Food choice motives and the nutritional quality of diet during the COVID-19 lockdown in France

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13

Abstract

14

15   To limit the transmission of COVID-19, nationwide lockdown was imposed in France

16 between March, 17th and May, 10th 2020. This disruption in individuals' daily routines likely

17 altered food consumption habits. We examined how changes in food choice motives related to

18 changes in nutritional quality during the lockdown compared to before. A convenience sample

19 of 938 French adults completed online questionnaires on the Qualtrics platform at the end of

20 April 2020. Participants were retrospectively asked about their food choice motives and food

21 consumption during the month before and in the first month of the lockdown. The importance

22 of nine food choice motives was assessed: health, convenience, sensory appeal, natural

23 content, ethical concern, weight control, mood, familiarity, and price, scoring from 1 to 4.

24 Food intakes were recorded using a food frequency questionnaire including 110 foods, 12

25 non-alcoholic beverages and 4 alcoholic beverages. Adherence to the French dietary

26 recommendations before and during the lockdown was estimated using the simplified PNNS-

27 GS2 score, scoring from -17 to 11.5. The nutritional quality of diet was lower during the

28 lockdown compared to before (-0.32, SD 2.28, $p<0.001$). Food choice motives significantly

29 changed and an increase in the importance of weight control was associated with increased

30 nutritional quality ($\beta=0.89$, $p<0.001$, partial $\eta^2=0.032$), whereas an increase in the importance

31 of mood was associated with decreased nutritional quality ($\beta=-0.43$, $p=0.021$, partial

32 $\eta^2=0.006$). The lockdown period in France was related to a decrease in nutritional quality of

33 diet on average, which could be partly explained by changes in food choice motives. The

34 lockdown was indeed related to modification of food choice motives, notably with an increase

35 of weight control, health, natural content and ethical concern.

36 **Keywords:** nutritional quality; food choice motives; lockdown; COVID-19

37

1. **Introduction**

The world is currently facing the COVID-19 pandemic. To avoid fast-growing transmission of the virus, governmental authorities have had to impose nationwide lockdowns. In France, between March, 17th and May, 10th 2020, most of the population was asked to stay home. In order to limit drastically any human contact, the French were allowed to leave their home only for grocery shopping, medical care, legal obligations, physical activity within a 1 km radius; except for workers from essential sectors (e.g., healthcare, food factories and shops). During this period, all businesses that sold food remained open to the public. However, major disruptions in daily routines caused by the lockdown (e.g., home-working, restaurant closures) were likely to alter food consumption habits in the French population. Moreover, closed borders led to changes in the distribution and availability of food products (Morel, Stroobants, Bran, Iwaniuk, & Hauteville, 2020; Oxfam France, 2020).

A large part of humans' eating behaviours are habits, i.e., automatic associations between specific context cues and responses, which have history of repetition and reward. Habits form as people pursue goals by repeating the same responses in given contexts, and become automatic and hard to change (Wood & Runger, 2016). Because food choices are performed every day and usually in the same context, they likely result from a habitual response; notably, food choices have been shown to be stable in adulthood (Borland, Robinson, Crozier, & Inskip, 2008; Hu et al., 1999; Khani, Ye, Terry, & Wolk, 2004; Weismayer, Anderson, & Wolk, 2006). However, when people are undergoing changes in their environment, their habits are vulnerable to change as they engage in a new non-automatic process of decision making (Verplanken & Wood, 2006). We thus hypothesised that the unusual lockdown period may have caused discontinuities in food choice habits.

In a constructionist perspective, food choice decisions result from one's personal food values that are shaped by life course events, personal and social factors (Furst, Connors,

63   Bisogni, Sobal, & Falk, 1996; Sobal & Bisogni, 2009). Food values are computed by

64   integrating a set of attributes (food choice motives) based on their importance or salience for

65   an individual at the point of choice (Rangel, 2013). A change in food choice motives may thus

66   lead to a change in food choice decisions. The most important food choice motives have been

67   shown to be taste, cost, nutrition and convenience with a large interindividual variability

68   (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998). We hypothesised that people engaging in

69   a new process of food choice decision making during the lockdown period may have caused

70   changes in food choice motives associated with changes in food choice habits, resulting in

71   modification of the nutritional quality of diet.

72   The present study aimed to examine the extent of changes in food choice motives

73   during the lockdown and how it related to changes in nutritional quality of diet. We

74   hypothesised that food choice motives and nutritional quality of diet changed during the first

75   month of lockdown (from March, 17th to April, 16th 2020) compared to the month just before

76   the lockdown (from February, 17th to March, 16th 2020). We also hypothesised that changes in

77   food choice motives were associated with changes in nutritional quality. Because poor

78   nutritional quality diet is one of the main risk factors for non-communicable diseases (Afshin

79   et al., 2019), it is of importance to examine the effect of the lockdown on nutritional quality to

80   help anticipating health consequences at a population level. Moreover, this unique nationwide

81   disruption in daily life gives the opportunity to investigate how changes in food choice

82   motives may influence the nutritional quality of diet at an individual level. The results may

83   inform future public health actions that aim at tackling diet related non-communicable

84   diseases by identifying which food choice motives changes may increase or decrease the

85   nutritional quality of diet.

86   2. **Methods**

87   *2.1. Design and data collection*

88   This was a cross-sectional, pre-registered online experiment conducted in Qualtrics

89   survey platform (www.qualtrics.com). Participants were recruited by emailing individuals

90   from a population registered in the Chemosens Platform's PanelSens database at Centre des

91   Sciences du Goût et de l'Alimentation (Dijon). This database was declared to the relevant

92   authority (Commission Nationale Informatique et Libertés; CNIL; n°1148039). Eligible

93   participants were aged over 18, had been residing in France at least since February 17th, 2020

94   (i.e., one month before the lockdown) and had access to a computer or tablet with an internet

95   connection. Eligible participants who completed the study received compensation in return for

96   their participation (15€ Amazon voucher). The study was approved by the ethical evaluation

97   committee for research of INSERM (reference: n°20-683, delivered on April 27th, 2020). All

98   participants were informed that the purpose of the study was to investigate food choices

99   during the lockdown and provided consent for their participation. Data were collected on

100   April, 30th and May, 1st 2020. Three attention check questions (e.g., 'How many times have

101   you visited the planet Mars?') were included in various parts of the questionnaire.

102   *2.2. Measures*

103   2.2.1. Participants' characteristics

104   Participants' characteristics assessment included demographic questions (age, gender,

105   employment status, highest educational qualification, professional situation during the

106   lockdown, living area, type of housing, household composition, financial situation) and food-

107   related behaviours questions (out-of-home eating habits before the lockdown, grocery

108   shopping frequency and time spent cooking during the lockdown, changes in their eating

109   habits during the lockdown, dietary restrictions, dieting status, weight and height at the time

110   of the study). Participants also answered questions about their consumption of organic and

111   local food products (not reported here). As participants were recruited during the COVID-19

112   pandemic, they were asked if they suspected having or having had COVID-19 and how

113   worried they were about their health. We also asked for current levels of stress, depression,

114   and loneliness (3 individual items) on a continuous scale from 0 to 100.

115   2.2.2. <u>Food choice motives</u>

116   Food choice motives were assessed using a French version of the Food Choice

117   Questionnaire developed in English by (Steptoe, Pollard, & Wardle, 1995) and adapted by

118   (Cottet, Ferrandi, Lichtlé, & Plichon, 2017). The French version included 24 items and nine

119   subscales: health (3 items), convenience (3 items), sensory appeal (3 items), natural content (3

120   items), ethical concern (2 items), weight control (3 items), mood (3 items), familiarity (2

121   items), and price (2 items). See Additional file – section 1 for the items in French and in

122   English. Instructions were adapted to assess food choice motives during the month before the

123   lockdown and during the first month of the lockdown simultaneously. For each subscale, two

124   scores were computed by averaging ratings for individual items before and during the

125   lockdown, respectively. The scores ranged from 1 to 4: 1 = Not at all important; 2 = A little

126   important; 3 = Moderately important; 4 = Very important. Δ motives were calculated as the

127   difference of the score for each of the nine subscales during and before the lockdown. Δ

128   motives > 0 indicated higher importance of the motives during the lockdown compared to

129   before.

130   2.2.3. <u>Food consumption and dietary nutritional quality</u>

131   Food consumption was retrospectively assessed for the month before the lockdown

132   and the first month of the lockdown simultaneously using a food frequency questionnaire

133   (FFQ) including 110 foods, 12 non-alcoholic drinks and 4 alcoholic drinks with frequency

134   assessed by a 6-item scale from "Never" to "Several times a day" (Kadawathagedara et al.,

135   2017). Usual portion sizes before and during the lockdown were estimated with photos for

136   different food types on a 5-level scale, derived from the SU.VI.MAX portion book (Hercberg,

137 Deheeger, & Preziosi, 2002), for 72 commonly eaten food items, and by the intermediate

138 portion size for the 38 remaining food items. Participants were also asked the size of the glass

139 or cup they used before and during the lockdown for each non-alcoholic beverage and

140 standard servings were used to estimate alcoholic beverage amounts. Consumption frequency

141 of each item before and during the lockdown was transformed into daily frequency, and daily

142 intake was calculated by multiplying the daily frequency by the estimated portion size.

143 Individual nutrients intakes were calculated before and during the lockdown by multiplying

144 the daily intake of each food item by its nutritional values from the SU.VI.MAX nutrient

145 composition database (Hercberg, 2006).

146   Adherence to the French dietary recommendations was evaluated during the month

147 before the lockdown and during the first month of the lockdown using the simplified PNNS-

148 GS2 score (sPNNS-GS2), an index previously designed to reflect the 2017 French main

149 dietary recommendations (Chaltiel et al., 2019). The sPNNS-GS2 builds on the distinction

150 between malus components (less healthy food groups which consumption should be limited,

151 carrying a negative score, i.e., red meat, processed meat, sugary foods, sweet-tasting

152 beverages, alcoholic beverages, salt) and bonus components (healthier food groups carrying a

153 positive score, i.e., fruits and vegetables, nuts, legumes, whole-grain food, milk and dairy

154 products, fish and seafood). The sPNNS-GS2 calculation has been previously described by

155 Chaltiel et al., 2019. A weight for each component is defined according to the level of

156 evidence of the association between food groups consumption and health status. sPNNS-GS2

157 scores were computed for each participant before and during the lockdown (range: -17 to

158 11.5). Slight modifications were brought to the calculation of the score. The sPNNS-GS2

159 originally included bonus points for added fat below 16% of energy intake (Chaltiel et al.,

160 2019). The FFQ did not make it possible to calculate the percentage of energy intake

161 accounted for added fat and this component was excluded from the score calculation.

162 However, a modified version of the sPNNS-GS2 including an added fat component based on

163 the ratio of plant over animal fat was also calculated. The main analysis was performed on

164 this indicator and results were similar (see Additional file – section 2). In addition, the only

165 whole grain food included in the used FFQ was whole grain bread. To obtain an estimation of

166 other whole grain foods consumption frequency as required by the sPNNS-GS2 calculation,

167 we calculated the ratio whole grain bread/(whole grain bread + white bread) and multiplied

168 the consumption frequency of other grains (pasta, rice and semolina) by this ratio.

169   *2.3. Outcome*

170   The primary outcome, Δ quality, was the difference in nutritional quality of diet

171 (sPNNS-GS2) between during and before the lockdown. Δ quality > 0 indicated better

172 nutritional quality during the lockdown compared to before.

173   *2.4. Statistical analyses*

174   Hypotheses were specified before the data were collected and we followed an analytic

175 plan that was pre-registered before data analysis (https://osf.io/gwfdb/). Only participants who

176 completed the study were included in the analyses. Participants who failed at least one

177 attention check were excluded. We analysed data from participants who reported plausible

178 energy intake, i.e. $\geq$ 500 kcal/day and $\leq$ 3500 kcal/day for women, and $\geq$ 800 kcal/day and $\leq$

179 4000 kcal/day for men (Banna, McCrory, Fialkowski, & Boushey, 2017; Willett, 2013).

180   For descriptive purposes, we compared food choice motives scores and sPNNGS-2

181 components scores before and during the lockdown using paired T-tests. As exploratory

182 analyses, we also examined whether changes in food choice motives or nutritional quality

183 during the lockdown compared to before differed across population subgroups using one-way

184 ANOVAs: people who are younger vs. older, male vs. female, normal-weight vs. overweight,

185 lower vs. higher educational level, facing financial difficulties vs. people who were not, living

186 alone during the lockdown vs. with others, living in a city vs. in the countryside, usually

187 having meal out of home at least four times a week vs. less than 4 times a week, infected by

188 the corona virus vs. not infected. We then examined the influence of changes in food choice

189 motives during and before the lockdown on the difference in nutritional quality of diet by

190 running a multiple linear regression including the nine Δ motives as predictors and Δ quality

191 as the dependant variable (main model). Sensitivity analyses were conducted to examine

192 whether the pattern of results from the main model differed: 1/ including age, gender, highest

193 educational level and reported BMI as covariates (adjusted model), 2/ excluding participants

194 who declared that they did not make any noticeable change in their diet during the lockdown,

195 3/ excluding participants who declared that they often did not find in store what they wanted

196 to buy during the lockdown, as change in diet quality could be due more to external

197 constraints than to personal motives, 4/ excluding participants who declared that they went to

198 work as normal during the lockdown. As an additional exploratory analysis, we also adjusted

199 the main model for the variables with significant effects on Δ motives or Δ quality in the

200 exploratory one-way ANOVAs.

201 All statistical analyses were performed using SAS version 9.3 (SAS Institute, Inc.,

202 2012 SAS® 9.3. Cary, NC). The level of significance was set at $p < 0.05$ applying Bonferroni

203 correction for multiple comparisons where appropriate.

204 *2.5. Sample size calculation*

205 We aimed to recruit a sample size of 1,000 participants to detect small differences in

206 food choice motives scores and sPNNS-GS2 score before and during the lockdown using

207 paired t-tests (d = 0.1) and small effects of Δ motives on Δ quality in a multiple linear

208 regression including nine predictors ($f^2 = 0.016$) at power 0.80 and level of significance 0.05

209 (GPower 3.1).

210 3. **Results**

211 *3.1. Participants*

212   A total of 1353 participants consented to participate. Participants who were not

213 eligible (n=110), did not complete the study (n=121), failed at least one attention check

214 (n=84) or reported implausible energy intake (n=100) were excluded and data from 938

215 participants were analysed. Participants' characteristics are presented **Table 1**. Eighteen

216 participants declared that they suspected having COVID-19 when they completed the study

217 and 59 declared that they suspected having had COVID-19 before. Six hundred participants

218 (64%) declared being slightly to very worried about their health. On average levels of stress,

219 depression, and loneliness were 26 (SD 28), 23 (SD 25), and 34 (SD 28) respectively on a

220 scale from 0 to 100.

221

222 **Table 1.** Participants' characteristics, n=938

Age, *years*, mean (SD)	38.7 (11.6)
Gender, *female*, n (%)	736 (78.5)
Employment status, n (%)	
Full or part-time	726 (77.4)
Student	66 (7.1)
Retired	48 (5.1)
Looking for a job	65 (6.9)
Looking after home	12 (1.3)
Other	21 (2.2)
Situation during the lockdown, n (% of workers) (several possible answers)	
Going to workplace	194 (20.7)
Working from home	418 (57.6)

Furloughed	122 (13.0)
Other	91 (9.7)
Highest educational qualification, n (%)	
< High-school +2 years diploma	227 (24.2)
High-school +2 years diploma	197 (21.0)
High-school +3 or +4 years diploma	230 (24.5)
≥ High-school +5 years diploma	284 (30.3)
Living area, n (%)	
Countryside	243 (25.9)
Suburban area	213 (22.7)
City centre	482 (51.4)
Type of housing, n (%)	
House	498 (53.1)
Flat	440 (46.9)
Household composition, n (%)	
1 adult	206 (22.0)
2 adults	246 (26.2)
> 2 adults	138 (14.7)
2 adults with children (<14 years old)	220 (23.5)
Other	128 (13.6)
Financial situation, n (%)	
Stable	660 (70.4)
Precarious	272 (29.0)
Chose not to answer	6 (0.6)
Eating out of home before the lockdown, n (%)	
3 times per month or less	378 (40.3)
Once to 3 times a week	241 (25.7)
4 to 6 times a week	280 (29.9)
7 times per week or more	39 (4.1)
Grocery shopping frequency during the lockdown, n (%)	

Twice a week or more	157 (16.7)
Once a week	493 (52.6)
Less than once a week	288 (30.7)
Difficulties to find food during the lockdown, n (%)	
Often	104 (11.1)
Sometimes	465 (49.6)
Rarely	272 (29.0)
Never	97 (10.3)
Increase in time spent cooking during the lockdown, n (%)	780 (83.2)
Changes in eating habits during the lockdown, *yes,* n (%)	747 (79.6)
Dietary restrictions, *none*, n (%)	834 (88.9)
Dieting status, *yes*, n (%)	132 (14.1)
Reported BMI, kg/m^2, mean (SD)	24.5 (4.88)
Implausible[a], n (%)	10 (1.1)

223   [a]Excluding weight < 30 kg or > 250 kg, height < 1.45 m or > 3 m (Hardy, Johnson, & Park, 2016; Miller, 2003)

224

225   *3.2. Food choice motives and nutritional quality of diet before and during the lockdown*

226   Food choice motives changed significantly during the lockdown compared to before

227 (**Table 2**). In particular, 48% of the participants declared that mood was more important in

228 their food choices during the lockdown compared to before and 48% declared that

229 convenience was less important. Health and weight control were more important during the

230 lockdown compared to before for 26 and 29% of the participants, respectively.

231

232 **Table 2.** Food choice motives before and during the lockdown, n=938

	Before lockdown	During lockdown	Difference during vs.	p-value[b]	Increased during vs.	Unchanged during vs.	Decrease during vs.

	mean (SD)[a]	mean (SD)[a]	before		before[c] n (%)	before[d] n (%)	before[e] n (%)
Δ Weight control	2.29 (0.71)	2.43 (0.80)	0.14 (0.53)	<.001	275 (29.3)	546 (58.2)	117 (12.5)
Δ Mood	2.21 (0.71)	2.46 (0.75)	0.25 (0.41)	<.001	453 (48.3)	426 (45.4)	59 (6.3)
Δ Health	2.74 (0.69)	2.85 (0.71)	0.12 (0.38)	<.001	247 (26.3)	619 (66.0)	72 (7.7)
Δ Sensory appeal	3.32 (0.54)	3.34 (0.56)	0.02 (0.25)	0.004	128 (13.7)	730 (77.8)	80 (8.5)
Δ Familiarity	2.55 (0.73)	2.44 (0.77)	-.12 (0.52)	<.001	113 (12.1)	592 (63.1)	233 (24.8)
Δ Price	2.86 (0.61)	2.81 (0.70)	-.05 (0.53)	0.003	152 (16.2)	591 (63.0)	195 (20.8)
Δ Ethical concern	2.83 (0.82)	2.91 (0.82)	0.07 (0.45)	<.001	196 (20.9)	644 (68.7)	98 (10.4)
Δ Natural content	2.89 (0.80)	2.95 (0.80)	0.06 (0.36)	<.001	176 (18.8)	673 (71.7)	89 (9.5)
Δ Convenience	2.51 (0.82)	2.10 (0.78)	-.41 (0.75)	<.001	93 (9.9)	400 (42.6)	445 (47.5)

Cronbach's α before: Health (0.71), Convenience (0.89), Sensory appeal (0.67), Natural content (0.86), Ethical concern (0.66), Weight control (0.81), Mood (0.65), Familiarity (0.64), Price (0.63). Cronbach's α during: Health (0.72), Convenience (0.85), Sensory appeal (0.66), Natural content (0.86), Ethical concern (0.64), Weight control (0.84), Mood (0.64), Familiarity (0.64), Price (0.67).

[a] range: 1 to 4, [b] paired t-tests, Bonferroni corrected alpha level: 0.006, [c] corresponds to participants with Δ motives > 0, [d] Δ motives = 0, [e] Δ motives < 0

On average, the participants consumed 1700 kcal/day (SD 596) during the month before the lockdown and 1935 kcal/day (SD 656) during the first month of lockdown and this increase was statistically significant (paired t-test: $t(937) = 13.57$, $p < 0.001$). Overall, the nutritional quality of diet significantly decreased during the first month of the lockdown compared to the month before (**Table 3**). Despite an increase in fruit and vegetables, pulses, fish and seafood consumption, the sharp increase in processed meat, sweet-tasting beverages and alcoholic beverages consumption negatively affected the sPNNS-GS2 score.

Table 3. Comparison of the nutritional quality of diet before and during the lockdown

	Recommendation	Before lockdown mean (SD)	During lockdown mean (SD)	p-value[a]
sPNNS-GS2 score[b]		1.2 (2.5)	0.8 (2.8)	<.001
Score components				
Fruit and vegetables (frequency/day)	At least 5 servings/day	2.6 (1.6)	3.2 (1.8)	<.001
Pulses (frequency/week)	At least 2 servings/week	0.7 (1.1)	0.9 (1.3)	<.001
Whole-grain foods (frequency/day)	Every day	0.5 (0.6)	0.6 (0.7)	0.019
Nuts (g/day)	A handful/day[c]	2.8 (5.2)	2.7 (5.8)	0.371
Dairy products (frequency/day)	2 servings/day	2.3 (1.4)	2.5 (1.4)	<.001
Fish and seafood (frequency/week)	2 servings/week	1.6 (1.5)	1.7 (1.5)	0.002
Red meat (g/week)	<500 g/week	292 (266)	302 (280)	0.154
Processed meat (g/week)	<150 g/week	113 (133)	145 (172)	<.001
Sugary foods (% EIWA)	<10% EIWA	11.6 (7.1)	12.5 (7.9)	<.001
Sweet-tasting beverages (ml/day)	0 ml/day	177 (376)	213 (413)	<.001
Alcoholic beverages (g of alcohol/week)	<100 g of alcohol/week	30 (59)	39 (72)	<.001
Salt (g/day)	<8 g/day	2.9 (1.1)	3.2 (1.2)	<.001

249   EIWA, energy intake without alcohol.

^a paired t-tests, Bonferroni corrected alpha level: 0.004, ^b without added fat component, range from -17

251   to 11.5. ^c one serving/handful of nuts = 30g (Chaltiel et al., 2019).

252

253   We explored whether changes in food choice motives and nutritional quality during

254   the lockdown compared to before differed across population subgroups and found relatively

255   few significant differences (see Additional file – section 3).

256   When examining the influence of changes in food choice motives on changes of the

257   nutritional quality of diet during the lockdown compared to before, we found that increased

258   importance of weight control motives was associated with increased nutritional quality and

259   that increased importance of mood motives was associated with decreased nutritional quality

260   in both raw and adjusted multiple linear regressions (**Table 4**). Changes in other food choice

261   motives were not associated with changes in the nutritional quality of diet. In the other three

262   multiple linear regressions testing the influence of changes in food choice motives on changes

263   of the nutritional quality conducted as sensitivity analyses (i.e., excluding participants who

264   declared that they did not have made any noticeable change in their diet during the lockdown,

265   excluding participants who declared that they often did not find in store what they wanted to

266   buy during the lockdown, excluding participants who declared that they went to work as

267   normal during the lockdown), Δ weight control and Δ mood remained significant or

268   marginally significant predictors of Δ quality (see Additional file – section 4). In addition, the

269   exploratory adjusted model, including the variables from exploratory analyses for which we

270   found differences in Δ motives or Δ quality, also led to similar results (see Additional file –

271   section 4).

272

286 importance of health, weight control, ethical concern, natural content, sensory appeal, and

287 mood, and a significant decrease in the importance of convenience, familiarity, and price. The

288 participants reported a 14% increase in energy intake and a decrease in nutritional quality of

289 their diet during the lockdown compared to before. An increase in the importance of weight

290 control during the lockdown was associated with increased nutritional quality, whereas an

291 increase in the importance of mood was associated with decreased nutritional quality.

292 Changes in the importance of other food choice motives were not associated with changes in

293 nutritional quality of diet.

294   Increase in energy intake and unhealthier dietary patterns during the lockdown

295 compared to before were also described in a study conducted among 37,252 French adults

296 from the web-based NutriNet-Santé cohort (Deschasaux-Tanguy et al., 2020). The authors

297 found an energy intake of 1942 kcal/day during the lockdown, which is similar to the reported

298 energy intake reported during the lockdown in the present study (1935 kcal/day on average).

299 The authors highlighted weight gain for 35% of the sample and increased consumption of

300 sweets, biscuits, and cakes. Consistently, despite the fact that the participants of the present

301 study increased their intake of fruit and vegetables, pulses, fish and seafood, they also

302 increased their consumption of processed meat, sugary foods, sweet-tasting beverages and

303 alcoholic beverages leading to a decrease in nutritional quality of their diet on average. These

304 changes in food consumption patterns echo studies showing increased snacking during the

305 lockdown (Deschasaux-Tanguy et al., 2020; Sanchez & Moreno, 2020), as fatty-sweet

306 products and sweet-tasting beverages (including fruit juices) are usually consumed during

307 snacking episodes by French adults (Si Hassen et al., 2018). In addition, a survey on 3,000

308 French adults reported that 42% declared having pre-meal drinks ("*apéritif*") more often

309 during than before the lockdown (Darwin Nutrition & IFOP, 2020). Pre-meal drinks are

310 usually the first part of a meal, opening a social eating time and are often accompanied by

311   finger foods (Danesi, 2018). The deterioration of nutritional quality during the lockdown may

312   be partly due to increased number of social and festive eating occasions within the home,

313   associated with consumption of low-nutritional-quality foods (e.g., sweet-tasting beverages

314   and alcoholic beverages, processed meat, sugary foods). Changes in health, ethical concern,

315   natural content, sensory appeal, and price food choice motives during the lockdown are in line

316   with the results of a survey conducted among a representative sample of 1,005 French adults

317   where the participants declared changes in their perception of the ecological (49%), social

318   (47%) and economical (57%) values of the food during the lockdown (YouGov, 2020). The

319   decrease in the importance of convenience for 48% of our sample mirrored that 83% declared

320   that they increased their time spent cooking during the lockdown. Collectively, these changes

321   in food choice motives may reflect a growing awareness of the importance of the

322   sustainability of food choices where preserving health and pleasure from eating, protecting the

323   environment and guaranteeing decent wages to farmers are equally important (FAO & WHO,

324   2019).

325   Increase in the importance of weight control (29% of the participants) and mood (48%

326   of the participants) food choice motives were prominent and associated with opposite changes

327   in nutritional quality of diet. Stress, feeling of emptiness and boredom management by eating

328   were common behaviours in the French population during the lockdown with 63%, 63%, and

329   57% prevalence in a 1,092 sample of French adults, respectively (Cherikh et al., 2020).

330   Occasional emotion regulation by eating is associated with the consumption of sweet foods

331   (De Lauzon et al., 2004; Macht & Simmons, 2011) which may explain the negative

332   relationship between changes in mood food choice motive and nutritional quality of diet. On

333   the contrary, increased importance of weight control led to increased nutritional quality,

334   suggesting that participants engaging in weight management behaviour successfully stuck

335   with their goal by managing their food intake during the first month of the lockdown. In line

336   with our results, a study investigating eating behaviour during the lockdown in 2,364 UK

337   adults showed that 35% of the participants declared eating a more healthy and balanced diet

338   during the lockdown compared to before (Robinson et al., unpublished results). It is worth

339   noticing that in the present study increased importance of health as a food choice motive was

340   not significantly correlated with increased nutritional quality; whereas people more motivated

341   by health were reported to adopt healthier diet than people less motivated by health

342   (Konttinen, Sarlio-Lähteenkorva, Silventoinen, Männistö, & Haukkala, 2012; Naughton,

343   McCarthy, & McCarthy, 2015). Moreover, we would have expected an increase in nutritional

344   quality when price became less important because of the positive association between price

345   and nutritional quality across individual food items (Andrieu, Darmon, & Drewnowski, 2006;

346   Marty et al., 2015; Rehm, Monsivais, & Drewnowski, 2011), but this is not supported by

347   these data. Similarly, we would have expected an increase in nutritional quality when

348   convenience became less important because the degree of food processing and convenience

349   were shown to be negatively associated with nutritional quality (Martínez Steele, Popkin,

350   Swinburn, & Monteiro, 2017; Poti, Mendez, Ng, & Popkin, 2015). Our results suggest that

351   choosing more expensive and less convenient foods (i.e., requiring more effort and time to

352   prepare) did not necessarily translate into better nutritional quality of diet. Overall, the

353   difference in the measured food choice motives only explained 5.7% of the variance of the

354   change in the nutritional quality during compared to before the lockdown. Nutritional quality

355   is multidimensional by nature; food choices are complex decisions and various other variables

356   may have influenced what people chose to eat and the resulting nutritional quality of their diet

357   during the lockdown, for instance the availability of food products.

358   *Strengths and limitations*

359   We were able to collect detailed information about food consumption during the

360   month before the lockdown and during the first month of the lockdown in a large sample of

361 French adults. Our study was timely as the data were collected two weeks after the end of the

362 first month of the lockdown. However, the participants retrospectively reported their food

363 consumption which is a clear limitation of this study. We could not anticipate the lockdown

364 and organise a measurement point before the lockdown. Participants were asked to report

365 simultaneously for each food item their consumption before and during the lockdown which

366 made it easier reporting differences in consumption frequency, even if a recall bias could have

367 affected the responses for the period before the lockdown. In other respects, due to this

368 exceptional situation, we compared food consumption in March (before the lockdown, end of

369 winter) and in April (during the lockdown, beginning of spring). We could have expected a

370 season effect in our data, with an improvement of the nutritional quality of diet in April

371 compared to March due to increased availability of fresh fruit and vegetables, although access

372 to fresh product may have been limited by the lockdown (Oxfam France, 2020). Finally, due

373 to unexpectedly high numbers of participants who failed an attention check or reported

374 implausible energy intake (16.4% of the eligible participants who completed the study), we

375 did not reach the sample size of 1,000 participants we aimed for. However, a sample size of

376 938 participants still allowed to detect small effects of Δ motives on Δ quality in a multiple

377 linear regression including nine predictors ($f^2 = 0.017$) at power 0.80 and level of significance

378 0.05 (GPower 3.1). A limitation of this study is that the sample was not representative of the

379 French population and included more women and individuals with higher educational level.

380 This is often the case in studies with volunteers on this topic (Deschasaux-Tanguy et al.,

381 2020). In addition, the participants were recruited from a population registered in the

382 Chemosens Platform's PanelSens database, gathering individuals who agreed to be contacted

383 to take part in research studies exploring eating behaviours. Thus, it is likely that our sample

384 was biased towards individuals with an interest in food. However, this can also be viewed as a

385 strength as these individuals were more likely to have paid attention to what they ate before

386   and during the lockdown and consequently to have cautiously reported their food

387   consumption.

388   *Future research*

389   In a follow-up study, it would be interesting to investigate whether changes in food

390   choice motives and nutritional quality remain stable overtime. Moreover, we analysed the

391   nutritional quality, but the lockdown may also have influenced other characteristics of diet

392   (e.g., proportion of organic and local products). A secondary objective of this online survey

393   was to compare consumption of organic and locally produced food before and during the

394   lockdown and to examine how it related to nutritional quality of diet. The collected data about

395   consumption of organic and local food products before and during the lockdown will be

396   analysed separately. An unanswered question is how diet of more disadvantaged populations

397   was modified during the lockdown and specific studies are needed to describe food choices

398   and eating behaviours among these populations. Finally, only increased weight control food

399   choice motive significantly predicted a better nutritional quality of diet. The increase in health

400   food choice motive did not translate into better nutritional quality of diet. Yet, numbers of

401   public health actions aim at increasing motivation towards health to encourage the individuals

402   to make healthier food choices (Capewell & Capewell, 2017; Frieden, 2010). Our results

403   suggest that increasing the importance of health as a food choice motive might not be

404   sufficient to increase the nutritional quality of diet, maybe because of a lack of nutritional

405   knowledge. From this perspective, making nutritional information easy to understand and

406   directly accessible by consumers at the point of choice should be prioritised, e.g., the front-of-

407   pack nutrition label Nutriscore (Egnell et al., 2018).

408   *Conclusion*

409   The lockdown period in France was related to a decrease in nutritional quality of diet

410 on average which could be partly explained by changes in food choice motives. The lockdown

411 was indeed related to modification of food choice motives in this sample. For instance,

412 whereas the importance of convenience and price motives decreased, the importance of

413 health, natural content and ethic motives increased, suggesting a growing awareness of the

414 importance of sustainable food choices.

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423

424 **Author contributions**

425 LM and SN designed the study and were responsible for data collection. LM and ML

426 analysed the data. BLG developed the food frequency questionnaire and assisted in data

427 analyses. LM was responsible for initial drafting of the paper, and all authors read and

428 approved the final manuscript.

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