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Physical activity, dietary habits and sleep quality before and during COVID-19 lockdown: A longitudinal study

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ABSTRACT

The COVID-19 pandemic has forced the health public authorities to impose a lockdown as an epidemiological containment strategy. This study aimed to provide information regarding the impact of the mandatory confinement on the physical activity, eating disorders risk, sleep quality and well-being on a Spanish sample. An online survey that included the Minnesota Leisure Time Physical Activity Questionnaire, the Eating Attitude Test-26, and Pittsburgh Sleep Quality Index was administered two days after the state of alarm was stablished in Spain and five days after such measures began to be eased. Out of the 693 people who answered the first questionnaire, 161 completed the second one. These participants spent a total of 48 days locked at home, a period during which a significant worsening in all the variables assessed except for the risk of developing eating disorders, was observed: weight (kg), 67.3 ± 14.8 vs 67.7 ± 15.1, $p = 0.012$; physical activity (MET minutes per week), 8515.7 ± 10260.0 vs 5053.5 ± 5502.0, $p < 0.001$; sleep problems (total score), 6.2 ± 3.5 vs 7.2 ± 3.9, $p < 0.001$; self-perceived well-being (score), 4 (3–4) vs 3 (3–4), $p < 0.001$. The confinement had a significant differential effect on physically active participants, who experienced a significant decline ($p < 0.05$) on their physical activity levels, quality of sleep and well-being; whereas physically inactive participants did not experience significant changes. Findings from this longitudinal study indicate that a lockdown period due to COVID-19 had a negative impact on the physical activity levels, sleep quality and well-being in a group of physically active Spanish adults. Public health authorities should be aware that people who usually lead an active lifestyle, might be particularly susceptible to such disruptions.

1. Introduction

The COVID-19 pandemic has forced public health authorities to impose lockdown measures as an epidemiological containment strategy. This mandatory self-isolation may affect people's physical and mental health, and therefore have a strong negative impact on healthy lifestyle behaviors (Balanzá–Martínez et al., 2020). For instance, prolonged home stay may lead to increased sedentary behaviors due to a decrease on the amount of daily physical activity (PA) performed (Chen et al., 2020). Similarly, it has been suggested that due to this period of abruptly reduced PA, changes in eating attitudes, such as overeating, will start to emerge (Martinez-Ferran et al., 2020), putting people at risk for developing or exhibiting an eating disorder. This lack of PA due to home confinement has also been considered to be a potential risk factor that negatively affects sleep quality (Cellini et al., 2020).

Continuous surveillance of the consequences that the lockdown has on healthy habits should become a routine, as part of preparedness efforts worldwide (Huang & Zhao, 2020). However, information on the

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real impact of the confinement on PA is lacking, since the existing body of knowledge so far comes from opinion articles and theoretical manuscripts. Similarly, although studies regarding the effect of the lockdown on nutrition and sleep quality are starting to appear, most of them have a cross-sectional design (Huang & Zhao, 2020; Scarmozzino & Visioli, 2020; Xiao et al., 2020), and scant research has been published comparing the PA levels, prevalence of eating disorders and sleep quality reported before the confinement and also during this period. This lack of studies makes it difficult to determine the actual impact such isolation measures made on the aforementioned healthy habits.

From an epidemiological point of view, it is important to identify how healthy habits are modified through a period of restrictions, and to determine the consequences of such changes on peoples' health too. For instance, it has been suggested that limiting the possibilities of performing PA might not be an optimal approach when trying to delay or helping to stop a pandemic's spread (Amekran & El Hangouche, 2020). Thus, scientific evidence regarding the consequences of imposing a very restrictive confinement on health status should be provided to politicians and health policy makers. Making available this information would allow governments to develop more accurate public health promotion strategies (i.e., recommendations for lifestyle modifications) during the COVID-19 pandemic, as well as to anticipate major consequences derived from this situation.

Spain became a COVID-19 hotspot; therefore, in order to reduce the spread of the infections, the Spanish Government issued a state of emergency on March 24 and imposed a severe lockdown period to Spanish citizens, during which they were only allowed to leave home for buying food, seeking medical attention or going to work, excluding essential workers in hospitals, supermarkets, the Army, mass-media, etc. This situation created a context of extreme self-isolation in which it was possible to register information regarding the prevalence of healthy habits before the confinement started and right after the easing of those restrictions began. The goal of this study is to show the impact that the lockdown period had on the PA levels, eating disorders and sleep quality with respect to a sample of Spanish individuals due to COVID-19.

2. Methods

2.1. Design

A pre and post lockdown longitudinal observational study was carried out, following the STROBE guidelines for cohort studies (von Elm et al., 2008).

2.2. Participants

We selected a convenience sample of people older than 18 years old who were either students at the four universities collaborating in this investigation or were part of the virtual networks of the authors of this study. Those participants who were living abroad during the quarantine were excluded from the study. Respondents did not receive any reward for taking part in the research. Written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki.

2.3. Procedure

Participants completed an anonymous online survey realized through Google Forms web survey platform. A personal invitation e-mail including the link to the web survey was sent via official channels of the involved universities. Besides, the survey was communicated through the social media (Facebook, LinkedIn and Twitter) and it was also shared to personal contacts of the researchers. The survey was hosted on the Google platform for a limited time window twice: two days after the state of emergency was issued (allotted time to submit questionnaire between March 16 and March 31, 2020), and five days after such measures began to be eased (between April 30 and May 11, 2020).

2.4. Measures

2.4.1. Sociodemographic characteristics

Participants provided information regarding sex, age, height, weight, occupation, marital status, as well as place of residence and number of people in the household during the confinement.

2.4.2. Physical activity levels

The effect of the confinement on the amount of PA usually performed by the participants in a typical week before the state of emergency was established and contrasted with that during a usual week during the confinement, as assessed by means of the Spanish version of the Minnesota Leisure Time PA Questionnaire (MLTPAQ) (Elosua et al., 1994). The respondents' total energy expenditure was estimated in metabolic equivalents of task performed in minutes per week (MET-min·wk^{-1}). For the purpose of this study, a cut-off point of 2100 MET-min·wk^{-1} was chosen to identify individuals who were either physically active or physically inactive, following previous procedures used with Spanish adult population (Sobejano Tornos et al., 2009).

2.4.3. Eating disorders

The impact of the confinement on eating disorders was assessed by means of the Spanish version of the Eating Attitude Test-26 (EAT-26) (Rivas et al., 2010). The test includes 26 items related to bulimia, dieting and oral control, with a summative score ranging from 0 to 78. A cut-off at 20 was used to determine eating disorder cases from no-cases.

2.4.4. Sleep quality

Changes on sleep quality due to the confinement were identified through the Spanish version of the 18-item Pittsburgh Sleep Quality Index (PSQI) (Royuela Rico & Macías Fernández, 1997). The PSQI scores ranges from 0 to 21, with higher scores indicating worse sleep quality. Those participants who scored above a cut-off of 5 were classified as "poor sleepers".

2.4.5. Self-perceived well-being

The participants were asked a closed question to indicate how they felt before and during the confinement, to which they responded on a Likert scale from one ("Bad") to five ("Great").

2.5. Statistical analysis

The hypotheses were specified before the data were collected. The analytic plan was pre-specified and any data-driven analyses are clearly identified and discussed appropriately. Descriptive statistics were used to know the sample characteristics: mean and standard deviation, percentage or mean and interquartile range (IQR). The independent-samples *t*-test and the Mann-Whitney *U* test were used in order to explore the dropout rates by calculating the differences between non-completers (those who only answered the online survey during the first time window) and completers (participants who completed the online survey during both time windows). The proportion of participants classified as physically inactive, being at risk of eating disorders and poor sleepers was calculated before and during the lockdown and the Wilcoxon signed-rank test (Z) was used to identify the significance of this change. The evaluation of normality was performed by means of the Kolmogorov-Smirnov and Shapiro-Wilk tests and homoscedasticity by the Levenne test (Atkinson & Nevill, 1998) in order to check the statistical assumptions. The paired-samples *t*-test and the Wilcoxon signed-rank test for the whole sample and for physically active and physically inactive groups separately were used to know the impact of lockdown within a group. The independent-samples *t*-test and the Mann-Whitney *U* test were applied to calculate the differences between physically active and physically inactive participants before and during

lockdown. For each of the main dependent variables (physical activity, eating disorder risk, sleep problems and self-perceived well-being), a repeated measures ANOVA (F) with two factors, within-subjects (time: before and during lockdown values for each dependent variable) and across-subjects (PA status: physically active and physically inactive), was calculated to explore the differential impact of lockdown in physically active and physically inactive participants. In order to estimate the effect size of lockdown, partial eta squared values (η^2_p) were used (0.01, small effect size; 0.06, medium effect size; 0.14, large effect size) (Ferguson, 2009). The change due to lockdown (difference from before to during lockdown) related to sociodemographic characteristics was explored by means of an independent-samples *t*-test for sex, Pearson correlation r-test for age, Spearman ρ correlation for the participants at home ordinal variable and a one-way ANOVA for occupation and marital status. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc. Version 25.0, Chicago, IL). Significance level was set at $p < 0.05$ for all the analyses.

3. Results

3.1. Sample characteristics at baseline

Out of the 693 participants who answered the first questionnaire, 161 (age: mean 35.0 ± 11.2, range 19–65 years old; 37% female; BMI: 23.7 ± 4) completed the second one Participants who completed the online survey during both time windows (n = 161) were compared to those who only answered to the online survey during the first time window (n = 523) in order to analyze potential bias, and no significant differences between groups were recorded for physical activity performed ($t = 1.47$, $p = 0.142$), eating disorder risk ($t = 1.30$, $p = 0.194$), sleep problems ($t = -0.13$, $p = 0.987$), weight ($t = 1.35$, $p = 0.178$) and self-perceived well-being ($U = 42018.0$, $p = 0.594$). The study sample was mostly made up of university students (73.9%). The participants spent a total of 48 days isolated at home and the time between questionnaires responses was 29.4 ± 4.9 days. A median of three persons (IQR: 2–4) lived at home during the lockdown. The marital status was distributed as follows: 37.3% single, 25.5% married, 35.4% partnership, and 1.9% divorced.

3.2. COVID-19 lockdown impact on healthy habits

The impact of the lockdown on the participants' healthy habits are shown in Table 1. All the variables assessed showed significant worsening, except for the risk of developing eating disorders.

The proportion of participants classified as physically inactive, as well as those suffering from eating and sleep disorders before and during lockdown can be seen in Fig. 1. At baseline, a considerable proportion of participants in the sample were active and had sleep problems, while the prevalence of eating disorders was very low. The number of participants considered physically inactive and presenting sleep problems increased from baseline into the lockdown (Table 2).

Table 1
Effect of COVID-19 lockdown on weight, physical activity, risk of eating disorders, sleep problems and self-perceived well-being. Values before and during lockdown are shown as means ± SD and mean (IQR).

	Before lockdown (*n* = 161)	During lockdown (*n* = 161)	Student *t*	
			t	p
Weight, *kg*	67.3 ± 14.8*	67.7 ± 15.1	−2.55	0.012
Physical activity, *MMW*	8515.7 ± 10260.0*	5053.5 ± 5502.0	4.37	<0.001
Eating disorder risk, *total score*	7.5 ± 7.9	7.2 ± 8.2	1.61	0.109
Sleep problems, *total score*†	6.2 ± 3.5*	7.2 ± 3.9	−4.09	<0.001
Self-perceived well-being, *score*	4 (3–4)*	3 (3–4)	−6.53	<0.001

Note. MMW, MET minutes per week. * significant values favouring before lockdown versus during lockdown. † a higher score indicates a poorer sleep quality.

3.3. Differential effects of lockdown among physically active and inactive participants

The confinement had a significant differential effect on physically active and physically inactive participants. Before lockdown, significant differences regarding PA and self-perceived well-being were observed in favour of those classified as physically active. The comparison with lockdown values showed significant worsening on both variables as well as on the participants' sleep quality. Those included in the physically inactive group did not experience any significant change in the assessed variables. In the physically active group, a significant reduction for developing eating disorders was found, while PA performed, sleep problems and self-perceived well-being exhibited a significant worsening. Changes in healthy habits taking into account PA levels can be seen in Fig. 2. Repeated measures ANOVA showed a main effect for time (before and during lockdown) in self-perceived well-being ($F = 12.90$, $p < 0.001$), and for PA status (physically active and physically inactive) in physical activity ($F = 16.78$, $p < 0.001$). Significant interactions were found between PA status before lockdown and the change in physical activity ($F = 4.92$, $p = 0.028$, $\eta^2_p = 0.031$), eating disorder risk ($F = 6.83$, $p = 0.010$, $\eta^2_p = 0.041$), sleep problems ($F = 4.21$, $p = 0.042$, $\eta^2_p = 0.026$) and self-perceived well-being ($F = 5.23$, $p = 0.024$, $\eta^2_p = 0.032$). All the reported partial eta squared values (η^2_p) were classified between small and medium effect sizes.

Sociodemographic characteristics did not seem to have an effect on the observed impact of the COVID-19 lockdown, except for the variable referring to the number of people in the household during the confinement. The statistical analysis showed that the greater the number of people in the participants' household during confinement, the greater the weight gain was ($\rho = 0.217$, $p = 0.006$); additionally, a larger decline in self-perceived well-being was attested for participants in more populated households ($\rho = -0{,}183$, $p = 0.020$).

4. Discussion

To the authors' knowledge, this is the first longitudinal study that provides information regarding the impact of the COVID-19 lockdown on weight, PA, dietary habits, sleep quality and self-perceived well-being on a confined population. The results shown here could be helpful for anticipating lifestyle changes during rapid outbreaks of highly infectious diseases which will force the imposition of strict confinement.

Our sample was predominantly active, sleep problems were frequently present and the risk of developing eating disorders was low. These results could be due to the characteristics of the sample, mostly made up of university students. Indeed, other studies carried out in Spanish university students have reported a remarkable prevalence of sleep disfunctions (around 50%) (Núñez et al., 2019) and a low prevalence (around 6%) of eating disorders (Lameiras Fernández et al., 2002). Regarding PA levels, we also found participants who showed a sedentary lifestyle, confirming previous results indicating that university students may be both highly active or highly sedentary (Peterson et al., 2018).

The findings from the online survey confirmed that the lockdown had a negative impact on almost all the assessed variables, as it was initially expected. Being confined at home imposed a structural barrier to maintaining a physically active lifestyle, as previously hypothesised (Heffernan & Young Jae, 2020), while the combination of anxiety and stress triggered by the COVID-19 pandemic could be responsible for the observed reduction on sleep quality (Xiao et al., 2020). Self-perceived well-being could have been negatively affected by both factors.

No increased risk of developing eating disorders was found in the

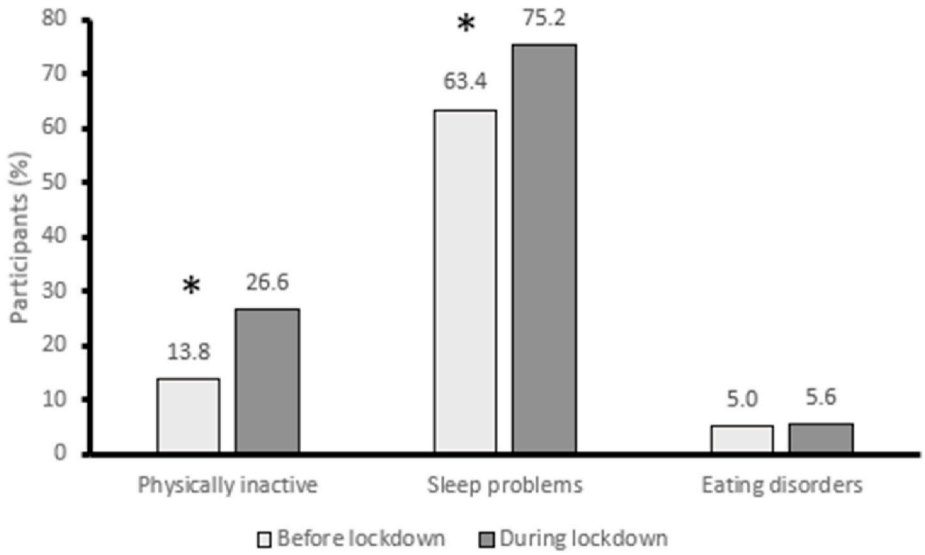

Fig. 1. Proportion of participants that were considered to be physically inactive, present sleep problems, or have eating disorders before and during lockdown.

Table 2
Number of participants that were considered to be physically inactive versus physically active, having versus not having eating disorders, presenting versus not presenting sleep problems. Values before and during lockdown are shown as *n* of total sample.

	Before lockdown (*n* = 161)	**During lockdown (*n* = 161)**	Wilcoxon signed-rank test	
			Z	*p*
Physically inactive/ active, *n*	23/138*	43/118	−3.420	0.001
Eating disorder risk/not, *n*	8/153	9/152	−0.557	0.564
Sleep problems/ not, *n*	102/59*	121/40	−3.413	0.001

Note. * significant values favouring before lockdown versus during lockdown.

present study, probably due to their low prevalence, since it has been speculated that those who already showed eating disorders beforehand are the ones that are particularly at risk of being affected by the lockdown (Touyz et al., 2020). Nevertheless, we observed a significant albeit small, increase in the participants' body weight, which could be due to reductions in PA levels or even to modifications on dietary habits. The lack of research on the impact of the pandemic on lifestyle changes, especially regarding PA and dietary habits, limits the possibility to elaborate a more comparative discussion.

One interesting finding of the present study is the fact that the lockdown had a significantly greater impact on those participants who were leading an active lifestyle before the confinement. When comparing data obtained at baseline and once the restrictions began to be eased, physically active participants experienced significant reductions not only in the amount of PA performed, but also on their sleep quality and their self-perceived well-being. On the other hand, no significant changes were observed in the physically inactive group. It is widely known that performing PA has a positive impact on both sleep quality and general well-being (Wunsch et al., 2017). Additionally, our results indicate that extreme and sudden reductions on the amount of PA performed have a negative impact on both factors. Nevertheless, it should be pointed out that active participants managed to significantly reduce the risk of developing an eating disorder. It could be hypothesised that they could have taken more care of their dietary habits as a strategy to avoid excessive weight gain, resulting from the decrease in the amount of PA they performed. Altogether, our data suggest that home confinement has a more severe impact on physically active participants and stress the idea that PA levels should be maintained in times of high stress, in order to prevent negative effects on sleep quality and self-perceived well-being. This interesting finding should be interpreted with caution, due to the reduced number of participants classified as physically inactive. Thus, there is a need for further research to confirm these results.

According to our analysis, the number of people in the household during the confinement also played an important role on weight control and self-perceived well-being. We found that the more people living together, the greater the weight gain and the greater the impact of confinement on self-perceived well-being. These unexpected lockdown consequences are worth mentioning, since it is generally assumed that people who eat alone are more likely to be overweight (Boles & Gunnarsdottir, 2015; Rah et al., 2019), and that living alone leads to a worse sense of well-being.

The main strength of this investigation lies on its novel findings, obtained through a longitudinal design. In spite of this, it should be noted that we obtained a very low response rate when the online survey was administered for the second time, which considerably reduced the final sample size of the present research. Several reasons could help to explain this high dropout rate. To begin with, the first online survey was sent very quickly, just after the state of emergency was issued and no study of this kind had been conducted yet. However, a number of investigations using similar online surveys and targeting the same population began to show up two or three weeks later in our country. Thus, it could be hypothesised that participants in our study received a fair number of online surveys and refused to answer the same questions again. Additionally, it should also be considered that the first online survey was sent when people were confined; therefore, they had plenty of time to fulfil it. On the contrary, when they were asked to answer the online survey for the second time, the first relief measures in response to the lockdown situation had been established, so it is plausible to think that most of the participants devoted their increasing free time to other activities. Furthermore, we informed participants that our intention was to compare baseline data with the same information collected during lockdown, but we did not specifically remind them that they would be asked to fulfil the online survey twice. Moreover, we did not precontact them before sending the online survey for the second time, a fact that could contribute to the low response rate (Liu & Wronski, 2018). Finally, it is worth mentioning that the online survey was long and exhaustive and some of the questions were not easy to answer, specifically those related to the amount of PA performed that appeared at the beginning of

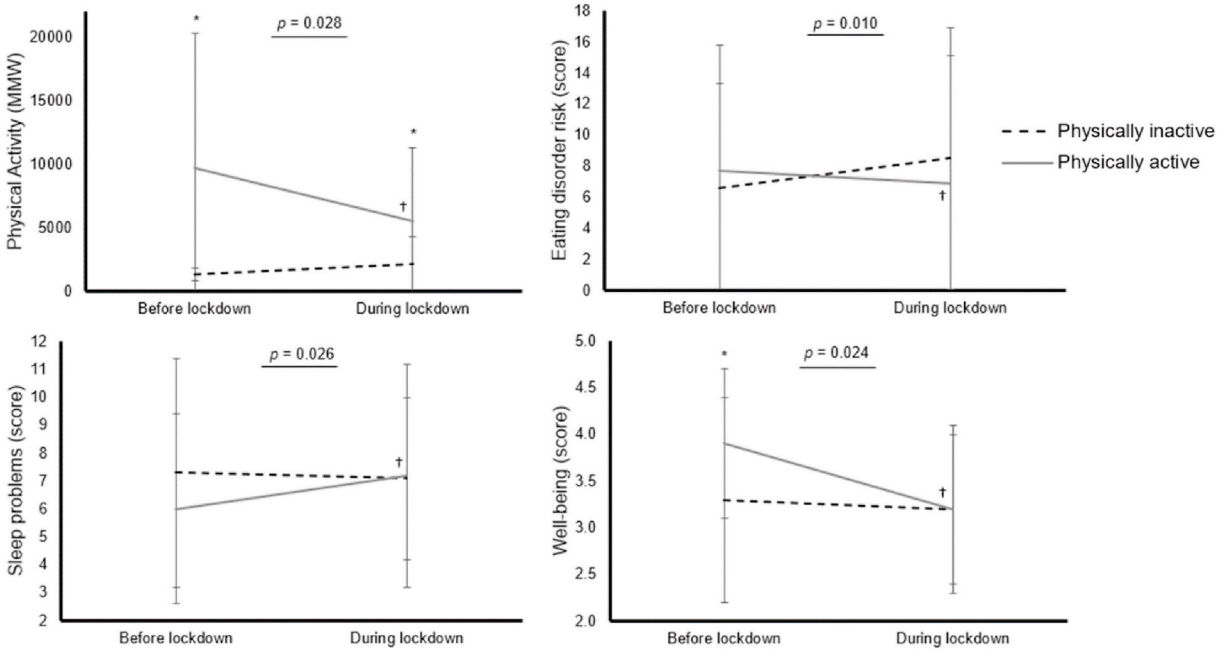

Fig. 2. Changes due to COVID-19 lockdown in physical activity (MMW, MET minutes per week), eating disorder risk, sleep problems and self-perceived well-being among active (n = 138) and inactive (n = 23) participants.

the online survey, which might have negatively affected the response rate (Van der Lei et al., 2007). Indeed, a negative relationship between completion rate and survey length as well as question difficulty has been observed in previous studies using online surveys (Liu Liu & Wronski, 2018). There are also a number of methodological weaknesses that should be acknowledged. First of all, the sample was small, as it has been previously mentioned, and mostly made up of university students, which limits the generalization of the results. Secondly, the data were obtained by means of a web-based survey. Although participants responded within a few days of being surveyed, the existence of a recall bias cannot be ruled out. Furthermore, we used a repeated measures ANOVA to assess the time (before-during) x group (active-inactive) interaction on the self-perceived wellbeing (ordinal variable), which is a 5-point Likert scale that diverges from normality. In any case, we calculated intra- and between-group differences of this outcome measure in the study groups by means of non-parametric tests. Finally, body weight was self-assessed and self-perceived well-being data were gathered by means of an *ad hoc* questionnaire. Thus, information related to both variables should be interpreted with caution.

5. Conclusion

Findings from this longitudinal study indicate that a lockdown period due to COVID-19 had a negative impact on the physical activity levels and sleep quality on a group of Spanish adults, while body weight and self-perceived well-being were also adversely affected. Our findings indicate that people who usually lead an active lifestyle, are particularly susceptible to such disruptions. Public health authorities should be aware that reducing the possibilities or performing PA during a quarantine might have negative consequences on the health status of the population.

Author note

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Declaration of competing interest

The authors also declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical statement

This article originates from researchers of four Spanish universities. The study followed all the research standards required by all institutions. The study was conducted in accordance with the Declaration of Helsinki. The informed consent was obtained from all individual participants included in the study, and data confidentiality was guaranteed.

CRediT authorship contribution statement

Óscar Martínez-de-Quel: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **David Suárez-Iglesias:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Marcos López-Flores:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - review & editing. **Carlos Ayán Pérez:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing.

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