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An alternative approach to acute respiratory illness through a sex-based analysis, psychosocial attitudes, mood, and self-perceived health

Raquel Sánchez-Recio[1,2], Juan A. Parrilla-Huertas[3], Antonio Sebastián-Ariño[4], Marcos Zuil[5], José María Llorente[6], Ángela Asensio-Martínez[2,7*] and María Zúñiga-Antón[2,3]

*Correspondence:
Ángela Asensio-Martínez
acasensi@unizar.es

Full list of author information is available at the end of the article

Abstract

Aim To examine the role of psychosocial attitudes in the relationship between mood and self-rated health by sex during COVID-19 pandemic.

Methodology A cross-sectional design was used with data from residents of Zaragoza (Spain) aged 16 years and older, collected during the initial lockdown (Phase I) and 20 months later (Phase II). Mediation analyses were conducted using three regression models to assess the role of psychosocial attitudes.

Results Psychosocial attitudes explained 30–55% of the variance in the relationship between mood and self-rated health in both sexes. Significant direct effects of mood on self-rated health were found in men and women (Phase I: β_{men}: 0.293, $p < .001$; β_{women}: 0.226, $p < .001$; Phase II: β_{men}: 0.266, $p < .001$; β_women = 0.292, $p < .001$), as well as significant effects of psychosocial attitudes (Phase I: β_{men}: 0.054, $p < .001$; β_{women}: 0.052, $p < .001$; Phase II: $\beta_{men} = 0.042$, $p < .001$; β_{women}: 0.049, $p < .001$). Indirect effects of mood through psychosocial attitudes were also significant (Phase I: β_{men}: 0.224; β_{women}: 0.273; Phase II: β_{men}: 0.163, $p < .001$; β_{women}: 0.193, $p < .001$). Women consistently reported worse moods and lower self-rated health than men across both phases.

Conclusion Promoting healthy behaviours is essential, particularly for women and other vulnerable groups, to reduce health disparities and support public health.

Keywords Psychosocial attitudes, Respiratory illness, Pandemic, Self-perceived health, Mood, Sex differences

1 Introduction

The first coronavirus respiratory syndrome diagnosis (SARS-CoV-2) was reported in December 2019. To reduce COVID-19 transmission and alleviate pressure on health-care systems, a range of public health measures were implemented worldwide. One measure adopted globally was the isolation of the population at home. Despite the positive

impact of confinement in reducing infection rates, previous pandemics demonstrated its negative effects on mental health [1].

The onset of this pandemic isolation had some peculiar aspects to consider, including too much free time, boredom and continuous exposure to news about the consequences of COVID-19. All this may have had certain consequences on the state of mind and the level of daily stress that people had to face. Several people developed unhealthy behaviours, including poor-quality diets, lack of physical activity, tobacco and alcohol use, excessive smartphone use and compulsive scrolling on digital platforms, which have been associated with mood disturbances such as depressive symptoms, as well as changes in lifestyle habits such as eating behaviours, medication use, and online gambling [2, 3]. Previous research has demonstrated that unhealthy behaviours and psychosocial attitudes directly influence health-related quality of life, including self-rated health and the ability to adapt to changing environments [4].

In addition, sex differences in health perceptions, behaviours, and psychosocial attitudes are well documented. Women consistently report poorer self-perceived health than men, a difference partly explained by factors such as educational level, functional limitations, and higher self-reported morbidity [5]. In contrast, men are more likely to engage in unhealthy behaviours such as smoking and alcohol consumption, whereas women more frequently adopt restrictive dietary practices, including avoidance of certain foods due to perceived health risks [6]. Women also tend to express greater concern about diet and health and place a higher value on maintaining a healthy lifestyle than men [6].

Psychosocial factors further contribute to these sex-related differences in health outcomes. Women generally experience higher levels of distress and being more affected by depression and loneliness, which strongly influence their health perceptions [7]. Men, on the other hand, are often influenced by traditional masculine norms that discourage help-seeking behaviours and may promote riskier health practices, including lower engagement in preventive healthcare and higher tobacco and alcohol use [8].

Furthermore, these unhealthy behaviours could be a driving force for common mental disorders such as stress, anxiety, depression and poorer self-perception of health and mood, and be associated with a higher global burden of disease and worse outcomes in psychiatric disorders [4, 9]. Those people with a low and/or fatalistic mood could develop worse lifestyles and have a worse self-concept of their health [10]. Although mood and self-rated health are both subjective constructs, they represent conceptually distinct dimensions. Mood refers primarily to a person's affective or emotional state at a given time, whereas self-rated health is a broader cognitive appraisal of one's overall health status, integrating physical, psychological, and functional aspects [11]. Self-rated health has consistently been recognized as a multidimensional indicator associated with morbidity and mortality, beyond transient emotional states.

Self-rated health is not only influenced by individual characteristics but also by the broader contextual and social framework. A six-year longitudinal study conducted in Canada identified community belonging and food insecurity as mediators in the relationship between mood and anxiety disorders and self-rated health [12]. Particularly in the COVID-19 lockdown, significant gender differences emerged in health behaviors, self-perceived health, and psychosocial attitudes. Women reported a greater adverse impact on health behaviors than men, engaging in fewer healthy lifestyle practices and

experiencing a more pronounced decline in physical activity, diet adherence, and sleep quality; and women were more likely to perceive a deterioration in their overall health status during the pandemic [13, 14]. In terms of mental health, women exhibited higher rates of depressive symptoms and disorders, whereas men reported more anxiety-related symptoms [15–17]. During periods of crisis such as the COVID-19 pandemic, affective states may influence behavioral and psychosocial responses, including sleep patterns, energy levels, anxiety manifestations, and health-related routines [18, 19]. These responses may, in turn, shape how individuals cognitively evaluate their overall health. From this perspective, psychosocial attitudes can be understood as intermediate mechanisms through which emotional states are associated with broader self-perceptions of health [20].

In this study, the term "psychosocial attitudes" is used in an operational sense to refer to a cluster of behavioral and affective responses reported during lockdown, including sleep disturbances, fatigue, anxiety-related symptoms, and somatic complaints. Although these components reflect related dimensions of psychosocial strain rather than a single latent psychological trait, they collectively capture individuals' adaptive or maladaptive responses to the crisis context. Few studies have examined the mediating role of psychosocial attitudes in the relationship between mood and self-rated health from a sex-based perspective during a large-scale public health crisis. Understanding these pathways is essential for integrating sex-specific determinants into public health strategies aimed at promoting healthier behaviours and reducing health inequalities during times of crisis.

1.1 Aim

The primary outcome was to analyse, based on sex, the relationships among a criterion variable (mood), a mediating variable (psychosocial attitudes), certain covariables (age, educational level, income, household size, number of persons in the household and chronic disease) and the self-rated health in the adult population.

Secondary outcomes were to study the behaviour of mood, self-rated health, psychosocial attitudes and the previously cited covariables depending on the moment of the pandemic and sex.

2 Methodology

This study utilized a repeated cross-sectional design, based on two independent population surveys conducted at different time points during the COVID-19 pandemic, to analyze data from residents of Zaragoza aged 16 years and older. The anonymized data were derived from two surveys, conducted at different points in the pandemic, both by the Zaragoza City Council [21].

The samples included in Phase I and Phase II were independent, and no longitudinal follow-up of participants was conducted. In Phase I of the study, data from Survey I, entitled "Living conditions, needs, and expectations during lockdown due to the COVID-19 pandemic," were used. This survey was conducted in April 2020 during the initial wave of the pandemic, coinciding with the strict lockdown measures in Spain (from March 14 to June 21, 2020). Survey I collected the concerns and aspirations of Zaragoza residents during the critical period of home confinement from March to May 2020.

Phase II was conductedapproximately 20 months later, from November 15 to December 15, 2021. Data from Survey II, entitled "Living conditions, needs, and expectations after 20 months of the COVID-19 pandemic" [21], were used. Survey II aimed to assess the concerns and expectations of city residents after 20 months of living with the pandemic without lockdown.

Both surveys were self-administered questionnaires conducted without interviewer participation and disseminated primarily through online channels supported by digital marketing strategies [21]. As the surveys were administered online, this mode of data collection may have limited the participation of older adults with reduced access to or familiarity with digital technologies; therefore, a potential underrepresentation of elderly participants should be considered when interpreting the findings [22].

Both surveys consisted of 52 questions organized into five thematic sections: (1) Personal situation, including household and family finances; (2) Mood and health; (3) Activities and attitudes during the pandemic; (4) Post-pandemic perspectives; and (5) Evaluation of the services provided by the City Council and other public administrations. Participants were recruited using a snowball sampling method supported by digital marketing strategies [21]. This non-probabilistic sampling approach may limit population representativeness and the generalizability of the findings, and the results should therefore be interpreted with caution [23].

2.1 Variables

The main variables of this study based on sex were self-perceived health as a result variable, mood as a criterion variable, and psychosocial attitudes as a mediating variable. Online resource 1 shows the description of the variables used in the study and the different survey questions used for this study.

The outcome variable, self-rated health, was obtained through the question "How is your health" with 5 answer options: 1 (Very bad), 2 (bad), 3 (regular), 4 (good) and 5 (Very good).

The criterion variable, mood, was obtained from the question "How do you feel about yourself before and during lockdown by COVID-19? with 5 answer options: 1 (Very bad), 2 (bad), 3 (regular), 4 (good) and 5 (Very good).

The mediating variable, psychosocial attitudes, was obtained through a synthetic index calculated as the sum of the answers obtained by asking whether during lockdown the individuals had suffered from "insomnia", "lack of appetite", "tiredness", "anxiety", "irritability", "gastric problems" and "concentration problems", where the lowest value obtained was 7 (appropriate psychosocial attitudes) and the highest was 35 (all the above are bad). To validate the index obtained, a scale reliability analysis of the variables used was carried out based on the exploratory factorial analysis by minimum squares that determined a single factor that explained 55.6% of the variance. Bartlett's KMO and sphericity test gave a result of 0.886 ($p < .001$) and presented a Cronbach's Alpha of 0.866 [24].

Finally, the following sociodemographic variables were considered as covariables: Age was recorded in three groups: 16–49 years; 50–65 years and > 65 years; Educational level defined in three groups: low (lower and secondary education), medium (high school and Intermediate Vocational Training), and high (higher and o career degrees); Income (Level of net monthly income (euros) per household) was classified into: <1000€, 1000–2000€, [000-3000€, 3000–4000€ and > 4000€; Household size in < 40 square meters,

41–60 m, 61–90 m, 91–120 m, 121–240 m, and > 240 m; Number of people in the household 1,2,3,4, 5 or > 5; and Chronic disease: yes or no.

2.2 Data analysis

Descriptive analyses were conducted separately by pandemic phase and sex. Frequencies were calculated for categorical variables and means with standard deviations for continuous variables. The Kolmogorov-Smirnov test with Lilliefors correction was used to assess normality, although we note that in large samples, even minor deviations from normality may be statistically significant. The normality check was conducted as a standard procedure, with parametric tests considered robust for large sample sizes. Subsequently, to determine sex differences across the variables, mean comparisons were performed using Student's t-test for quantitative variables, while the chi-square test was employed for qualitative variables.

Covariates used for model adjustment were those statistically significant in the univariate analysis, as well as those which, despite having no statistical significance, were of clinical and epidemiological interest, such as age, educational level, income, household size, number of people living in the household and chronic disease [25].

To evaluate the mediating role of psychosocial attitudes in the relationship between mood and self-rated health, three regression analyses were conducted following the procedure outlined by Hayes. The analysis based on the pandemic phase and sex was grounded in the assumption that the predictor variable (mood), the criterion variable (self-rated health), and the mediator (psychosocial attitudes) were positively correlated. Given the significant positive associations identified between self-rated health and covariates such as age, educational attainment, income, household size, number of cohabitants, and presence of chronic diseases, these variables were included as controls in the initial step of the regression models.

To assess whether psychosocial attitudes served as mediators between mood and self-rated health, three mediation analyses were performed using the PROCESS macro for SPSS. Separate analyses based on the pandemic phase and sex were conducted for men and women to explore potential sex-specific variations and allow for a detailed examination of sex disparities. The bootstrapping method, utilizing 10,000 resamples, was applied to estimate 95% confidence intervals for the indirect effects.

It should be noted that, given the cross-sectional design, the mediation analyses reflect statistical mediation rather than causal mediation, and causal inferences cannot be drawn. The simple mediation process is defined by three regression equations that statistically quantify the influence of the antecedent causal variable X, criterion variable (Mood) on the result of a consequent variable Y (Self-rated Health), considering or not, a third variable called mediator M (Psychosocial Attitude). The first regression equation (model-1) quantifies the relationship between Mood and Psychosocial Attitude, adjusted by the covariables (age, educational level, income, household size, number of people living in the household and chronic disease). The second equation (model-2) quantifies the relationship between Psychosocial Attitude and Self-rated Health, as well as the direct relationship between Mood and Self-rated health when the Psychosocial Attitude remains constant. From these two models, the indirect effect is calculated, given by the product of the coefficients given by model 1 and 2, adjusted by the covariables (age, educational level, income, household size, number of people living in the household and

chronic disease). The third equation (model-3) quantifies the total effect determined by the influence of the Psychosocial Attitude on the relationship between Mood and Self-rated Health, adjusted by the covariables (age, educational level, income, household size, number of people living in the household and chronic disease).

3 Results

A total of 4,186 valid surveys were collected in Phase I and 1,763 in Phase II. In both phases, women participated more than men (Phase I: 62% vs. 38%; Phase II: 62% vs. 38%). The majority of participants were aged 16–49 years, and over 55% reported a high level of education. Most participants lived in dwellings of 61–90 m^2. Full descriptive statistics are provided in Online Resource 2.

Concerning the state of health, in both phases of the study, men reported better self-reported health than women. Likewise, the percentage of women who reported having a chronic disease was higher than that of men (Phase I women 25.9% vs. 34.4% men, $p < .001$, Phase II women 34.4% vs. 29.3% men, $p < .005$). In the Phase I no differences were observed between men and women in mood during lockdown. However, during the Phase II, 20 months after lockdown, mood was better in both men and women, with statistically significant differences (mood very well in men 3% to 32% vs. women 4% to 22.5%; $p < .001$).

In Phase I, as shown in Table 1 in men and women, self-rated health correlated negatively and significantly with age (r_{men}: .-092, $p < .001$; r_{women}: .-054; $p < .005$). Likewise, self-rated health correlated positively and significantly with psychosocial attitudes (r_{men}: 0.420, $p < .001$; r_{women}: 0.432, $p < .001$) educational level (r_{men}: 0.097, $p < .005$; r_{women}: 0.112, $p < .005$), income, euros per month (r_{men}: 0.129, $p < .005$; r_{women}: 0.133, $p < .005$) and chronic disease (r_{men}: 0.229, $p < .001$; r_{women}: 0.228, $p < .005$).

In Phase II, as shown in Table 2 in men and women, self-rated health correlated positively and significantly in men and women with mood (r_{men}: 0.410, $p < .005$; r_{women}: 0.414, $p < .005$), psychosocial attitudes (r_{men}: 0.464, $p < .05$; r_{women}: 0.530, $p < .005$), income (r_{men}: 0.171, $p < .005$; r_{women}: 0.220, $p < .001$) and chronic disease (r_{men}: 0.178, $p < .005$; r_{women}: 0.221, $p < .005$) and in women in educational level (r:0.153, $p < .005$).

3.1 Mediation analysis

Mediation analyses examined the role of psychosocial attitudes in the relationship between mood and self-rated health, separately by sex and pandemic phase. As shown in Figs. 1, 2, 3 and 4; Tables 3 and 4, the direct effect of mood on self-rated health was significant in both men and women across phases (Phase I β_{men}:0.293, $p < .001$; βwomen:0.226, $p < .001$; Phase II β_{men}:0.266, $p < .001$; β_{women}: 0.292, $p < .001$). Similarly, the direct effect of the psychosocial attitudes on self-rated health was significant in both sexes across both phases (Phase I β_{men}: 0.054, $p < .001$; βwomen: 0.052, $p < .001$; Phase II β_{men}: 0.042, $p < .001$; β_{women}: 0.049, $p < .001$).

The analysis of the indirect effect of mood on self-rated health revealed significant results for both sexes across both phases of the study (Phase I β_{men}: 0.224, $p < .001$; β_{women}: 0.273, $p < .001$; Phase II β_{men}: 0.163, $p < .001$; β_{women}: 0.193, $p < .001$). Additionally, the covariates analyzed influenced the relationship between mood and self-rated health in both sexes and across both phases. In men found an influence for age (Phase I β_{men}: .-102, $p < .001$; Phase II β_{men}: .-204, $p < .005$) and chronic disease (Phase I β_{men}:

Table 1 Correlations of the study variables in men and women in Phase I

Men	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1. Self-rated health	1								
2. Mood	.-001	1							
3. Psychosocial actitudes	0.420**	0.003	1						
4. Age	.-092**	0.017	0.163**	1					
5.Educational level	0.097**	0.017	0.060**	.-101**	1				
6.Income (euros/month)	0.129**	.-005	0.172**	0.053**	0.314**	1			
7.Household size	0.012	0.111**	.-009	0.009	0.003	.-032	1		
8.Number of people in household	0.019	.-026	0.018	0.012	.-012	0.006	0.295**	1	
9.Chronic disease	0.229**	0.024	0.083**	.-232**	0.123**	0.050**	0.023	.-004	1
Women	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1. Self-rated health	1								
2. Mood	0.009	1							
3. Psychosocial actitudes	0.432**	0.015	1						
4. Age	.-054**	0.020	0.177**	1					
5. Educational level	0.112**	0.023	0.101**	.-058**	1				
6. Income (euros/month)	0.133**	0.005	0.176**	0.050*	0.337**	1			
7. Household size	0.030	0.094**	0.004	0.006	0.000	.-040**	1		
8. Number of people in the household	0.016	.-033	0.027	0.027	.-003	0.023	0.304**	1	
9. Chronic disease	0.228**	0.035	0.094**	.-172**	0.113**	0.053**	0.027	0.011	1

1. Self-rated health, was obtained through the question: "How do you feel about yourself before and during confinement by COVID-19? With 5 possible answers from 1 (Very Bad) to 5 (Very Good); 2.Mood, was obtained from the question "How do you feel about yourself before and during confinement by COVID-19? With 5 possible answers from 1 (Very Bad) to 5 (Very Good). 3.Psychosocial Attitudes, were obtained by means of a synthetic index calculated as the sum of the answers obtained from asking whether during confinement the individuals had suffered from "insomnia", "lack of appetite", "tiredness", "anxiety", "irritability", "gastric problems" and "concentration problems", where the lowest value obtained is 7 (appropriate psychosocial attitudes) and the highest is 35 (all the above are bad), 4.Age was grouped in three groups ([16–49 years]; [50–65 years] and [> 65 years]); 5.Educational level was defined in three groups: low (lower and secondary education), medium (high school and Intermediate Vocational Training) and high (higher and o career degrees) ; 6. Income per household (euros/month) ([< 1000€], [1000–2000€], [2000–3000€], [3000–4000€] and [> 4000€]). 7.Household size: meters^2; 8. Number of people in household: 1,2,3,4,5 or 6+; 9. Chronic Disease, yes or not

***$p < .001$; **$p < .005$; *$p < .10$;

0.015, $p < .001$; Phase II β_{men}: 0.408, $p < .001$). In women, differences were observed compared to men, as the relationship between mood and self-rated health was influenced by additional covariates. Specifically, age (Phase I β_{women}: .-051, $p < .001$; Phase II β_{women}: .-105, $p < .001$), income (euros per month) (Phase I βwomen: 0.145, $p < .001$; Phase II β_{women}: 0.069, $p < .001$) and chronic disease (Phase I β_{women}: 0.505, $p < .001$; Phase II β_{women}: 0.471, $p < .001$).

4 Discussion

This study examined the role of psychosocial attitudes in the relationship between mood and self-rated health in men and women during two significant phases of the COVID-19 pandemic. The findings indicate that this relationship was statistically associated with indicators such as insomnia, loss of appetite, fatigue, anxiety, irritability, gastric issues, and difficulty concentrating in both sexes.

In the study period, both men and women reported a poor self-perception of their health, with higher negative ratings during the COVID-19 lockdown (Phase I). In Phase II, 20 months after lockdown, the results indicated an overall improvement in mood and self-perceived health within the population analyzed. In both phases, significant sex differences were observed, with women consistently reporting worse health status and mood compared to men.

Table 2 Correlations of the study variables in men and women in Phase II

Men	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.Self-rated health	1								
2.Mood	0.410**	1							
3.Psychosocial actitudes	0.464**	0.523**	1						
4.Age	.-075	0.017	0.112**	1					
5.Educational level	0.031	0.021	0.039	.-145**	1				
6.Income (euros/month)	0.171**	0.157**	0.200**	.-037	0.341**	1			
7.Household size	0.005	0.057	0.027	0.085*	0.056	0.040	1		
8.Number of people in the household	0.014	0.003	0.028	.-022	0.018	0.016	0.257**	1	
9.Chronic disease	0.178**	0.114**	0.112**	.-224**	0.057	0.068	.-048	0.010	1

Women	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.Self-rated health	1								
2.Mood	0.414**	1							
3.Psychosocial actitudes	0.530**	0.516**	1						
4.Age	.-062*	.-021	0.104**	1					
5.Educational level	0.153**	0.104**	0.099**	.-153**	1				
6.Income (euros/month)	0.220**	0.164**	0.164**	.-035	0.374**	1			
7.Household size	0.000	.-026	.-013	.-008	0.030	0.022	1		
8.Number of people in the household	.-003	0.019	.-020	.-049	.-054	.-009	0.276**	1	
9.Chronic disease	0.221**	0.095**	0.156**	.-106**	0.015	0.081**	.-009	0.044	1

(1) Self-rated health, was obtained through the question: "How do you feel about yourself before and during confinement by COVID-19? With 5 possible answers from 1 (Very Bad) to 5 (Very Good); (2) Mood, was obtained from the question "How do you feel about yourself before and during confinement by COVID-19? With 5 possible answers from 1 (Very Bad) to 5 (Very Good). 3.Psychosocial Attitudes, were obtained by means of a synthetic index calculated as the sum of the answers obtained from asking whether during confinement the individuals had suffered from "insomnia", "lack of appetite", "tiredness", "anxiety", "irritability", "gastric problems" and "concentration problems", where the lowest value obtained is 7 (appropriate psychosocial attitudes) and the highest is 35 (all the above are bad), 4.Age was grouped in three groups ([16–49 years]; [50–65 years] and [> 65 years]); 5.Educational level was defined in three groups: low (lower and secondary education), medium (high school and Intermediate Vocational Training) and high (higher and o career degrees) ; 6. Income per household (euros/month) ([< 1000€], [1000–2000€], [2000–3000€], [3000–4000€] and [> 4000€]). 7.Household size: meters2; 8. Number of people in household: 1,2,3,4,5 or 6+; 9. Chronic Disease, yes or not

***$p < .001$; **$p < .005$; *$p < .10$;

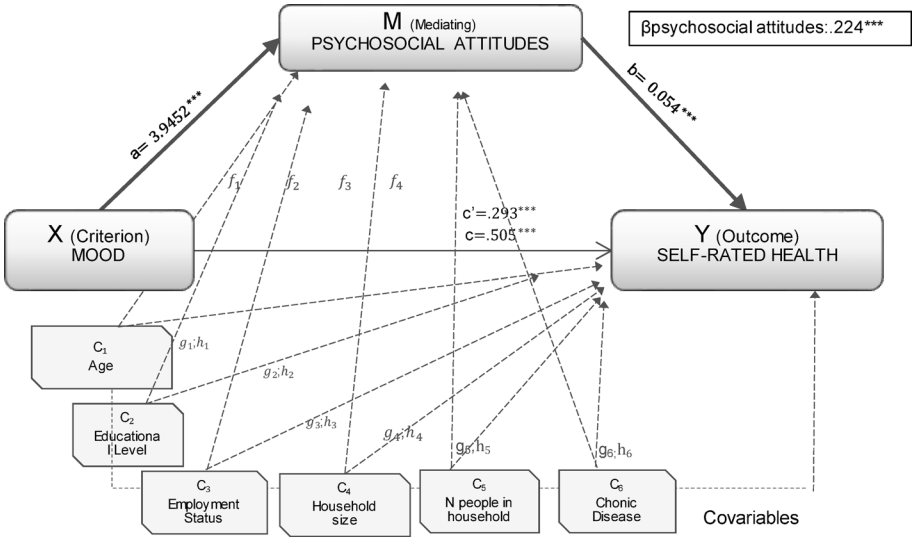

Fig. 1 Visual representation of the mediation analysis results on psychosocial attitudes in the relationship between mood and self-rated health in men in Phase I

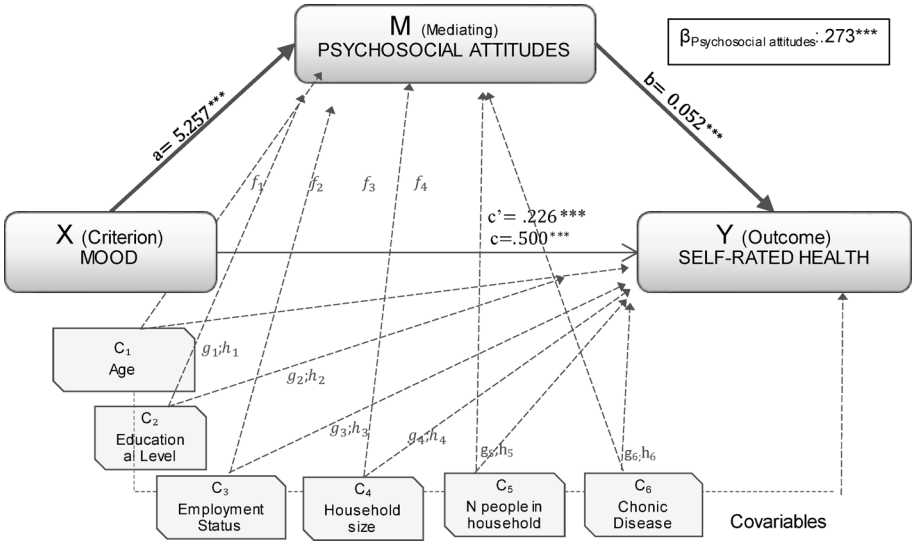

Fig. 2 Visual representation of the mediation analysis results on psychosocial attitudes in the relationship between mood and self-rated health in women in in Phase I

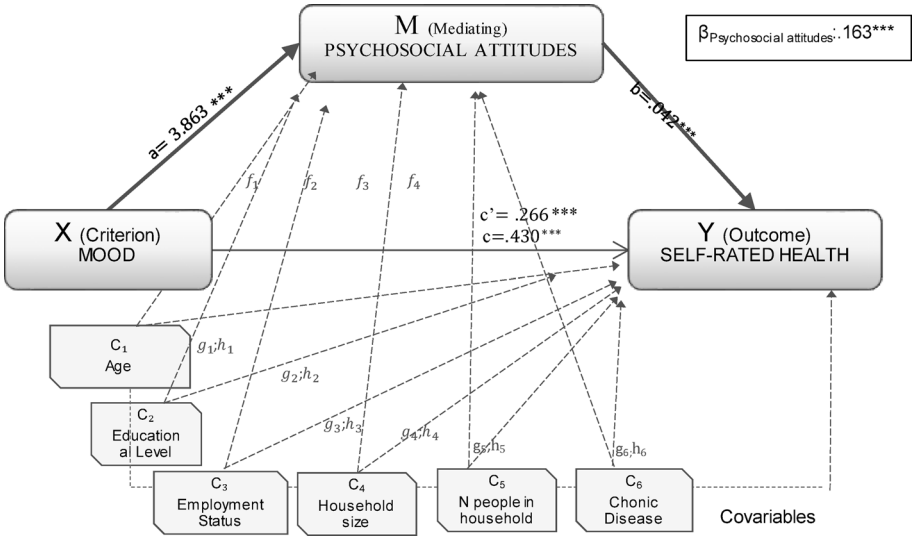

Fig. 3 Visual representation of the mediation analysis results on psychosocial attitudes in the relationship between mood and self-rated health in men in Phase II

The mediation analyses indicated that psychosocial attitudes were statistically associated with the relationship between mood and self-rated health in both phases and in both sexes. Furthermore, women's household income was found to have a positive effect, further amplifying the impact of psychosocial attitudes on the relationship between mood and self-perceived health. These findings suggest that the psychosocial attitudes index may function as an intermediate correlate linking emotional states and global health perceptions. However, given the cross-sectional design, these results should be interpreted as evidence of statistical mediation rather than confirmation of temporal or causal mechanisms.

The present results align with previous literature. The term "coronaphobia" has been used to describe the pandemic's negative psychological effects [20]. Studies have shown

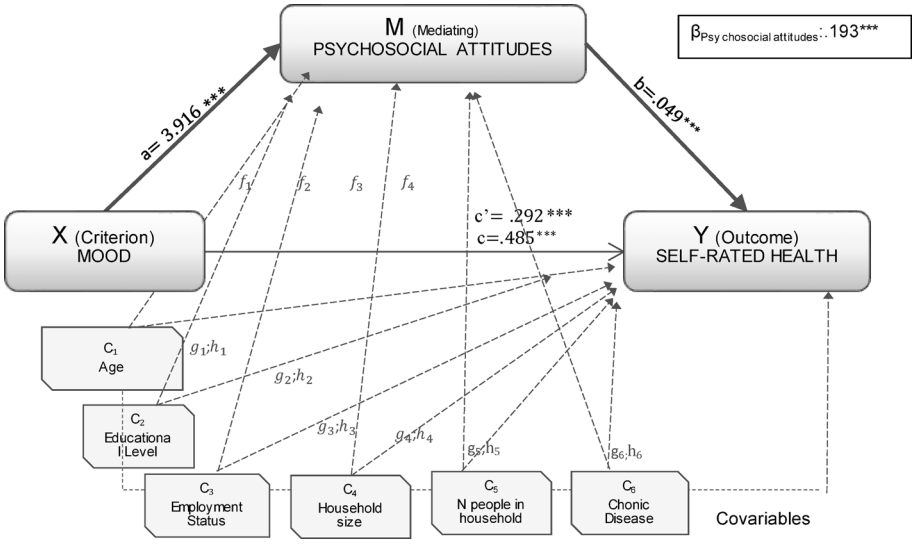

Fig. 4 Visual representation of the mediation analysis results on psychosocial attitudes in the relationship between mood and self-rated health in women in Phase II

that healthy lifestyle behaviors during the pandemic contributed to improved mental well-being and mood regulation [26, 27]. Positive psychosocial attitudes and physical activity were linked to better immune function and stress mitigation during lockdowns [23, 24], which may partly explain the improvements observed between Phase I and Phase II [28, 29]. It should be noted that the psychosocial attitudes index reflects a composite of behavioral, affective, and somatic responses (e.g., sleep disturbances, fatigue, anxiety-related symptoms) reported during lockdown. Therefore, it should be interpreted as an indicator of psychosocial strain rather than as a single underlying psychological trait. This captures the multidimensional nature of adaptive and maladaptive responses during crisis contexts.

The present study found that in both analyzed phases, women reported worse self-rated health than men. These results agree with the recently released Health and Gender 2022 report published by the Ministry of Health (Spain), as well as other research highlighting the negative impact of the COVID-19 pandemic on women's health [30, 31].

The results further indicate that women and older adults experienced higher levels of anxiety and stresscompared to younger men during the lockdown. In the case of social and economic factors, previous studies have shown that existing socio-economic and sex inequalities directly affect health perception, with people from the least favoured social classes and women reporting the worst self-rated health [32, 33]. Behavioral changes, such as disrupted sleep and altered physical activity, were more pronounced in women, although their engagement in physical exercise appeared to partially mitigate some of the negative effects [29, 30]. These findings support the concept of syndemics, highlighting the interaction between concurrent pathologies and structural social inequalities [34]. In addition, alternative explanations for the consistently poorer outcomes observed in women should be considered. These may include unequal caregiving responsibilities during lockdown, greater employment instability in female-dominated sectors, and pre-existing sex differences in vulnerability to anxiety and depressive symptoms [35, 36]. Such structural and contextual factors may have contributed to amplifying gender gaps in mood and self-rated health during the pandemic.

Table 3 Results of the mediation analysis of psychosocial attitudes in the relationship between mood and self-rated health in men and women in Phase I

MEN													
	Predictors	**Y**	**Model-1[1]**			**Y**	**Model-2[2]**			**Y**	**Model-3[3]**		
			(PA) psychosocial attitudes				**(H) sel-rated health**				**(H) sel-rated health**		
			B	**t**	**β**		**B**	**t**	**β**		**B**	**t**	**β**
X	(MO) Mood	a	4.961***	14.867	0.494	c′	0.284***	5.439	0.213	c	0.509***	10.676	0.380
M	(PA) psychosocial attitudes					b	0.045***	8.530	0.339				
C_1	Age	f_1	1.821***	3.759	0.127	g_1	.-184**	-2.789	.-097	h_1	.-102***	-1.486	.-054
C_2	Education	f_2	0.022	0.044	0.002	g_2	.-056	.-838	.-030	h_2	.-055	.-781	.-029
C_3	Income	f_3	1.102***	3.452	0.121	g_3	0.085**	1.955	0.070	h_3	0.135*	2.965	0.111
C_4	Household size	f_4	.-238	.-646	.-022	g_4	.-008	.-160	.-005	h_4	.-018	.-356	.-013
C_5	Number of people in the household	f_5	0.298	0.965	0.032	g_5	0.002	0.044	0.001	h_5	0.015	0.348	0.012
C_6	Chornic disease	f_6	1.601***	2.213	0.074	g_6	0.257**	2.624	0.090	h_6	0.015**	3.201	0.116
	$R^{2\,(7)}$		0.305				0.279				0.99		
	F[8]		41.236***				31.724***				23.308***		
	Women												
	Predictors		**Model-1[1]**				**Model-2[2]**				**Model-3[3]**		
		Y	**(PA) psychosocial attitudes**			**Y**	**(H) sel-rated health**			**Y**	**(H) sel-rated health**		
			B	**t**	**β**		**B**	**t**	**β**		**B**	**t**	**β**
X	(MO) Mood	a	5.257***	19.167	.493	c'	.226***	5.841	0.168	c	0.500***	13.721	0.371
M	(PA) Psychosocial Attitudes					b	0.052***	14.054	0.411				
C_1	Age	f_1	2.38***	5.209	0.134	g_1	0.-175**	-3.093	0.-078	h_1	0.-051**	0.-843	0.-022
C_2	Education	f_2	0.580	1.482	0.042	g_2	0.-079*	1.664	0.044	h_2	0.110	2.114	0.061
C_3	Income6	f_3	0.590**	2.257	0.062	g_3	0.114**	3.561	0.095	h_3	0.145**	4.170	0.121
C_4	Household Size	f4	0.077	0.253	0.006	g4	0.013	0.344	0.008	h4	0.017	0.416	0.011
C5	Number of people in the household	f5	0.-251	-1.009	0.-026	g5	0.-008	0.-267	0.-006	h5	0.-021	0.-641	0.-017
C6	Chornic disease	f6	2.553***	4.628	0.118	g6	0.338**	4.966	0.124	h6	0.471**	6.429	0.173

Table 3 (continued)

	Women											
	Predictors		**Model-1[1]**				**Model-2[2]**				**Model-3[3]**	
		Y	**(PA) psychosocial attitudes**			**Y**	**(H) sel-rated health**			**Y**	**(H) sel-rated health**	
			B	**t**	**β**		**B**	**t**	**β**		**B**	**t**	**β**
	R2(7)		0.302				0.347				0.239		
	F8		67.53***				72.657***				46.459***		

The simple mediation process is defined by three regression equations that statistically quantify the influence of the antecedent causal variable X, criterion variable (Mood) on the result of a consequent variable Y (Self-rated Health), considering or not, a third variable called mediator M (Psychosocial Attitude)

1.Model 1: quantifies the relationship between Mood and Psychosocial Attitude through lineal regression adjusted by Sex, Age, Education and Income

2.Model 2: quantifies the relationship between Psychosocial Attitude and Self-rated Health, as well as the direct relationship between Mood and Self-rated health when the Psychosocial Attitude remains constant. From these two models, the indirect effect is calculated, given by the product of the coefficients given by model 1 and 2, adjusted by covariables Model 1.

3.Model 3: quantifies the total effect determined by the influence of the Psychosocial Attitude on the relationship between Mood and Self-rated Health adjusted by covariables Model 1

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 4 Results of the mediation analysis of psychosocial attitudes in the relationship between mood and self-rated health in men and women in Phase II

Men													
	Predictors	**Y**	**Model-1[1]**			**Y**	**Model-2[2]**			**Y**	**Model-3[3]**		
			(PA) psychosocial attitudes				**(H) sel-rated health**				**(H) sel-rated health**		
			B	**t**	**β**		**B**	**t**	**β**		**B**	**t**	**β**
X	(MO) Mood	a	3.863***	27.786	0.567	c′	0.266***	5.841	0.235	c	0.430***	16.904	0.380
M	(PA) Psychosocial attitudes					b	0.042***	14.054	0.254				
C_1	Age	f_1	1.265***	5.601	0.119	g_1	.-257**	-3.093	.-146	h_1	.-204**	-4.931	.-0116
C_2	Education	f_2	.-302	-1.546	.-033	g_2	0.006*	1.664	0.004	h_2	.-006	.-168	.-004
C_3	Income	f_3	0.345**	2.618	0.055	g_3	0.045**	3.561	0.044	h_3	0.060	2.501	0.058
C_4	Household size	f_4	.-114	.-753	.-015	g_4	.-015	0.344	.-013	h_4	.-021	.-745	.-017
C_5	Number of people in the household	f_5	.-077	.-633	.-013	g_5	0.022	.-267	0.023	h_5	0.019	0.868	0.020
C_6	Chornic disease	f_6	1.373***	4.582	0.097	g_6	0.350**	4.966	0.149	h_6	0.408**	7.443	0.174
	$R^{2\,(7)}$		0.358				0.263				0.221		
	F[8]		28.397***				70.286***				64.036***		
Women													
	Predictors	**Y**	**Model-1[1]**			**Y**	**Model-2[2]**			**Y**	**Model-3[3]**		
			(PA) psychosocial attitudes				**(H) sel-rated health**				**(H) sel-rated health**		
			B	**t**	**β**		**B**	**t**	**β**		**B**	**t**	**β**
X	(MO) Mood	a	3.916***	34.548	0.550	c′	0.292***	11.568	0.238	c	0.485***	22.447	0.396
M	(PA) Psychosocial attitudes					b	0.049***	13.639	0.286				
C_1	Age	f_1	1.883***	9.437	0.151	g_1	.-198**	-5.304	.-092	h_1	.-105**	-2.769	.-049
C_2	Education	f_2	0.011	0.070	0.001	g_2	0.023*	0.806	0.014	h_2	0.024	0.797	0.014
C_3	Income	f_3	0.525***	4.957	0.083	g_3	0.043**	2.210	0.039	h_3	0.069***	3.428	0.063
C_4	Household size	f_4	.-021	.-167	.-003	g_4	0.034	1.473	0.025	h_4	0.032	1.380	0.025
C_5	Number of people in the household	f_5	0.010	.-103	0.002	g_5	.-009	.-518	.-009	h_5	.-009	.-474	.-008
C_6	Chornic disease	f_6	1.264***	5.087	0.081	g_6	0.443**	9.625	0.165	h_6	0.505***	10.662	0.189

Table 4 (continued)

Women

Predictors	Y	Model-1[1]			Y	Model-2[2]			Y	Model-3[3]		
		(PA) psychosocial attitudes				(H) sel-rated health				(H) sel-rated health		
		B	t	β		B	t	β		B	t	β
$R^{2\,(7)}$		0.366				0.273				0.221		
F[8]		29.442***				122.056***				105.395***		

The simple mediation process is defined by three regression equations that statistically quantify the influence of the antecedent causal variable X, criterion variable (Mood) on the result of a consequent variable Y (Self-rated Health), considering or not, a third variable called mediator M (Psychosocial Attitude)

1.Model 1: quantifies the relationship between Mood and Psychosocial Attitude through lineal regression adjusted by Sex, Age, Education and Income

2.Model 2: quantifies the relationship between Psychosocial Attitude and Self-rated Health, as well as the direct relationship between Mood and Self-rated health when the Psychosocial Attitude remains constant. From these two models, the indirect effect is calculated, given by the product of the coefficients given by model 1 and 2, adjusted by covariables Model 1

3.Model 3: quantifies the total effect determined by the influence of the Psychosocial Attitude on the relationship between Mood and Self-rated Health adjusted by covariables Model 1

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Following the conceptual framework outlined by de Palma, Vosough and Liao on the effects of COVID-19 on the population, the measures implemented during the pandemic had both direct and indirect consequences [37]. Decisions made in the long term influenced short-term responses and vice versa, shaping behavioral patterns and overall well-being. Within this context, significant changes in health-related behaviors were observed, particularly in relation to stress and population well-being during lockdown periods. During the initial lockdown, when social restrictions were more stringent, previous studies, as well as the present study, the population reported increased alcohol consumption and reduced physical activity [38, 39]. Additionally, there was a decline in healthy psychosocial attitudes such as poorer sleep quality [40] and unhealthy dietary habits [41].

Finally, age and chronic diseases were positively associated with the relationship between mood and self-rated health, particularly in older adults and individuals with pre-existing conditions, who experienced the most severe consequences during lockdown periods [42, 43]. In this sense, people with chronic pathology are relevant, as they have registered higher morbimortality rates in the face of confirmed cases of COVID-19 [44].

Overall, the findings suggest that positive psychosocial responses, such as healthier sleep patterns, balanced nutrition, and avoidance of harmful substances, are associated with more favorable mood and health perceptions during key phases of the COVID-19 pandemic [45, 46].These findings underscore the potential importance of psychosocial and behavioral factors in shaping subjective health evaluations, particularly during periods of social restriction.

5 Limitations and strengths of the study

This study provides valuable insights into the impact of lockdown and restrictive measures on health and mood within a specific population in Spain. By examining two distinct phases of the pandemic, the initial lockdown and the subsequent phase 20 months later, the findings emphasize the crucial role of healthy psychosocial attitudes.

However, several limitations should be considered when interpreting the results. One of the primary limitations is the study's reliance on a cross-sectional design, which prevents the establishment of causal relationships between mood, psychosocial attitudes, and self-rated health. Although mediation analyses were conducted, the findings should be interpreted with caution, as longitudinal data would be needed to confirm the temporal directionality of the observed relationships. Another limitation is the use of non-probability sampling, which affects the representativeness of the sample and restricts the generalizability of the results to the broader population.

Moreover, data were collected entirely through online surveys, which may have influenced participation, particularly among older adults who are less likely to engage in digital surveys.

The study's sample size is adequate for the research objectives, and the consistency of findings with official COVID-19 reports and existing literature supports the reliability of the results. Additionally, the data were collected using self-reported measures, which are subject to potential biases such as social desirability and recall bias.

Future studies could incorporate objective health indicators or clinical assessments to complement self-reported data, as well as consider alternative survey administration

strategies, particularly for older adults, to increase participation and ensure a more representative sample. Furthermore, although the study adjusted for relevant sociodemographic and health-related covariates, residual confounding cannot be ruled out. Variables such as pre-existing mental health conditions, personality traits, specific coping mechanisms, or patterns of smartphone use (e.g., excessive use or continuous scrolling) were not included in the analysis, which may have influenced the relationship between psychosocial attitudes, mood, and self-rated health. Although these factors were not measured, they should be taken into account when interpreting the results, as they may mask or exacerbate certain effects.

Despite these limitations, the study contributes valuable knowledge about the psychosocial impact of the COVID-19 pandemic, reinforcing the need for targeted public health interventions. The results highlight the importance of promoting positive psychosocial attitudes and healthy behaviors, particularly among vulnerable groups, to mitigate the adverse effects of prolonged crises on mental and physical well-being. Future research should consider longitudinal designs and more diverse sampling strategies to enhance the generalizability and depth of the findings.

6 Conclusion

These findings highlight the crucial role of psychosocial attitudes in the relationship between mood and self-rated health, with persistent sex differences observed throughout the study. Women reported worse health perceptions and mood, emphasizing the need for targeted public health interventions to address these disparities. The COVID-19 pandemic and its associated lockdown measures have impacted social structures and individual well-being, altered daily routines and fostered detrimental psychosocial attitudes. The crises exacerbate stress and exhaustion, reinforcing negative psychosocial patterns. Additionally, in these scenarios that strain healthcare systems and intensify health inequalities, it is essential to implement programs that promote healthy behaviors. Special attention should be given to at-risk groups, including women, older adults, and individuals with chronic conditions, to prevent further health deterioration. Thus, fostering healthy lifestyles becomes a key strategy for mitigating both communicable and non-communicable diseases and alleviating the burden on public health systems.

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Author contributions

RS-R: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JA-P: Conceptualization, Data curation, Formal analysis, Methodology,Supervision, Writing – original draft, Writing – review & editing. ÁA-M: Data curation, Writing – original draft, Writing – review & editing. RSR, MZ, ÁA-M, JML: Supervision, Visualization, Writing – review & editing. MZ-A, AS: Funding acquisition, Resources, Supervision, Visualization, Writing – review & editing.

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Data availability
The anonymized datasets used in this study are publicly available and can be accessed through the official portal of the Zaragoza City Council: First Survey: https://www.zaragoza.es/sede/portal/coronavirus/encuesta/encuesta-1 ; Second Survey: https://www.zaragoza.es/sede/portal/coronavirus/encuesta/index. For more details on the methodology and results, see the publication by Pueyo Campos et al. (2022): Pueyo Campos, A., López Escolano, C., Valdivielso Pardos, S., & Parrilla Huertas, J.A. (2022). II Encuesta condiciones de vida, necesidades y expectativas tras 20 meses de pandemia por Covid-19. Ayuntamiento de Zaragoza. [https://www.zaragoza.es/sede/portal/coronavirus/encuesta/](https://www.zaragoza.es/sede/portal/coronavirus/encuesta). These datasets are available for research use, in accordance with the terms and conditions established by the Zaragoza City Council.

Declarations

Ethics approval and consent to participate
The study was approved by the local Corporation of the Zaragoza City Council, and the research team only had access to anonymized data files. Therefore, no Ethical Committee approval was required for conducting this study. The microdata was provided by the Zaragoza City Council to the Territorial Planning Chair for anonymous analysis, following evaluation and filtering by the relevant municipal body. The Zaragoza City Council was responsible for obtaining informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Research Group on Health Services in Aragon (GRISSA), Department of Preventive Medicine and Public Health, Faculty of Social and Labor Sciences, Universidad de Zaragoza, St. Violante de Hungría 23, 50009 Zaragoza, Spain
[2]Institute for Health Research in Aragon (IIS Aragón), St. de San Juan Bosco, 13, 50009 Zaragoza, Spain
[3]Spatial Planning Study Group, Department of Geography and Spatial Planning (IUCA, IISA), Universidad de Zaragoza, St. Pedro Cerbuna, 12, 50009 Zaragoza, Spain
[4]Hospital Clínico Universitario Lozano Blesa, St. de San Juan Bosco,13, 50009 Zaragoza, Spain
[5]Hospital Universitario San Jorge, Av. de Martínez de Velasco, 36, 22004 Huesca, Spain
[6]Health Center Borja, Aragonese Health Service, St. Barbalanca, 50540 Borja, Zaragoza, Spain
[7]Department of Psychology and Sociology, Universidad de Zaragoza, St. Pedro Cerbuna, 12, Zaragoza 50009, Spain

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