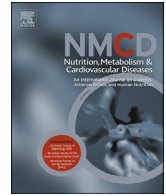




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The COVID-19 lockdown as an opportunity to change lifestyle and body weight in people with overweight/obesity and diabetes: Results from the national French COVIDIAB cohort

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Received 26 November 2020; received in revised form 10 May 2021; accepted 28 May 2021

Handling Editor: A. Siani

Available online 17 June 2021

KEYWORDS

COVID 19;
Lockdown;
Obesity;
Diabetes;
Lifestyle;
Weight;
Physical activity

Abstract *Background and aims:* To analyze lifestyle habits and weight evolution during the COVID-19 pandemic-associated lockdown, in diabetes and overweight/obesity patients (body mass index (BMI) [25–29.9] and ≥ 30 kg/m², respectively).

Methods and results: We collected information on participants' characteristics and behavior regarding lifestyle before and during the lockdown, through the CoviDIAB web application, which is available freely for people with diabetes in France. We stratified the cohort according to BMI (≥ 25 kg/m² vs < 25 kg/m²) and examined the determinants of weight loss (WL), WL > 1 kg vs no-WL) in participants with a BMI ≥ 25 kg/m², in both univariate and multivariate analyses.

Of the 5280 participants (mean age, 52.5 years; men, 49%; diabetes, 100% by design), 69.5% were overweight or obese (mean BMI, 28.6 kg/m² (6.1)). During the lockdown, patients often quit or decreased smoking; overweight/obese participants increased alcohol consumption less frequently as compared with normal BMI patients. In addition, overweight/obese patients were more likely to improve other healthy behaviors on a larger scale than patients with normal BMI: increased intake of fruits and vegetables, reduction of snacks intake, and reduction of total dietary intake. WL was observed in 18.9% of people with a BMI ≥ 25 kg/m², whereas 28.6% of them gained weight. Lifestyle favorable changes characterized patients with WL.

Conclusions: A significant proportion of overweight/obese patients with diabetes seized the opportunity of lockdown to improve their lifestyle and to lose weight. Identifying those people may help clinicians to personalize practical advice in the case of a recurrent lockdown.

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Introduction

Because of the COVID-19 pandemic, a generalized lockdown was announced in France in March 2020. People with diabetes and obesity were identified as at the risk of severe forms of diseases and were instructed to stay at home for 10 weeks [1–6]. Patients were understandably anxious and contacted clinicians for advice. To provide support and updated information, the Federation of Diabetology in Paris (AP-HP) opened a web application, www.CoviDIAB.fr, a specialized social medium available freely nationwide upon registration. This interactive service included live sessions with experts, quizzes related to COVID-19 symptoms for appropriate referral, or more extensive questionnaires on diabetes and lifestyle. Approximately 14,800 patients were quickly enrolled after communication through mainstream media (television, print, radio, and internet).

The consequences of the combined pandemic and lockdown on lifestyle habits, weight, and metabolic health are a cause for concern, especially in people with comorbidities such as overweight/obesity and diabetes [7]. Social isolation is associated with increased food consumption, snacking, and weight gain [8]. Such impact on lifestyle may eventually lead to an increase in cardiometabolic risk. However, many people had more available time during the lockdown to prepare and organize meals and to exercise. Hence, many patients also took advantage of this period to improve their lifestyles.

We wondered how the lockdown affected weight, feeding behavior, smoking, alcohol consumption, and physical activity in people with overweight/obesity and diabetes, and whether it differs according to baseline body mass index (BMI). To address this, we analyzed data assessing the lifestyle and weight evolution during the lockdown from questionnaires sent to the French CoviDIAB cohort, in accordance with BMI categories.

Methods

We performed a nationwide online survey using an electronic questionnaire administrated through the CoviDIAB web application to the whole French CoviDIAB cohort. The questionnaire analyzed here was submitted to the participants after March 17, 2020–38 days after the beginning of the lockdown in France (April 23, 2020, with a reply before April 28, 2020). Information on participants' characteristics and lifestyle behavior before and during lockdown was collected. The questionnaire was divided into three parts: (1) weight evolution, (2) feeding behavior, diet quality, smoking habits, and alcohol consumption before and during the lockdown, and (3) physical activity pre- and post-lockdown. We stratified the cohort according to BMI categories (≥ 25 kg/m² vs < 25 kg/m²), and in supplementary analyses (1) according to 2 categories of abnormally high BMI (BMI 25–30 vs BMI > 30 kg/m²) and (2) according to the subtype of diabetes (type 1 vs type 2). We examined determinants of weight loss in overweight and obese patients (BMI ≥ 25 kg/m²). For this analysis, the

population was divided into two subgroups of overweight/obese patients according to weight changes: weight loss (WL, > 1 kg), and no-WL (i.e., stable -1 kg to $+1$ kg weight change) or weight gain (>1 kg). Multivariate analysis (logistic regression) was carried out to identify independent factors associated with WL (>1 kg) vs no-WL. All variables associated with weight loss and a $p < 0.15$ were included in the adjustment model in the univariate analysis. Registered participants to CoviDIAB gave consent for anonymized data analysis in accordance with the European General Data Protection Regulation. The study was declared to and authorized by the French data protection committee (Commission Nationale Informatique et Liberté, CNIL, authorization n° 2218292v0) and was approved by the institutional review board (authorization number IRB 00006477) from the local scientific and ethical committee (CEERB Paris Nord). All participants included in this study were informed about the use of their data for research and none objected to the reuse of their data.

The continuous variables are expressed as mean (SD) and comparisons between groups were performed using ANOVA. P -value < 0.05 were considered as significant. All data were analyzed using R software, version 3.6.3 (R Project for Statistical Computing).

Results

Information was available for $>90\%$ of the items for 5280 patients who responded to the questionnaires, of whom 34.2% were overweight and 35.3% were obese. The cohort included 2677 women (50.7%) and 2587 men, respectively. The mean BMI was 28.6 (6.1) kg/m² and the mean age was 53.5 years (13.6). Clinical characteristics at baseline and changes according to baseline BMI categories during lockdown are presented in Table 1 and Table 2, respectively. Weight changes, i.e. weight gain or WL, were more frequent in overweight and obese participants (47.5%) vs participants with a normal BMI (35.7%), $p < 0.001$. WL was observed in 18.9% of overweight and obese participants vs 12.8% of those with a normal BMI. Moreover, overweight/obese patients and those with a normal BMI often quit (among smokers at baseline, 13.7% and 13.0%, respectively) or decreased (19% in both groups) smoking, whereas overweight/obese patients increased alcohol consumption less frequently than patients with BMI < 25 (7.6% vs 12.5%, $p < 0.001$). In addition, overweight/obese patients were more likely to improve other healthy behaviors on a larger scale than patients with a normal BMI: increase in consumption of fruits and vegetables, reduction of snacks intake, and reduction of total dietary intake. When the two subpopulations of overweight and obese participants were considered, similar patterns of changes in body weight and lifestyle habits during lockdown were observed; suggesting that in patients with diabetes and supranormal BMI, BMI levels did not impact the changes in lifestyle and body weight associated with the lockdown (Table S2).

Changes in body weight and lifestyle were also examined according to the type of diabetes (Table S3). As expected, BMI was higher in patients with type 2 diabetes as

Table 1 Clinical characteristics at baseline.

	Normal BMI <25	Overweight (BMI: 25–29.9) and obesity (BMI≥30)	Missing data (n)	p
n	1610	3670		
Sex (%)			16	<0.001
Women (n, %)	926 (57.5)	1751 (47.7)		
Men (n, %)	682 (42.4)	1905 (51.9)		
Age (mean (sd))	50.1 (15.2)	55.1 (12.5)		<0.001
BMI (mean (sd))	22.37 (1.86)	31.28 (5.28)		<0.001
Current smoking (n, %)			44	<0.001
No	1219 (75.7)	3092 (84.3)		
Yes	380 (23.6)	545 (14.9)		
Fruit consumption; portion/d (n, %)			16	0,271
< 1	331 (20.6)	682 (18.6)		
1	472 (29.3)	1062 (28.9)		
2	544 (33.8)	1337 (36.4)		
3	199 (12.4)	420 (11.4)		
> 3	60 (3.7)	157 (4.3)		
Vegetable consumption; portion/d (n, %)			27	<0.001
< 1	185 (11.5)	489 (13.3)		
1	529 (32.9)	1406 (38.3)		
2 to 3	784 (48.7)	1617 (44.1)		
> 3	103 (6.4)	140 (3.8)		
Snacking (n, %)			31	<0.001
Never	898 (55.8)	1601 (43.6)		
Rarely	62 (3.9)	231 (6.3)		
Frequently	647 (40.2)	1810 (49.3)		
Alcohol consumption^b; Glasses/d (n, %)			116	<0.001
≤ 1	1144 (73.1)	2760 (76.7)		
1–2	340 (21.7)	621 (17.3)		
2–3	51 (3.3)	112 (3.1)		
> 3	31 (2.0)	105 (2.9)		
Physical activity^a (n, %)			1	<0.001
0	109 (6.8)	369 (10.1)		
1	188 (11.7)	595 (16.2)		
2	304 (18.9)	947 (25.8)		
3	533 (33.1)	1138 (31.0)		
4	351 (21.8)	475 (12.9)		
5	125 (7.8)	145 (4.0)		

^a Assessed with an analogic scale.

^b The relatively high number of missing data for alcohol consumption is certainly because of the misunderstanding of some abstinent subjects who did not answer the question.

compared to type 1 patients (32.0 (5.5) vs 29.2 (3.9); $p < 0.001$). In addition, patients with type 2 diabetes were more likely to lose weight and to improve diet habits (excepted the change in vegetable consumption) as compared to patients with type 1 diabetes. Conversely, patients with type 1 diabetes more frequently increased physical activity compared to those with type 2 diabetes.

Determinants of WL during the lockdown in patients with a BMI ≥ 25 kg/m² were further examined in univariate, and then in multivariate analysis. The comparison between subgroups, WL vs no-WL is presented in Table 3. In univariate analysis, as compared to patients who stabilized or gained weight, those who lost weight were characterized by a higher likeliness of reducing their total dietary intake, snack intake, and alcohol consumption, along with a higher likeliness of increased physical activity (endurance or resistance exercise). Patients who lost weight were significantly more prone to increased or decreased fruit and vegetable consumption as compared to patients who stabilized or gained weight. In addition, patients who lost weight tended to quit smoking more

frequently (21% among smokers at baseline vs 11.3% among smokers at baseline in the subpopulation of patients with weight gain or stable weight $p < 0.01$). Compared to weight losers, weight gainers had mirroring lifestyle changes, i.e., they deteriorated their lifestyle habits (data not given). In multivariate analysis (Table 4), reduced dietary intake, reduced snacking, reduced alcohol consumption, cessation of smoking, and the increase in endurance activities were independently associated with the likeliness of losing weight.

Discussion

The present study supports that lockdown may affect weight change and lifestyle habits in patients with diabetes, particularly in people with a high BMI. During the stressful period of lockdown, overweight/obese patients did deteriorate their lifestyle in a higher proportion than people with a normal BMI. But at the same time, other overweight/obese patients improved their lifestyle, and

Table 2 Body weight evolution and change in lifestyle habits during lockdown in patients with normal BMI vs overweight and obesity.

Changes	Normal BMI <25	Overweight (BMI: 25–29.9) and obesity (BMI≥30)	Missing Data (n)	p
n	1610	3670		
Weight change (n, %)			48	<0.001
Decrease	206 (12.8)	695 (18.9)		
Stability	1027 (63.8)	1885 (51.4)		
Increase	368 (22.9)	1051 (28.6)		
Dietary intake (n, %)			68	<0.001
Decrease	318 (20.0)	1023 (28.3)		
Stability	1027 (64.5)	1972 (54.5)		
Increase	248 (15.6)	624 (17.2)		
Snacking (n, %)			124	<0.001
Decrease	225 (14.3)	702 (19.6)		
Stability	1043 (66.5)	2129 (59.4)		
Increase	301 (19.2)	756 (21.1)		
Physical activity (n, %)			60	0.007
Decrease	809 (50.9)	1752 (48.3)		
Stability	433 (27.2)	1145 (31.5)		
Increase	348 (21.9)	733 (20.2)		
Introduction of endurance activities (n, %)			50	0.002
No	1013 (62.9)	2489 (67.8)		
Yes	583 (36.2)	1145 (31.2)		
Introduction of resistance activities (n, %)			164	<0.001
No	1103 (68.5)	3008 (82.0)		
Yes	451 (28.0)	554 (15.1)		
Smoking (n, %)			20	<0.001
Cessation	52 (3.2)	71 (1.9)		
Decrease	71 (4.4)	106 (2.9)		
Stability	1393 (87.0)	3367 (92.0)		
Increase	86 (5.4)	114 (3.1)		
Fruit consumption (n, %)			53	0.092
Decrease	245 (15.4)	629 (17.3)		
Stability	1124 (70.4)	2449 (67.4)		
Increase	227 (14.2)	553 (15.2)		
Vegetable consumption (n, %)			47	0.01
Decrease	189 (11.8)	521 (14.3)		
Stability	1179 (73.7)	2533 (69.7)		
Increase	232 (14.5)	579 (15.9)		
Alcohol consumption^a (n, %)			493 ^a	<0.001
Decrease	173 (11.7)	384 (11.6)		
Stability	1124 (75.8)	2671 (80.8)		
Increase	185 (12.5)	250 (7.6)		

^a The relatively high number of missing data for alcohol consumption is certainly because of the misunderstanding of some abstinent subjects who did not answer the question.

they did so in a higher proportion than people with a normal BMI. In other words, overweight/obese patients were less stable, but not systematically in the wrong direction. Weight changes were also more prevalent in patients with a BMI ≥ 25 kg/m² vs patients with a BMI <25, but unexpectedly, the lockdown was beneficial in an important proportion of overweight/obese patients. Moreover, one out of five patients with a high BMI ≥ 25 kg/m² lost weight, while 29% gained weight during the same period. Weight loss was associated with lifestyle changes consistent with the usual recommendations: reduction in total food intake and alcoholic beverages, and increased physical activity. The main lesson is that overweight/obese patients are not prone to gain weight when external conditions theoretically complicate their efforts to eat well and exercise more. They can also seize the opportunity to improve their health. Patients who lost weight adopted

healthier lifestyle habits. In a recent synthesis, Mattioli et al. [9] pointed out that although quarantine and isolation are effective measures to reduce and prevent the pandemic, these conditions can induce depression, anxiety, anger, and stress that lead people to eat sugar-rich food and drink alcohol to feel better. Our study proves that these negative effects of a lockdown do occur, but are not systematic, particularly in a population with diabetes and overweight/obesity. While the association between weight loss and changes in food intake, alcohol consumption, and physical activity was expected, the observation of a higher prevalence of smoking cessation in patients who lost weight was not expected.

However, this finding is consistent with the results of a recent study which shows that obese persons who quit smoking were more than seven times more likely to lose weight than normal-weight quitters [10]. Presumably,

Table 3 Change in lifestyle habits during the lockdown in patients who lost weight vs patients with stable or increased body weight (i.e., no weight loss) in the subpopulation of patients with overweight or obesity (BMI ≥ 25 kg/m²) at baseline. Missing data among the population for which weight change was available is indicated.

Changes	Weight loss (n = 695)	Weight gain or stable weight (n = 2918)	Missing Data (N)	p
Dietary intake (n, %)			43	<0.001
Decrease	459 (66.6)	554 (19.2)		
Stability	208 (30.2)	1735 (60.2)		
Increase	22 (3.2)	592 (20.5)		
Snacking (n, %)			79	<0.001
Decrease	254 (37.1)	440 (15.4)		
Stability	376 (55.0)	1721 (60.4)		
Increase	54 (7.9)	689 (24.2)		
Physical activity (n, %)			48	<0.001
Decrease	262 (38.1)	1457 (50.6)		
Stability	191 (27.8)	937 (32.6)		
Increase	235 (34.2)	483 (16.8)		
Introduction of endurance activities (n, %)			91	<0.001
No	382 (55.0)	2070 (70.9)		
Yes	307 (44.2)	822 (28.2)		
Introduction of resistance activities (n, %)			100	<0.001
No	533 (76.7)	2432 (83.3)		
Yes	147 (21.2)	401 (13.7)		
Smoking (n, %)			12	0.12
Cessation	21 (3.0)	50 (1.7)		
Decrease	21 (3.0)	84 (2.9)		
Stability	630 (91.0)	2684 (92.3)		
Increase	20 (2.9)	91 (3.1)		
Fruit consumption (n, %)			38	<0.001
Decrease	144 (21.0)	474 (16.4)		
Stability	417 (60.9)	1997 (69.1)		
Increase	124 (18.1)	419 (14.5)		
Vegetable consumption (n, %)			34	<0.001
Decrease	138 (19.9)	375 (13.0)		
Stability	416 (60.1)	2079 (72.0)		
Increase	138 (19.9)	433 (15.0)		
Alcohol consumption (n, %)			352	<0.001
Decrease	133 (21.1)	245 (9.3)		
Stability	472 (75)	2165 (82.3)		
Increase	24 (3.8)	222 (8.4)		

Table 4 Multivariate analysis (weight loss > 1 kg as a dependent variable) in the subpopulation of patients with overweight or obesity (BMI ≥ 25 kg/m²) at baseline.

	OR	95%CI	p	
Snacking				
Reduction	1.65	1.30 2.08	<0.001	
Increase	0.68	0.47 0.99	0.04	
Dietary intake				
Reduction	5.34	4.27 6.67	<0.001	
Increase	0.32	0.19 0.55	<0.001	
Smoking				
Cessation	2.16	1.15 4.08	0.02	
Reduction	0.75	0.42 1.34	0.33	
Increase	1.32	0.71 2.45	0.39	
Alcohol consumption				
Reduction	1.68	1.28 2.22	<0.001	
Increase	0.60	0.37 0.99	0.05	
Introduction of endurance activities	1.59	1.27 1.99	<0.001	
Introduction of resistance activities	1.01	0.76 1.34	0.94	
Fruits consumption				
Reduction	0.82	0.61 1.11	0.21	
Increase	1.44	1.06 1.94	0.02	
Vegetable consumption				
Reduction	1.27	0.92 1.75	0.15	
Increase	1.15	0.86 1.55	0.34	

obese patients who decided to quit smoking during the lockdown were also very determined not to gain extra weight after quitting.

Several studies [11–18] have been published on both body weight and/or lifestyle changes during lockdown or semi-lockdown, but none have reported both body weight and lifestyle changes in the vulnerable overweight/obese population with diabetes. For instance, in a small study performed in China [18,19], a subpopulation with a BMI > 24 (n = 101) was characterized by weight gain in men and weight reduction in women. However, the proportion of patients who lost weight or gained weight was not described. Another study from Poland found that in 1097 participants (29% of whom were overweight/obese), 43% and 52% reported eating and snacking more, respectively [20]. No data on the frequency of participants who improved their lifestyle was available in this study. Our population includes only patients with a history of diabetes (60% type 2 diabetes). Although weight gain is not systematically deleterious in participants with normal BMI or with high BMI without any comorbidity, it is an undesirable evolution in patients

with diabetes, especially type 2 diabetes, as hyperglycemia and other associated cardiometabolic risk factors are strongly impacted by weight variations. The good rate of questionnaire response and the good gender balance, which are both quite unusual in the lifestyle area (especially women are more likely to respond to such questionnaires) may be explained as follows: (1) because our survey was carried out as an appendix to a program of assistance to diabetic patients in which they were enrolled voluntarily, and (2) because this survey was carried out during a period of lockdown where patients are possibly more available.

Our study has some limitations. First, this study included only subjects with a smartphone and/or a computer connection. Thus, we cannot generalize our result to a nonconnected population, which may be enriched in patients with a lower socioeconomic status. In addition, the self-reported nature of the questionnaire led to obvious biases. However, the collection of only more objective data from patients at our center would have drastically limited the recruitment and would have introduced a selection bias. Additionally, data are lacking to assess changes in anxiety and sleep quality as these factors may affect eating habits. One of the inclusion criteria in CoviDIAB was a history of diabetes; thus, the results of this study cannot be generalized to overweight/obese people in general. The strengths of this study include a large number of participants, far more than that reported in any other studies on this subject; and the recruitment being at the national level – the study not being limited to patients followed up in expert centers.

In conclusion, our study reveals that the lockdown was associated with a risk of deleterious lifestyle changes and weight gain in vulnerable overweight/obese patients with type 2 diabetes. However, we have also shown that a significant proportion of overweight/obese patients with type 2 diabetes can take advantage of a lockdown to lose weight and improve their lifestyle. From a practical standpoint, identifying patients who improved, or conversely, deteriorated their lifestyle during the lockdown can help health care providers personalize practical advice in the event of a recurring lockdown.

Acknowledgment

We thank the company AG2R–La mondiale, the French-speaking Foundation for Research on Diabetes (FFRD), and Foundation AP-HP for Research who provided unrestricted financial support to the CoviDIAB project. They did not participate in the data analysis.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.numecd.2021.05.031>.

Conflicts of interest

Authors do not have any competing financial interests in relation to the work described.

LP reports personal fees and non financial support from Sanofi, personal fees, and nonfinancial support from Eli Lilly, personal fees, and nonfinancial support from Novo Nordisk, and personal fees and non financial support from MSD. RR reports grants, personal fees, and non financial support from Sanofi, grants, personal fees, and nonfinancial support from Novo Nordisk, personal fees, and nonfinancial support from Eli Lilly, personal fees from Mundipharma, personal fees from Janssen, personal fees from Servier, grants and personal fees from AstraZeneca, personal fees from MSD, personal fees from Medtronic, personal fees from Abbott, grants from Diabnext, and personal fees from Applied Therapeutics. JFG reports personal fees and non-financial support from Eli Lilly, personal fees, and non financial support from Novo Nordisk, personal fees, and non financial support from Gilead, and personal fees and non financial support from AstraZeneca. BH, JPR, EL, FD, VM, BV, JCL, SK, DK have nothing to disclose relevant to this article.

Authors contributions

RR and BH designed the project. All authors obtained, validated, and cleaned the data. LP performed the statistical analyses. All authors drafted the manuscript, revised it critically for important intellectual content, discussed the results, and contributed to the final manuscript. All of them reviewed and approved the manuscript. BH and RR had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Funding

No funding source was involved in this research.

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