy diets from sustainable food systems (4)
218 was fashioned to assess which diets and food production systems would ensure the
219 achievement of the UN Sustainable Development Goals (SDGs) and Paris Agreement. They
220 concluded in their commission, "that a dietary change towards increased adoption of plant-
221 based diets has high mitigation potential, which is probably needed to limit global warming to
222 a less than 2°C increase" (4). Similarly, a recent modeling study conducted for 140 different
223 countries underlined that vegan diets exhibited a 70% reduction GHG footprint per capita
224 compared to current diets (42). However, GHG emissions' reduction certainly depends on the

225 amount and type of meat included in the diet, but also on the environmental impact of the
226 meat substitute (16,43). For instance, plant-based diet may exhibit various pressure. While
227 legumes, presenting interesting nutritional profiles, exhibited 250 times lower GHGe
228 ruminant meats (11), rice production emits five times more GHGe than wheat production
229 when considering gram of protein as function unit (11).

230 However, most of these studies did not distinguish between farming practices, even though
231 organic food consumption has been markedly and positively correlated with plant-based diet
232 (18,28). While organic production usually reduces CED compared to conventional
233 production, it often increases land use and has comparable on GHG emissions (when
234 considered by amount of food) (23,24,27). We found that a 100% organic omnivorous diet
235 exhibited higher environmental pressures, suggesting that following an organic diet without
236 changing towards a more plant-based diet is of little help, at least as regards the studied
237 indicators. It should be however noted that organic farming may contribute to maintain
238 biodiversity and limit water and soil pollution (21,22).

239 Herein, a reduction of GHGe of 76% was observed when comparing vegans to omnivorous.
240 In comparison, in a work conducted by Scarborough et al (44) in the EPIC-Oxford cohort
241 study, aimed at comparing GHGe four different groups, namely meat-eaters, fish-eaters,
242 vegetarians and vegans (defined using self-reporting), GHGe (kgCO₂eq/day) were 7.19 for
243 high meat eaters, 5.63 for medium meat-eaters and 2.89 for vegans (corresponding to a
244 reduction of 60% compared to high meat-eaters). Since it has been documented that organic
245 farming has no substantial effect on GHGe (23,24,27), with some variations according to the
246 food product considered, these can be explained by the stages accounting in the LCA in the
247 present study which focus on the cradle-to-farm perimeter. Of note, in the present study as
248 well as in a modeling study (9), pesco-vegetarian and vegetarian diets exhibited relatively
249 similar GHGe (9). Most of French studies did not focus on self-selected diets and used

250 modeling approaches (20,45,46). A French work based on INCA2 data has compared pre-
251 defined diets (i.e. “Lower-Carbon,” “Higher-Quality,” and “More Sustainable” diets) and
252 concluded that food choices could lead to a 20% reduction in GHGe (47). As expected, this is
253 far lower than the differences observed between the groups in the present study and hardly
254 comparable as in the INCA2 study, participants were mostly omnivorous. Another recent
255 study has optimized several European diets to identify the dietary changes to operate by
256 applying stepwise 10% decrease in GHGe (48). In all these models, a reduction in the
257 consumption of animal products was necessary, with some variations between countries. In
258 this study, it was also observed that reductions in GHGe higher than 60% could be achieved
259 only with drastic diet changes, which is the case for vegetarian diet. Furthermore, in line with
260 our results, this study showed that, for large reductions in overall GHGe, animal food
261 consumption decreased leading to higher contributions of fruits, vegetables and starchy foods
262 to GHGe.

263 There are fewer studies that have investigated land occupation associated with different types
264 of diets and those available are mostly not based on observational data (8). The present results
265 are consistent with the available literature in terms of differences in land occupation according
266 to diet, with significantly lower land use, despite smaller differences than for GHGs, for diets
267 avoiding animal products and in particular for vegan diets.

268 However, farming practices were not considered in the previous observational studies while it
269 has been documented that organic farming requires higher land use but lower energy demand
270 than conventional one (23,24,27). In this study, organic farming for food production led to
271 higher pReCiPe for omnivorous’ diet only. For other diets, excluding meat, compensation
272 between indicators (higher land use, lower energy demand) results in few differences in
273 pReCiPes for 100% organic and 100% conventional scenarios. An interesting modelling study
274 evaluated environmental impact of omnivorous, vegetarian, vegan considering 100% organic

275 or 100% conventional diet (49). In this study, consistently with the present findings, for a type
276 of diet, land use was higher in organic than in conventional for a given diet. As regards
277 GHGe, we have previously shown that organic farming has overall no effect (28). Finally,
278 logically, vegetarian diets have always environmental impacts between those of meat
279 consumers and those of vegans.

280 Based on actual data, as vegans and all types of vegetarians consumed a higher proportion of
281 organic food than meat eaters, some differences observed in the previous studies may have
282 been overestimated for some indicators. Similarly to the present findings, a modeling study
283 (9) reported slight differences in environmental pressures between pesco-vegetarian and other
284 vegetarian diets. However, land use of fishing is often considered as null. In the study of
285 Baroni et al. (49), pesco-vegetarians were not considered. It would be therefore of great
286 importance to consider other environmental indicators such as water footprint or biodiversity
287 (50). A recent small study conducted in Italy documented higher environmental pressures
288 (GHGe, water and ecological footprints) for omnivorous diets than for ovo-lacto-vegetarians
289 and vegans diets and interestingly highlighted that vegetarians and vegans were more
290 adherent to the Mediterranean diet, whose sustainability has been consistently documented
291 (9,51–54).

292 Overall, to the best of our knowledge, this study is the first, to introduce farming practices in
293 the LCA assessment of the diets. Despite accounting higher land occupation in organic
294 farming, the vegan diet, whatever the indicator considered, remained less resource-intensive
295 and environmentally damaging than other diets. It is noteworthy that omnivorous in the
296 present study exhibited relatively high consumption of meat (>120g/d on average with a wide
297 variability in intake). It is therefore essential to identify possible food substitutions, as they
298 may induce counterproductive effects. First, with regard to environmental pressures of meat,
299 interestingly, a recent modeling study, based on baseline data from 5 European countries,

300 identified sustainable diets who did not entirely exclude meat (55). It should be born in mind
301 that the present study considers three indicators but other environmental pressures not
302 accounted herein are also of great interest when considering pressure of livestock (15,56). In
303 addition, there is also a great variability in livestock methods (57). Second, environmental
304 impacts of the meat substitutes (16) may be questionable. For instance, plant-based meat
305 substitutes may exhibit important environment pressure but current data are scarce (16,43).
306 Third, besides cultural acceptability, a vegan diet may exhibit some disadvantages in terms of
307 nutrition, raising health concerns in particular among young people (9,58,59).

308 Some limitations should be considered. First, as the NutriNet-Santé cohort is composed of
309 volunteers, participants are certainly more concerned about food issues. Therefore, the
310 consumption data are not representative of the French population consumption, which may
311 limit the generalization of the results. Regarding the environmental impact assessment, herein,
312 the stages of food transportation and processing, as well as the environmental cost of food
313 waste and losses were not accounted for. The use of a FFQ, which is prone to an
314 overestimation of intakes, has probably led to some imprecisions in the estimations.

315 Moreover, due to the lack of data regarding pressure of sea farming (land occupation and
316 other reliable indicators) the present results minimize seafood and fish environmental impacts,
317 and consequently impacts of pesco-vegetarian diets. Finally, other indicators related to water
318 use, biodiversity, excess nitrogen or soil quality were not available, which limited a more
319 comprehensive assessment of the environmental footprint.

320 However, this study has also major strengths. To our knowledge, this is the first study
321 considering different farming practices, hereby organic and conventional, in the evaluation of
322 diet-related environmental impacts. Furthermore, environmental impacts were computed for
323 three indicators: GHG emissions, LO and CED while most of previous studies generally only
324 assess carbon footprint (60). Furthermore, in order to consider environmental impacts more

325 globally, the pReCiPe index was used. Regarding the data collection, the large size of the
326 sample allowed to provide a large range of eating habits, food consumption choices, and
327 validated dietary data were available.

328 **CONCLUSION**

329 The present observational study conducted in French adults highlighted that omnivorous, with
330 respect to GHGe, cumulative energy demand and land occupation, have by far the diets with
331 the most serious consequences on resources and environment when compared to diets with
332 restricted animal food. These findings also emphasize the positive link between organic
333 consumption and plant-based diets underlying the significance of accounting for farming
334 practices in environmental pressure assessment, as organic production may offer potential
335 environmental benefits/disadvantages depending on the indicator considered. In future
336 research, other environmental indicators should be considered, including, for instance,
337 biodiversity and ecotoxicity impacts, nitrate and pesticide leaching, soil quality or water use.
338 A systemic and holistic assessment only will make it possible to consider diets' consequences
339 on the environment in a broader scale. However, environmental indicators distinguishing
340 several farming practices are scarce underlining the need for more research in this field to
341 conduct a broadly evaluation.

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502 **Figure 1: pReCiPe of each food group according to the type of diet**

503 Abbreviation: NAD, nonalcoholic drinks

504