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ARTICLE

Staying at home in the COVID-19 period: Effects on well-being and physical activity in women living with overweight or obesity

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Abstract – Background: Between March and May 2020, the COVID-19 pandemic led governments to take specific lockdown measures. Investigations have defined obesity as a risk factor for disease severity, but none has addressed the effects of lockdown on psychological well-being and physical activity in this population. The objective of the study was to analyze the evolution (before *vs.* during lockdown) of well-being and physical activity among French adult women living with overweight or obesity. **Methods:** 250 women, divided into 5 Body Mass Index (BMI) categories (healthy weight, overweight, obesity I, II or III), provided online information concerning their self-perceived psychological well-being and level of physical activity before and after one month (± 1 week) of lockdown. **Results:** This study shows that BMI is a factor that is associated with well-being and physical activity. Compared to women with a healthy weight who significantly increased their level of physical activity, those living with overweight or obesity perceived a significant decrease in psychological well-being, positive affect, and physical exercise. **Conclusions:** This study highlights the importance of taking into account the well-being and active behavior of women living with overweight or obesity during any lockdown period that could occur in future pandemics.

Keywords: COVID-19 pandemic, overweight, obesity, lockdown, well-being, physical activity

Résumé – Rester chez soi en période de pandémie à la Covid-19 : effets sur le bien-être et l'activité physique chez une population de femmes en surpoids ou en obésité. Contexte : Entre mars et mai 2020, la pandémie de Covid-19 a amené les gouvernements à prendre des mesures spécifiques de confinement des populations. Les recherches ont rapidement défini l'obésité comme un facteur de risque de développer des formes sévères de la maladie, mais aucune ne s'est intéressée spécifiquement aux effets du confinement sur le bien-être psychologique et le niveau d'activité physique chez cette population. L'objectif de cette étude était d'analyser l'évolution (avant *vs.* pendant le confinement) des niveaux de bien-être perçu et d'activité physique chez une population de femmes adultes en surpoids ou en obésité. **Méthodes :** 250 femmes, réparties dans une des 5 catégories d'Indice de Masse Corporelle (IMC ; normo-pondérées, surpoids, obésité I, II ou III), ont répondu à des questionnaires en ligne concernant la perception de leur bien-être psychologique et leur niveau d'activité physique en amont et après un mois (± 1 semaine) de confinement. **Résultats :** Cette étude a montré que l'IMC est un facteur associé au bien-être et au niveau d'activité physique. Ils ont notamment révélé que les femmes en surpoids ou en obésité ont perçu une baisse significative de leur bien-être psychologique, des émotions positives et du niveau d'activité physique. À l'inverse, les femmes normo-pondérées ont significativement augmenté leur niveau d'activité physique sans connaître de baisse de leur perception de bien-être. **Conclusion :** Cette étude souligne l'importance de prendre en compte le bien-être psychologique et le niveau d'activité physique des femmes en surpoids ou obèses pendant toute période de confinement qui pourrait survenir lors de futures pandémies.

Mots clés : pandémie de Covid-19, indice de masse corporelle, confinement, bien-être, activité physique

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1 Introduction

"Stay at home". In early March 2020, following its appearance in China in December 2019, there were over one hundred thousand confirmed cases of Coronavirus Disease 2019 (COVID-19) throughout the world, with the number of deaths exceeding three thousand. One month later, roughly three million people had caught the disease and the death toll had risen to over two hundred thousand. To prevent the spread of the pandemic and curb hospitalizations, several countries took exceptional lockdown measures. In France, three lockdown periods were implemented: the first from March 17 to May 11, 2020; the second from October 30 to December 15 in the same year; and the third from April 2 to May 3, 2021. This study is based on the first lockdown period. Due to its unprecedented nature and the measures taken by the government, which were stricter than for the following two periods (compulsory homeworking, closure of schools and sports centers, restrictions on outings to only one hour and limitations on travel within a 1 km perimeter, etc.), this first lockdown turned daily life upside down for millions of people.

Numerous studies have analyzed the effects of the first lockdown on the practice of physical activity (*e.g.*, Ammar *et al.*, 2020; Cheval *et al.*, 2021) and mental health (*e.g.*, Carriedo, Cecchini, Fernandez-Rio, & Méndez-Giménez, 2020; Ferreira, Pereira, da Fé Bras, & Ilchuck, 2021). For example, Cheval *et al.* (2021) showed that during the lockdown, individuals within a population with a mean of Body Mass Index (BMI) under 25 kg/m^2 (defined as the healthy weight range in the BMI classification), exhibited certain behavioral changes. Specifically, there was higher leisure-related sedentary activity, lower leisure-related vigorous physical activity, and a higher amount of time spent walking and doing moderate physical exercise. In a scoping review, Caputo & Reichert (2020) confirmed these results and showed that physical activity levels decreased during the pandemic. These findings were corroborated by FitBit (2020)'s study, highlighting that physical activity levels decreased by 7 to 38% in European countries during the month of March 2020. On the other hand, the risk of mental health issues due to the COVID-19 lockdown also impacted people's lives (Wang *et al.*, 2020). For example, in China, within 2 months of the start of the COVID-19 pandemic, Huang & Zhao (2020) observed a 20.1% depression rate and a 35.1% anxiety disorders rate among the 7236 volunteers taking part in their study. In Spain, Planchuelo-Gómez, Odriozola-González, Irurtia, & de Luis-García (2020) reported a significant increase in the symptomatic scores of anxiety, depression, and stress during the COVID-19 lockdown. Moreover, in a sample taken from Portugal's population, Ferreira *et al.* (2021) showed that individuals quarantined at home reported higher anxiety and lower health-related quality of life levels. These authors pointed out that women experienced the highest levels of anxiety and poorest quality of life. Finally, food consumption (type of food, snacks between meals, number of main meals) was unhealthier during confinement (Ammar *et al.*, 2020), thus leading to a potential worsening of pre-existing eating disorders and the increased risk of new additional eating problems appearing (Mengin *et al.*, 2020).

While studies have analyzed the effects of quarantine on physical and mental health among individuals with a healthy weight, to our knowledge no study has yet examined these effects on individuals living specifically with overweight or obesity.

However, this research question is important since obesity is a chronic disease of particular concern to public health bodies. The latest WHO statistics report over 2 billion overweight adults worldwide (BMI $\geq$ 25 kg/m^2), 700 million of whom are considered obese (BMI $\geq$ 30 kg/m^2)[1]. In the United States, for example, the prevalence of obesity has steadily increased over the last few years, affecting over 42% of the population in 2017 (Hales, Carroll, Fryar, & Ogden, 2020). In France, the results of the latest surveys reveal that over 47% of adults are currently living with overweight, 17% of whom are considered to be suffering from obesity[2].

Since March 2020, numerous studies have been carried out to identify the risk factors associated with the appearance of severe forms of COVID-19 and thus limit contagion of the most vulnerable (*e.g.*, Grasselli *et al.*, 2020). Based on previous knowledge stemming from the H1N1 influenza virus (Louie *et al.*, 2009) and on the results of studies published in France (Simonnet *et al.*, 2020), the United Kingdom (Mahase, 2020) or United States (Bhatraju *et al.*, 2020) for example, health agencies have included people suffering from chronic diseases, including obesity, on the list of those "at risk" of COVID-19. Hence, at the end of April 2021, the French Health Minister announced that obese adults should be considered a priority for vaccination against COVID-19.

Besides being a risk factor for COVID-19, obesity has also been shown to incur major behavioral consequences (*e.g.*, Zoeller, 2007). Multiple studies have highlighted a greater tendency among those suffering from obesity to have a sedentary lifestyle and not follow the WHO's recommendations for daily physical exercise (*e.g.*, Bull *et al.*, 2020; Davis, Hodges, & Gillham, 2006). This is even more worrying as a sedentary lifestyle seems to be associated with a higher risk of severe forms of COVID-19 (Sallis *et al.*, 2021). At the same time, regular physical exercise has numerous positive consequences. On a physiological level, regular physical activity is clearly conducive to losing or maintaining weight (*e.g.*, Fox & Hillsdon, 2007), while also reducing comorbidities (*e.g.*, Ciangura, Faucher, & Oppert, 2014). On the social front, physical exercise works positively towards integration and the development of interaction with other people (*e.g.*, Di Bartolomeo & Papa, 2019). Lastly, it is effective in the prevention and treatment of psychological disorders

[1] OECD Obesity Update 2017. http://www.oecd.org/health/obesityupdate.htm.

[2] Results of ObEpi-Roche 2020 study on overweight and obesity in France. Available from https://liguecontrelobesite.org/actualite/forte-progression-de-lobesite-en-france-en-2020/.

Table 1. Women's characteristics (*N*, means, SD and % of all).

	N (%)	Mean age	Mean BMI
Healthy weight (BMI: 18.5–24.9)	26 (10.4%)	42.5 (10.5)	23.3 (1.2)
Overweight (BMI: 25.0–29.9)	64 (25.6%)	46.1 (12.7)	27.6 (1.5)
Obesity I (BMI: 30.0–34.9)	54 (21.6%)	41.8 (10.7)	32.2 (1.3)
Obesity II (BMI: 35.0–39.9)	46 (18.4%)	46.0 (13.9)	37.4 (1.5)
Obesity III (BMI: ≥ 40.0)	60 (24.0%)	43.2 (11.3)	45.9 (5.2)
Total	250	44.1 (12.0)	34.3 (8.2)

BMI: Body Mass Index (kg/m^2).

affecting a person's mental health (*e.g.*, Fox, 1999), by reducing the symptoms of depression and anxiety for example (*e.g.*, Rebar *et al.*, 2015), or enhancing the perception of well-being (Zhang & Chen, 2019). Some studies have also focused on the beneficial effects of physical activity on mental health during the lockdown period. Ginoux *et al.* (2021) showed that moderate to vigorous physical activity was correlated with recovery experiences, such as psychological detachment or relaxation. These authors concluded, notably, that during this period, recovery experiences during PA were positively related to well-being. However, this study did not consider participants' BMI, and the results cannot be generalized to this specific population.

In addition to its repercussions on behavior, obesity also gives rise to psychosocial consequences (*e.g.*, Hill, 2005). Compared to people with a normal weight, those living with overweight and obesity are much more likely to suffer from severe depression (*e.g.*, Linde *et al.*, 2004) or to attempt suicide (*e.g.*, Carpenter, Hasin, Allison, & Faith, 2000). Such people also tend to have lower levels of self-esteem or well-being (*e.g.*, Fabricatore & Wadden, 2004; Hill, 2005; Le Foll, Lechaux, Rascle, & Cabagno, 2020; Wardle & Cooke, 2005), a tendency that is more pronounced in women than men (*e.g.*, Jorm *et al.*, 2003; Le Foll *et al.*, 2020; Linde *et al.*, 2004). In this sense, many studies have shown greater adverse psychological effects of obesity on the female participants than the male ones. For example, in a study with patients seeking bariatric surgery, Le Foll *et al.* (2020) showed that in the preoperative period, women had lower global perception of quality of life than men. Other authors also highlighted the fact that women living with obesity had higher levels of weight bias internalization and/or shape/weight concern (Boswell & White, 2015), higher levels of body image dissatisfaction (Grilo & Masheb, 2005), and/or lower perception of global self-esteem (Bleidorn *et al.*, 2016) than men. For these reasons, we chose to focus specifically on women in this study.

The main objective of this study was to investigate the impact of the lockdown caused by the COVID-19 pandemic on psychological and affective components of subjective well-being, as well as on the active behaviors of French women living with overweight or obesity. Due to the unprecedented nature of the lockdown in our country, we cannot make clear assumptions about the results of our study. Nevertheless, in view of the data in the literature, highlighting low perceived levels of quality of life during the lockdown (*e.g.*, Almandoz *et al.*, 2020; Carriedo *et al.*, 2020), one might expect a drop in psychological well-being and positive affect, along with a rise in negative affect. However, what cannot be known *a priori* is whether these effects vary according to the degree of obesity. Regarding the rate of physical activity, in accordance with the results of the systematic reviews of Caputo & Reichert (2020) and Violant-Holz *et al.* (2020), a decrease in the levels of PA, whatever the category of BMI studied, may be expected. Once again, we cannot put forward a specific hypothesis concerning potential differences between women depending on their BMI.

2 Materials and methods

2.1 Design and participants

After giving their consent to participate, 250 French women ($M_{age} = 44.1$ years; $M_{BMI} = 34.3\ kg/m^2$), all members of an association for fighting obesity or following an online weight loss program, agreed to take part in this study. Out of the 250 women, 10.4% have a healthy weight; 25.6% are overweight, and 64.0% fall within the obese category, as presented in Table 1.

Between April 15 and 30, 2020, that is to say at least one month after the government's total lockdown decision, the women were contacted by email and asked to complete a two-part online questionnaire. In Part 1, women had to describe how they felt (psychological well-being and affects) and give their level of physical activity during a normal pre-lockdown week (Time 1 measure). In Part 2, they answered the same questions but referred, here, to the moment the survey was administered, that is to say during lockdown (Time 2 measure). Lastly, questions on weight and size were asked at the end of the Time 2 measure. All of the participants were teleworking full-time during the lockdown period.

The study complied with the World Medical Association's Helsinki Declaration and was approved by the Ethics Commission of the Sport Sciences Laboratory of the University of Rennes. For this non-interventional study, an information letter was attached to the emailed questionnaire, in which information was given on the study aim, the procedure for data collection, the right to abstain from participation or to withdraw consent to participate at any time, and the researcher's institutional affiliation, together with contact details. No single individual can be identified.

2.2 Outcome measures

2.2.1 Body Mass Index (BMI)

Height (in cm) and weight (in kg) were self-reported by participants at the end of the questionnaire, which allowed the researchers to calculate their BMI, expressed in kg/m^2. According to the categories defined by the World Health Organization, the women were placed into one of these five groups: healthy weight (18.5–24.9), overweight (25–29.9), obesity I (30–34.9), obesity II (35–39.9), and obesity III (≥ 40). These data were only requested when the questionnaire was administered, *i.e.* at Time 2. No anthropometric data were requested at Time 1, *i.e.* before lockdown.

2.2.2 Psychological Well-Being (PWB)

A French translation (Bouffard & Lapierre, 1997) of the shortened form of the Ryff's Psychological Well-Being scale (Ryff & Keyes, 1995) was used in this study. In this questionnaire, 18 items are averaged to produce an indicator of overall psychological well-being. A 6-point Likert scale, coded from 1 ("Strongly disagree") to 6 ("Strongly agree"), was used for scoring. Negative items were reverse scored, so that higher scores reflected a higher level of PWB. For the present study, and confirming the values obtained for the original PWB, internal consistency was acceptable ($\alpha = 0.75$ in Time 1 and $\alpha = 0.77$ in Time 2).

2.2.3 Positive (PA) and Negative (NA) Affect

In order to assess mood, we used a French version of the International Positive and Negative Affect Schedule Short Form (I-PANAS-SF) (Thompson, 2007). The I-PANAS-SF is composed of two five-item mood subscales (positive affect *vs.* negative affect). The five positive affective states are: active, determined, attentive, inspired, and alert, while the five negative affective states are: afraid, nervous, upset, hostile, and ashamed. Respondents were requested to rate each statement on a 5-point scale, from 1 ("Very slightly or not at all") to 5 ("Extremely"). Past studies showed PA and NA dimensions are relatively independent of each other so that higher scores on both PA and NA subscales indicate a tendency to experience both positive and negative moods. The internal consistency of the PA ($\alpha = 0.72$ in Time 1 and $\alpha = 0.71$ in Time 2) and NA ($\alpha = 0.81$ in Time 1 and $\alpha = 0.89$ in Time 2) subscales was acceptable and the same as that presented by Thompson (2007).

2.2.4 Level of Physical Activity (LPA)

Level of physical activity was assessed using the French Ricci-Gagnon questionnaire (Ricci & Gagnon, 2011). This questionnaire was chosen for its simplicity, its instantaneous production of a numerical global score of physical activity, and its relatively short administration time, which was of interest for our study because of a "double dose" of this measure (Time 1 – retrospective and Time 2 – measures). The latter was recommended by the Ministry of Health and derived from the Baecke questionnaire for the evaluation of habitual physical activity in adults (Baecke, Burema, & Frijters, 1982). The questionnaire consists of nine items that assess three aspects of LPA (occupational physical activities, physical exercises in leisure, and leisure and locomotion activities). It uses a 5-point Likert-type response scale. Data collected from each item were added together to provide a global physical activity score with a range of 9 to 45 (the greater the positive value of the score, the higher the level of physical activity). All items were equally weighted.

2.3 Data analysis

Statistical analyses were performed using STATISTICA for Windows, version 7.1 (Tibco Software, Palo Alto, CA, USA). Data are expressed as means ± standard deviation unless otherwise indicated, and data for all assessed variables across all times are shown in Table 2. Differences in PWB, PA, NA, and LPA scores when comparing the conditions prior to and during the lockdown were each analyzed, using a 5 (BMI groups: Healthy Weight, Overweight, Obesity I, Obesity II, Obesity III) × 2 (Time 1 – before lockdown, Time 2 – during lockdown) ANOVA, with repeated measures on the last factor (RM-ANOVA). Effects of Time, BMI groups and Interaction (Time*BMI groups) are presented in Table 3. In order to avoid potential risk of bias with RM-ANOVA, we took care to ensure that there were no missing data in our sample. To assess the evolution of the four dependent variables for each of the 5 BMI groups, independently of each other, we performed paired-sample t-tests, whose results are presented in Table 2.

A sensitivity analysis was conducted for a 5 (healthy, overweight, obesity I, obesity II, obesity III) × 2 (pre *vs.* during lockdown) mixed-factorial ANOVA with time measurement as the within factor, an alpha = 0.05, a power of 80% and 250 participants, using G*Power. Results indicated that we were able to detect an effect size $f = 0.11$ with this sample size. Finally, values with $P < 0.05$ were considered statistically significant.

3 Results

3.1 Preliminary analyses: Correlations between BMI and other variables (PWB, PA, NA, and LPA)

Before lockdown, the analyses showed a marginally significant negative correlation only between BMI and LPA ($r = -0.12$, $P = 0.05$). During lockdown, significant negative correlations were found between BMI and PWB ($r = -0.19$, $P = 0.002$), PA ($r = -0.19$, $P = 0.002$) and LPA ($r = -0.26$, $P < 0.0001$). Lastly, the analyses showed no significant correlation between BMI and NA ($r = 0.10$, $P = 0.09$).

3.2 Main analyses

3.2.1 Psychological Well-Being (PWB)

The analysis revealed a main effect for Time ($F_{(1.245)} = 8.95$, $P = 0.003$, *cf.* Tab. 3), indicating that

Table 2. Means (SD and lower-upper 95% C.I.) of PWB, PA, NA, and LPA before (Time 1) and during (Time 2) lockdown, and results of intra-group comparisons for each dependent variable.

		BMI classes				
		Healthy weight	Overweight	Obesity I	Obesity II	Obesity III
Psychological Well-Being	Time 1	4.37 *(0.11)* *[4.17–4.57]*	4.50 *(0.07)* *[4.37–4.61]*	4.35 *(0.08)* *[4.19–4.50]*	4.36 *(0.08)* *[4.17–4.54]*	4.30 *(0.07)* *[4.13–4.45]*
	Time 2	4.46 *(0.12)* *[4.26–4.65]*	4.40 *(0.08)* *[4.26–4.54]*	4.24 *(0.08)* *[4.08–4.40]*	4.24 *(0.09)* *[4.05–4.42]*	4.10 *(0.08)* *[3.99–4.27]*
	t-test	0.86	1.72	1.78	2.34	3.18
df	25	63	53	45	59	
P-value	*0.396*	*0.089*	*0.080*	*0.023*	*0.002*	
Positive Affect	Time 1	3.25 *(0.12)* *[2.97–3.53]*	3.17 *(0.08)* *[3.00–3.32]*	3.22 *(0.09)* *[3.07–3.36]*	3.22 *(0.09)* *[3.02–3.41]*	3.13 *(0.08)* *[2.95–3.30]*
	Time 2	3.20 *(0.14)* *[2.89–3.50]*	2.85 *(0.09)* *[2.67–3.03]*	2.66 *(0.10)* *[2.49–2.82]*	2.68 *(0.10)* *[2.46–2.90]*	2.65 *(0.09)* *[2.46–2.85]*
	t-test	0.31	2.50	5.32	4.63	3.88
df	25	63	53	45	59	
P-value	*0.753*	*0.014*	*0.0001*	*0.0001*	*0.0002*	
Negative Affect	Time 1	1.91 *(0.15)* *[1.64–2.18]*	1.94 *(0.10)* *[1.77–2.11]*	2.01 *(0.10)* *[1.79–2.23]*	1.94 *(0.11)* *[1.70–2.17]*	2.04 *(0.10)* *[1.82–2.26]*
	Time 2	2.27 *(0.20)* *[1.88–2.67]*	2.23 *(0.13)* *[1.98–2.48]*	2.42 *(0.14)* *[2.12–2.71]*	2.36 *(0.15)* *[2.10–2.62]*	2.53 *(0.13)* *[2.24–2.82]*
	t-test	2.15	2.28	2.45	2.64	3.42
df	25	63	53	45	59	
P-value	*0.041*	*0.025*	*0.017*	*0.011*	*0.001*	

Table2. (continued).

		BMI classes			
		Healthy weight	Overweight	Obesity I	Obesity II	Obesity III
Level of Physical Activity	Time 1	21.50 *(1.14)* *[18.89–24.10]*	23.40 *(0.72)* *[21.90–24.87]*	22.17 *(0.79)* *[20.66–23.66]*	22.70 *(0.85)* *[20.84–24.54]*	20.43 *(0.75)* *[19.06–21.779]*
	Time 2	23.92 *(1.08)* *[21.51–26.33]*	22.50 *(0.69)* *[20.96–24.03]*	20.31 *(0.75)* *[18.90–21.72]*	20.47 *(0.81)* *[18.85–22.10]*	18.36 *(0.71)* *[17.11–19.62]*
	t-test	2.17	0.94	2.06	2.28	2.83
df		25	63	53	45	59
P-value		*0.039*	*0.348*	*0.043*	*0.027*	*0.006*

PWB scores decreased overall from before lockdown to during lockdown (*cf.* Fig. 1a). More specifically, paired sample t-tests between Time Scores within each group revealed that PWB significantly decreased from Time 1 to Time 2 in the Obesity II and III groups ($P = 0.02$ and $P = 0.002$, respectively; *cf.* Tab. 2).

3.2.2 Positive Affect (PA)

The analysis revealed a main effect for Time ($F_{(1.245)} = 42.92$, $P < 0.0001$, *cf.* Tab. 3), indicating that, overall, PA scores decreased from before lockdown to during lockdown (*cf.* Fig. 1b). Paired sample t-tests between Time scores within each group revealed that PA significantly decreased from Time 1 to Time 2 for all the categories except women with a healthy weight, as follows: Overweight ($P = 0.01$), Obesity I ($P < 0.0001$), Obesity II ($P < 0.0001$) and Obesity III ($P < 0.0001$; *cf.* Tab. 2).

3.2.3 Negative Affect (NA)

The analysis revealed a main effect for Time ($F_{(1.245)} = 29.02$, $P < 0.0001$, *cf.* Tab. 3), indicating that NA scores decreased overall from before lockdown to during lockdown (*cf.* Fig. 1c). Paired sample t-tests between Time scores within each group revealed that NA significantly increased from Time 1 to Time 2 for all the categories of BMI, as follows: Healthy weight ($P = 0.04$), Overweight ($P = 0.02$), Obesity I ($P = 0.01$), Obesity II ($P = 0.01$) and Obesity III ($P = 0.001$; *cf.* Tab. 2).

3.2.4 Level of Physical Activity (LPA)

The analysis revealed a main effect for Time ($F_{(1.245)} = 4.44$, $P = 0.03$, *cf.* Tab. 3), indicating that, overall, LPA scores dropped from before lockdown to during lockdown (*cf.* Fig. 1d). Moreover, the BMI × Time interaction was also significant ($F_{(4.245)} = 2.68$, $P = 0.03$). Paired sample t-tests between Time scores within each group revealed that (i) women with a healthy weight significantly increased their level of physical activity ($P = 0.03$), while (ii) those living with obesity decreased their LPA (Obesity I, $P = 0.04$; Obesity II, $P = 0.02$; Obesity III, $P = 0.006$; *cf.* Tab. 2).

4 Discussion

In France, as in most countries in the world, the SARS-COV-2 pandemic gave rise to an exceptional period of lockdown between March and May 2020. The consequences of this quarantine have been documented in the scientific literature, particularly with regard to perceptions of well-being and quality of life (*e.g.*, see Seckman, 2023 for review with older adults; Ebrahim, Dhahi, Husain, & Jahrami 2022 for review with students), dietary habits (*e.g.*, see Bennett, Young, Butler, & Coe, 2021 for review) and active *vs.* sedentary behavior (*e.g.*, see Mehraeen *et al.*, 2023; Wilke *et al.*, 2022 for reviews). However, these studies on the impact of the lockdown have

Table 3. One-way repeated-measure ANOVA with BMI group as independent variable and Time as the repeated measure.

Independent variables	Dependent measures							
	PWB		PA		NA		LPA	
	F(1.245)	*P*-value	F(1.245)	*P*-value	F(1.245)	*P*-value	F(1.245)	*P*-value
Time	8.95	*0.003*	42.92	*0.0001*	29.02	*0.0001*	4.44	*0.036*
BMI group	1.93	*0.105*	2.07	*0.085*	0.74	*0.562*	5.17	*0.001*
	F(4.245)	*P*-value	F(4.245)	*P*-value	F(4.245)	*P*-value	F(4.245)	*P*-value
Time*BMI group	1.92	*0.107*	1.96	*0.101*	0.26	*0.899*	2.68	*0.032*

PWB: Psychological Well-Being; PA: Positive Affect; NA: Negative affect; LPA: Level of Physical Activity.

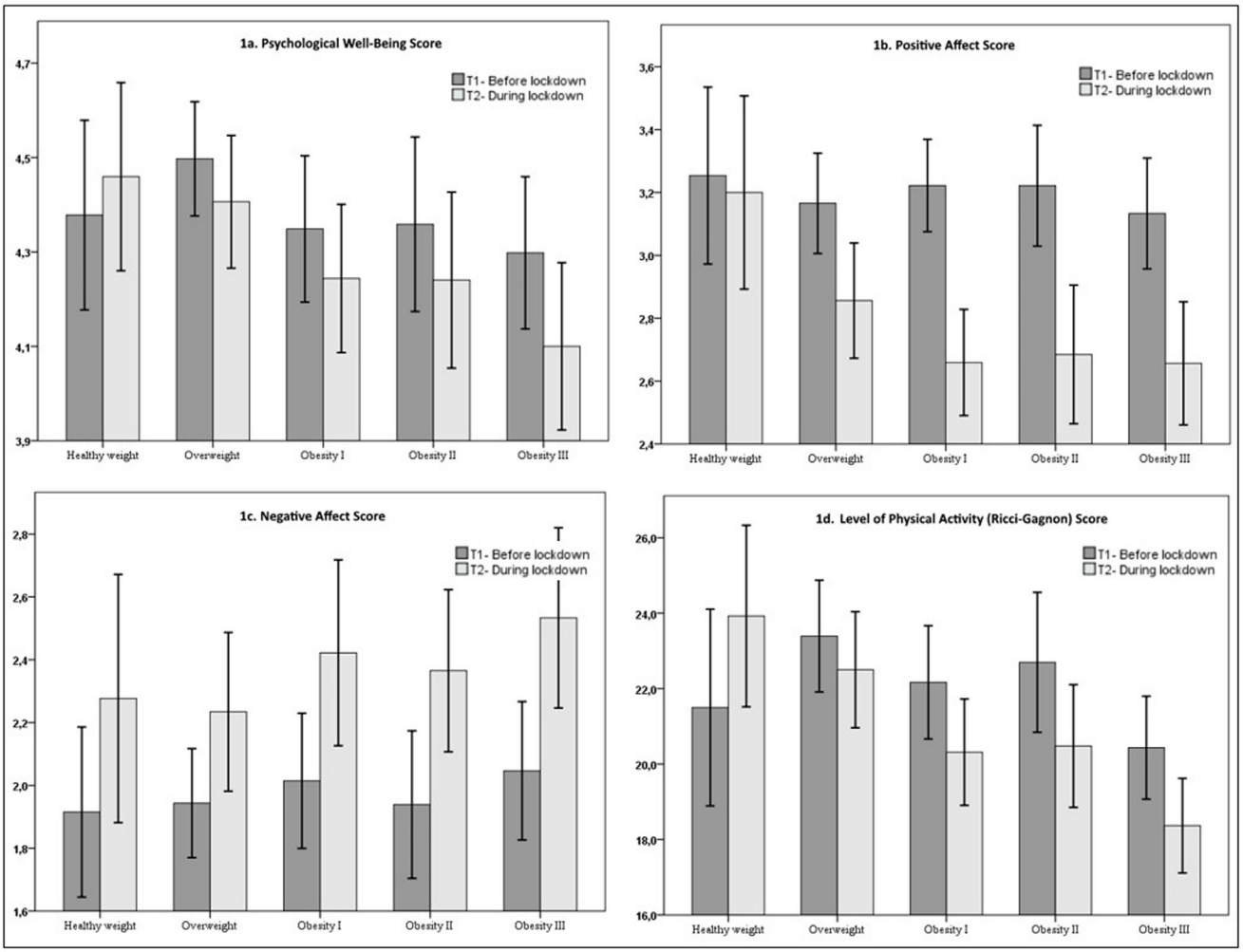

Fig. 1. Evolution of scores before and during lockdown for all dependent variables, based on women's BMI.

scarcely looked into the effect of personal weight on the development of these variables. The aim of this study was to assess the influence of the first lockdown on the well-being, affect, and active behavior of women living with overweight or obesity.

First, the results of our study confirmed the negative effects of the confinement situation. Regardless of their BMI, the women experienced a decreased perception of well-being, a drop in the positive affects felt, and they reduced their level of physical activity. These results can be explained, in particular, by the anxiety-provoking situation linked to the pandemic (*e.g.*, fear of being infected, fear of dying) and the environmental stressors inherent in confinement (*e.g.*, financial insecurity) (Woods *et al.*, 2023), as well as the strict social distancing measures implemented by governments (Chiesa, Antony, Wismar, & Rechel, 2021).

One study focused especially on the effects of the COVID-19 pandemic on chronic diseases (Pérez-Gisbert *et al.*, 2021). In their meta-analysis, these authors showed that physical activity levels during the pandemic were reduced with respect to previous levels of physical activity in patients with chronic diseases. However, in their systematic review, only five studies were analyzed and not one focused on obesity but rather on heart failure, hypertension, or patients with multimorbidity such as cancer, chronic low back pain, or chronic respiratory diseases. Thus, concerning this unprecedented period of pandemic and lockdown, no data were available for people living with overweight or obesity.

In response to this lack of empirical literature, our study focused exclusively on obesity as a chronic disease. The main results reveal that BMI has an effect on all these psychological (well-being and affects) and behavioral (physical activity) variables. Specifically, and to different degrees according to the category of obesity, the levels of psychological well-being (Obesity II and III); positive affect (Overweight, Obesity I, II and III); and physical activity (Obesity I, II and III) fell during the lockdown for the women taking part in the study, while negative affect (Overweight, Obesity I, II and III) rose. In comparison, the well-being and positive affect of women living with healthy weights did not change during the lockdown, while their physical activity increased.

The overall results highlight the extent to which the lockdown was particularly detrimental for women suffering from obesity. A research report for Darwin Nutrition Media published on May 6, 2020[3] states that the lockdown brought about an average weight gain of 2.3 kilos for 58% of French women. However, this weight gain changed according to BMI, since the same survey shows that 71% of women who were suffering from obesity before the lockdown period claimed to have gained weight during it (as opposed to 55% of women with normal weights). Brooks *et al.* (2020) also showed that the first lockdown gave rise to symptoms of anxiety and depression, as well as other negative emotions within the general population. According to Mengin *et al.* (2020), such affect likewise poses the potential risk of the appearance or exacerbation of eating disorders (*e.g.*, dieting, comfort eating, or binge eating). The results of our study confirm those of Brooks *et al.* (2020) and focus, in particular, on the women living with obesity who report, more than others, feeling negative emotions during the lockdown.

Furthermore, the results of our study showed a reduction in active behavior among women living with obesity during the lockdown. These results confirmed those of Pérez-Gisbert *et al.* (2021) concerning patients with chronic diseases and could be explained by a rise in sedentary behavior during lockdown (Cheval *et al.*, 2021; Violant-Holz *et al.*, 2020), an increase in time spent on social media platforms, associated with anxiety symptoms (Lee *et al.*, 2022), and mandatory and non-flexible homeworking (Niu *et al.*, 2021). Another explanation, more specific to people living with obesity, is the closing, throughout France and for the full duration of the lockdown, of all the sports centers, including those offering a specialized program of adapted physical activity. For example, Virmasalo *et al.* (2023) showed that indoor sports restrictions had a negative impact on physical activity levels, especially among women. The latter did not (or could not) change their habits to use outdoor environments. Consequently, the authors concluded that this population's decrease in physical activity was mainly explained by the decrease in indoor sport.

5 Limitations

This study has several limitations. The main one lies in the fact that the participants were asked retrospectively about their pre-lockdown perceptions. Due to the unexpected situation of lockdown and its sudden implementation, we were unable to administrate the questionnaire at the very beginning of the lockdown period. Although the method had been used in previous studies (*e.g.*, Ammar *et al.*, 2020; Cheval *et al.*, 2021), it might have resulted in recall bias, with possibly varying recall bias depending on the participant's BMI. This calls for caution when interpreting the results. Secondly, our study is one of the research studies collecting information on the levels of physical activity during the COVID-19 lockdown (see Violant-Holz *et al.*, 2020 for review). However, the data on physical activity was self-reported in this case. The validity of such a measurement depends on an individual's ability to provide accurate information on their actual level of physical activity, failing which the data may be over- or under-estimated (Van Hoye, Nicaise, & Sarrazin, 2014). The same applies to the self-reported measurements of the participants' weight. Shiely, Hayes, Perry, & Kelleher (2013) highlighted a self-reporting

[3] Ifop report for Darwin – Nutrition (2020). Quel est l'impact du confinement sur le poids et les habitudes alimentaires des Français ? https://mk0darwinnutrit3vtub.kinstacdn.com/wp-content/uploads/2020/05/Rapport_Ifop_Darwin-Nutrition.pdf.

height and weight bias, revealing that individuals living with obesity tend to understate their weight when self-reporting. Third, there is a limitation related to the use of the Ricci-Gagnon self-questionnaire, which has not yet been validated. This lack of validation makes it difficult to compare or generalize our results to other studies using different self-reported measures of physical activity. Nevertheless, Pavy, Tisseau, & Caillon (2011) demonstrated a significant correlation between the self-reported Ricci–Gagnon global score and validated objective measures of physical activity. Fourth, no data were requested on the type of daily mobility or occupational activity before lockdown. Therefore, it is not possible to know whether the decrease in the level of physical activity, particularly in women suffering from obesity, was the consequence of the lack of access to specialized facilities or the more direct effect of the period of confinement on the termination or modification (*e.g.*, teleworking) of professional activities for example. Fifth, no information about the participants' weight was requested at Time 1 (*i.e.*, before lockdown). It was therefore not possible to analyze the evolution of BMI resulting from this first period of lockdown, or the potential consequences on the level of physical activity and/or self-perception of well-being. Lastly, questionnaires were administered *via* social networks (Weight Watchers Facebook page and Twitter page in particular), and organizations or associations working in the field of obesity and weight management (*e.g.*, Obésité Bretagne Nord, Obésité Bretagne Sud, FED-MIND®, etc.). These associations, and more especially Weight Watchers, are not exclusively intended for individuals with overweight or obesity issues. Thus, women with a healthy weight, who simply wish to lose a few pounds, can also sign up on these weight management platforms. In addition, it is not uncommon for overweight people who have managed to lose their extra pounds to remain members of these associations and to continue following the recommendations and activities they offer. Nevertheless, healthy weight women are under-represented in such programs or associations, which is also the case in our sample. We must therefore be cautious about the results of the present study.

6 Conclusions

This research reveals significant decreases in psychological well-being, positive affect, and level of physical activity, particularly among women living with obesity during the first lockdown in France, from March 17 to May 11, 2020. Since the end of the third lockdown in the country, in May 2021, it is still unclear whether those suffering from obesity have resumed physical activity and, if so, how frequently. Future studies seem necessary to measure whether the decrease in the observed variables of the present study was temporary with a short-term effect due to the confinement or more long-lasting. Considering that the COVID-19 pandemic may last a long time and that there is a potential risk of new pandemics, many researchers (*e.g.*, Laddu, Lavie, Phillips, & Arena, 2021; Sallis *et al.*, 2021; Violant-Holz *et al.*, 2020) advocate regular physical activity due to its immune-supporting role. Obesity and COVID-19 are closely related. It was noted that the lockdown caused weight gain (Pietrabissa *et al.*, 2021) and exposed those living with obesity to a greater risk of additional weight gain due to the deterioration of healthy eating habits and worsening eating disorders (Mengin *et al.*, 2020). This situation is so serious that research has referred to it as a "fatal shock between two pandemics" (Scheen, 2020) or "covibesity" (Khan & Moverley Smith, 2020).

Conflicts of interest

The authors declare that there is no conflict of interest.

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Ethical approval

All procedures performed in this study were in accordance with the 1964 Helsinki Declaration and its later amendments, or comparable ethical standards.

Scientific workshop

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