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# Association between positive psychological traits and changes in dietary behaviour related to first COVID-19 lockdown: A general population-based study

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## ABSTRACT

**Background:** The spread of the coronavirus disease (COVID-19) led many countries to implement lockdown measures, which resulted in changes in dietary behaviours that could persist over the long term and have associated health consequences. Psychological traits may impact these changes given their known association with dietary behaviours. We aimed to investigate in a population-based study, whether positive psychological traits were associated with changes of snacking behaviour and food consumption observed during the first COVID-19 lockdown period.

**Design:** In 2016, levels of optimism, resilience, self-esteem, satisfaction with life, mindfulness and mastery were assessed in 33,766 adults of the French NutriNet-Santé cohort. Snacking and food group consumption were assessed in April–May 2020. Association between psychological traits and changes (no change, increase, decrease) in snacking and food group consumption were assessed using logistic regressions. Multiple correspondence analysis followed by ascending hierarchical classification were used to derive clusters of dietary behaviours. Covariance analyses were used to compare mean scores of psychological traits between clusters. Analyses were adjusted for sociodemographic and lifestyle characteristics, anxiety and depressive symptomatology.

**Results:** Participants with higher levels of optimism, resilience, self-esteem, satisfaction with life, mindfulness or mastery were less likely to change their snacking behaviour and food group consumption of various food groups. Individuals with lower levels were more likely to make changes, with either unhealthy (e.g., less fruits and vegetables, more processed meat) or healthy (e.g., more pasta/rice (whole-grain)) changes. Overall, individuals showed higher levels of positive psychological traits in the “no change” cluster, followed by the “healthy” and the “unhealthy” cluster (all  $P < 0.05$ ).

**Conclusions:** Individuals with higher levels of optimism, resilience, self-esteem, satisfaction with life, mindfulness or mastery were less impacted by the lockdown in terms of dietary behaviours.

## 1. Background

In 2019, a novel corona virus disease (COVID-19) leading to severe acute respiratory syndrome emerged in China and quickly spread all

over the globe. On March 12, 2020, the World Health Organization (WHO) declared COVID-19 as a global pandemic (WHO, 2020), which has led the national authorities of many countries to implement a nationwide lockdown to constrain the transmission of the virus. In

**Abbreviations:** BMI, Body Mass Index; BRS, Brief Resilience Scale; CI, Confidence Interval; CU, Consumption Unit; FFMQ, Five Facets Mindfulness Questionnaire; GAD-7, General Anxiety Disorder 7 scale; LOT-T, Life Orientation Test Revised; OR, Odds Ratio; PHQ-9, Patient Health Questionnaire 9 scale; PMS, Pearlin Mastery Scale; SES, Self-Esteem Scale; SWLS, Satisfaction With Life Scale.

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France, the first lockdown entered into force on March 17, 2020, and was loosened on May 11, 2020. Under that situation, social distancing was advocated and French people could leave their home only for grocery shopping, medical care, legal obligation and physical activity within a 1 km radius (Décret n° 2020-293 du 23, 2020). Only workers from what was called “essential” sectors (healthcare, medical research, food and drug manufactures and supplies, garbage collection, city cleaning, vehicle and technology maintenance) maintained their usual activity (Décret n° 2020-293 du 23, 2020). All other non-essential public spaces including school and universities, workplaces, open spaces, recreational spaces and non-food spaces were closed (Décret n° 2020-293 du 23, 2020). As a result, a vast majority of the population either was asked to telework from home or became partially unemployed, and parents had to relay school teachers at home (Décret n° 2020-293 du 23, 2020).

Studies conducted among the general population showed changes in the diet during the first COVID-19 lockdown but with contrasted results. Both positive changes were observed, with an increase in consumption of fruit and vegetables (Deschasaux-Tanguy et al., 2021; Górnicka, Drywień, Zielinska, & Hamułka, 2020; Marty, de Lauzon-Guillain, Labesse, & Nicklaus, 2021; Scarmozzino & Visioli, 2020), whole grains (Górnicka et al., 2020), legumes and nuts (Deschasaux-Tanguy et al., 2021), and a reduced consumption of confectionery and salty snacks (Górnicka et al., 2020), ice cream (Górnicka et al., 2020) and alcohol (Scarmozzino & Visioli, 2020), and negative changes, characterised by an increase in snacking (Deschasaux-Tanguy et al., 2021; Robinson et al., 2021; Sidor & Rzymiski, 2020), chocolate (Deschasaux-Tanguy et al., 2021; Scarmozzino & Visioli, 2020), ice cream (Górnicka et al., 2020; Scarmozzino & Visioli, 2020), salty snack (Bin Zarah, Enriquez-Marulanda, & Andrade, 2020; Scarmozzino & Visioli, 2020), processed meat (Marty et al., 2021), sugary food (Marty et al., 2021) and alcohol (Bin Zarah et al., 2020; Marty et al., 2021), and a decrease in fruits and vegetables (Bin Zarah et al., 2020; Deschasaux-Tanguy et al., 2021; Górnicka et al., 2020), fish (Bin Zarah et al., 2020; Górnicka et al., 2020) and whole grain products (Bin Zarah et al., 2020; Górnicka et al., 2020). Other behaviours such as a decrease in physical activity (Brown et al., 2021; Deschasaux-Tanguy et al., 2021; Robinson et al., 2021; Rodríguez-Pérez et al., 2020; Rossinot, Fantin, & Venne, 2020), an increase in sedentary time (Deschasaux-Tanguy et al., 2021), and an increase in tobacco consumption (Rossinot et al., 2020) were also observed.

Given the impact of dietary behaviours on chronic diseases (World Health Organization, 2003) and their potential impact on the immune response (Childs, Calder, & Miles, 2019), it is important to understand their determinants. More specifically, a better understanding of these determinants may help prevent unhealthy changes in dietary behaviour in potential future similar crises such as the COVID-19 pandemic. This is particularly important since negative dietary behaviour resulting from the lockdown may last thereafter, as nutritional behaviours have been shown to be relatively stable over time (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2005).

Individual psychological resources may have had an impact on the lockdown experience, and in particular on changes in dietary behaviour, given the recognised influence of psychological traits on dietary behaviours in general (Keller & Siegrist, 2015; Lunn, Nowson, Worsley, & Torres, 2014). For example, individuals in a cluster characterised by higher neuroticism, insecurity, stress and ‘type A’ personality (i.e. more competitive and ambitious) reported more negative impact of the lockdown on their lifestyle behaviour, and in particular on their diet (Flint, Brown, Tahrani, Piotrkowicz, & Joseph, 2020). Positive psychological resources are of specific interest since focusing on building competencies rather than correcting weakness could be a step forward in health promotion (Seligman & Csikszentmihalyi, 2000). Optimism (Ait-Hadad et al., 2020), satisfaction with life (Grant, Wardle, & Steptoe, 2009), self-esteem (Muros, Cofre-Bolados, Arriscado, Zurita, & Knox, 2017), resilience (Whatnall, Patterson, Siew, Kay-Lambkin, &

Hutchesson, 2019), mindfulness (Jordan, Wang, Donatoni, & Meier, 2014) and mastery (Cobb-Clark, Kassenboehmer, & Schurer, 2014) are all positive psychological resources that have previously been associated with a healthier diet. Therefore, it is likely that these traits may have played a role in the way individuals experienced the lockdown, and more specifically their overall dietary behaviour during this period.

The aim of the present study was therefore to assess the association between several positive psychological traits (optimism, satisfaction with life, self-esteem, resilience, mindfulness and mastery), and changes in snacking behaviour, food group consumption and overall dietary behaviours related to the first COVID-19 lockdown period in a large population-based sample.

## 2. Methods

### 2.1. Study population and design

This study was conducted within the NutriNet-Santé Study, an ongoing web-based prospective cohort launched in 2009, the aims of which being to explore the relations between nutrition and health, as well as the determinants of eating behaviours and nutritional status. The rationale, design and methods have been described elsewhere (Herberg et al., 2010). Participants are volunteers aged  $\geq 18$  years from the general French population. At inclusion, they are asked to complete a set of self-reported web-based questionnaires to assess their diet, health status, physical activity, anthropometric data, socio-economic conditions and lifestyle characteristics. In addition, optional questionnaires related to eating behaviour determinants and specific health-related outcomes are sent each month.

The NutriNet-Santé study was conducted in accordance with the Declaration of Helsinki, and all procedures were approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n° 0000388FWA00005831) and the Commission Nationale de l’Informatique et des Libertés (CNIL n° 908450 and n° 909216). Electronic informed consent was obtained from all participants. The study was registered at [clinicaltrials.gov](https://clinicaltrials.gov) as #NCT03335644.

### 2.2. Assessment of positive psychological traits

#### 2.2.1. Dispositional optimism

Dispositional optimism is defined as the general expectation that good things, rather than bad things, will occur in one’s future (Scheier & Carver, 1993). It was assessed with the French version (Trottier, Mageau, Trudel, & Halliwell, 2008) of the Life Orientation Test - Revised (LOT-R) (Scheier, Carver, & Bridges, 1994), which was administered between October and December 2016. This validated questionnaire consists of 6 items: 3 positively worded (e.g., “I’m always optimistic about my future”) and 3 negatively worded (e.g., “I hardly ever expect things to go my way”), rated on a 5-point Likert scale ranging from 0 (strongly disagree) to 4 (strongly agree). The scoring for the negatively worded items was reversed. Item scores were summed up and divided by the number of items, leading to a final score ranging from 0 (low optimism) to 4 (high optimism). The scale showed good internal consistency (Cronbach’s  $\alpha = 0.84$ ).

#### 2.2.2. Satisfaction with life

Satisfaction with life is defined by a global assessment of a person’s quality of life according to his/her chosen criteria (Shin & Johnson, 1978). It was evaluated by the validated French version (Blais, Vallierand, Pelletier, & Brière, 1989) of the Satisfaction With Life Scale (SWLS) (Diener, Emmons, Larsen, & Griffin, 1985) between October and December 2016. The SWLS is composed of 5 items (e.g., “The conditions of my life are excellent”) rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The items scores were summed up and the score was divided by the number of items leading to a final

score ranging from 1 (low satisfaction with life) to 7 (high satisfaction with life). The scale displayed good internal consistency (Cronbach's  $\alpha = 0.89$ ).

### 2.2.3. Self-esteem

Self-esteem refers to an individual's evaluation of their own worth (Rosenberg, 1965). It was assessed with the French version (Vallieres & Vallerand, 1990) of the Rosenberg Self-Esteem Scale (R-SES) (Rosenberg, 1965) which was completed by participants between October and December 2016. This validated questionnaire is composed of 10 items: 5 positively worded (e.g., "I feel I have a number of good qualities") and 5 negatively worded (e.g., "At times I think I am no good at all"). All items are rated on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The scoring for the negatively worded items was reversed. The scores were summed and then divided by the number of items. The final score of self-esteem was ranging from 1 (low self-esteem) to 4 (high self-esteem). The scale showed good internal consistency (Cronbach's  $\alpha = 0.88$ ).

### 2.2.4. Resilience

Resilience, the ability to bounce back or recover from stress (Smith et al., 2008), was assessed with the French version of the Brief Resilience Scale (BRS) (Smith et al., 2008) between January and July 2017. This validated questionnaire consists of 3 items positively worded (e.g., "I tend to bounce back quickly after hard times") and 3 items negatively worded (e.g., "I have a hard time making it through stressful events"), each rated on a 5-points Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The scoring for the negatively worded items was reversed. Item scores were summed and divided by the number of items, leading to a final score ranging from 1 (low resilience) to 5 (high resilience). The scale showed good internal consistency (Cronbach's  $\alpha = 0.84$ ).

### 2.2.5. Mindfulness

Mindfulness reflects the propensity to be mindful in daily life (Heeren, Douilliez, Peschard, Debrauwere, & Philippot, 2011). It was assessed with the French version (Heeren et al., 2011) of the Five Facets Mindfulness Questionnaire (FFMQ) (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), between January and June 2013. This validated questionnaire is composed of 39 items: 20 positively worded (e.g., "While walking, I am aware of the sensations in my body") and 19 negatively worded (e.g., "I am easily distracted") rated on a 5-points Likert scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The score of the negative worded items were reversed before summing all items. This score was divided by the number of items, leading to a final overall score ranging from 1 (low degree of mindfulness) to 5 (high degree of mindfulness). The scale displayed good internal consistency (Cronbach's  $\alpha = 0.89$ ).

### 2.2.6. Mastery

Mastery is defined as the extent to which individuals perceive having control over important circumstances of their lives (Pearlin, Nguyen, Schieman, & Milkie, 2007). This psychological trait was measured with the Pearlin Mastery Scale (PMS) (Pearlin, Menaghan, Lieberman, & Mullan, 1981) between May and November 2014, which is a 7-item validated questionnaire: 3 positively worded (e.g., "What happens to me in the future mostly depends on me") and 4 negatively worded (e.g., "There is really no way I can solve some of the problems I have") rated on a 7-point Likert scale ranging from 1 (strongly agree) to 7 (strongly disagree). The items scores were summed and then divided by the number of items. The score was ranging from 1 (low mastery) to 7 (high mastery). The scale displayed good internal consistency (Cronbach's  $\alpha = 0.84$ ).

## 2.3. Assessment of changes in snacking behaviour and food group consumption

During the first lockdown period, a set of lockdown related questionnaires was sent to all participants between April 1 and May 13, 2020. The set included a self-report questionnaire assessing participants' exposure to SARS-CoV2 infection and experience of the lockdown, as part of a national multi-cohort project (*Health, Practices, Relationships and Social inequalities in the general population during the COVID-19 crisis*, SAPRIS), and a questionnaire to qualitatively assess changes in physical activity, food supply, weight and dietary habits. Accesses to the questionnaire are on supplementary material 1. To assess changes in snacking behaviour, participants were asked to choose an answer between the following statements: "Compared to the situation before lockdown: I snack more, I snack less, I snack neither more nor less". To assess potential changes in dietary habits, participants were also asked to choose an answer between the following statements: "Check the answer that best describe your situation for each food group: I increased my consumption, I decreased my consumption, I did not change my consumption, I do not consume this food group". Among the 48 food groups assessed in the questionnaire, we selected 17 groups according to two criteria. Since multiple correspondence analysis requires that there are no low frequency modalities for each variable (Husson), we removed food groups that were mostly non-consumed. In addition, we selected food groups that were of particular interest from a nutritional perspective, and in particular groups targeted by the French National Nutrition and Health Program (PNNS) (HCSF, 2017). Selected groups were: whole-grain bread, whole-grain pasta and rice, fresh fruits, fresh vegetables, legumes, fresh fish and shellfish, fresh red meat, processed meat, sandwiches, pizzas and savoury pies, yoghurt and cottage cheese, sweets and chocolate, biscuits and cakes, butter, sugar, honey and marmalade, sugary drinks and sodas, and alcoholic drinks.

## 2.4. Covariates

Socio-demographic, anthropometric and lifestyle data were self-reported each year, using a set of web-based questionnaires that have been validated against traditional methods (Touvier et al., 2010; Vergnaud et al., 2011). We used the latest data available prior to baseline (October 2016). Collected information included: age (years), gender (men, women), educational level (primary, secondary, undergraduate, and postgraduate), occupational status (unemployed, student, self-employed and farmer, employee and manual worker, intermediate profession, managerial staff and intellectual profession, and retired), monthly income per household unit, smoking status (never, former smokers, and current smokers), physical activity, body mass index (BMI), dietary energy intake (including alcohol), general anxiety disorders (General Anxiety Disorder-7 scale) and depressive symptomatology (Patient Health Questionnaire-9). Monthly income per household unit was calculated using information about income and household composition. The number of people in the household was converted into a number of consumption units (CU) according to the OECD (Organisation for Economic Cooperation and Development) equivalence scale: one CU is attributed for the first adult in the household, 0.5 for other persons aged 14 or older and 0.3 for children under 14 (E Institut national, 2019). Categories of monthly income were defined as follows: <1,200; 1,200–1,799; 1,800–2,299; 2,300–2,699; 2,700–3,699; and  $\geq 3,700$  euros per household unit as well as "unwilling to answer". Physical activity was assessed with the short form of the French version of the International Physical Activity Questionnaire (Craig et al., 2003). Weekly energy expenditure, expressed in Metabolic Equivalent of Task in minutes per week (MET in minutes/week), was estimated and three levels of physical activity were constituted: low (<30 min/day), moderate (30–60 min/day), and high ( $\geq 60$  min/day). BMI was calculated on the basis of self-reported height and weight. Energy intake (kcal) was assessed with a set of three 24-hr-dietary

records which participants are asked to complete every 6 months. Participants reported all food and beverages consumed in a day, using standard measurements and/or validated photographs when reporting portion sizes (Le Moullec, Deheeger, & Preziosi, 1996). Nutrient intakes were estimated by using the published NutriNet-Santé food composition database. Mean daily food intake (in grams per day) was weighted according to the day of the week (weekday or weekend). In addition, various covariates were collected between April 1 and May 13, 2020 (first lockdown period) as part as the SAPRIS questionnaire. Data on professional activity during lockdown (working outside home, partially unemployed, fully working from home, partially working from home, student, and other), and the presence of children or grandchildren <18 years at home during the lockdown (yes, no) were collected. In addition, data on anxiety and depressive symptomatology were collected. Anxiety was assessed with the French version of the General Anxiety Disorder 7 (GAD-7) scale (Spitzer, Kroenke, Williams, & Löwe, 2006). The GAD-7 scale is a 7-item questionnaire assessing general anxiety disorders, with each item rated on a 4-point scale, leading to a 0–21 range. A score  $\geq 10$  indicates the presence of anxiety disorders (Spitzer et al., 2006). Depressive symptomatology was assessed with the French version of the Patient Health Questionnaire-9 (PHQ-9) scale (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 scale is a 9 items questionnaire assessing depressive symptomatology. Its items are rated on a 4-point scale leading to a 0–27 range. A score  $\geq 10$  indicates the presence of depressive symptoms (Kroenke et al., 2001).

## 2.5. Statistical analyses

We used chi-square test and student *t*-test to compare included with excluded participants, as appropriate. Individual characteristics, changes in snacking behaviour and food group consumption were described with frequencies or mean  $\pm$  standard deviation. Relationship between individual characteristics and positive psychological traits levels were described with Pearson correlations for continuous variables and Student *t*-test and variance analysis (ANOVA) for categorical variables.

We used multinomial logistic regression models to assess the link between positive psychological traits (independent variables) and changes in snacking behaviour and food group consumption (dependent variables). Three levels of change in snacking behaviour and food group consumption were defined: increased, decreased and no change (reference). Participants who do not consume the food group of interest were excluded from the analyses for this specific food group. The strength of all associations was determined by computing odds ratios (ORs) and 95% confidence intervals (CI).

We applied a multiple correspondence analysis (MCA), a data reduction procedure, to derive clusters of dietary behaviours from changes in snacking and food group consumption. Changes in snacking behaviour and all 17 food groups were included in the MCA as active variables. Two dimensions were kept based on inertia decomposition and the relevance and interpretability of the obtained profiles (Husson) (explaining respectively 7.7% and 5.7% of the variation). Coordinates of changes in snacking and food groups along these dimensions are shown in [Supplementary Table 1](#). We then performed an ascending hierarchical classification (AHC) on the scores of participants along these two dimensions to define clusters of participants displaying similar dietary behaviours. Dietary behaviours were classified as “healthy” or “unhealthy”, following the French nutritional recommendations (PNNS) (HCSF, 2017). Covariance analysis (ANCOVA) were used to compare mean scores of each psychological trait between clusters. We then computed post-hoc pairwise comparisons using Bonferroni’s test to account for multiple comparisons. We provided adjusted mean values and 95% CI.

Potential confounders were selected based on variables shown in the literature to be associated with positive psychological traits (Campbell-Sills, Forde, & Stein, 2009; Fung et al., 2015; Haq, 2016;

Marques-Vidal, Waeber, Vollenweider, & Guessous, 2018; Pearlin & Schooler, 1978) and diet (Liu et al., 2007; Marques-Vidal et al., 2018; Yannakoulia et al., 2008). Then, confounders associated with the different psychological traits, changes in snacking behaviour, food group consumption and dietary behaviour at the  $P < 0.2$  level were retained in multivariable logistic regressions and covariance analyses. We performed 3 different model: Model 1 was adjusted for age, gender, educational level, occupational status, professional activity during lockdown, monthly household income, presence of children or grandchildren <18 years during lockdown, smoking status, physical activity, BMI and dietary energy intake. Model 2 was: Model 1 + general anxiety disorders and depressive symptoms during lockdown. In addition, a raw model is presented in [Supplementary Table 2](#). Analyses were not stratified by gender or BMI as the interactions between the positive psychological traits and gender or BMI were non-significant for most food groups and clusters of dietary behaviours ( $P > 0.2$ ).

Missing data with regard to confounders were handled with multiple imputations by fully conditional specification (20 imputed data sets). All tests of statistical significance were 2-sided, and significance was set at 5%. The MCA and the ACH were performed using the FactoMineR package version 1.34 (Lê, Josse, & Husson, 2008) (R-software). All other statistical analyses were performed using SAS version 9.4 software (SAS Institute, Inc.).

## 3. Results

### 3.1. Characteristics of the sample

A total of 40,550 participants completed the optional questionnaire on dietary and snacking behaviour during the first COVID-19 lockdown. Among them, 23,400 participants completed the LOT-R (among which 52 were excluded because they had an acquiescence bias, meaning they agreed to all questions without consideration of the reverse items), 23,455 completed the SWLS ( $N = 0$  with an acquiescence bias), 23,435 completed the R-SES ( $N = 18$  with an acquiescence bias), 25,965 completed the BRS ( $N = 58$  with an acquiescence bias), 29,179 completed the FFMQ ( $N = 14$  with an acquiescence bias), and 17,058 participants completed the PMS ( $N = 57$  with an acquiescence bias). Compared with excluded participants, included participants (the 33,766 individuals who had completed the COVID-19 lockdown questionnaire and at least one psychological trait questionnaire) were older ( $53.4 \pm 13.8$  years for included participants vs.  $48.8 \pm 15.2$  years for excluded participants,  $P < 0.0001$ ) and included a higher proportion of men (24.1% vs 20.1%,  $P < 0.0001$ ), individuals with university education (70.1% vs. 66.9%,  $P < 0.0001$ ), individuals with high incomes ( $>2,700€$  monthly income) (32.8% vs 22.8%,  $P < 0.0001$ ), and a lower proportion of current or former smoker (49.4 vs 50.7,  $P < 0.0001$ ).

[Table 1](#) shows individuals characteristics of the sample and their associations with the positive psychological traits. Overall, positive psychological traits were higher in men, in participants with higher education level (except for resilience), income, physical activity, and in individuals reporting no symptoms of anxiety disorders or depressive symptomatology (except for optimism). Psychological traits were positively correlated with age (except for mastery). Levels of psychological traits were higher in managerial staff and intellectual professions (for optimism, satisfaction with life, mindfulness, self-esteem) or self-employed and farmer (for resilience, mastery, self-esteem). Associations with smoking were mixed: individuals with greater optimism, satisfaction with life and self-esteem were more often smokers or former smokers, while those with greater resilience, mindfulness and mastery were more often never smokers. Psychological trait levels were higher in participants with children or grandchildren at home during the lockdown (except for satisfaction with life and mastery). Finally, all psychological traits correlated negatively with BMI (except for resilience).

[Table 2](#) shows the distribution of participants who declared increasing, decreasing or not having changed their snacking behaviour

**Table 1**  
Individual characteristics of the 33,766 participants and comparison of the positive psychological score according to these characteristics (NutriNet-Santé Study, 2016–2020).

	% or Mean ± SD	Optimism (LOT-R) <sup>a</sup>	P value <sub>b</sub>	Satisfaction with life (SWLS) <sup>a</sup>	P value <sub>b</sub>	Self-esteem (R-SES) <sup>a</sup>	P value <sub>b</sub>	Resilience (BRS) <sup>a</sup>	P value <sub>b</sub>	Mindfulness (FFMQ) <sup>a</sup>	P value <sub>b</sub>	Mastery (PMS) <sup>a</sup>	P value <sub>b</sub>
All													
<b>Data collected at baseline</b>													
Age (years)	53.39 ± 13.82 <sup>c</sup>	0.05 (0.03, 0.06)	<.0001	0.04 (0.02, 0.05)	<.0001	0.07 (0.06, 0.08)	<.0001	0.1 (0.09, 0.11)	<.0001	0.1 (0.09, 0.11)	<.0001	−0.09 (−0.11, −0.08)	<.0001
Gender (%)			<.0001		<.0001		<.0001		0.017		<.0001		<.0001
Men	24.07	3.15 ± 0.59		5.28 ± 1.02		3.26 ± 0.42		3.49 ± 0.67		3.38 ± 0.39		5.05 ± 1.04	
Women	75.93	3.12 ± 0.64		5.14 ± 1.11		3.18 ± 0.47		3.27 ± 0.68		3.33 ± 0.43		4.87 ± 1.16	
Educational level (%)			0.0016		<.0001		<.0001		0.0008		<.0001		<.0001
Primary	1.85	3.09 ± 0.53		4.98 ± 1.15		3.16 ± 0.45		3.38 ± 0.7		3.26 ± 0.43		4.59 ± 1.23	
Secondary	27.29	3.11 ± 0.6		4.99 ± 1.14		3.15 ± 0.45		3.33 ± 0.69		3.28 ± 0.41		4.71 ± 1.17	
Undergraduate	31.66	3.13 ± 0.64		5.18 ± 1.07		3.2 ± 0.45		3.3 ± 0.69		3.34 ± 0.42		4.9 ± 1.13	
Postgraduate	38.43	3.14 ± 0.65		5.33 ± 1.04		3.24 ± 0.47		3.34 ± 0.67		3.39 ± 0.43		5.07 ± 1.07	
Missing data	0.77												
Occupational status (%)			<.0001		<.0001		<.0001		<.0001		<.0001		<.0001
Unemployed	8.68	3.05 ± 0.68		4.75 ± 1.38		3.08 ± 0.54		3.18 ± 0.76		3.31 ± 0.46		4.63 ± 1.27	
Student	1.27	3.05 ± 0.7		5.24 ± 1.13		3.04 ± 0.52		3.13 ± 0.65		3.27 ± 0.4		5.06 ± 1.04	
Self-employed, farmer	1.70	3.3 ± 0.71		5.27 ± 1.1		3.26 ± 0.47		3.48 ± 0.69		3.4 ± 0.43		5.23 ± 1.02	
Employee, manual worker	13.47	3.05 ± 0.62		4.83 ± 1.21		3.12 ± 0.49		3.21 ± 0.71		3.25 ± 0.41		4.79 ± 1.15	
Intermediate professions	15.33	3.11 ± 0.64		5.14 ± 1.07		3.18 ± 0.46		3.28 ± 0.67		3.32 ± 0.42		4.95 ± 1.09	
Managerial staff, intellectual profession	24.70	3.17 ± 0.66		5.36 ± 1.02		3.26 ± 0.46		3.37 ± 0.67		3.38 ± 0.42		5.16 ± 1.02	
Retired	33.43	3.15 ± 0.59		5.27 ± 0.98		3.22 ± 0.42		3.4 ± 0.66		3.36 ± 0.42		4.81 ± 1.15	
Missing data	1.42												
Monthly household income (%)			<.0001		<.0001		<.0001		<.0001		<.0001		<.0001
< 1200 €	9.13	3.04 ± 0.68		4.6 ± 1.37		3.08 ± 0.53		3.24 ± 0.73		3.29 ± 0.45		4.56 ± 1.25	
1200 - 1799 €	19.44	3.08 ± 0.62		4.97 ± 1.14		3.15 ± 0.48		3.29 ± 0.69		3.31 ± 0.42		4.81 ± 1.14	
1800 - 2299 €	15.33	3.11 ± 0.63		5.07 ± 1.1		3.18 ± 0.46		3.31 ± 0.68		3.32 ± 0.42		4.89 ± 1.13	
2300 - 2699 €	10.01	3.15 ± 0.62		5.25 ± 0.99		3.22 ± 0.44		3.36 ± 0.68		3.33 ± 0.42		4.9 ± 1.09	
2700 - 3699 €	18.46	3.16 ± 0.62		5.39 ± 0.94		3.25 ± 0.43		3.37 ± 0.66		3.37 ± 0.41		5.06 ± 1.06	
> 3700 €	14.36	3.22 ± 0.66		5.54 ± 0.9		3.3 ± 0.43		3.44 ± 0.66		3.41 ± 0.41		5.19 ± 1.02	
Unwilling to answer	11.43	3.11 ± 0.6		5.17 ± 1.05		3.18 ± 0.46		3.26 ± 0.69		3.34 ± 0.44		4.79 ± 1.17	
Missing data	1.85												
Smoking status (%)			0.0001		<.0001		0.0065		<.0001		<.0001		<.0001
Never	50.50	3.1 ± 0.66		5.03 ± 1.18		3.18 ± 0.48		3.35 ± 0.69		3.36 ± 0.43		5.03 ± 1.1	
Former	38.99	3.15 ± 0.62		5.18 ± 1.06		3.21 ± 0.45		resili		3.35 ± 0.42		4.93 ± 1.13	
Current	10.39	3.12 ± 0.63		5.2 ± 1.09		3.2 ± 0.47		3.29 ± 0.69		3.33 ± 0.42		4.87 ± 1.14	
Missing data	0.12												
Physical activity (%)			<.0001		<.0001		<.0001		<.0001		<.0001		<.0001
High	36.33	3.18 ± 0.63		5.28 ± 1.03		3.23 ± 0.45		3.41 ± 0.68		3.38 ± 0.42		4.96 ± 1.13	
Moderate	40.36	3.12 ± 0.63		5.18 ± 1.08		3.19 ± 0.46		3.3 ± 0.67		3.34 ± 0.42		4.92 ± 1.12	
Low	22.90	3.07 ± 0.63		5 ± 1.18		3.16 ± 0.48		3.23 ± 0.7		3.27 ± 0.42		4.8 ± 1.16	
Missing data	0.41												
Body Mass Index (kg/m <sup>2</sup> )	24.13 ± 4.49	−0.03 (−0.04, −0.02)	<.0001	−0.12 (−0.13, −0.1)	<.0001	−0.02 (−0.03, 0)	0.0177	0.02 (0, 0.03)	0.0142	−0.05 (−0.06, −0.04)	<.0001	−0.08 (−0.09, −0.06)	<.0001
Dietary energy intake (Kcal)	1837.57 ± 484.89	0 (−0.01, 0.02)	0.7308	0.05 (0.03, 0.06)	<.0001	0.04 (0.03, 0.05)	<.0001	0.02 (0.01, 0.04)	0.0002	−0.01 (−0.03, 0)	0.0145	0.03 (0.02, 0.05)	<.0001
Snacking frequency (%)			<.0001		<.0001		<.0001		<.0001		<.0001		<.0001
Never	22.55	3.19 ± 0.66		5.28 ± 1.08		3.25 ± 0.46		3.43 ± 0.71		3.41 ± 0.43		5 ± 1.18	
< once a week	17.90	3.16 ± 0.61		5.26 ± 1.03		3.22 ± 0.44		3.36 ± 0.66		3.37 ± 0.42		4.95 ± 1.08	
≥ once a week and < once a day	32.70	3.11 ± 0.62		5.2 ± 1.06		3.2 ± 0.45		3.3 ± 0.67		3.33 ± 0.42		4.93 ± 1.09	
≥ once a day	26.85	3.07 ± 0.63		4.99 ± 1.15		3.14 ± 0.48		3.23 ± 0.69		3.27 ± 0.42		4.78 ± 1.16	

(continued on next page)

Table 1 (continued)

	% or Mean ± SD	Optimism (LOT-R) <sup>a</sup>	P value <sup>b</sup>	Satisfaction with life (SWLS) <sup>a</sup>	P value <sup>b</sup>	Self-esteem (R-SES) <sup>a</sup>	P value <sup>b</sup>	Resilience (BRS) <sup>a</sup>	P value <sup>b</sup>	Mindfulness (FFMQ) <sup>a</sup>	P value <sup>b</sup>	Mastery (PMS) <sup>a</sup>	P value <sup>b</sup>
<b>General anxiety disorders (GAD-7) (%)</b>			<b>0.0403</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>
No	89.93	3.16 ± 0.62		5.23 ± 1.05		3.22 ± 0.45		3.36 ± 0.67		3.36 ± 0.42		4.96 ± 1.1	
Yes	7.18	2.75 ± 0.6		4.46 ± 1.33		2.91 ± 0.54		2.86 ± 0.72		3.12 ± 0.45		4.27 ± 1.29	
Missing data	2.89												
<b>Depressive symptomatology (PHQ-9) (%)</b>			<b>0.30</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>
No	89.00	3.16 ± 0.62		5.25 ± 1.03		3.23 ± 0.44		3.37 ± 0.67		3.36 ± 0.41		4.97 ± 1.09	
Yes	8.11	2.75 ± 0.63		4.28 ± 1.36		2.83 ± 0.55		2.85 ± 0.73		3.1 ± 0.46		4.23 ± 1.31	
Missing data	2.89												
<b>Data collected during the lockdown</b>													
<b>Professional activity during lockdown (%)</b>			<b>0.0384</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>		<b>&lt;.0001</b>
No professional activity prior to lockdown		3.18 ± 0.79		4.7 ± 1.24		2.99 ± 0.56		3.18 ± 0.69		3.26 ± 0.44		4.86 ± 1.25	
Working outside home	8,64	3.14 ± 0.61		5.21 ± 1.06		3.21 ± 0.44		3.36 ± 0.69		3.36 ± 0.43		4.8 ± 1.16	
Partially unemployed	10,61	3.13 ± 0.67		5.03 ± 1.21		3.19 ± 0.51		3.26 ± 0.71		3.33 ± 0.43		4.93 ± 1.15	
Teleworking from home (fully)	21,91	3.11 ± 0.66		5.21 ± 1.09		3.2 ± 0.49		3.29 ± 0.68		3.33 ± 0.42		5.05 ± 1.07	
teleworking from home (partially)	5,46	3.13 ± 0.64		5.21 ± 1.07		3.22 ± 0.45		3.34 ± 0.66		3.33 ± 0.43		5.07 ± 1.05	
student	0,33	3.19 ± 0.71		5.03 ± 1.1		3.12 ± 0.5		3.41 ± 0.6		3.32 ± 0.47		5 ± 1.14	
other	0,24	3.09 ± 0.63		5.09 ± 1.14		3.17 ± 0.47		3.32 ± 0.69		3.3 ± 0.42		5.02 ± 1.07	
Missing	4,99												
<b>Children or grandchildren &lt;18 y at home during the lockdown (%)</b>			<b>&lt;.0001</b>		<b>0.13</b>		<b>&lt;.0001</b>		<b>0.80</b>		<b>0.023</b>		<b>0.0001</b>
Yes	22.13	3.15 ± 0.61		5.28 ± 1.02		3.22 ± 0.44		3.35 ± 0.68		3.35 ± 0.42		4.92 ± 1.12	
No	55.33	3.14 ± 0.66		5.33 ± 1.04		3.2 ± 0.48		3.3 ± 0.68		3.3 ± 0.41		5.1 ± 1.06	
Missing	22.54												

Abbreviations: BRS, Brief Resilience Scale; FFMQ, Five Facets Mindfulness Questionnaire; GAD-7, General Anxiety Disorder 7 scale; LOT-T, Life Orientation Test – Revised; PHQ-9, Patient Health Questionnaire 9 scale; PMS, Pearlin Mastery Scale; SES, Self-Esteem Scale; SWLS, Satisfaction With Life Scale.

<sup>a</sup> A higher score corresponds to a higher level of positive psychological trait.

<sup>b</sup> All P-Value based on Pearson correlation for continuous variables and Student *t*-test, and variance analyses (ANOVA) for categorical variables.

<sup>c</sup> Mean ± SD, all such value.

**Table 2**

Distribution of participant who declared increasing, decreasing or not changing their snacking frequency and food group consumption during the COVID-19 lockdown. (NutriNet-Santé study, 2016–2020).

Food group (N = 33,766)	Consumption change	Frequency (%)
Snacking	Increased	19.5
	No change	71.2
	Decreased	9.4
Bread, whole-grain	Increased	9.0
	No change	59.2
	Decreased	10.4
	Do not consume	21.6
Pasta, rice, whole-grain	Increased	6.2
	No change	64.2
	Decreased	4.6
	Do not consume	25.1
Fruit, fresh	Increased	13.3
	No change	68.1
	Decreased	17.5
	Do not consume	1.2
Vegetables, fresh	Increased	14.8
	No change	67.0
	Decreased	17.8
	Do not consume	0.5
Legumes	Increased	14.7
	No change	76.8
	Decreased	2.9
	Do not consume	5.6
Fish or shellfish, fresh	Increased	4.7
	No change	49.8
	Decreased	35.4
	Do not consume	10.1
Red meat, fresh	Increased	5.6
	No change	56.2
	Decreased	22.8
	Do not consume	15.4
Processed meat	Increased	7.6
	No change	56.4
	Decreased	13.6
	Do not consume	22.4
Sandwich, pizzas, savoury pies	Increased	5.2
	No change	54.1
	Decreased	14.8
	Do not consume	25.9
Yoghurt, cottage cheese	Increased	10.0
	No change	74.4
	Decreased	6.1
	Do not consume	9.5
Sweets, chocolate	Increased	20.7
	No change	63.0
	Decreased	8.9
	Do not consume	7.4
Biscuits, cakes	Increased	19.8
	No change	58.7
	Decreased	9.8
	Do not consume	11.7
Butter	Increased	8.1
	No change	78.2
	Decreased	3.7
	Do not consume	10.0
Sugar, honey, marmalade	Increased	6.6
	No change	80.3
	Decreased	4.7
	Do not consume	8.5
Sugary drinks, sodas	Increased	2.4
	No change	20.4
	Decreased	3.3
	Do not consume	73.9
Alcoholic drinks	Increased	14.1

**Table 2 (continued)**

Food group (N = 33,766)	Consumption change	Frequency (%)
	No change	53.
	Decreased	10.3
	Do not consume	22.6

Abbreviations: N, number of participants; %, percentage.

and food group consumption. The proportion of participants who did not change their consumption was greater than 50% for every food group considered, except for sugary drinks and sodas (20.4%).

A large proportion of participants increased their intake, and in particular, more than 10% reported an increase in snacking (19.5%), and in the consumption of fresh fruits (13.3%), fresh vegetables (14.8%), legumes (14.7%), sweets and chocolate (20.7%), biscuits and cakes (19.8%) and alcoholic drinks (14.1%). In addition, more than 10% reported a decrease in their consumption of whole-grain bread (10.3%), fresh fruits (17.5%), fresh vegetables (17.8%), fresh fish or shellfish (35.4%), fresh red meat (22.8), processed meat (13.6%), sandwich, pizzas and savoury pies (14.8%), and alcoholic drinks (10.3%).

### 3.2. Association between positive psychological traits and changes in snacking behaviour and food group consumption during the first lockdown period

Table 3 present the results of the multinomial logistic regression models assessing the association between the different positive psychological traits (i.e., optimism, satisfaction with life, self-esteem, resilience, mindfulness and mastery), and changes in snacking behaviour and food group consumption related to the first lockdown period.

Results of model 1 showed that participants with a higher level of any of the positive psychological traits assessed were less likely to increase (ORs ranges from 0.67 (95% CI: 0.62, 0.72) to 0.95 (95% CI: 0.91, 0.98)), but also decrease (ORs ranges from 0.81 (95% CI: 0.73, 0.89) to 0.95 (95% CI: 0.90, 1.0)), their snacking behaviour compared with individuals with lower levels of positive psychological traits.

In addition, participants with higher positive psychological traits were less likely (ORs ranges from 0.62 (95% CI: 0.51, 0.76) to 0.95 (95% CI: 0.92, 0.99)) to increase their consumption of whole-grain bread, whole-grain pasta and rice (except for mastery), fresh fruits and vegetables (only for satisfaction with life), legumes (except for optimism, mindfulness and mastery), fresh fish or shellfish (only for satisfaction with life), fresh red meat (except for optimism, resilience and mastery), processed meat, sandwich, pizzas and savoury pies, yoghurt and cottage cheese (except for mastery), sweets and chocolate (except for mastery), biscuits and cakes, butter (except for optimism), sugar, honey and marmalade, sugary drinks and sodas (except for mastery), and alcoholic drinks.

Participants with higher positive psychological traits were also less likely (ORs ranges from 0.74 (95% CI: 0.69, 0.80) to 0.95 (95% CI: 0.93, 0.98)) to decrease their consumption of whole-grain bread (except for optimism and mindfulness), fresh fruits, fresh vegetables, legumes (only for satisfaction with life and mastery), fresh fish and shellfish, fresh red meat, processed meat (only for satisfaction with life), sandwich, pizzas and savoury pie (except for mindfulness), yoghurt and cottage cheese, sweets and chocolate (except for mindfulness), biscuits and cakes (except for mindfulness), butter (except for mindfulness), sugar, honey and marmalade (only for satisfaction with life and mastery), sugary drinks and sodas (only for satisfaction with life), and alcoholic drinks (only for satisfaction with life).

Finally, they were more likely (OR = 1.26 (95% CI: 1.11, 1.44)) to decrease their consumption of honey and marmalade (only for mindfulness).

The raw model (supplemental data) showed very few differences with model 1. In addition, analyses with further adjustment for anxiety and depressive symptomatology (model 2) showed similar results



**Table 3a**

Association between optimism, satisfaction with life and self-esteem, and changes in snacking and food consumption related to the COVID-19 lockdown period (NutriNet-Santé study, 2016-2020).

		Optimism (LOT-R) (N = 23,400)				Satisfaction with life (SWLS) (N = 23,455)				Self-esteem (SES) (N = 23,435)			
		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
		OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>
Snacking	Increased	0.82 (0.78, 0.87)	<.0001	0.88 (0.83, 0.93)	<.0001	0.83 (0.80, 0.86)	<.0001	0.87 (0.84, 0.90)	<.0001	0.74 (0.69, 0.80)	<.0001	0.84 (0.78, 0.91)	<.0001
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.88 (0.82, 0.95)	<b>0.0007</b>	0.91 (0.84, 0.98)	<b>0.012</b>	0.88 (0.84, 0.92)	<.0001	0.9 (0.86, 0.94)	<.0001	0.83 (0.75, 0.92)	<b>0.0002</b>	0.87 (0.79, 0.97)	<b>0.0087</b>
Bread, whole-grain <sup>d</sup>	Increased	0.91 (0.84, 0.98)	<b>0.012</b>	0.93 (0.86, 1.00)	<b>0.047</b>	0.89 (0.85, 0.93)	<.0001	0.9 (0.86, 0.95)	<.0001	0.8 (0.72, 0.89)	<.0001	0.82 (0.74, 0.92)	<b>0.0003</b>
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.97 (0.9, 1.04)	0.37	1.02 (0.95, 1.10)	0.60	0.88 (0.84, 0.92)	<.0001	0.91 (0.87, 0.95)	<.0001	0.85 (0.77, 0.93)	<b>0.0009</b>	0.92 (0.83, 1.02)	0.11
Pasta, rice, whole-grain	Increased	0.83 (0.75, 0.91)	<.0001	0.87 (0.79, 0.95)	<b>0.0029</b>	0.84 (0.79, 0.88)	<.0001	0.86 (0.82, 0.91)	<.0001	0.79 (0.70, 0.89)	<b>0.0001</b>	0.85 (0.75, 0.97)	<b>0.012</b>
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.95 (0.85, 1.05)	0.31	1.00 (0.90, 1.11)	0.98	0.88 (0.83, 0.93)	<.0001	0.91 (0.86, 0.97)	<b>0.0026</b>	0.90 (0.78, 1.03)	0.13	0.98 (0.85, 1.14)	0.83
Fruit, fresh	Increased	0.97 (0.91, 1.03)	0.30	0.98 (0.92, 1.05)	0.61	0.91 (0.88, 0.95)	<.0001	0.92 (0.89, 0.96)	<.0001	0.96 (0.88, 1.05)	0.36	0.99 (0.90, 1.08)	0.83
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.83 (0.78, 0.88)	<.0001	0.89 (0.84, 0.94)	<.0001	0.84 (0.81, 0.86)	<.0001	0.87 (0.84, 0.90)	<.0001	0.80 (0.75, 0.87)	<.0001	0.89 (0.83, 0.97)	<b>0.0043</b>
Vegetables, fresh	Increased	0.98 (0.92, 1.04)	0.49	0.97 (0.91, 1.04)	0.41	0.94 (0.91, 0.98)	<b>0.0029</b>	0.94 (0.90, 0.98)	<b>0.0014</b>	0.95 (0.87, 1.04)	0.24	0.94 (0.86, 1.03)	0.17
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.76 (0.72, 0.81)	<.0001	0.82 (0.77, 0.86)	<.0001	0.81 (0.79, 0.84)	<.0001	0.85 (0.82, 0.87)	<.0001	0.74 (0.69, 0.80)	<.0001	0.83 (0.77, 0.90)	<.0001
Legumes	Increased	0.97 (0.92, 1.03)	0.39	0.99 (0.93, 1.05)	0.65	0.94 (0.91, 0.98)	<b>0.0023</b>	0.95 (0.92, 0.99)	<b>0.010</b>	0.92 (0.84, 1.00)	<b>0.044</b>	0.94 (0.86, 1.02)	0.13
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.90 (0.79, 1.01)	0.084	0.95 (0.84, 1.08)	0.43	0.82 (0.76, 0.87)	<.0001	0.85 (0.79, 0.91)	<.0001	0.85 (0.72, 1.00)	0.052	0.94 (0.80, 1.12)	0.50
Fish or shellfish, fresh	Increased	1.06 (0.95, 1.17)	0.30	1.07 (0.96, 1.19)	0.21	0.92 (0.86, 0.98)	<b>0.0063</b>	0.92 (0.87, 0.98)	<b>0.013</b>	0.97 (0.84, 1.12)	0.68	0.99 (0.85, 1.15)	0.89
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.92 (0.88, 0.97)	<b>0.0006</b>	0.95 (0.91, 1.00)	0.052	0.92 (0.90, 0.95)	<.0001	0.94 (0.92, 0.97)	<.0001	0.90 (0.85, 0.96)	<b>0.0012</b>	0.95 (0.89, 1.02)	0.14
Red meat, fresh	Increased	0.94 (0.85, 1.04)	0.21	0.96 (0.87, 1.07)	0.48	0.9 (0.85, 0.96)	<b>0.0009</b>	0.92 (0.87, 0.98)	<b>0.012</b>	0.81 (0.71, 0.93)	<b>0.0025</b>	0.85 (0.74, 0.98)	<b>0.027</b>
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.91 (0.87, 0.96)	<b>0.0007</b>	0.94 (0.89, 0.99)	<b>0.031</b>	0.89 (0.86, 0.91)	<.0001	0.91 (0.88, 0.93)	<.0001	0.86 (0.8, 0.93)	<.0001	0.91 (0.85, 0.98)	<b>0.012</b>
Processed meat	Increased	0.87 (0.80, 0.94)	<b>0.0010</b>	0.92 (0.84, 1.00)	0.052	0.84 (0.80, 0.88)	<.0001	0.87 (0.83, 0.91)	<.0001	0.79 (0.71, 0.89)	<.0001	0.87 (0.78, 0.98)	<b>0.020</b>
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	1.00 (0.94, 1.06)	0.95	1.01 (0.95, 1.08)	0.66	0.93 (0.90, 0.97)	<b>0.0003</b>	0.94 (0.91, 0.98)	<b>0.0037</b>	0.96 (0.88, 1.05)	0.37	0.99 (0.90, 1.08)	0.77
	Increased		<.0001		<b>0.0053</b>		<.0001		<.0001		<.0001		<b>0.0002</b>

(continued on next page)

Table 3a (continued)

		Optimism (LOT-R) (N = 23,400)				Satisfaction with life (SWLS) (N = 23,455)				Self-esteem (SES) (N = 23,435)			
		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
Sandwich, pizzas, savory pies	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
	Decreased	0.89 (0.83, 0.94)	<b>0.0002</b>	0.91 (0.85, 0.97)	<b>0.0031</b>	0.85 (0.82, 0.88)	<.0001	0.86 (0.83, 0.9)	<.0001	0.82 (0.75, 0.89)	<.0001	0.85 (0.78, 0.93)	<b>0.0004</b>
Yoghurt, cottage cheese	Increased	0.89 (0.83, 0.96)	<b>0.0028</b>	0.94 (0.87, 1.01)	0.079	0.84 (0.81, 0.88)	<.0001	0.87 (0.83, 0.91)	<.0001	0.85 (0.77, 0.94)	<b>0.0014</b>	0.92 (0.84, 1.02)	0.13
	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
Sweets, chocolate	Decreased	0.86 (0.79, 0.94)	<b>0.0012</b>	0.91 (0.83, 1.00)	0.052	0.85 (0.8, 0.89)	<.0001	0.88 (0.83, 0.92)	<.0001	0.78 (0.70, 0.88)	<.0001	0.86 (0.76, 0.97)	<b>0.015</b>
	Increased	0.87 (0.82, 0.92)	<.0001	0.91 (0.86, 0.96)	<b>0.0009</b>	0.87 (0.84, 0.90)	<.0001	0.90 (0.87, 0.93)	<.0001	0.77 (0.72, 0.83)	<.0001	0.84 (0.77, 0.90)	<.0001
Biscuits, cakes	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
	Decreased	0.91 (0.84, 0.98)	<b>0.014</b>	0.94 (0.87, 1.01)	0.11	0.85 (0.82, 0.89)	<.0001	0.87 (0.83, 0.91)	<.0001	0.76 (0.69, 0.84)	<.0001	0.80 (0.72, 0.88)	<.0001
Butter	Increased	0.89 (0.84, 0.95)	<b>0.0001</b>	0.94 (0.89, 1.00)	<b>0.037</b>	0.88 (0.85, 0.91)	<.0001	0.91 (0.88, 0.94)	<.0001	0.80 (0.74, 0.87)	<.0001	0.88 (0.81, 0.95)	<b>0.0010</b>
	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
Sugar, honey, marmalade	Decreased	0.93 (0.86, 1.00)	<b>0.048</b>	0.96 (0.89, 1.03)	0.23	0.86 (0.82, 0.89)	<.0001	0.87 (0.84, 0.91)	<.0001	0.81 (0.73, 0.89)	<.0001	0.85 (0.76, 0.93)	<b>0.0010</b>
	Increased	0.92 (0.85, 1.00)	0.062	0.97 (0.90, 1.06)	0.55	0.85 (0.81, 0.89)	<.0001	0.88 (0.83, 0.92)	<.0001	0.75 (0.67, 0.84)	<.0001	0.82 (0.74, 0.92)	<b>0.0009</b>
Sugary drinks, sodas	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
	Decreased	0.89 (0.79, 0.99)	<b>0.039</b>	0.93 (0.83, 1.05)	0.23	0.87 (0.81, 0.92)	<.0001	0.89 (0.83, 0.95)	<b>0.0005</b>	0.76 (0.65, 0.88)	<b>0.0002</b>	0.81 (0.69, 0.94)	<b>0.0062</b>
Alcoholic drinks	Increased	0.87 (0.80, 0.96)	<b>0.0038</b>	0.94 (0.85, 1.03)	0.15	0.81 (0.77, 0.86)	<.0001	0.85 (0.81, 0.89)	<.0001	0.74 (0.66, 0.83)	<.0001	0.83 (0.74, 0.94)	<b>0.0029</b>
	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
Alcoholic drinks	Decreased	0.98 (0.89, 1.08)	0.69	1.01 (0.91, 1.12)	0.90	0.90 (0.85, 0.95)	<b>0.0002</b>	0.91 (0.86, 0.96)	<b>0.0016</b>	1.00 (0.88, 1.15)	0.94	1.06 (0.92, 1.21)	0.46
	Increased	0.75 (0.63, 0.88)	<b>0.0005</b>	0.81 (0.68, 0.95)	<b>0.011</b>	0.87 (0.79, 0.95)	<b>0.0012</b>	0.91 (0.83, 1.00)	<b>0.0400</b>	0.78 (0.64, 0.96)	<b>0.019</b>	0.88 (0.72, 1.09)	0.25
Alcoholic drinks	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
	Decreased	1.02 (0.89, 1.16)	0.79	1.08 (0.95, 1.24)	0.25	0.88 (0.82, 0.95)	<b>0.0008</b>	0.91 (0.85, 0.98)	<b>0.015</b>	0.86 (0.73, 1.03)	0.103	0.93 (0.78, 1.12)	0.45
Alcoholic drinks	Increased	0.90 (0.84, 0.96)	<b>0.0026</b>	0.95 (0.89, 1.02)	0.15	0.91 (0.87, 0.94)	<.0001	0.94 (0.90, 0.98)	<b>0.0040</b>	0.84 (0.77, 0.92)	<b>0.0003</b>	0.92 (0.84, 1.01)	0.078
	No change	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	
Alcoholic drinks	Decreased	1.04 (0.97, 1.11)	0.31	1.06 (0.99, 1.14)	0.089	0.94 (0.90, 0.98)	<b>0.0036</b>	0.95 (0.91, 1.00)	<b>0.037</b>	0.97 (0.88, 1.08)	0.60	1.02 (0.92, 1.13)	0.73

Abbreviations: LOT-T, Life Orientation Test – Revised; N, number of participants; SES, Self-Esteem Scale; SWLS, Satisfaction With Life Scale.

<sup>a</sup> Model 1: Adjusted for age, gender, educational level, occupational status, professional activity during lockdown, monthly household income, presence of children or grandchildren < 18 y during the lockdown, smoking status, physical activity, body mass index and dietary energy intake.

<sup>b</sup> Model 2: Model 1 + general anxiety disorders and depressive symptoms.

<sup>c</sup> P value based on multinomial logistic regression with psychological characteristics as continuous independent variables.

<sup>d</sup> For each food group, participants who did not consume the food group of interest were excluded from the analyses.

**Table 3b**  
Association between resilience, mindfulness and mastery, and changes in snacking and food group consumption related to the COVID-19 lockdown period (NutriNet-Santé study, 2016-2020).

		Resilience (BRS) (N = 25,965)				Mindfulness (FFMQ) (N = 29,179)				Mastery (PMS) (N = 17,058)			
		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>		Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
		OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>
Snacking	Increased	0.80 (0.76, 0.84)	<.0001	0.86 (0.82, 0.91)	<.0001	0.67 (0.62, 0.72)	<.0001	0.73 (0.68, 0.79)	<.0001	0.91 (0.88, 0.94)	<.0001	0.95 (0.91, 0.98)	0.0057
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.89 (0.83, 0.95)	0.0003	0.92 (0.86, 0.98)	0.0093	0.81 (0.73, 0.89)	<.0001	0.84 (0.76, 0.93)	0.0005	0.93 (0.89, 0.98)	0.0039	0.95 (0.9, 1.0)	0.0410
Bread, whole-grain <sup>d</sup>	Increased	0.87 (0.82, 0.93)	<.0001	0.89 (0.83, 0.95)	0.0009	0.83 (0.75, 0.92)	0.0003	0.85 (0.77, 0.94)	0.0022	0.94 (0.9, 0.99)	0.025	0.95 (0.91, 1.0)	0.060
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.90 (0.84, 0.96)	0.0009	0.95 (0.89, 1.01)	0.11	0.96 (0.87, 1.06)	0.42	1.03 (0.94, 1.13)	0.54	0.92 (0.88, 0.97)	0.0006	0.94 (0.9, 0.99)	0.011
Pasta, rice, whole-grain	Increased	0.86 (0.80, 0.93)	0.0002	0.91 (0.84, 0.99)	0.022	0.74 (0.66, 0.84)	<.0001	0.80 (0.70, 0.90)	0.0002	0.95 (0.89, 1.00)	0.065	0.98 (0.92, 1.04)	0.43
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.97 (0.88, 1.06)	0.45	1.02 (0.93, 1.12)	0.71	0.90 (0.78, 1.03)	0.11	0.95 (0.83, 1.09)	0.46	1.02 (0.96, 1.09)	0.48	1.05 (0.98, 1.13)	0.19
Fruit, fresh	Increased	0.98 (0.92, 1.03)	0.43	1.00 (0.95, 1.06)	0.93	0.98 (0.90, 1.07)	0.67	1.02 (0.93, 1.11)	0.73	1.00 (0.96, 1.04)	0.88	1.01 (0.97, 1.06)	0.63
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.81 (0.77, 0.85)	<.0001	0.86 (0.82, 0.90)	<.0001	0.77 (0.72, 0.83)	<.0001	0.85 (0.79, 0.92)	<.0001	0.87 (0.84, 0.90)	<.0001	0.90 (0.86, 0.93)	<.0001
Vegetables, fresh	Increased	1.00 (0.95, 1.06)	0.92	1.01 (0.95, 1.07)	0.82	0.97 (0.89, 1.05)	0.49	0.98 (0.9, 1.07)	0.68	1.03 (0.99, 1.07)	0.17	1.03 (0.99, 1.08)	0.13
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.78 (0.74, 0.82)	<.0001	0.84 (0.80, 0.88)	<.0001	0.76 (0.71, 0.82)	<.0001	0.84 (0.78, 0.91)	<.0001	0.86 (0.83, 0.90)	<.0001	0.90 (0.87, 0.93)	<.0001
Legumes	Increased	0.88 (0.83, 0.92)	<.0001	0.89 (0.84, 0.94)	<.0001	1.04 (0.96, 1.13)	0.38	1.08 (0.99, 1.17)	0.070	0.98 (0.94, 1.02)	0.22	0.99 (0.95, 1.03)	0.48
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.91 (0.82, 1.02)	0.10	0.98 (0.87, 1.09)	0.68	0.91 (0.77, 1.08)	0.30	1.01 (0.85, 1.19)	0.95	0.91 (0.84, 0.99)	0.021	0.94 (0.87, 1.02)	0.13
Fish or shellfish, fresh	Increased	1.03 (0.94, 1.12)	0.58	1.05 (0.95, 1.15)	0.33	0.97 (0.84, 1.11)	0.63	1.00 (0.87, 1.14)	0.96	1.00 (0.94, 1.07)	0.90	1.02 (0.95, 1.09)	0.59
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.86 (0.83, 0.90)	<.0001	0.89 (0.86, 0.93)	<.0001	0.93 (0.87, 0.99)	0.017	0.98 (0.92, 1.04)	0.47	0.95 (0.93, 0.98)	0.0031	0.98 (0.95, 1.01)	0.11
Red meat, fresh	Increased	0.92 (0.84, 1.00)	0.051	0.95 (0.87, 1.04)	0.24	0.77 (0.67, 0.88)	<.0001	0.81 (0.71, 0.92)	0.0018	0.96 (0.90, 1.02)	0.16	0.98 (0.92, 1.05)	0.53
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.87 (0.83, 0.91)	<.0001	0.90 (0.86, 0.95)	<.0001	0.88 (0.82, 0.95)	0.0005	0.93 (0.87, 1.00)	0.061	0.94 (0.91, 0.97)	0.0005	0.96 (0.93, 0.99)	0.021
Processed meat	Increased	0.88 (0.82, 0.95)	0.0008	0.94 (0.87, 1.01)	0.087	0.75 (0.67, 0.84)	<.0001	0.83 (0.75, 0.93)	0.0017	0.92 (0.87, 0.97)	0.0027	0.96 (0.91, 1.01)	0.14
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.95 (0.9, 1.00)	0.059	0.98 (0.92, 1.04)	0.44	1.05 (0.97, 1.15)	0.22	1.09 (1.00, 1.19)	0.045	0.99 (0.95, 1.03)	0.70	1.01 (0.97, 1.05)	0.67
Sandwich, pizzas, savoury pies	Increased	0.81 (0.74, 0.88)	<.0001	0.87 (0.80, 0.95)	0.0018	0.74 (0.65, 0.85)	<.0001	0.83 (0.72, 0.95)	0.0055	0.89 (0.84, 0.95)	0.0005	0.93 (0.87, 0.99)	0.027
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.93 (0.88, 0.98)	0.010	0.95 (0.90, 1.01)	0.091	0.95 (0.88, 1.04)	0.27	0.99 (0.91, 1.08)	0.79	0.95 (0.91, 0.99)	0.0078	0.96 (0.92, 1.00)	0.059
Yoghurt, cottage cheese	Increased	0.87 (0.81, 0.92)	<.0001	0.91 (0.85, 0.97)	0.0039	0.85 (0.77, 0.94)	0.0011	0.92 (0.83, 1.02)	0.098	0.98 (0.93, 1.03)	0.40	1.01 (0.96, 1.06)	0.66
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.84 (0.78, 0.91)	<.0001	0.89 (0.83, 0.97)	0.0056	0.86 (0.77, 0.97)	0.014	0.95 (0.84, 1.07)	0.42	0.89 (0.84, 0.94)	<.0001	0.92 (0.87, 0.97)	0.0046
Sweets, chocolate	Increased	0.82 (0.78, 0.86)	<.0001	0.87 (0.82, 0.91)	<.0001	0.75 (0.69, 0.80)	<.0001	0.81 (0.75, 0.87)	<.0001	0.96 (0.93, 1.00)	0.056	1.00 (0.96, 1.03)	0.82
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.90 (0.84, 0.96)	0.0016	0.93 (0.87, 1.00)	0.037	0.94 (0.85, 1.04)	0.25	0.98 (0.89, 1.09)	0.76	0.94 (0.90, 0.99)	0.017	0.95 (0.91, 1.00)	0.059
Biscuits, cakes	Increased	0.80 (0.76, 0.84)	<.0001	0.84 (0.80, 0.89)	<.0001	0.70 (0.64, 0.75)	<.0001	0.75 (0.69, 0.81)	<.0001	0.95 (0.92, 0.99)	0.0063	0.98 (0.95, 1.02)	0.42
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.85 (0.80, 0.91)	<.0001	0.87 (0.82, 0.93)	<.0001	0.95 (0.87, 1.05)	0.33	0.99 (0.90, 1.09)	0.80	0.94 (0.90, 0.99)	0.012	0.95 (0.91, 1.00)	0.044
Butter	Increased	0.91 (0.85, 0.98)	0.014	0.97 (0.90, 1.04)	0.35	0.78 (0.7, 0.86)	<.0001	0.85 (0.76, 0.94)	0.0025	0.94 (0.89, 0.99)	0.013	0.97 (0.92, 1.02)	0.22
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	0.87 (0.79, 0.96)	0.0048	0.91 (0.82, 1.01)	0.065	1.14 (0.98, 1.32)	0.081	1.23 (1.06, 1.43)	0.0068	0.93 (0.86, 1.00)	0.044	0.96 (0.89, 1.03)	0.24
Sugar, honey, marmalade	Increased	0.83 (0.77, 0.89)	<.0001	0.89 (0.82, 0.96)	0.0022	0.73 (0.65, 0.82)	<.0001	0.81 (0.72, 0.91)	0.0004	0.94 (0.89, 1.00)	0.039	0.98 (0.93, 1.04)	0.58
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
	Decreased	1.00 (0.92, 1.09)	0.96	1.03 (0.94, 1.12)	0.5700	1.25 (1.09, 1.43)	0.0010	1.31 (1.14, 1.50)	<.0001	0.99 (0.93, 1.05)	0.72	1.00 (0.93, 1.07)	0.94

(continued on next page)

Table 3b (continued)

	Resilience (BRS) (N = 25,965)			Mindfulness (FFMQ) (N = 29,179)			Mastery (PMS) (N = 17,058)						
	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>				
	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>	OR (95% CI)	P value <sup>c</sup>			
Sugary drinks, sodas	Increased	0.84 (0.74, 0.95)	0.0070	0.92 (0.81, 1.05)	0.21	0.62 (0.51, 0.76)	<.0001	0.71 (0.58, 0.88)	0.0016	0.94 (0.85, 1.04)	0.25	0.99 (0.90, 1.10)	0.92
	No change	Ref		Ref		Ref		Ref		Ref		Ref	
Alcoholic drinks	Decreased	0.93 (0.84, 1.04)	0.23	1.00 (0.89, 1.12)	0.98	0.97 (0.82, 1.15)	0.72	1.05 (0.88, 1.25)	0.61	1.00 (0.92, 1.09)	0.91	1.03 (0.95, 1.13)	0.49
	No change	0.87 (0.82, 0.92)	<.0001	0.91 (0.86, 0.97)	0.0035	0.79 (0.72, 0.86)	<.0001	0.85 (0.78, 0.93)	0.0004	0.94 (0.90, 0.98)	0.0053	0.97 (0.92, 1.01)	0.16
	Decreased	1.01 (0.95, 1.07)	0.81	1.03 (0.97, 1.10)	0.31	1.04 (0.94, 1.14)	0.47	1.08 (0.98, 1.19)	0.11	0.96 (0.92, 1.01)	0.14	0.98 (0.93, 1.03)	0.35

Abbreviations: BRS, Brief Resilience Scale; FFMQ, Five Facets Mindfulness Questionnaire; N, number of participants; PMS, Pearlin Mastery Scale

<sup>a</sup> Model 1: Adjusted for age, gender, educational level, occupational status, professional activity during lockdown, monthly household income, presence of children or grandchildren <18 y during the lockdown, smoking status, physical activity, body mass index and dietary energy intake.

<sup>b</sup> Model 2: Model 1 + general anxiety disorders and depressive symptoms.

<sup>c</sup> P value based on multinomial logistic regression with psychological characteristics as continuous independent variables.

<sup>d</sup> For each food group, participants who did not consume the food group of interest were excluded from the analyses.

overall compared with model 1, although some associations were weakened.

### 3.3. Association between positive psychological traits and changes in overall dietary behaviours during the first lockdown period

Table 4 presents the distribution of dietary behaviour change related to the lockdown across the clusters derived from the AHC. We identified three clusters. Cluster 1 included 43.89% of the participants and was composed of individuals who mainly reported no change in their food consumption during the lockdown period. Cluster 2 included 28.74% of the participants. This cluster mainly corresponded to “Healthy changes” and was characterised by a noticeable decrease in snacking and consumption of unhealthier food groups: fresh red meat, processed meat, sandwich, pizza and savoury pies, sweets and chocolate, biscuits and cakes, butter, sugar, honey and marmalade, sugary drinks and sodas, and alcoholic drinks, with an increase in consumption of legumes. A decrease in consumption of whole-grain bread, and fresh fish and shellfish was also observed. Conversely, cluster 3, which was composed of 13.74% of the participants, was mainly characterised by “Unhealthy changes”, i.e., an increase in snacking and consumption of several unhealthier food groups: processed meat, sweets and chocolate, biscuits and cakes, butter, sugar, honey and marmalade, and alcoholic drinks, with a decreased consumption of healthier food groups: fresh fruits, fresh vegetables and fresh fish and shellfish. This cluster was also characterised by an increased consumption of whole-grain pasta and rice, legumes, and yoghurt and cottage cheese.

Table 5 present the results of the ANCOVA comparing mean scores of each psychological trait level between clusters. Mean scores of all psychological traits considered were significantly different across clusters of dietary behaviour (all  $P < 0.05$ ). Scores for positive psychological traits were higher in cluster 1 followed by cluster 2 and then cluster 3. In the first model, all pairwise comparisons were significant with the exception of cluster 1 vs 2 for optimism and mindfulness. Overall, results were similar in model 2, except for cluster 1 vs 2 that became non-significant in the case of resilience and cluster 1 vs 2 that became significant in the case of mindfulness.

## 4. Discussion

This large population-based study is, to our knowledge, the first to investigate the association between positive psychological traits and the changes in snacking behaviour, food group consumption and overall dietary behaviour related to the first COVID-19 lockdown period in France. Our results showed that participants with higher optimism, satisfaction with life, self-esteem, resilience, mindfulness or mastery scores were less likely to change their snacking behaviour, food group consumption and overall dietary behaviour during the lockdown. Individuals who scored lower in terms of these positive psychological traits were more likely to display unhealthy changes and, to a lower extent, healthy changes.

### 4.1. Association between higher levels of positive psychological traits and no change in overall dietary behaviour

We found that participants with higher positive psychological traits levels were less likely to make changes in their snacking behaviour, food group consumption and overall dietary behaviour during the lockdown compared to individuals with lower psychological scores. In particular, they were less likely to decrease, but also less likely to increase their snacking and food group consumption. To our knowledge, no previous study has investigated the link between psychological traits and dietary changes during lockdown, but several studies reported an overall change in dietary behaviour during this period (Bin Zarah et al., 2020; Deschasaux-Tanguy et al., 2021; Górnicka et al., 2020; Marty et al., 2021; Rossinot et al., 2020). In a study conducted in the same population

**Table 4**

Distribution of changes in snacking and food group consumption during the lockdown period across the three clusters derived from the ascending hierarchical classification (AHC) (NutriNet-Santé study, 2016–2020).

	Cluster 1 "No change" (43.89%)	Cluster 2 "Healthy changes" (28.74%)	Cluster 3 "Unhealthy changes" (27.38%)	P value <sup>a</sup>
<b>Snacking</b>				<0.0001
Increase	5.15	7.07	55.41	
No change	91.90	70.02	39.21	
Decreased	2.96	22.91	5.38	
<b>Bread, whole-grain</b>				<0.0001
Increased	3.12	7.84	19.60	
No change	72.71	49.72	47.35	
Decreased	2.72	18.51	13.63	
No consumption	21.45	23.93	19.42	
<b>Pasta, rice, whole-grain</b>				<0.0001
Increased	1.17	6.11	14.17	
No change	74.00	58.51	54.35	
Decreased	0.58	10.35	5.06	
No consumption	24.25	25.03	26.42	
<b>Fruit, fresh</b>				<0.0001
Increased	5.36	17.39	21.61	
No change	88.93	58.18	45.12	
Decreased	4.85	22.85	32.04	
No consumption	0.86	1.59	1.22	
<b>Vegetables, fresh</b>				<0.0001
Increased	5.52	20.27	23.77	
No change	88.94	55.96	43.54	
Decreased	5.30	22.98	32.22	
No consumption	0.24	0.78	0.48	
<b>Legumes</b>				<0.0001
Increased	4.34	18.24	27.55	
No change	91.08	69.15	62.06	
Decreased	0.28	5.71	4.14	
No consumption	4.30	6.89	6.24	
<b>Fresh fish and shellfish</b>				<0.0001
Increased	1.71	5.91	8.29	
No change	68.13	36.42	34.49	
Decreased	23.72	41.98	47.03	
No consumption	6.44	15.70	10.20	
<b>Red meat, fresh</b>				<0.0001
Increased	1.18	2.97	15.34	
No change	78.04	34.44	44.06	
Decreased	9.76	36.70	29.15	
No consumption	11.02	25.89	11.45	
<b>Processed meat</b>				<0.0001
Increased	1.32	2.22	23.44	
No change	76.33	33.34	48.58	
Decreased	4.37	28.37	13.04	
No consumption	17.98	36.07	14.94	
<b>Sandwich, pizzas, savoury pies</b>				<0.0001
Increased	0.70	1.71	15.92	
No change	68.59	35.40	50.63	
Decreased	4.88	26.23	18.84	
No consumption	25.84	36.66	14.60	
<b>Yoghurt, cottage cheese</b>				<0.0001
Increased	2.13	8.55	24.04	
No change	89.50	62.45	62.74	
Decreased	0.92	13.49	6.62	
No consumption	7.45	15.50	6.60	
<b>Sweets, chocolate</b>				<0.0001
Increased	5.63	6.71	59.63	
No change	88.39	51.18	34.77	
Decreased	0.58	28.01	2.12	
No consumption	5.40	14.10	3.48	
<b>Biscuits, cakes</b>				<0.0001
Increased	5.37	5.99	57.52	
Decreased	0.56	31.05	2.17	
No change	84.05	43.00	34.64	
No consumption	10.02	19.96	5.67	
<b>Butter</b>				<0.0001
Increased	1.09	3.38	24.43	

(continued on next page)

Table 4 (continued)

	Cluster 1 "No change" (43.89%)	Cluster 2 "Healthy changes" (28.74%)	Cluster 3 "Unhealthy changes" (27.38%)	P value <sup>a</sup>
No change	91.89	65.72	69.40	
Decreased	0.09	11.80	0.96	
No consumption	6.92	19.10	5.21	
<b>Sugar, honey, marmalade</b>				<0.0001
Increased	0.70	2.67	20.15	
No change	93.33	66.79	73.39	
Decreased	0.20	14.94	1.10	
No consumption	5.78	15.59	5.35	
<b>Sugary drinks, sodas</b>				<0.0001
Increased	0.29	0.62	7.63	
No change	23.04	9.22	28.00	
Decreased	0.49	8.33	2.44	
No consumption	76.18	81.83	61.93	
<b>Alcoholic drinks</b>				<0.0001
Increased	6.27	6.25	34.87	
No change	70.88	39.75	38.27	
Decreased	4.35	20.92	8.56	
No consumption	18.50	33.08	18.30	

<sup>a</sup> P value based on chi square test.

as ours, reasons mentioned included changes in lifestyle (change of routine, spending more time cooking) and food supply (buying less fresh products, difficulty going to usual stores or finding usual products), voluntary changes (trying to avoid weight gain, opportunity to balance weight gain) and emotional reasons (eating out of boredom, out of

anxiety) (Deschasaux-Tanguy et al., 2021). Various hypotheses can be made to explain our results. Previous studies have shown that participants with a higher level of self-esteem, resilience and satisfaction with life best adapted to lockdown situation and tended to have more positive attitudes and behaviours, compared with participants with lower levels

Table 5

Covariance Analysis (ANCOVA) comparing mean scores of each psychological trait of participants belonging to each cluster of nutritional behaviour during the lockdown period (NutriNet-Santé study, 2016–2020).

		Clusters mean (95% CI)			P Value <sup>a</sup>	Cluster 1 VS 2		Cluster 1 vs 3		Cluster 2 vs 3	
		Cluster 1 "No change" (43.89%)	Cluster 2 "Healthy changes" (28.74%)	Cluster 3 "Unhealthy changes" (27.38%)		Mean difference (95%CI)	P Value <sup>b</sup>	Mean difference (95%CI)	P Value <sup>b</sup>	Mean difference (95%CI)	P Value <sup>b</sup>
Optimism (LOT-R) (N = 23,400)	Model 1 <sup>c</sup>	3.19 (3.15, 3.23)	3.19 (3.15, 3.23)	3.13 (3.09, 3.17)	<0.0001	0.01 (−0.01, 0.03)	0.46	0.07 (0.05, 0.09)	<.0001	0.06 (0.04, 0.08)	<0.0001
	Model 2 <sup>d</sup>	2.98 (2.93, 3.02)	2.99 (2.94, 3.03)	2.94 (2.9, 2.98)	0.0013	−0.01 (−0.03, 0.01)	0.43	0.04 (0.02, 0.06)	0.0003	0.05 (0.02, 0.07)	0.0001
Resilience (BRS) (N = 23,455)	Model 1 <sup>c</sup>	3.45 (3.41, 3.49)	3.42 (3.38, 3.46)	3.35 (3.31, 3.39)	<0.0001	0.04 (0.02, 0.05)	0.0005	0.11 (0.09, 0.13)	<.0001	0.07 (0.05, 0.1)	<0.0001
	Model 2 <sup>d</sup>	3.2 (3.16, 3.24)	3.18 (3.14, 3.23)	3.13 (3.08, 3.17)	<0.0001	0.02 (0, 0.04)	0.10	0.07 (0.05, 0.09)	<.0001	0.06 (0.03, 0.08)	<0.0001
Self-esteem (SES) (N = 23,435)	Model 1 <sup>c</sup>	3.22 (3.19, 3.25)	3.18 (3.15, 3.21)	3.15 (3.12, 3.18)	<0.0001	0.04 (0.02, 0.05)	<.0001	0.07 (0.05, 0.08)	<.0001	0.03 (0.01, 0.05)	0.0005
	Model 2 <sup>d</sup>	3.04 (3.01, 3.07)	3.01 (2.98, 3.04)	3 (2.96, 3.03)	<0.0001	0.03 (0.01, 0.04)	0.0002	0.04 (0.03, 0.06)	<.0001	0.02 (0, 0.03)	0.048
Satisfaction with life (SWLS) (N = 25,965)	Model 1 <sup>c</sup>	5.21 (5.14, 5.27)	5.03 (4.97, 5.1)	4.97 (4.9, 5.04)	<0.0001	0.17 (0.14, 0.2)	<.0001	0.24 (0.21, 0.28)	<.0001	0.07 (0.03, 0.11)	0.0004
	Model 2 <sup>d</sup>	4.79 (4.72, 4.86)	4.64 (4.57, 4.72)	4.61 (4.53, 4.68)	<0.0001	0.14 (0.11, 0.17)	<.0001	0.18 (0.15, 0.22)	<.0001	0.04 (0, 0.08)	0.039
Mindfulness (FFMQ) (N = 29,179)	Model 1 <sup>c</sup>	3.23 (3.2, 3.25)	3.24 (3.22, 3.27)	3.18 (3.15, 3.2)	<0.0001	−0.02 (−0.03, −0.01)	0.0010	0.05 (0.03, 0.06)	<.0001	0.07 (0.05, 0.08)	<0.0001
	Model 2 <sup>d</sup>	3.35 (3.32, 3.37)	3.36 (3.33, 3.38)	3.28 (3.26, 3.31)	<0.0001	−0.01 (−0.02, 0)	0.084	0.07 (0.05, 0.08)	<.0001	0.08 (0.06, 0.09)	<0.0001
Mastery (PMS) (N = 17,058)	Model 1 <sup>c</sup>	4.99 (4.91, 5.08)	4.92 (4.84, 5)	4.88 (4.79, 4.96)	<0.0001	0.07 (0.03, 0.11)	0.0003	0.12 (0.07, 0.16)	<.0001	0.04 (0, 0.09)	0.076
	Model 2 <sup>d</sup>	4.63 (4.54, 4.72)	4.58 (4.49, 4.67)	4.57 (4.48, 4.66)	0.0009	0.05 (0.01, 0.09)	0.020	0.06 (0.02, 0.1)	0.0054	0.01 (−0.03, 0.06)	0.57

Abbreviations: BRS, Brief Resilience Scale; FFMQ, Five Facets Mindfulness Questionnaire; GAD-7, General Anxiety Disorder 7 scale; LOT-T, Life Orientation Test – Revised; PHQ-9, Patient Health Questionnaire 9 scale; PMS, Pearlin Mastery Scale; SES, Self-Esteem Scale; SWLS, Satisfaction With Life Scale.

<sup>a</sup> P value based on covariance analysis (ANCOVA).

<sup>b</sup> Adjusted P values for multiple comparisons (Holm-Bonferroni method).

<sup>c</sup> Model 1: Adjusted for age, gender, educational level, occupational status, professional activity during lockdown monthly household income, presence of children or grandchildren >18 y during the lockdown, smoking status, physical activity, body mass index and dietary energy intake.

<sup>d</sup> Model 2: Model 1 + general anxiety disorders and depressive symptoms.

(Morales-Vives, Dueñas, Vigil-Colet, & Camarero-Figuerola, 2020). Other studies showed overall greater coping strategies in individuals with higher optimism (Carver, Scheier, & Segerstrom, 2010; Nes & Segerstrom, 2006), satisfaction with life (Gori, Topino, & Fabio, 2020), mindfulness (Bergomi, Ströhle, Michalak, Funke, & Berking, 2013; Weinstein, Brown, & Ryan, 2009), and mastery (Pearlin & Schooler, 1978). A greater sense of personal control was also observed in individuals with higher positive psychological traits levels, and in particular life satisfaction (Gilman & Huebner, 2006). Finally, more deliberate and less affective choices could be observed in individuals with higher levels of mastery (Cobb-Clark et al., 2014). These data would suggest that greater coping, positive attitudes and less affective choices in individuals with higher positive psychological traits levels may have resulted in greater adaptation during lockdown, and thus led to fewer changes in dietary behaviour. Previous studies indicated that women were particularly affected by lockdown, as they reported increased stress (Mattioli, Sciomer, Maffei, & Gallina, 2021), which is an initiator of dietary changes (Torres & Nowson, 2007). Therefore, differences between men and women could have been expected. Yet, interestingly, interactions between psychological traits and sex were non-significant for most food groups in our study, suggesting a similar effect of psychological traits on changes in snacking and overall dietary behaviour in men and women.

#### 4.2. Association between lower levels of positive psychological traits and unhealthy changes in overall dietary behaviour

Our study showed that individuals with lower positive psychological traits levels were more likely to display unhealthy changes in their dietary behaviour. Though there is no similar data existing in the literature, previous studies reported that individuals with lower levels of positive psychological traits were less likely to have a healthier diet (Ait-Hadad et al., 2020; Cobb-Clark et al., 2014; Grant et al., 2009; Jordan et al., 2014; Muros et al., 2017; Whatnall et al., 2019), which is consistent with our results. Potential explanation of our findings could involve the fact that individuals with higher positive psychological traits levels were less impacted by lockdown side-effects, such as an increase in stress (due to work interruption, fear of contracting COVID-19, low satisfaction with health information received, etc.), anxiety and depression (Di Renzo et al., 2020; Rossinot et al., 2020; Wang et al., 2020; Zhang et al., 2020), loneliness (Elmer, Mepham, & Stadtfeld, 2020), isolation and boredom as emotional reactions to social distancing (DiGiovanni, Conley, Chiu, & Zaborski, 2004), and sleep disturbances (Huang & Zhao, 2020). Indeed, in the literature, higher levels of optimism (Biber, Melton, & Czech, 2020), satisfaction with life (Passos, Prazeres, Teixeira, & Martins, 2020; Trzebiński, Cabański, & Czarnecka, 2020), self-esteem (Rossi et al., 2020), resilience (Barzilay et al., 2020; Kimhi, Marciano, Eshel, & Adini, 2020), mindfulness (Conversano et al., 2020; Dubey, Podder, & Pandey, 2020), and mastery (Ben-Kimhy et al., 2020; Flesia et al., 2020) have been negatively associated with anxiety, stress or depression. In addition, higher levels of satisfaction with life (Ozben, 2013) and mindfulness (Creswell et al., 2012; Jin, Zhang, Wang, & An, 2020) have been associated with less loneliness, while higher levels of optimism and self-esteem were associated with greater declared social support (Baumeister, Campbell, Krueger, & Vohs, 2003). Finally, lower optimism (Hernandez et al., 2020), satisfaction with life (Brand et al., 2010), and mindfulness (Murphy, Mermelstein, Edwards, & Gidycz, 2012; Zheng, Yao, & Narayanan, 2020) were associated, though indirectly, to greater sleep disturbance. These lockdown side-effects could have had an impact on the diet during the lockdown. For instance, anxiety and depression are known to be associated with unhealthy changes in nutritional behaviours (Liu et al., 2007; Yannakoulia et al., 2008), and negative changes in mental state was reported to be a reason of eating practices modifications during the COVID-19 lockdown (Deschasaux-Tanguy et al., 2021; Marty et al., 2021; Rossinot et al., 2020). Loneliness, boredom and sleep disturbances have also been

previously associated with deleterious food choices (Bosy-Westphal et al., 2008; Cherikh et al., 2020; Henriksen, Torsheim, & Thuen, 2014; Hogenkamp et al., 2013; Rokach, 1990). These results suggest that participants with lower positive psychological traits levels could have been more exposed to anxiety, depression, loneliness, boredom or sleep disturbances during lockdown and were therefore more likely to engage in unhealthy dietary behaviours. In particular, our results showing a weakening of the association between the psychological traits and dietary behaviours when controlling for anxiety and depressive symptomatology, support the fact that part of the associations could be due to these mental states.

#### 4.3. Association between lower levels of positive psychological traits and healthy changes in overall dietary behaviour

Healthy dietary changes were also observed in individuals with lower positive psychological traits levels, although to a lesser extent. As previously mentioned, lower levels in positive psychological traits are associated with greater stress and anxiety (Barzilay et al., 2020; Biber et al., 2020; Conversano et al., 2020; Flesia et al., 2020; Sowislo & Orth, 2013; Trzebiński et al., 2020). In addition, individuals with lower levels of optimism (Jovančević & Miličević, 2020), resilience (Satici, Kayis, Satici, Griffiths, & Can, 2020), self-esteem (Morales-Vives et al., 2020), and mindfulness (Belen, 2020) specifically reported greater fear of COVID-19. It is possible that fear of COVID-19 has led these individuals to improve their dietary behaviours in order to remain in good health, reinforce their immune system (Childs et al., 2019) and prevent the development of certain diseases such as overweight or cardiovascular diseases, which are risk factor for COVID-19-related mortality (Lighter et al., 2020; Zheng et al., 2020).

#### 4.4. Differences between psychological traits

Overall, similar results were observed for all positive psychological traits considered in our study, although some specificity could be observed. Satisfaction with life was the psychological trait most consistently associated with dietary behaviour since it was significantly associated with each food group. In contrast, mindfulness and mastery were associated with a more limited number of food groups. This suggests that mechanisms underlying the associations between positive psychological traits and dietary behaviour during lockdown could differ from trait to trait.

#### 4.5. Application

Our results suggest that positive psychological traits may have a protective effect on changes in eating behaviour during major life events, such as the COVID-19 lockdown. Various interventions have been shown to be effective in increasing optimism (Gillham et al., 2007), self-esteem (Gallagher et al., 2021), resilience (Loprinzi, Prasad, Schroeder, & Sood, 2011) gratitude (Emmons & McCullough, 2003) or mindfulness (Sipe & Eisendrath, 2012). These interventions could target the general population or focus on individuals with lower levels of positive psychological traits identified using self-declared questionnaires (Baer et al., 2006; Diener et al., 1985; Pearlin et al., 1981; Rosenberg, 1965; Scheier et al., 1994; Smith et al., 2008). Interventions could be set in various settings such as health care, professional or academic environments. Components of these interventions could also be part of more general public health messages.

#### 4.6. Strengths and limitations

This study is particularly original as, to our knowledge, no other study has previously investigated the link between positive psychological traits and changes in dietary behaviours during the COVID-19 lockdown. An important strength of our study is its large sample size

with participants of various socio-demographic characteristics and nutritional status. Although we adjusted for a wide range of potential confounders, we cannot rule out the existence of residual confounding due to other environmental or residual factors such as the housing type, exposure to COVID-19 or modifications of food supply. Due to the design of the NutriNet-Santé study, positive psychological traits were assessed between 2013 and 2017, i.e., seven to three years prior to lockdown. The longitudinal design of this study is a strength since it gives indications about the direction of the association. However, the large time gap is a limit of our methodology since psychological traits might have changed during this period. However, psychological traits have been shown to be relatively stable over time (Johnson, McGue, & Krueger, 2005). In addition, depressive symptomatology (PHQ-9) and anxiety disorders (GAD-7) were assessed during the lockdown, along with the food groups, and used as confounders in our models. Another strength is that positive psychological traits were measured with validated questionnaires (Blais et al., 1989; Diener et al., 1985; Jordan et al., 2014; Pearlin & Schooler, 1978; Scheier & Carver, 1993; Shin & Johnson, 1978), and each displayed good internal consistency in our sample. The main limitation of our study is the self-assessment nature of the questionnaires assessing changes in snacking behaviour and food group consumption. In addition, the NutriNet-Santé study is a prospective cohort focusing on nutrition and health based on voluntary recruitment, implying that our participants are more likely to have a higher interest in nutrition and health, and therefore to have a healthier diet. In addition, participants were more educated and had a higher income and professional status than the overall French population (Andreeva et al., 2016). Caution is needed when extrapolating our results to the whole French population.

## 5. Conclusion

This study examined the associations between optimism, satisfaction with life, self-esteem, resilience, mindfulness and mastery, and changes in snacking behaviour, food group consumption and overall dietary behaviours in a large population-based sample during the COVID-19 lockdown period in France compared with before the lockdown. We found that the lockdown seemed to have had a lower impact on the dietary behaviour of participants with higher levels of positive psychological traits. On the contrary, individuals with lower levels tended to modify their dietary behaviour, some towards unfavourable changes and some others, to a lesser extent, towards favourable changes. Further population-based studies are needed to confirm our results, and in particular longitudinal studies to assess whether the observed changes will last after the pandemic and over a longer period and have later health consequences. Our results underline that it is important to consider positive psychological traits in policies aiming to prevent behavioural changes during specific periods, such as global pandemics or important life events.

## Author contributions

M.R. conducted the literature review and drafted the manuscript. M.R. performed analyses. M.R., M.D.T, R.S, N.D.P., Y.E., F.S.D., J.B., P.G., S.H., M.T., and S.P. were involved in interpreting results and critically reviewed the manuscript. M.T., P.G. S.H. and S.P. and SAPRIS study group were responsible for developing the design and protocol of the study. M.R., M.D.T, R.S, N.D.P., Y.E., F.S.D., J.B., P.G., S.H., M.T., and S.P. report no conflict of interest.

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## Ethical statement

The NutriNet-Santé study was conducted in accordance with the Declaration of Helsinki, and all procedures were approved by the Institutional Review Board of the French Institute for Health and Medical Research (IRB Inserm n° 0000388FWA00005831) and the Commission Nationale de l'Informatique et des Libertés (CNIL n° 908450 and n° 909216). Electronic informed consent was obtained from all participants. The study was registered at [clinicaltrials.gov](https://clinicaltrials.gov) as #NCT03335644.

## Data

Data described in the manuscript, code book, and analytic code will be made available upon request pending application and approval.

## Declaration of competing interest

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2021.105885>.

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