



Research paper

Lifestyle changes and mental health during the COVID-19 pandemic: A repeated, cross-sectional web survey



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ABSTRACT

Background: This study aimed to compare self-reported changes on lifestyle behaviors during two phases of the COVID-19 pandemic in Spain, and to evaluate clinical and sociodemographic factors associated with lifestyles.

Methods: Two cross-sectional web surveys were conducted during lockdown (April 15–May 15, 2020) and seven months later (November 16–December 16, 2020). Lifestyle behaviors were self-reported by a multidimensional scale (SMILE-C). Two separate samples of respondents were analyzed. A multivariate regression model was performed to evaluate the association of SMILE-C scores with demographic and clinical variables.

Results: The sample comprised, 3412 participants from the first survey (S1) and in the S1 and 3635 from the second (S2). SMILE-C score decreased across surveys ($p < 0.001$). The rates of positive screenings for depression and anxiety were similar between the surveys, whereas those for alcohol abuse decreased ($p < 0.001$). Most participants in S2 reported that their lifestyle had not changed compared to those before the pandemic. Variables independently associated with an unhealthier lifestyle were working as an essential worker, lower educational level, previous mental disease, worse self-rated health, totally/moderate changes on diet, sleep or social support, as well as positive screenings for alcohol abuse, anxiety and depression.

Limitations: The cross-sectional design and recruitment by non-probabilistic methods limit inferring causality and the external validity of the results.

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Conclusions: Overall lifestyle worsened seven months after the lockdown in Spain. Several demographic and clinical factors were associated with lifestyle scores. The contribution of common mental disorders to unhealthier lifestyles should be considered in order to prevent the negative impact of the pandemic.

1. Introduction

In the last year, the new coronavirus (SARS-CoV-2) has become a global sanitary emergency. The pandemic itself, and the measures adopted to combat it have changed our lifestyle (Crespo-Facorro, 2020). The consequences are not only measured in the number of lives lost, but also in its economic and social impact (Mcbride et al., 2020; Mofijur et al., 2021; Vieta et al., 2020).

Lifestyle is currently considered a multidimensional construct, which integrates behaviors from nutrition, physical activity, restorative sleep, outdoor activities, substance use, stress management and social support (European Lifestyle Medicine Organization, 2021). Meta-analytical evidence supports that several psychiatric disorders are associated with poorer sleep quality, low levels of physical activity, substance abuse and poor nutritional patterns (Firth et al., 2020b) which are the foundations of the emerging fields of *Lifestyle Psychiatry* (Firth et al., 2019; García et al., 2020), and *Positive Psychiatry* (Verdolini and Vieta, 2021).

Growing evidence supports that COVID-19 pandemic has a significant impact on most lifestyle behaviors, especially during populations lockdowns (Branchi and Giulani, 2021; Verdolini et al., 2021). For instance, research across the world estimates the prevalence of *sleep* disturbances between 21.9 and 55.8% (Cellini et al., 2020; Dal Santo et al., 2021; Ernstsen and Havnen, 2020; Fu et al., 2020; Li et al., 2020) which in turn were significantly associated with anxiety and depressive symptoms (Cellini et al., 2020; Ernstsen and Havnen, 2020; Fu et al., 2020; Li et al., 2020; Smith et al., 2020).

Regarding *diet*, the lockdown has been associated with a greater adherence to Mediterranean diet compared to before the pandemic (Rodríguez-Pérez et al., 2020), whereas according to other studies energy intake and snacking increased, and diet quality worsened (Battelle-Bayer et al., 2020; Sidor and Rzymiski, 2020) during COVID-19 confinement.

Regarding *exercise*, several studies suggest that almost half of the participants became less active during the quarantine, which in turn was associated with lower subjective well-being and lower health-related quality of life (Suzuki et al., 2020). Engaging in physical activity during confinement has been consistently associated with better outcomes on anxiety or mood disorders worldwide (López-Bueno et al., 2020; Maugeri et al., 2020; Meyer et al., 2020; Morrey et al., 2020; Zhang et al., 2020).

Changes in *environmental exposures* and increased *screen time*, such as TV, smartphone, and Internet usage, represent an expected consequence of confinement (Colley et al., 2020; Qin et al., 2020; Rolland et al., 2020; Smith et al., 2020; Wiederhold et al., 2020). Moreover, reducing the use of screen-based devices combined with outdoor exercise had more benefits for mental health than either healthy behavior alone (Colley et al., 2020).

In a web survey in Belgium, 30.3% participants reported consuming more alcohol, 7.4% stated smoking more than before COVID-19 pandemic, while no significant changes in the consumption of cannabis were found. Boredom, lack of social contacts, loss of daily routines, reward after a hard-working day, and loneliness were reported to be the main reasons for a higher *substance use* during the pandemic (Vanderbruggen et al., 2020). On the contrary, other studies point to the opportunity posed by COVID to motivate smoking cessation (Jaén-Moreno et al., 2020; Klempere et al., 2020; Pettigrew et al., 2020).

However, most evidence on lifestyle changes is based on cross-sectional studies conducted during the early stages of the pandemic, whereas a few studies exist on its long-term impact on lifestyle (Salfi et al., 2020; Vogel et al., 2021; Zhang et al., 2020). Given the rapidly

changing nature of the COVID-19 pandemic, repeated measurements would provide a better insight on the dynamics of its consequences and their relationship with risk and protective factors. For instance, improvement in sleep problems (Beck et al., 2021), increased physical activity (McCarthy et al., 2021), and worsened feelings of loneliness (Killgore et al., 2020) have been described several months after the confinement across the world.

Moreover, most cross-sectional and longitudinal studies have focused on single or a few lifestyle domains. So far, a handful of studies have assessed lifestyle from a comprehensive, multidimensional perspective (Balanzá-Martínez et al., 2021; Rolland et al., 2020; Stanton et al., 2020; Van Rheenen et al., 2020). In sum, the medium to long term impact of the pandemic on lifestyle, from a multidimensional perspective, is yet to be described.

Based on the above, the main study aim was to compare changes on a wide range of lifestyle behaviors (comprising diet/nutrition, substance use, physical activity, stress management, restorative sleep, social support, and environmental exposures) among general population living in Spain, during two phases of the COVID-19 pandemic: under home confinement/lockdown (April-May) and 7 months later. Secondary objectives were (1) to analyze the association of lifestyle behaviors changes with sociodemographic characteristics and previous history of physical and mental health conditions and (2) to analyze the association of lifestyle and positive screenings for concurrent mental health problems (depression, anxiety, and alcohol abuse).

2. Method

2.1. Study design

Two cross-sectional, online surveys were conducted during two periods: April 15-May 15, 2020 (Survey 1, S1) and November 16-December 16, 2020 (Survey 2, S2). The online questionnaires were programmed in SurveyGizmo®.

The S1 took place one month after the declaration of the state of alarm on March 14, 2020. The restrictions included the suspension of all academic activities and Spanish citizens were obliged to stay at home except to purchase essential items, go to work if they were essential workers, or attend emergencies. During the subsequent waves of the pandemic, restrictions such as home confinement were not issued in Spain. However, social distancing measures were reinforced, the curfew was established, and the mandatory use of a mask and restriction of mobility between territories were imposed. After a peak in early November, the incidence fell to the lowest point on December 10, after which it rised again (Centro Nacional de Epidemiología, 2021). The S2 of this study took place during this intercritical period.

2.2. Study population

The study population included individuals from all over Spain, adults over 18 years from both sexes who had access to the Internet and who agreed to participate in the study after reading the informed consent form (Balanzá-Martínez et al., 2021; De Boni et al., 2020).

2.3. Sample size and recruitment

The survey was disseminated through social networks (Twitter, Facebook, and WhatsApp), and mailing lists, using a snowball sampling. Fundamental parameters were unknown at the moment defining sample size on the S1. Previous experiences with similar surveys were able to

recruit a significant number of people. For this reason, instead of defining a sample a priori, a 30 day-period of data collection was specified. The S2 followed the same methods aiming to obtain comparability. To avoid repeated responses, at the very beginning of the survey, participants were specifically asked if they had completed the survey previously. Therefore, repeated responses were eliminated from the final sample.

2.4. Outcome

The main outcome was the total score of the Short Multidimensional Inventory Lifestyle Evaluation (SMILE-C) scale (Balanzá-Martínez et al., 2021). This scale was developed, during one week of confinement in Spain, to approach lifestyle from a multidimensional perspective in a pandemic context. This tool was developed from the original SMILE, which is a self-assessed 43-item questionnaire comprising seven lifestyle habits or domains: diet/nutrition, substance abuse, physical activity, stress management, restorative sleep, social support, and environmental exposure. The original SMILE scale was developed to carry out a multidimensional and comprehensive assessment of the seven (healthy) lifestyle during the pandemic self-isolation.

The SMILE-C scale analyzes lifestyle during the previous 30 days, with a 27 items questionnaire comprising seven domains as mentioned above. Multidimensional evaluations of lifestyle are still scarce. Nutrition, physical activity, and restorative sleep are regarded as fundamental aspects of human health, as well as the three pillars of lifestyle (Firth et al., 2019). However, lifestyle as a construct has evolved to include a wider pattern of behaviors, such as stress management, social support, substance avoidance, and environmental exposure such as screen time and contact with natural spaces. This comprehensive approach is aligned with contemporary views about the multidimensional nature of lifestyle, as defined by scientific societies (European Lifestyle Medicine Organization, 2021).

Response options are measured through a 4-point Likert-type scale and the final score is obtained by the sum of all questions (noting that some questions present reverse scores). The higher the score, the healthier the lifestyle (scores range from 27 to 108). The SMILE-C presents an overall Cronbach- $\alpha=0.75$ and Kaiser-Meyer-Olkin Measure=0.77 (Balanzá-Martínez et al., 2021).

2.5. Variables and measurements

Sociodemographic information included sex, age, educational level, occupational status, being an essential worker (yes/no), number of people living in the house and self-isolation by contagion or high-risk contact. The COVID-19 questions were related to diagnosis (yes/no) and loss of significant ones (yes/no).

Self-rated health (SRH) was measured using the question “How would you rate your health in general?” with possible answer choices of “Very bad”, “Bad”, “Regular”, “Good” and “Very good” (De Salvo et al., 2006; Idler et al., 1997; Jylhä, 2009). Response options were aggregated into “Very good/Good” and “Regular/Bad/Very bad”.

Change in lifestyle behaviors during the COVID-19 pandemic as compared to before the pandemic was assessed by questions such as: “Did you change your (nutritional habits and diet) during the COVID-19 pandemic?”, with a 4-point Likert-type response (Totally, Moderately, Mildly, Not changes), and aggregated into “Totally/Moderately changes” and “Mild/No changes”. In this case, two groups were created, “Totally/Moderately changes” and “Mild/No changes”, for all variables related to lifestyle changes, as some variables had sparse classes. Thus, we grouped qualitatively similar values, with new similar categories for all variables for comparison. Sparse classes were grouped into qualitatively similar values to avoid the problems of large confidence intervals.

To retrospectively assess the direction of changes on lifestyle factors, compared to before pandemic, we used the question “You consider that your (nutritional habits and diet) nowadays are...”, with three possible

answers, “as healthy as before”, “healthier than before” or “less healthy than before”.

Previously diagnosed conditions were self-reported using the question “In the last 12 months, have you been diagnosed by a medical doctor or health professional, or received treatment for any of the following conditions?”. Possible health problems investigated include diabetes, heart disease, hypertension, anaemia, asthma, depression, anxiety, schizophrenia, bipolar disorder, anorexia/bulimia nervosa, HIV/AIDS, cancer, tuberculosis, cirrhosis, kidney disease and others.

Current depression was screened using the Patient Health Questionnaire-2 (PHQ-2) (Kroenke et al., 2003) using a cut-off ≥ 3 , and current anxiety was screened using the Generalized Anxiety Disorder 7-item (GAD-7) (Spitzer et al., 2006) using a cut-off ≥ 10 . Two dichotomous variables were created “Positive Depression” and “Positive Anxiety”. Then a composite variable was created using the aforementioned variables with the following categories: no positive screening, positive screening for depression only, positive screening for anxiety only, and positive screening for both. Screening for alcohol abuse was performed using the AUDIT-C (Bush et al., 1998) and cut-off was ≥ 3 . The shorter versions of both instruments were chosen to decrease the length of the online questionnaire, which decreases the burden on the participant and increases the overall quality of the answers/completeness (Biffignandi and Bethlehem, 2021).

2.6. Statistical analysis

Sociodemographics, COVID-19 related questions, SRH, change in lifestyle during the COVID-19 pandemic, self-reported diagnosed conditions, as well as screening for alcohol abuse, depression and anxiety were described by absolute and relative frequencies, stratified by groups (S1 and S2). Distributions between groups (S1 and S2) were compared using the Pearson’s chi-squared test. Means and standard deviation were summarized for SMILE-C score and age by groups, using Student’s *t*-test and median and interquartile were summarized for number of the people living in the house, by groups, using Mann-Whitney test. A *p*-value < 0.05 was considered statistically significant for all tests.

Multivariate linear regression model was performed to evaluate the effect of independent factors on the SMILE-C Score, controlled by S1 and S2. Variables presenting *p*-value < 0.20 at the bivariate tests (Pearson’s chi-squared test, Student’s *t*-test, and Mann-Whitney test) were considered for regression linear model. Sex, age, and the variable of the first and second survey were defined to be included a priori, either by importance in the literature and adjusting a model that indicates cases related to S1 and S2. Stepwise linear models were performed until reaching the most parsimonious model. The fit of the final model was evaluated by graphical analysis of the residuals, with a quantile-quantile graph destined for normal distribution (qq-plot) and a graph of standardized residues versus the adjusted values, the latter to verify the assumption of constant variance. All the analyzes were conducted in SPSS version 20.

2.7. Ethical aspects

The study was approved by the Ethics Committee at the Hospital Universitari i Politècnic La Fe, in Valencia, Spain (2020-149-1). The surveys were anonymous (no identification -name-, city or IP address was collected) and participants read the consent form and confirmed their interest on participating in the first screen of the online questionnaires.

3. Results

The final sample consisted of 7047 answered surveys, 3412 in the S1 and 3635 in the S2. Initially, a total of 7491 answered surveys were obtained. Among them, 444 were not eligible for the study (207 had already participated in the survey, 77 were not living in Spain, and 160

were younger than 18 years).

Sociodemographic and clinical variables (including screening for depression and anxiety) as well as the SMILE-C scores for both surveys are shown in [Table 1](#). In both cases, there was a predominance of women among the participants, with a mean age of 40 years in S1 and 44 years in S2. In the S1 unemployed participants predominated, followed by non-essential workers and essential workers, while in the S2 the essential workers predominated, followed by the unemployed and non-essential workers. There was a majority of respondents with a university degree or Bachelor/Professional degree (for further details, see [Table 1](#)).

Consistent with the restrictions, the percentage of self-isolated participants significantly decreased across surveys. Moreover, the prevalence of individuals diagnosed with COVID-19 significantly increased over time, whereas the rate of responders who had lost a significant one due to COVID-19 did not. Self-rated health (SRH) was better seven months later. No significant differences were found for most self-reported conditions in the previous year, except for heart disease/hypertension and asthma/bronchitis.

Overall lifestyle, as measured with the SMILE-C score, differed across surveys, which suggests the existence of unhealthier lifestyles in S2. In both surveys, more than 70% of participants had a negative screening for depression and anxiety. The rate of positive screenings for depression and/or anxiety were similar between the surveys, whereas a significant decrease in positive screening for alcohol abuse was observed.

[Table 2](#) depicts the self-reported changes on each lifestyle behavior during the two surveys of this study. Significant differences were observed over time in all cases, except for substance use. In terms of magnitude, the greatest decrease in the rate of totally / moderate changes were found in environmental exposure, followed by physical activity. Nevertheless, in both domains these rates remained the highest during S2. Significant decreases were also observed in diet/nutrition, social support, stress management, and especially in restorative sleep.

As depicted in [Fig. 1](#), most participants considered each of their lifestyle behaviors to be as healthy as before the pandemic, except for physical activity (45.6% considered it to be as healthy as before, 31.8% less healthy than before and 22.6% healthier than before).

[Table 3](#) reports the results obtained from the two surveys for each domain of the SMILE-C. Significant differences were found in all the domain mean scores, except for stress management. In all cases, changes implied a worsening of the lifestyle behaviors, except for environmental exposures, which improved in S2.

The final adjusted linear regression model is shown in [Table 3](#). The variables that remained independently associated with a healthier lifestyle (i.e., higher SMILE-C scores) were older age, not working, totally/moderate changes on stress management and physical activity, and previous heart disease/hypertension. On the other hand, several variables were independently associated with an unhealthier lifestyle (i.e., lower SMILE-C scores): second survey, working as an essential worker, each educational level below master/doctorate degree, SRH as regular/bad/very bad, totally/moderate changes on diet/nutrition, restorative sleep and social support, as well as previous mental disease. In addition, positive screenings for anxiety, depression (either alone or combined), as well as positive screening for alcohol abuse were associated with lower scores on the SMILE-C.

4. Discussion

The first aim of this study was to compare changes on lifestyle behaviors between two phases of the COVID-19 pandemic in Spain: under confinement and seven months later. Overall lifestyle, evaluated by the SMILE-C scores, worsened in the second survey of this study. To our knowledge, no previous study has evaluated the long-term changes in lifestyle from a multidimensional approach as the pandemic progresses.

Self-reported changes in lifestyle (totally/moderate vs mild /no change) significantly decreased over time for each lifestyle behavior,

except for substance use. This might be explained by the strict home confinement measures adopted in Spain early in the pandemic, and the relative softening of the measures seven months later, which allowed a better adaptation to the ‘new normal’.

The most noticeable changes were found in environmental exposures, physical activity and restorative sleep that seem to be the lifestyle behaviors most sensitive to the effects of strict lockdown and mandatory home isolation issued during the early phase of the pandemic. Several studies across the world have also observed the remarkable effects of confinement on these three behaviors ([Colley et al., 2020](#); [Dal Santo et al., 2021](#); [Qin et al., 2020](#); [Rolland et al., 2020](#); [Smith et al., 2020](#); [Wiederhold et al., 2020](#)). Moreover, a longitudinal study found a trend towards the disappearance of the sleep disturbances after the lockdown release in France ([Beck et al., 2021](#)). Being able to leave the house, either to work, entertain or play sports, seems to be a key change to organize personal routines, which in turn would help to restore sleep-wake rhythms.

Conversely, lesser remarkable changes were observed in diet/nutrition, stress management and social support. A few studies have assessed changes in these lifestyle domains several months apart from the beginning of the current pandemic. For instance, several healthy eating habits that appeared during the early pandemic worsened over time among Chinese population ([Zhang et al., 2020](#)), whereas loneliness significantly increased six months later in American general population, which was correlated with depression and suicidal ideation ([Killgore et al., 2020](#)).

Regarding the direction of the changes, lifestyle habits during the second survey mostly remained as healthy as before the pandemic. Nevertheless, changes to healthier as well as unhealthier lifestyles were also described by smaller proportions of participants. For behaviors such as environmental exposures, social support, restorative sleep and physical activity, a higher percentage of respondents affirm that their habits were unhealthier than before the pandemic. By contrast, the pandemic would have had a more positive impact on behaviors such as substance abuse, diet/nutrition, and strategies to deal with stress. This variability in responses may result from multiple variables that would act as either risk or resilience factors during the sanitary crisis, as suggested by previous evidence. Indeed, an association was found between pre-pandemic lifestyle and changes on physical activity during the confinement ([Martínez-de-Quel et al., 2021](#); [McGrath et al., 2020](#)). Similarly, people with previous obesity showed unhealthier diets, lower rates of physical exercise, and more weight gain during the pandemic ([Robinson et al., 2021](#)). According to a longitudinal study, women showed greater long-term resilience than men as the crisis progresses, despite having worse baseline levels of insomnia, anxiety or depression ([Salfi et al., 2020](#)). Moreover, sleep disturbances during the early pandemic have been associated with several variables, such as increased worry about COVID-19, lower perceived social support, more severe occupational interference due to COVID-19 and poorer self-reported physical health, the insufficient availability stock of masks ([Yu et al., 2020](#)), chronic conditions ([Gualano et al., 2020](#)), a higher educational level or a passive coping style ([Fu et al., 2020](#)). Further studies are needed to better understand these diverging lifestyle trajectories in order to identify specific vulnerable groups, to whom health promotion actions should be targeted.

After adjusting for confounders, substantial changes in all behaviors except environmental exposures, were associated with lifestyle as a whole, as measured by the SMILE-C scores. On the one hand, totally/moderate changes in restorative sleep, diet/nutrition, social support, and substance use were independently associated with an unhealthier lifestyle. In contrast, changes in strategies to deal with stress and engagement in physical activity were associated with a healthier lifestyle. This interrelation between the different lifestyle behaviors, in response to a stressful situation such as the pandemic, has not received much research attention to date. In this regard, the results suggest that less physical activity, more sedentary behavior (including an increased

Table 1
Sociodemographic, clinical characteristics and the mean SMILE-C score among participants (n = 7047) between the two surveys.

Variables/Categories	Survey						p-value
	First		Second		Totally		
	n	%	N	%	N	%	
SMILE-C ^a	80.3 (8.22)		78.7 (8.1)		79.5 (8.2)		<0.001
Sex ^b							
Male	1123	31.8	929	26.4	2052	29.1	<0.001
Female	2406	68.2	2588	73.6	4994	70.9	
Age	40 (27-52)		44 (29-53)		42 (27-53)		<0.001
Working Status							
Not working	1433	40.6	1221	34.7	2654	37.7	<0.001
Working (not as an essential worker)	1007	28.5	928	26.4	1935	27.5	
Working (as an essential worker)	903	25.6	1320	37.5	2223	31.5	
Lost the job during the pandemic	186	5.3	49	1.4	235	3.3	
Education level							
Primary/Secondary education	267	7.6	273	7.8	540	7.7	<0.001
Bachelor/Professional degree	959	27.2	955	27.1	1914	27.2	
University degree	1412	40.0	1593	45.3	3005	42.6	
Master/Doctorate degree	891	25.2	697	19.8	1588	22.5	
Median # people living in the house (IQR)	3 (2-4)		3 (2-4)		3 (2-4)		<0.001
Self-isolation							
Yes	1689	48.2	101	2.9	1790	25.5	<0.001
No	1814	51.8	3417	97.1	5231	74.5	
Diagnosed with COvid-19							
Yes	68	1.9	290	8.2	358	5.1	<0.001
No	3455	98.1	3228	91.8	6683	94.9	
Lost somebody in the epidemic							
Yes	337	9.6	382	10.9	719	10.2	0.079
No	3178	90.4	3136	89.1	6314	89.8	
Self-rated health ^c							
Very good or good	2524	71.7	2880	81.9	5404	76.8	<0.001
Regular, bad or very bad	994	28.3	638	18.1	1632	23.2	
Diagnosed or treated for diabetes ^d							
No	3348	95.4	3359	95.5	6707	95.5	0.93
Diagnosis or treatment	160	4.6	159	4.5	319	4.5	
Diagnosed or treated for heart disease or hypertension ^e							
No	3398	96.6	3146	89.4	6544	93.0	<0.001
Diagnosis or treatment	119	3.4	372	10.6	491	7.0	
Diagnosed or treated for anaemia ^f							
No	3278	93.2	3258	92.6	6536	92.9	0.38
Diagnosis or treatment	241	6.8	260	7.4	501	7.1	
Diagnosed or treated for asthma/bronchitis ^g							
No	3253	92.4	3329	94.6	6582	93.5	<0.001
Diagnosis or treatment	269	7.6	189	5.4	458	6.5	
Diagnosed or treated for depression ^h							
No	3209	92.2	3263	92.8	6472	92.5	0.37
Diagnosis or treatment	272	7.8	255	7.2	527	7.5	
Diagnosed or treated for anxiety ⁱ							
No	2968	85.3	2941	83.6	5909	84.5	0.048
Diagnosis or treatment	511	14.7	577	16.4	1088	15.5	
Diagnosed or treated for Schizophrenia/bipolar disorder/anorexia/bulimia ^j							
No	3463	98.8	3458	98.3	6921	98.5	0.095
Diagnosis or treatment	43	1.2	60	1.7	103	1.5	
Diagnosed or treated for others (HIV/SIDA, tuberculosis, cancer, cirrhosis, kidney disease, other) ^k							
No	2804	80.2	2855	81.2	5659	80.7	0.32
Diagnosis or treatment	692	19.8	663	18.8	1355	19.3	
Screening for depression and anxiety							
Negative for depression/anxiety	2511	71.2	2571	73.1	5082	72.1	0.072
Positive depression only	293	8.3	239	6.8	532	7.5	
Positive anxiety only	286	8.1	265	7.5	551	7.8	
Positive for both	439	12.4	443	12.6	882	12.5	
Screening for alcohol abuse							
Negative	2440	69.1	3018	85.8	5458	77.5	< 0.001
Positive	1089	30.9	500	14.2	1589	22.5	
Chronic disease ^l							
No	2537	72.6	2666	75.8	5203	74.2	0.002
Yes	959	27.4	852	24.2	1811	25.8	
Mental health ^m							
No	2904	83.8	2904	82.5	5808	83.2	0.17
Yes	562	16.2	614	17.5	1176	16.8	
Infectious disease ⁿ							
No	3506	99.6	3512	99.8	7018	99.7	0.11
Yes	13	0.4	6	0.2	19	0.3	

Note: missing values (not answered, not saved...) for

- ^a :211;
- ^b :1;
- ^c :11;
- ^d :21;
- ^e :12;
- ^f :10;
- ^g :7;
- ^h :48;
- ⁱ :50;
- ^j :23;
- ^k :33;
- ^l :33;
- ^m :63;
- ⁿ :10

Table 2
Self-reported changes in lifestyle behaviors between the two surveys (n = 7047).

Variables/Categories		Survey				Totally		p-value
		First n	%	Second n	%	N	%	
Diet and nutrition ^a	Mild/no changes	2663	75.5	2802	79.6	5465	77.6	<0.001
	Totally/moderate changes	864	24.5	716	20.4	1580	22.4	
Substance abuse ^b	Mild/no changes	3114	89.8	3147	89.5	6261	89.6	0.669
	Totally/moderate changes	355	10.2	371	10.5	726	10.4	
Physical activity ^c	Mild/no changes	1106	31.4	2065	58.7	3171	45.0	<0.001
	Totally/moderate changes	2420	68.6	1453	41.3	3873	55.0	
Stress management ^d	Mild/no changes	2393	68.2	2518	71.6	4911	69.9	0.002
	Totally/moderate changes	1114	31.8	1000	28.4	2114	30.1	
Restorative sleep ^e	Mild/no changes	2239	63.5	2819	80.1	5058	71.8	<0.001
	Totally/moderate changes	1287	36.5	699	19.9	1986	28.2	
Social support ^f	Mild/no changes	2245	64.8	2358	67.0	4603	65.9	0.045
	Totally/moderate changes	1221	35.2	1159	33.0	2380	34.1	
Environmental exposures (pattern of indoor/outdoor) ^g	Mild/no changes	285	8.1	2204	62.6	2489	35.4	<0.001
	Totally/moderate changes	3229	91.9	1314	37.4	4543	64.6	

Note: missing value (not answered, not saved...) for

- ^a : 2;
- ^b : 60;
- ^c :3;
- ^d : 22;
- ^e : 3;
- ^f : 64;
- ^g : 15

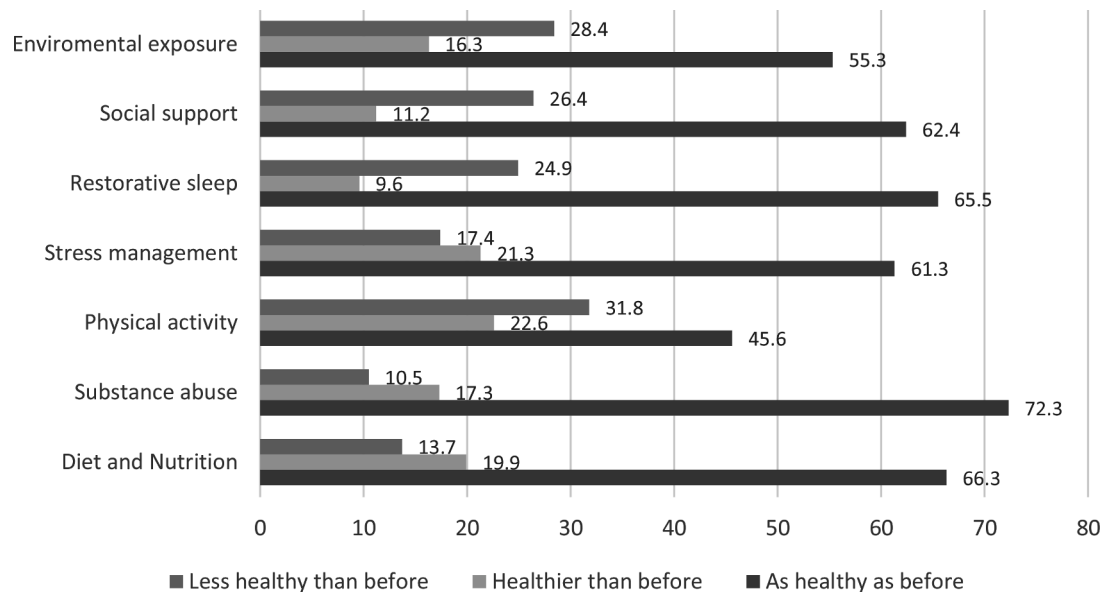


Fig. 1. Direction of changes in each lifestyle behavior in the second survey compared to before the pandemic (n = 3635).

sleep time) and poorer diet quality would be interconnected (Pellegrini et al., 2020; Vogel et al., 2021; Zheng et al., 2020), a phenomenon known as ‘multiple health behavior change’ (Geller et al., 2017).

One of the secondary aims of the present research was to analyze the association of lifestyle changes with sociodemographic characteristics and previous history of physical and mental health conditions. Being older, but not gender, was associated with a healthier lifestyle. A higher educational level was significantly associated with healthier lifestyle habits. This finding might be explained by the likely higher health literacy among the more educated participants (Yamashita and Kunkel, 2015). The findings regarding working status were more counterintuitive. Unexpectedly, being unemployed was associated with a healthier lifestyle. Having more leisure time for personal care or the absence of stressors associated with work, among other factors, may play a role in this regard.

Regarding previously diagnosed conditions, heart disease/hypertension was associated with a healthier lifestyle, whereas previous mental illness was associated with a poorer lifestyle. In a recent web survey, participants without a psychiatric condition were found to show more adaptive coping strategies such as following a routine, talking to significant ones, engaging in physical exercise or keeping a balanced diet. By contrast, gaining weight, sleep changes, and tobacco smoking were more prevalent among those with a mental illness (Solé et al., 2021).

Finally, poor self-rated health (SRH) was independently associated with an unhealthier lifestyle. Moreover, the improvement in self-perceived health status after seven months of the pandemic is also remarkable, even more taking into account that lifestyle worsened in parallel. SRH is a complex parameter that approaches health from a subjective perspective. Moreover, multiple variables can exert an

Table 3
Mean scores in the SMILE-C domains in the two surveys (n = 7047).

Variables/Categories	Survey				p-value
	First		Second		
	n	Mean (SD)	N	Mean (SD)	
Diet and nutrition ^a	3497	16,01 (2.33)	3518	15.45 (2.16)	<0.001
Substance abuse ^b	3509	15,34 (1.24)	3518	15.08 (1.39)	<0.001
Physical activity ^c	3525	2.68 (1.04)	3518	2.52 (0.99)	<0.001
Stress management ^d	3440	13.74 (2.71)	3518	13.66 (2.63)	0.22
Restorative sleep ^e	3514	11.97 (2.52)	3518	11.83 (2.52)	0.026
Social support ^f	3443	18.82 (3.15)	3517	18.03 (3.40)	<0.001
Environmental exposures (pattern of indoor/outdoor) ^g	3529	1.84 (0.91)	3518	2.05 (0.97)	<0.001

Note: missing value (not answered, not saved...) for

- ^a : 32;
- ^b : 20;
- ^c : 4;
- ^d : 89;
- ^e : 15;
- ^f : 87;
- ^g : 0

influence on SRH, which makes obtaining counterintuitive results likely. Previous crises, such as the worldwide financial crisis in 2008, showed that despite the socioeconomic consequences, the SRH improved while the mental health risk increased, for instance in Spain (Urbanos-Garrido and Lopez-Valcarcel, 2014). Conversely, in other European countries, the changes in the SRH were in the opposite direction during the same crisis (Abebe et al., 2016).

In the present study, a global improvement in SRH was observed in the second survey, while the lifestyle worsened. However, we believe that causality cannot be obtained from the coexistence of two temporal trends. Even less when, after controlling the covariates, an independent relationship was found between the worsening of the SRH and the SMILE-C scores.

The current COVID-19 crisis has stressed the primary care health system as never before in Spain (de Nicolás Jiménez et al., 2020) The increase in the caseload focused on the community control of the pandemic might have decreased the healthcare providers’ attention to the diagnosis and treatment of chronic diseases such as hypertension. In addition, being afraid of infection could have limited patients’ attendance at medical appointments during the pandemic, which in turn may have delayed diagnoses or even not detecting them. The results of our study are in line with recent reviews showing a decrease in the number of hospitalizations due to ischemic heart disease during the COVID-19 pandemic (Seidu et al., 2021).

Several observational studies have consistently shown that the relationship between lifestyles and mental health is bidirectional in nature (Firth et al., 2019,2020a). During the COVID-19 pandemic, research has mostly focused on the role of lifestyle behaviors as either risk or protective factors for common mental health symptoms and disorders (Bendau et al., 2021; Cellini et al., 2020; Fullana et al., 2020; Lu et al., 2020; Novotný et al., 2020; Pham et al., 2020; Santabàrbara et al., 2020; Stanton et al., 2020). Growing evidence supports that diet (Fullana et al., 2020; Pham et al., 2020), physical activity (Lu et al., 2020), and other lifestyle behaviors (Cellini et al., 2020; Santabàrbara et al., 2020; Stanton et al., 2020) are significant predictors of anxiety and/or depression. Conversely, much less studies have examined the reverse direction. Increased depressive and anxiety states early in the

pandemic were associated with poorer outcomes in specific lifestyles, e. g. dietary habits and sleep health (Al-Ajlouni et al., 2020; Amatori et al., 2020). In our study, positive screenings for anxiety and/or depression were among the most relevant predictors of an unhealthier lifestyle as a whole. This finding confirms that the concurrent existence of common mental disorders may also influence lifestyles in the general population during pandemic times and expands this relationship from the multidimensional and longer-term perspectives.

The present results should be considered in light of some limitations. Firstly, the non-probabilistic nature of the sample makes it difficult to generalize the results to the entire Spanish population. Moreover, it is likely that a high percentage of participants were healthcare workers, with a higher level of education and a higher gender imbalance. In addition, the limited access to online surveys and the dissemination via social networks may limit the scope of the survey to specific population groups. However, there is growing evidence that supports the usefulness of these sources of information, especially in confined or difficult-to-access populations (Sun et al., 2020), when traditional research is complex to carry out. Secondly, this study uses repeated cross-sectional surveys, with two different samples at two points in time, and does not follow up the same cohort over time. Despite having used the same recruitment method for both surveys, some sociodemographic and clinical variables have been distributed differently between the samples, which could generate a bias when comparing the results. The use of multivariate linear regression would attempt to control *a posteriori* the possible bias that these differences could generate. Hence, it is not possible to infer causality and the associations must be interpreted cautiously. Thirdly, mental disorders (depression, anxiety, alcohol abuse) were assessed with screening instruments, which are not equivalent to a proper clinical diagnosis. In addition, it should be noted that the scores of the different domains of the SMILE-C should be interpreted with caution, because their psychometric validity to measure each domain independently has not yet been demonstrated. Nevertheless, they are validated for the reference population and are commonly used in web surveys. Fourthly, the formulation of the question about changes in the different lifestyle behaviors (Table 2) is not the most appropriate as it does not accurately reflect the direction of change. Lastly, research based on self-reported data could favor information bias due to the social desirability effect and memory error. In some retrospective questions, such as that about the direction of change, memory bias cannot be entirely ruled out. In this regard, studies with objective measures of lifestyle are needed to provide more valuable information (Sun et al., 2020).

Table 4

Despite these limitations, this is one of the first studies to assess the longer-term impact of the COVID-19 pandemic on lifestyle and mental health in the general population, with important implications for the pandemic aftermath (Vieta et al., 2020). In addition, the use of a multidimensional scale allows a comprehensive and holistic approach to lifestyle, which aligns with contemporary perspectives (European Lifestyle Medicine Organization, 2021). Unlike most web surveys, we also collected health-related data of the participants, including previously diagnosed medical and psychiatric conditions, self-perceived health, and personal information regarding the COVID-19. In the context of a spreading pandemic, the present findings are innovative and timely.

In sum, lifestyle as a whole worsened seven months after the first confinement in Spain. The proportion of relevant changes in most lifestyle behaviors decreased in the second survey. In addition, most of participants in the second survey reported that their habits had not changed from before the pandemic. However, the responses were very heterogeneous, which suggests that the long-term evolution of lifestyles over time may be complex and in no case deterministic but is probably influenced by multiple variables. Moreover, our findings support the bidirectional relationship between lifestyle behaviors and mental health. The specific contribution of common mental disorders to unhealthier lifestyles should be further explored and taken into account

Table 4
Multivariable linear regression evaluating variables associated with higher SMILE-C score during the two surveys (*n* = 7047).

Variables	B	95.0% C.I.		p-value
		Lower	Upper	
Survey				<0.001
First	Reference	-	-	
Second	-2.51	-2.91	-2.12	
Sex				0.57
Male	Reference	-	-	
Female	0.11	-0.26	0.47	
Age	0.02	0.01	0.03	0,004
Working Status				
Not working	1.77	1.35	2.20	<0.001
Working (not as an essential worker)	Reference	-	-	
Working (as an essential worker)	-0.92	-1.34	-0.50	<0.001
Lost the job during the pandemic	0.54	-0.42	1.50	0.27
Education level				
Primary/Secondary education	-3.18	-3.89	-2.47	<0.001
Bachelor/Professional degree	-1.82	-2.31	-1.34	<0.001
University degree	-0.85	-1.27	-0.43	<0.001
Master/Doctorate degree	Reference	-	-	
Self-isolation				0.14
No	-0.33	-0.78	0.11	
Yes	Reference	-	-	
Self-rated health				<0.001
Very good or good	Reference	-	-	
Regular, bad or very bad	-4.57	-4.99	-4.16	
Screening for depression and anxiety				
Negative for depression and anxiety	Reference	-	-	
Positive for depression only	-4.31	-4.93	-3.68	<0.001
Positive for anxiety only	-3.48	-4.10	-2.86	<0.001
Positive for depression and anxiety	-7.20	-7.75	-6.64	<0.001
Screening for alcohol abuse				<0.001
Negative	Reference	-	-	
Positive	-1.1	-1.50	-0.71	
Diet and nutrition				
Mild/no changes	Reference	-	-	
Totally/moderate changes	-1.40	-1.80	-1.00	<0.001
Stress management				
Mild/no changes	Reference	-	-	
Totally/moderate changes	1.54	1.16	1.91	<0.001
Restorative sleep				
Mild/no changes	Reference	-	-	
Totally/moderate changes	-2.47	-2.86	-2.08	<0.001
Social support				
Mild/no changes	Reference	-	-	
Totally/moderate changes	-0.521	-0.87	-0.17	0.004
Physical activity				
Mild/no changes	Reference	-	-	
Totally/moderate changes	0.48	0.13	0.84	0.007
Mental Disease				
No	Reference	-	-	
Yes	-1.30	-1.77	-0.84	<0.001
Diagnosed/treated for heart disease/hypertension				
No	Reference	-	-	
Diagnosis or treatment	1.03	0.37	1.69	0.002

Positive *B* indicates increase in the SMILE-C score (better lifestyle), while negative *B* indicates decrease in the SMILE-C score (worse lifestyle).

when developing public health campaigns addressed to prevent the negative emotional impact of the pandemic.

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CRedit authorship contribution statement

Jose Cervera-Martínez: Formal analysis, Writing – original draft, Funding acquisition, Writing – review & editing. **Beatriz Atienza-**

Carbonell: Funding acquisition, Writing – review & editing. **Jurema C. Mota:** Formal analysis, Writing – review & editing. **Teresa Bobes-Bascarán:** Funding acquisition, Writing – review & editing. **Benedicto Crespo-Facorro:** Funding acquisition, Writing – review & editing. **Cristina Esteban:** Funding acquisition, Writing – review & editing. **María Paz García-Portilla:** Funding acquisition, Writing – review & editing. **Susana Gomes-da-Costa:** Funding acquisition, Writing – review & editing. **Ana González-Pinto:** Funding acquisition, Writing – review & editing. **M. José Jaén-Moreno:** Funding acquisition, Writing – review & editing. **Fernando Sarramea:** Funding acquisition, Writing – review & editing. **Eduard Vieta:** Funding acquisition, Writing – review & editing. **Iñaki Zorrilla:** Funding acquisition, Writing – review & editing. **Rafael Tabarés-Seisdedos:** Funding acquisition, Writing – review & editing. **Flavio Kapczinski:** Visualization, Writing – review & editing. **Raquel B. De Boni:** Visualization, Writing – review & editing. **Vicent Balanzá-Martínez:** Formal analysis, Writing – original draft, Visualization, Writing – review & editing.

Declaration of Competing Interest

SVBM has received grants and served as consultant, advisor or continuing medical education (CME) speaker during the last 5 years for the following entities: Angelini Spain, Angelini Portugal, Bristol-Myers-Squibb, Ferrer, Janssen, Juste, Lundbeck, Nutrición Médica, and Otsuka.

JC-M has served as continuing medical education (CME) speaker during the last years for Otsuka.

EV has received grants and served as consultant, advisor or CME speaker for the following entities (unrelated to the present work): AB-Biotics, Abbott, Allergan, Angelini, Celon, Dainippon Sumitomo Pharma, Ferrer, Gedeon Richter, GH Research. Janssen, Lundbeck, Otsuka, Sage, Sanofi-Aventis, and Takeda.

SGC has received CME-related honoraria, or consulting fees from Janssen-Cilag, Italfarmaco, Angelini and Lundbeck and reports no financial or other relationship relevant to the subject of this article.

AGP has received grants and served as consultant, advisor or CME speaker for the following entities: Janssen-Cilag, Lundbeck, Otsuka, Pfizer, Sanofi-Aventis, Alter, Angelini, Exeltis, Takeda, the Spanish Ministry of Science and Innovation (CIBERSAM), the Ministry of Science (Carlos III Institute), the Basque Government, and the European Framework Program of Research.

CE has received grants and served as consultant, advisor or CME speaker during the last 5 years for the following entities: Janssen-Cilag, Lundbeck, Otsuka and Casen Recordati.

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IZ has received grants and served as consultant, advisor or CME speaker for the following entities: Janssen-Cilag, Lundbeck, Otsuka, Angelini, Takeda

The remaining authors have no conflicts to declare.

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