Anxiety and Depression Symptoms During the COVID-19 Pandemic: A Cluster Analysis of Individuals Living in Portugal

Sintomas de Ansiedade e Depressão Durante a Pandemia de COVID-19: Uma Análise de Clusters em Residentes Portugueses

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ABSTRACT
Introduction: The COVID-19 pandemic is an illustration of how a physical illness can damage people's minds. In this regard, the goal of this study was to see how different sociodemographic and behavioral factors were linked to anxiety and depression symptoms in a group of individuals living in Portugal.
Methods: Between November 2020 and February 2021, a cross-sectional, snowball online study was conducted. The study's target population was adults over the age of 18, residents of the country. For the statistical analysis, the clustering technique – K-means algorithm was applied. The chi-squared test was used to determine the relationships between clusters and sociodemographic and behavioral characteristics. Statistical analyses were conducted in R language, with a significance level of 0.05. A total of 453 participants were included.
Results: The majority were female (69.8%), under the age of 40 (60.8%), with a higher education degree (75.3%), and not married (54.4%). Furthermore, the majority were from the country's north region (66%). Cluster 1 (n = 194) was characterized by low or nonexistent levels of anxiety and depression symptoms, which means normal; cluster 2 by severe symptoms (n = 82), meaning case; and cluster 3 by mild symptoms (n = 177), which means border-line. Younger participants (*p*-value 0.024), female (*p*-value 0.041), with drinking habits (*p*-value 0.002), food insecurity (*p*-value < 0.001), food affordability exacerbation (*p*-value < 0.001), comorbidity (*p*-value < 0.001), use of anxiolytics (*p*-value < 0.001), insufficient household income (*p*-value 0.017) and income change (*p*-value < 0.001) were significantly associated with the anxiety-depression clusters. From the three clusters, cluster 2 was mainly represented by younger participants, with more persons stating that their household income was insufficient and that their income has changed as a result of COVID-19 and that they had the highest probability of food insecurity.
Conclusion: The impacts of a crisis on mental health extend longer than the event itself. We were able to observe that younger women with insufficient household income who suffered a change in income due to COVID-19 and were classified as food insecure presented higher levels of anxiety and depression symptoms. These results highlight the presence of a social gradient where we saw that people who were less advantaged in terms of socioeconomic position presented worse mental health outcomes, stressing, in this sense, the need to bring the best public health responses for these specific groups of the population.
Keywords: Anxiety Disorders; Cluster Analysis; COVID-19/complications; Depressive Disorder; Mental Health; Portugal; Public Health

RESUMO
Introdução: A pandemia de COVID-19 é uma ilustração de como uma doença física pode prejudicar a mente das pessoas. Neste sentido, o objetivo deste estudo foi verificar como diferentes fatores sociodemográficos e comportamentais se associaram a sintomas de ansiedade e depressão num grupo de indivíduos residentes em Portugal.
Métodos: Entre novembro de 2020 e fevereiro de 2021, foi realizado um estudo *online* transversal de bola de neve. A população-alvo do estudo foram os adultos maiores de 18 anos, residentes no país. Para a análise estatística foi aplicada uma técnica de *cluster* – algoritmo K-médias. O teste qui-quadrado foi utilizado para determinar as relações entre os *clusters* e as características sociodemográficas e comportamentais. As análises estatísticas foram realizadas na linguagem R, com nível de significância de 0,05. Um total de 453 participantes foi incluído.
Resultados: A maioria era do sexo feminino (69,8%), com menos de 40 anos (60,8%), com nível de ensino superior completo (75,3%) e não casados (54,4%). Além disso, a maioria era da região Norte do país (66%). O *cluster* 1 (n = 194) foi caracterizado por um nível baixo ou inexistente de sintomas de ansiedade e depressão, que significa normal, o *cluster* 2 por sintomas altos (n = 82), que significa caso e o *cluster* 3 por sintomas leves (n = 177), que significa limítrofe. Participantes mais jovens (valor-*p* 0,024), do sexo feminino (valor-*p* 0,041), que consumiam álcool (valor-*p* 0,002), com insegurança alimentar (valor-*p* < 0,001), exacerbação da acessibilidade alimentar (valor-*p* < 0,001), comorbidade (valor-*p* < 0,001), uso de ansiolíticos (valor-*p* < 0,001), rendimento familiar insuficiente (valor-*p* 0,017) e alteração de rendimento (valor-*p* < 0,001) foram significativamente associados aos *clusters* ansiedade-depressão. Dos três *clusters*, o *cluster* 2 foi representado principalmente por participantes mais jovens, com mais pessoas a afirmar que o seu rendimento familiar era insuficiente e que sofreu alteração em decorrência da COVID-19, apresentando maior probabilidade de insegurança alimentar.
Conclusão: Os impactos de uma crise na saúde mental vão além do evento em si. Pudemos observar que as mulheres mais jovens com rendimento familiar insuficiente que sofreram alteração do mesmo devido à COVID-19, e classificadas como tendo insegurança alimentar, apresentaram maiores níveis de sintomas de ansiedade e depressão. Esses resultados destacam a presença de um gradiente social onde observámos que as pessoas menos favorecidas em termos de posição socioeconómica apresentam piores resultados em saúde mental, ressaltando, nesse sentido, a necessidade de trazer as melhores respostas de saúde pública para esses grupos específicos da população.
Palavras-chave: Análise de Clusters; COVID-19/complicações; Perturbação Depressiva; Perturbações Ansiosas; Portugal; Saúde Mental; Saúde Pública

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INTRODUCTION

The COVID-19 pandemic has impacted mental health, which has shown, to some extent, how vulnerable people may be in the face of circumstances that threaten their health. Moreover, this sanitary crisis was an example of how a disease can spread beyond the biological realm to affect the mental realm, resulting in psychological manifestations in addition to the usual symptoms.[1,2]

Due to the high incidence of cases, their rapid spread, and their severity, COVID-19 was designated a pandemic on March 11, 2020.[3] Since then, governments worldwide, including Portugal, have employed various containment techniques, including quarantine, isolation, and social distance. These policies had an impact on individual and group behavioral patterns, had biopsychosocial consequences, and had an impact on the population's mental health.[4,5] Reduced contact with other people may hinder the beneficial effects of social bonding and interactions. These social resources are crucial for dealing with, and alleviating, psychological discomfort and fostering mental and physical health.[6-8]

Several studies about the psychological impact of the COVID-19 pandemic on mental health have already been conducted. The authors found that the association appeared to be stronger in women[9] and young adults with ages between 18 and 34.[6,9,10] In addition, low socioeconomic status, unemployment, and regular exposure to social media and news about COVID-19 were also risk factors for psychological stress.[11,12]

There is still a scarcity of epidemiological data on the Portuguese community's prevalence rate of COVID-19-related mental health issues. On the other hand, previous research has found a significant burden of mental health issues in Portugal, with an estimated lifetime prevalence of at least one psychiatric condition of 42.7%.[13] Furthermore, ongoing research[14] has shown that around 83% of participants (n = 157 927) have felt low mood, agitation, anxiety, or sadness as a result of physical distancing measures one week after they were implemented, and that both the youngest (16 - 25 years old) and the female respondents were the most vulnerable to the distress caused by confinement measures.[14] Moreover, another study on adults belonging to three different groups – survivors of SARS-CoV-2, those who were tested but received negative results, and those who were never tested – presented a higher rate of symptoms of anxiety and depression when compared to pre-pandemic normative data.[15] Moreover, one study carried out in Portuguese college students found that 17.2%, 23.6%, and 6% of participants reported moderate to extremely severe symptoms of depression, anxiety, and stress, respectively. However, these results were lower when compared to the pre-pandemic period,[16,17] and are not in line with what has been found in other studies.

Maia and Dias[18] studied the levels of anxiety, depression, and stress among Portuguese university students, and found a significant increase in psychological distress during the pandemic period (between the suspension of classes and the declaration of a state of emergency in Portugal) when compared to regular periods.

As a result, it is critical to move from the prevention domain towards active interventions in order to identify particularly vulnerable population groups and their features in order to quickly implement measures to mitigate the impact that the pandemic has had, thus preventing further deterioration. In this sense, the aim of this study was to explore how different sociodemographic and behavioral characteristics were associated with symptoms of anxiety and depression among a sample of adults living in Portugal.

METHODS
Participants and procedures

This cross-sectional study was carried out in Portugal between November 2020 and February 2021. Using a snowball sampling method, all participants were recruited online. Adults over the age of 18 who were residents of the country were the study's target group. The questionnaire was separated into different sub-sections – sociodemographic characteristics, symptoms of anxiety and depression, and prior history of COVID-19 infection – and each participant had access to it via an online link. More information on the study procedures can be found elsewhere.[19]

A total of 929 Portuguese citizens responded to the survey. From that, 476 subjects had at least one missing observation in at least one of the considered variables under study (sociodemographic, behavioral and food security, presented below). This proportion of missing values was considered too high, making a successful application of imputation methods almost impossible. Moreover, there was not a single imputation method to be applied, and different methods usually lead to different solutions. Taking this high level of uncertainty into account and the fact that the complete dataset did not substantially differ from the original (incomplete) dataset (Table 1), the clustering analysis included 453 people who had completed the survey for all variables under study.

Before and during the data collection period, the epidemiological situation concerning COVID-19 in the country could have increased the levels of anxiety, stress, and depression in the population. On September 15, 2020, the number of new

cases increased exponentially again, and on a much larger scale than in the first wave. On November 9, 2020, the state of emergency in Portugal was declared again, and more restrictive measures were imposed in the country, corresponding to the start of data collection. The number of cases increased substantially on December 29 (Rt = 1.2) and nearly tripled after two weeks. The maximum number of daily cases reached during this wave was 12 890 on January 28, 2021. Portugal had the world's highest cumulative mortality rate of 14 days per million inhabitants as of February 1, 2021. On February 12, the number of deaths caused by this pandemic had reached 15 000.

Ethics

The Ethics Committee of the Institute of Public Health of the University of Porto gave its approval to the study (CE20166). All participants were requested to provide informed consent, in order to proceed in the questionnaire, following the Declaration of Helsinki's Ethical Principles for Medical Research involving Human Subjects and current national legislation.

Instrument for anxiety and depression symptoms

The Hospital Anxiety and Depression Scale (HADS),[20] which measures symptoms experienced in the previous week, was used to assess symptoms of anxiety and depression. The approved Portuguese version of the scale was used.[21] In the Portuguese version of the scale, the Cronbach's alpha for anxiety was 0.76, and for depression was 0.81.[21] The HADS demonstrated strong internal consistency in the current study, with a Cronbach's alpha of 0.81 (95% CI: 0.77 - 0.84).

HADS comprises two subscales, each with seven items, one for anxiety and the other for depression, which is scored individually. Each question was graded on a four-point (0 – 3) scale, with anxiety and depression ratings ranging from 0 to 21. The scoring method ranged from no symptoms (score of 0, 'normal') to the most severe symptom manifestation (score of 21, 'abnormal case'). As a result, the higher the score, the more severe the symptoms of anxiety and/or depression are.

Variables under analysis

For the purpose of this study, we have included the following variables:
1. Sociodemographic: age, sex, education, marital status, household income, income change (answer to the question 'Has your household's income changed due to the pandemic?'), region of the country, job situation after COVID-19 started (answer to the question 'Please indicate the extent to which your professional situation has changed since March 16, 2020 to the present'), household size and, comorbidities;
2. Behavioral: drinking habits (answer to the question 'Do you drink or have you ever drunk alcoholic beverages?') smoking habits (answer to the question 'Do you smoke or have you ever smoked?') and, use of anxiolytics or antidepressants;
3. Food: food security was assessed by using the U.S. Household Food Security Survey Module: Six-Item Short Form. Economic Research Service, USDA, Portuguese version, and food affordability exacerbation was assessed based on the question 'Regarding questions related with Food security, did these situations worsen during the pandemic?'.

Data analysis

Cluster analysis is a multivariate classification technique aiming to identify homogeneous groups based on their similarities in a set of user selected features. The groups of similar objects are called clusters.[22,23]

The present study aimed to: (1) understand the different types of behavior profiles associated with anxiety and depression symptoms; (2) characterize those profiles in terms of sociodemographic and behavioral features. As the individual observations were not previously partitioned into groups regarding the anxiety and depression scales, the task in (1) corresponded to an unsupervised machine learning problem. The chosen clustering technique was the K-means algorithm, which is known to have good statistical properties.[24] The number of clusters was determined based on the domain knowledge and supported by quantitative criteria such as the elbow method, silhouette approach and the gap statistics.[22] The associations between the obtained clusters and the sociodemographic and behavioral features were identified by the chi-squared test. The significance level was set at 0.05, and the statistical analyses were performed in the R language and environment for statistical computing – R version 4.1.3 (Rstudio 2021.11.01 Build 461), packages: dplyr, haven, ggplot2, gridExtra, grid, klaR, MASS, factoextra, rgl and ggpubr.[25]

RESULTS

Most participants were female (69.8%), aged less than 40 years old (60.8%), with a higher education degree (75.3%), and 54.4% were not married. Moreover, most were from the Northern region of the country (66%) with a household size of

three or more persons (53.8%) and with no known comorbidities (78.4%).

Cluster 1, 2 and 3 contained 194 (42.8%), 82 (18.1%) and 177 (39.1%) participants, respectively. Cluster 1 was characterized by low or nonexistent levels of anxiety and depression symptoms, which means normal (average 4.21 and 1.98, resp.), cluster 2 by high anxiety and depression symptoms, meaning case (average 14.82 and 9.43, resp.), and cluster 3 by mild anxiety and mild depression symptoms (average 8.66 anxiety and 6.36, resp.), which means borderline (Fig. 1).

In Table 2, a description of the three clusters in terms of the collected sociodemographic and behavioral variables is provided. Among the 16 variables studied, nine were significantly associated with the anxiety-depression clusters, namely: age, specifically young participants (p-value 0.024), female participants (p-value 0.041), those who have drinking habits (p-value 0.002), participants classified as food insecure (p-value < 0.001), those who reported a food affordability exacerbation (p-value < 0.001), individuals with comorbidity (p-value < 0.001), that use anxiolytics (p-value < 0.001), participants that reported household income as insufficient (p-value 0.017) and those who stated that income (referring to change before and after the pandemic) was changed (p-value < 0.001) (Table 2).

Cluster 1 was characterized as having older people (≥ 40 years), more male than female participants, and most individuals with a higher education degree (Table 2). Moreover, individuals within this cluster: (i) reported a higher income perception than in the remaining clusters, showing a safer economic position; (ii) were less prone to be characterized as food insecure; and (iii) used fewer anxiolytics or antidepressants.

Cluster 2 consisted of the worst outcomes concerning anxiety and depression symptomatology. This cluster was mainly represented by younger participants equally distributed in terms of marital status, two thirds with a higher degree (Table 2). Concerning household income perception, cluster 2 was characterized as having more people stating that the household income was insufficient and that due to COVID-19, the income has changed. Lastly, among the three clusters, cluster 2 had the highest risk of being food insecure.

On the other hand, cluster 3 included the highest percentage of female participants, the highest percentage of persons who classified themselves as 'not married', and the highest percentage of people who reported insufficient household income (Table 2). In addition, this cluster had a larger household size (≥ 3 people), more frequent use of anxiolytics or antidepressants, and had higher levels of food insecurity.

It was also important to understand how each variable under study was significantly associated with the anxiety-depression cluster (Fig. 2). Broadly speaking, and as shown in Fig. 2, we can see that women (Fig. 2A) and younger participants (under 40 years of age) (Fig. 2B) appeared to have higher levels of anxiety and depression symptoms. Moreover, people who had insufficient household income (Fig. 2C) or suffered a change in their income due to COVID-19 (Fig. 2D) had higher levels of anxiety and depression symptoms.

As for household income, individuals with insufficient income presented higher levels of anxiety and depression, reaching the highest percentages within cluster 3. Participants that reported having at least one medical condition that required medical assistance (comorbidity) (Fig. 2E) also had higher levels of anxiety and depression symptoms, with more than half of these individuals belonging to clusters 2 and 3. This means that, out of the total amount of individuals with comorbidity, only 30% presented lower levels of symptoms of anxiety and depression.

Lastly, even though the variable concerning the job situation did not have a positive statistical result, it was visible from the plot analysis (Fig. 2F) that those who were unemployed were more distributed within the second and third clusters, with almost half of those individuals present in these clusters. In addition, individuals that lost their job after the pandemic also showed higher percentages within clusters 2 and 3 with 3.5% and 2% of the overall sample compared to 3.1% in cluster 1.

Also, those who reported using anxiolytics or antidepressants (Fig. 3A) presented more severe symptoms, showing that the scale, at least to some extent is measuring the outcomes properly. However, for people consuming anxiolytics, only 24% of these individuals (3.5% of the overall sample) fell under cluster 1. More importantly, the distribution weights for these individuals between cluster 2 and 3 is almost equivalent (5.5% for cluster 3 and 5.2% for cluster 2, approximately 38% and 37% of the total amount of individuals that consumed anxiolytics). Concerning food, those classified as food insecure (Fig. 3B) were predominately within cluster 2 (51.7% of the total amount of individuals with food insecurity) and those that stated that the food situation was aggravated after the pandemic started (Fig. 3C) presented higher levels of anxiety and depression symptoms, with most of the individuals in this category – approximately 72% of the total amount of individuals. Also, drinking habits triggered our attention – most people who did not drink reported anxiety and depression symptoms, whereas over half of those with current or past drinking habits reported very few symptoms (Fig. 3D). Although the outcome was unexpected, it is important to note that we asked participants about drinking or having ever drunk alcoholic beverages, without knowing if it is excessive alcohol consumption or normal habit during meals, for instance.

DISCUSSION

The aim of this study was to see how different sociodemographic and behavioral factors were linked to anxiety and depression symptoms in a sample of Portuguese residents. We already know that the COVID-19 outbreak had a variety of long-term mental health repercussions. The mental health effects and stress behaviors are a result of governments around the world privileging social distancing and isolation measures, and these circumstances may also increase the vulnerability to mental health disorders.[26] Furthermore, previous evidence has revealed that various socio-demographic characteristics are important mental health predictors in this health crisis. For example, during the COVID-19 pandemic, women and younger people reported higher levels of feelings of anxiety, depression, and fear.[27-29]

Our sample was split into three different clusters based on anxiety and depression symptoms. Cluster 1 and cluster 3 – low or nonexistent levels of anxiety and depression symptoms and mild anxiety and depression symptoms, respectively – and cluster 2 with high anxiety and depression symptoms. In this sense, we observed a positive association between age, gender, drinking, food insecurity, food affordability exacerbation, comorbidity, use of anxiolytics or antidepressants, household income and change in income due to COVID-19 and higher levels of anxiety and depression symptoms.

In the present study, women were associated with a higher level of symptoms of anxiety and depression in cluster 3, which is consistent with previous studies[30,31] showing that being male is associated with lower levels of symptoms. Also, concerning age, the significant result that we found (higher risk for younger people) is in line with previous national and international studies[32,33] showing that even with different scales and methods, the results point in the same direction.

Concerning employment status, we did not find any relation with anxiety and depression symptoms as another study conducted in Portugal found – 'working at home or working without restrictions when compared to not working was associated with better mental health and life satisfaction during the COVID- 19 pandemic'.[34] Herein, we did not discriminate the answer given to the general question, and this could be a possible explanation for the different results found. Similarly, there was no relation between symptoms and lower education levels, as previously reported.[17,35] But, in this sense, it is important to highlight that the majority of individuals in our sample had a higher education degree, which could underestimate the association compared to other studies.

The relationship between mental illness, suicide, life satisfaction, and income has long attracted people's attention.[36-38] Other mental diseases, such as depression, anxiety, and substance misuse, have mixed results when it comes to income.[39] Lorant *et al* did a meta-analysis and found that having a low income was associated with a higher odds of depression (1.81 odds) compared to having a higher income.[40] Also, another study published in JAMA found that a drop in income was associated with an increased incidence of mood and substance use disorders, but not incident anxiety disorders.[41] In our study, the results point in the same direction. We found that people with insufficient household income or who suffered a change in their income due to the pandemic had higher levels of anxiety and depression symptoms. It was visible that these individuals had higher percentages within clusters 2 and 3 – 14.1% and 7.1%.

Another interesting finding that is also in line with previous research is that anxiety and depressive disorders were notably comorbid during the COVID-19 pandemic,[42] with higher levels of depression symptoms being substantially related to increasing levels of anxiety symptoms and vice versa[43] as seen in our sample in cluster 2 and 3. Those who had higher anxiety levels also had higher levels of depression symptoms.

The science of mental health and its connection to global well-being is still evolving. The link between major depressive disorders and different concomitant medical conditions, such as cardiovascular disease and diabetes, has been subject of research for many years.[44,45] Anxiety disorders are also disproportionately common among those with various medical problems.[46] And these findings are also visible in our study: participants who reported having at least one medical condition requiring medical assistance (comorbidity) had higher levels of anxiety and depression symptoms, with more than half of these individuals belonging to clusters 2 – 8.4% – and 3 – 6.6% – to 6.6% of the overall sample falling into cluster 1. This suggests that only 30% of people with comorbidities had mild symptoms of anxiety and depression.

Also, a clear link between food insecurity and mental health outcomes has already been established (as some of the present authors already discuss in another article with the same sample) – those who presented anxiety symptoms had seven-fold higher odds of belonging to a food-insecure household.[47] Here, we could see that those classified as food insecure were predominantly within cluster 2, with a prevalence of food insecurity of 4.4%. Furthermore, another study showed that food insecurity was associated with a 257% higher risk of anxiety and a 253% higher risk of depression.[48]

Finally, another result of interest must be underlined: drinking. According to the 'yes' and 'no' categories, 49.6% of people who reported drinking belong to cluster 1, 35% to cluster 3, and 15% to cluster 2, while 33% of people who did not drink belong to cluster 1, 44.5% to cluster 3, and 22% to cluster 1. With these findings, we found that most people who did not drink had anxiety and depression symptoms, but over half of those who reported drinking had a very low level of

symptoms. This result was quite surprising but is in line with previous studies showing that hazardous drinking, binge drinking, or alcohol dependence did not significantly increase the risk of anxiety and depression at follow-up. In addition, neither anxiety nor depression increased the risk of excessive alcohol consumption.[49] Moreover, other studies have not found the benefits of abstinence compared with moderate drinking.[50] It is also important to highlight that this result could come from the way we asked the question 'Do you drink or have you ever drank alcoholic beverages?', which includes current drinking and past drinking history. Also, with this study design – cross-sectional – and type of question we cannot differentiate who has a hazardous drinking profile. Moreover, we know that drinking wine and beer, for instance, is an intrinsic aspect of European life and culture, ingrained within social and cultural traditions that shape the diets of Europeans.[51] Wine and beer are acceptable beverages when drunk in moderation as part of a healthy, balanced diet and lifestyle.[52-54]

This health crisis, as well as the public health measures enforced to address it, has had a significant impact on people's lives, particularly in terms of their income, employment, and social contacts,[55] posing unique challenges in the realm of mental health that should be considered.[56] Many people, for various reasons, including mobility difficulties (due to motor difficulties, isolation, or a lack of resources), were unable to resort to psychological intervention. In Portugal, for instance, the use of free of charge remote psychological intervention (the National Health System's helpline as an example) may have resulted in significant gains, namely the facilitation of access to psychological intervention for a greater number of people. Even more so, the pandemic demonstrated how e-health may be useful (e.g., telemedicine). Digital health, which we have enabled during this crisis, must continue to make services, particularly psychiatric services, available and easy to use for everyone in the present and future.

Since the pandemic outbreak, the media has proven to be a highly successful vehicle for disseminating accurate and reliable information. Investing in national campaigns directed at these groups with media exposure can assist in directing individuals to the services they require and raise awareness of the need to reduce the stigma associated with mental illness. Public health teams are also crucial in planning swift and effective responses. A close collaboration between various specialists could provide significant benefits to the general public. Multidisciplinary collaboration between governmental decision-making bodies, public health professionals, psychologists, and community members should be prioritized.

It was confirmed once again that certain social groups are more vulnerable to the effects of health crises, which suggests there is a need to develop proactive actions to safeguard them and mitigate harm. This study also identified those flaws. More research, particularly qualitative research, is needed to better understand the procedural mechanisms that make these demographic vectors more vulnerable, as well as to collect ideas from these groups to improve interventional practice through participatory techniques.

Limitations

This study had a few limitations that should be considered. First, snowball sampling is based on referrals: the researcher recruits the initial participants, who then recruit the next participants. Participants may share similar characteristics and/ or be acquainted. As a result, not every member of the population has the same chance of being included in the sample, resulting in sampling bias. Secondly, because of the study's cross-sectional design, it could not determine the causal association between the numerous factors and depression and anxiety symptoms. In addition, this study used an online survey methodology and self-reported questionnaires, which could have resulted in participant response bias. Also, we excluded approximately half of the respondents' answers for the cluster analysis due to missing data necessary for conducting the K-means algorithm. We acknowledge that the missing data mechanism may not have been missing completely at random (MCAR), and therefore our results may not be completely reliable. However, the uncertainty about the method to be followed in the imputation (as different methods may lead to different solutions) and the very large percentage of missing observations did not provide enough confidence for the authors to proceed with an imputation method. Finally, there were clear gender discrepancies among the participants in our study, which may have influenced the sample's representativeness.

Strengths

One strength was the fact that the questionnaire was anonymous and online, which had the advantage of allowing researchers to reach people in far-flung regions in a faster and cheaper way. Also, because participants were responding alone, without the researcher's presence, they tended to be more honest in their responses. Although we cannot generalize our findings to the entire population, the results provide a starting point for tailoring specific interventions to specific groups of people. Also, as a strength, we should highlight the use of k-means clustering, which ensured data convergence, easily adapted to the dataset, and allowed generalization to clusters of different shapes and sizes, such as elliptical

clusters.

CONCLUSION

During the data collection period, between November 2020 and February 2021, the worst results for the mental health outcomes that were assessed – anxiety and depression symptoms – were more frequent in women, younger participants (< 40 years), those with insufficient household income, those who suffered changes in income due to COVID-19, and those classified as food insecure. Compared to these individuals, those who were older (≥ 40 years), male, with a higher education degree, with higher income perception, and less prone to being characterized as food insecure had, in some way, a safer economic position, compared to the first cluster. These findings show the existence of a social gradient in health, with those who are less advantaged in terms of socioeconomic status having poorer mental health outcomes, namely anxiety and depression symptoms.

The coronavirus pandemic has influenced people's mental health around the world. The impacts of a crisis on one's mental health extend beyond the event itself. Therefore, we need to think about long-term demand and work together to bring the best public health responses to the greatest number of groups at risk of mental health problems.

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AUTHOR CONTRIBUTIONS

AA, AB: Data collection, analysis, and interpretation drafting of the manuscript.

RG, MP, RD: Supervision, data collection, and interpretation, critical review of the manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

COMPETING INTERESTS

All authors have declared that no competing interests exist.

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REFERENCES

1. Martinez-Esquivel D. Desafíos para la enfermería de salud mental después del COVID-19. Rev Cienc Cuidad. 2020;1:122-9.
2. Trujillo-Hernández PE, Gómez-Melasio DA, Lara-Reyes BJ, Medina-Fernández IA, Hernández-Martínez EK. Asociación entre características sociodemográficas, síntomas depresivos, estrés y ansiedad en tiempos de la COVID-19. Enferm Glob. 2021;20:1-25.
3. World Health Organization. WHO Director-General's Opening Remarks at the Media Briefing on COVID-19. 2020. [cited 2022 Sep 05]. Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-may-2020.
4. Lippi G, Henry BM, Bovo C, Sanchis-Gomar F. Health risks and potential remedies during prolonged lockdowns for coronavirus disease 2019 (COVID-19). Diagnosis. 2020;7:85-90.
5. Xiao C. A novel approach of consultation on 2019 novel coronavirus (COVID-19)-related psychological and mental problems: structured letter therapy. Psychiatry Investig. 2020;17:175-6.
6. Lingelbach K, Piechnik D, Gado S, Janssen D, Eichler M, Hentschel L, et al. Effects of the COVID-19 pandemic on psychological well-being and mental health based on a German online survey. Front Public Health. 2021;9:655083.

7. Luanaigh CO, Lawlor BA. Loneliness and the health of older people. Int J Geriatr Psychiatry. 2008;23:1213-21.
8. Valtorta NK, Kanaan M, Gilbody S, Ronzi S, Hanratty B. Loneliness and social isolation as risk factors for coronary heart disease and stroke: systematic review and meta-analysis of longitudinal observational studies. Heart. 2016;102:1009-16.
9. Jha IP, Awasthi R, Kumar A, Kumar V, Sethi T. Learning the mental health impact of COVID-19 in the United States with explainable artificial intelligence: observational study. JMIR Ment Health. 2021;8:e25097.
10. Tasso AF, Hisli Sahin N, San Roman GJ. COVID-19 disruption on college students: academic and socioemotional implications. Psychol Trauma. 2021;13:9-15.
11. Delmastro M, Zamariola G. Depressive symptoms in response to COVID-19 and lockdown: a cross-sectional study on the Italian population. Sci Rep. 2020;10:22457.
12. Torales J, O'Higgins M, Castaldelli-Maia JM, Ventriglio A. The outbreak of COVID-19 coronavirus and its impact on global mental health. Int J Soc Psychiatry. 2020;66:317-20.
13. Caldas-de-Almeida J, Xavier M, Cardoso G, Gonçalves Pereira M, Gusmão R, Corrêa B. Estudo epidemiológico nacional de saúde mental: 1.º relatório. Lisboa: Faculdade de Ciências Médicas, Universidade Nova de Lisboa; 2013.
14. Dias S, Pedro A, Abrantes A, Gama A, Moniz A, Nunes C, et al., Opinião social: perceção individual do risco de contrair COVID-19, Barómetro COVID-19. Lisboa: Escola Nacional de Saúde Pública, Universidade Nova de Lisboa; 2020.
15. Trindade A, Pinto H, Palmeira L, Carvalho S, Pereira M. Mental health outcomes in Portuguese SARS-CoV-2 survivors and the general population during the covid-19 pandemic. "la Caixa" Foundation. 2021. [cited 2022 Aug 19]. Available from: https://oobservatoriosocial.fundacaolacaixa.pt/en/-/saude-mental-depois-da-infecao-por-covid-19.
16. Ferreira MJ, Sofia R, Carreno DF, Eisenbeck N, Jongenelen I, Cruz JF. dealing with the pandemic of COVID-19 in Portugal: on the important role of positivity, experiential avoidance, and coping strategies. Front Psychol. 2021;12:647984.
17. Moreira P, Ferreira S, Couto B, Machaco-Sousa M, Fernández M, Raposo-Lima C, et al. Protective elements of mental health status during the COVID-19 outbreak in the Portuguese population. Int J Environ Res Public Health. 2021;18:1910.
18. Maia B, Dias P. Anxiety, depression and stress in university students: the impact of COVID-19. Estud Psicol. 2020;37:e200067.
19. Aguiar A, Pinto M, Duarte R. Psychological impact of the COVID-19 pandemic and social determinants on the Portuguese population: protocol for a web-based cross-sectional study. JMIR Res Protoc. 2021;10:e28071.
20. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983;67:361-70.
21. Pais-Ribeiro J, Silva I, Ferreira T, Martins A, Meneses R, Baltar M. Validation study of a Portuguese version of the hospital anxiety and depression scale. Psychol Health Med. 2007;12:225-37.
22. Wunsch D, Xu R. Clustering. New Jersey: John Wiley & Sons, Inc; 2009. p.1-30.
23. Forgy E. Cluster analysis of multivariate data : efficiency versus interpretability of classifications. Biometrics. 1965;21:768-9.
24. Hartigan J. Algorithm AS 136: a k-means clustering algorithm. Applied Statistics. 1979;28:100-8.
25. R Core Team. R: a language and environment for statistical computing. R Foundation for Statistical Computing. 2018. [cited 2022 Jul 27]. Available from: https://www.R-project.org/.
26. Vahia IV, Blazer DG, Smith GS, Karp JF, Steffens DC, Forester BP, et al. COVID-19, mental health and aging: a need for new knowledge to bridge science and service. Am J Geriatr Psychiatry. 2020;28:695-7.
27. Andrade EF, Pereira LJ, Oliveira AP, Orlando DR, Alves DA, Guilarducci JS, et al. Perceived fear of COVID-19 infection according to sex, age and occupational risk using the Brazilian version of the fear of COVID-19 scale. Death Stud. 2022;46:533-42.
28. Bäuerle A, Teufel M, Musche V, Weismüller B, Kohler H, Hetkamp M, et al. Increased generalized anxiety, depression and distress during the COVID-19 pandemic: a cross-sectional study in Germany. J Public Health. 2020;42:672-8.
29. Caycho-Rodríguez T, Tomás JM, Barboza-Palomino M, Ventura-León J, Gallegos M, Reyes-Bossio M, et al. Assessment of fear of COVID-19 in older adults: validation of the fear of COVID-19 scale. Int J Ment Health Addict. 2022;20:1231-45.
30. Kuehner C. Gender differences in unipolar depression: an update of epidemiological findings and possible explanations [published correction appears in Acta Psychiatr Scand. 2003;108:406]. Acta Psychiatr Scand. 2003;108:163-74.
31. Lim GY, Tam WW, Lu Y, Ho CH, Zhang MW, Ho RC. Prevalence of depression in the community from 30 countries between 1994 and 2014. Sci Rep. 2018;8:2861.
32. Huang Y, Zhao N. Mental health burden for the public affected by the COVID-19 outbreak in China: who will be the high-risk group? [retracted in: Psychol Health Med.] Psychol Health Med. 2021;26:23-34.
33. Silva Moreira P, Ferreira S, Couto B, Machado-Sousa M, Fernández M, Raposo-Lima C, et al. Protective elements of mental health status during the COVID-19 outbreak in the Portuguese population. Int J Environ Res Public Health. 2021;18:1910.
34. Picó-Pérez M, Ferreira S, Couto B, Raposo-Lima C, Machado-Sousa M, Morgado P. Sociodemographic and lifestyle predictors of mental health adaptability during COVID-19 compulsory confinement: a longitudinal study in the Portuguese population. J Affect Disord. 2021;295:797-803.
35. Paulino M, Dumas-Diniz R, Brissos S, Brites R, Alho L, Simões MR, et al. COVID-19 in Portugal: exploring the immediate psychological impact on the general population. Psychol Health Med. 2021;26:44-55.
36. Demyttenaere KJ. WHO World Mental Health Survey Consortium: prevalence, severity, and unmeet need for treatment of mental disorders in the World Health Organization World Mental Health Surveys. JAMA. 2004;291:2581-90.
37. Fryers T, Melzer D, Jenkins R. Social inequalities and the common mental disorders: a systematic review of the evidence. Soc Psychiatry Psychiatr Epidemiol. 2003;38:229-37.
38. Kahneman D, Krueger AB, Schkade D, Schwarz N, Stone AA. Would you be happier if you were richer? A focusing illusion. Science. 2006;312:1908-10.
39. McMillan KA, Enns MW, Asmundson GJ, Sareen J. The association between income and distress, mental disorders, and suicidal ideation and attempts: findings from the collaborative psychiatric epidemiology surveys. J Clin Psychiatry. 2010;71:1168-75.
40. Lorant V, Deliège D, Eaton W, Robert A, Philippot P, Ansseau M. Socioeconomic inequalities in depression: a meta-analysis. Am J Epidemiol. 2003;157:98-112.
41. Sareen J, Afifi TO, McMillan KA, Asmundson GJ. Relationship between household income and mental disorders: findings from a population-based longitudinal study. Arch Gen Psychiatry. 2011;68:419-27.
42. Kalin NH. The critical relationship between anxiety and depression. Am J Psychiatry. 2020;177:365-7.
43. Passos L, Prazeres F, Teixeira A, Martins C. Impact on mental health due to COVID-19 pandemic: cross-sectional study in Portugal and Brazil. Int J Environ Res Public Health. 2020;17:6794.
44. Olver JS, Hopwood MJ. Depression and physical illness. Med J Aust. 2013;199:S9-12.
45. Schulberg HC, McClelland M, Burns BJ. Depression and physical illness: the prevalence, causation, and diagnosis of comorbidity. Clin Psychol Rev. 1987;7:145-67.

46. Aquin JP, El-Gabalawy R, Sala T, Sareen J. Anxiety disorders and general medical conditions: current research and future directions. Focus. 2017;15:173-81.
47. Aguiar A, Pinto M, Duarte R. The bad, the ugly and the monster behind the mirror - food insecurity, mental health and socio-economic determinants. J Psychosom Res. 2022;154:110727.
48. Fang D, Thomsen MR, Nayga RM. The association between food insecurity and mental health during the COVID-19 pandemic. BMC Public Health. 2021;21:607.
49. Turk CL. Excessive alcohol consumption is not a risk factor for anxiety and depression, nor are anxiety and depression a risk factor for excessive alcohol consumption. Evid Based Ment Health. 2006;9:85.
50. Paschall MJ, Freisthler B, Lipton RI. Moderate alcohol use and depression in young adults: findings from a national longitudinal study. Am J Public Health. 2005;95:453-7.
51. Poelmans E, Swinnen JF. A brief economic history of beer. Oxford: Oxford Academic; 2011.
52. Lindberg ML, Amsterdam EA. Alcohol, wine, and cardiovascular health. Clin Cardiol. 2008;31:347-51.
53. Arranz S, Chiva-Blanch G, Valderas-Martínez P, Medina-Remón A, Lamuela-Raventós RM, Estruch R. Wine, beer, alcohol and polyphenols on cardiovascular disease and cancer. Nutrients. 2012;4:759-81.
54. National Institutes of Health. Biological sciences curriculum study. nih curriculum supplement series. 2007 [cited 2023 Mar 20]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK20360/.
55. Aguiar A, Maia I, Duarte R, Pinto M. The other side of COVID-19: preliminary results of a descriptive study on the COVID-19-related psychological impact and social determinants in Portugal residents. J Affect Disord Rep. 2022;7:100294.
56. Kumar M, Kumar P. Impact of pandemic on mental health in lower- and middle-income countries (LMICs). Glob Ment Health. 2020;7:e35.

Table 1 – Comparison of the characteristics between included participants and non-participants

Factors	Included participants (n = 453) n (%)	Excluded participants (n = 447) n (%)	p-value
Mental health			
Anxiety symptoms (mean, SD)	7.87 (4.394)	8.10 (4.425)	0.432
Depression symptoms (mean, SD)	5.04 (3.498)	5.04 (3.436)	0.489
Demographic			
Age			0.115
< 40 years	275 (60.7)	294 (65.8)	
≥ 40 years	178 (39.3)	153 (34.2)	
Sex			0.119
Male	137 (30.2)	113 (25.6)	
Female	316 (69.8)	329 (74.4)	
Education			0.309
≤ 12	112 (24.7)	95 (21.8)	
Higher education	341 (75.3)	340 (78.2)	
Marital status			0.164
Married/in a civil partnership	207 (45.7)	182 (41.1)	
Not married	246 (54.3)	261 (58.9)	
Household income			0.393
Insufficient	23 (5.1)	16 (3.7)	
Sufficient	285 (62.9)	290 (66.7)	
Comfortable	145 (32.0)	129 (29.7)	
Income change			0.433
Changed due to COVID-19	165 (36.4)	168 (39.0)	
Did not change	288 (63.6)	263 (61.0)	
Region			0.671
North	299 (66.0)	271 (63.2)	
Lisbon Metropolitan area	91 (20.1)	92 (21.4)	
Others	63 (13.9)	66 (15.4)	
Household size			0.307
1 person	79 (17.4)	62 (14.4)	
2 persons	130 (28.7)	140 (32.6)	
≥ 3 persons	244 (53.9)	228 (53.0)	
Job situation after COVID-19			0.723
Continued employed	348 (76.8)	287 (79.3)	
Became unemployed	39 (8.6)	31 (8.6)	
Continued unemployed	25 (5.5)	19 (5.2)	
Others	41 (9.1)	25 (6.9)	
Have any illness diagnosed by the doctor that requires regular health care			0.823
No	355 (78.4)	342 (79.0)	
Yes	98 (21.6)	91 (21.0)	
Behavioral			
Drinking habits			0.072
No	191 (42.2)	210 (48.2)	
Yes	262 (57.8)	226 (51.8)	
Smoking habits			0.155
No	344 (75.9)	346 (79.9)	
Yes	109 (24.1)	87 (20.1)	
Use of anxiolytics			0.126
No	388 (85.7)	352 (81.9)	
Yes	65 (14.3)	78 (18.1)	
COVID-19			
COVID-19 diagnoses			0.158
No	437 (96.5)	413 (94.5)	
Yes	16 83.5)	24 (5.5)	
Food			
Food security			0.249
Food secure	378 (94.3)	418 (92.3)	
Food insecure	23 (5.7)	35 (7.7)	
Food affordability exacerbation			**< 0.001***
Did not worsen	356 (78.6)	108 (65.5)	
Worsened	97 (21.4)	57 (34.5)	

*p-value < 0.05;
SD: standard deviation

Table 2 – Description of the socio and behavioral variables by participants' proportion in each cluster

	Cluster			
	1 (n = 194)	2 (n = 82)	3 (n = 177)	
Factors	n (%)	n (%)	n (%)	*p*-value*
Demographic				
Age				**0.024**
< 40 years	121 (62.4)	44 (53.7)	110 (62.1)	
≥ 40 years	73 (37.6)	38 (46.3)	67 (37.9)	
Sex				**0.041**
Male	58 (29.9)	25 (30.5)	54 (30.5)	
Female	136 (70.1)	57 (69.5)	123 (69.5)	
Education				0.116
≤ 12	38 (19.6)	25 (30.5)	49 (27.7)	
Higher education	156 (80.4)	57 (69.5)	128 (72.3)	
Marital status				0.620
Married/in a civil partnership	99 (51.0)	33 (40.2)	75 (42.4)	
Not married	95 (49.0)	49 (59.8)	102 (57.6)	
Household income				**0.017**
Insufficient	55 (28.4)	29 (35.4)	55 (31.1)	
Sufficient	72 (37.1)	28 (34.1)	69 (39.0)	
Comfortable	67 (34.5)	25 (30.5)	53 (29.9)	
Income change				**< 0.001**
Changed due to COVID-19	69 (35.6)	31 (37.8)	65 (36.7)	
Did not change	125 (64.4)	51 (62.2)	112 (63.3)	
Region				0.938
North	137 (70.6)	47 (57.3)	115 (65.0)	
Lisbon Metropolitan area	35 (18.0)	15 (18.3)	41 (23.2)	
Others	22 (11.3)	20 (24.4)	21 (11.9)	
Household size				0.958
1 person	34 (17.5)	13 (15.9)	32 (18.1)	
2 persons	61 (31.4)	20 (24.4)	49 (27.7)	
≥ 3 persons	99 (51.0)	49 (59.8)	96 (54.2)	
Job situation after COVID-19				0.320ᵀ
Continued employed	154 (79.4)	60 (73.2)	134 (75.7)	
Became unemployed	14 (7.22)	7 (8.54)	18 (10.2)	
Continued unemployed	8 (4.12)	5 (6.10)	12 (6.78)	
Others	18 (9.28)	10 (12.2)	13 (7.34)	
Have any illness diagnosed by the doctor that requires regular health care				**< 0.001**
No	150 (77.3)	69 (84.1)	136 (76.8)	
Yes	44 (22.7)	13 (15.9)	41 (23.2)	
Behavioral				
Drinking habits				**0.002**
No	81 (41.8)	41 (50.0)	69 (39.0)	
Yes	113 (58.2)	41 (50.0)	108 (61.0)	
Smoking habits				0.737
No	139 (71.6)	60 (73.2)	145 (81.9)	
Yes	55 (28.4)	22 (26.8)	32 (18.1)	
Use of anxiolytics				**< 0.001**
No	168 (86.6)	63 (76.8)	157 (88.7)	
Yes	26 (13.4)	19 (23.2)	20 (11.3)	
COVID-19				
COVID-19 diagnoses				0.780ᵀ
No	192 (99.0)	78 (95.1)	167 (94.4)	
Yes	2 (1.03)	4 (4.88)	10 (5.65)	
Food				
Food security				**< 0.001**
Food secure	184 (94.8)	74 (90.2)	160 (90.4)	
Food insecure	10 (5.15)	8 (9.76)	17 (9.6)	
Food affordability exacerbation#				**< 0.001**
Did not worsen	167 (86.1)	61 (74.4)	128 (72.3)	
Worsened	27 (13.9)	21 (25.6)	49 (27.7)	

Cluster 1: Low anxiety and depression symptoms; Cluster 2: people with high anxiety and depression symptoms; Cluster 3: people with mild anxiety and mild depression
p-values from the chi-squared test; ᵀ Fisher exact test; values with *p* < 0.05 are in bold; # the variable 'Food affordability exacerbation' was created having as based question in the questionnaire 'Regarding questions related with Food security, did these situations worsen during the pandemic?' with 'yes' and 'no' answer.
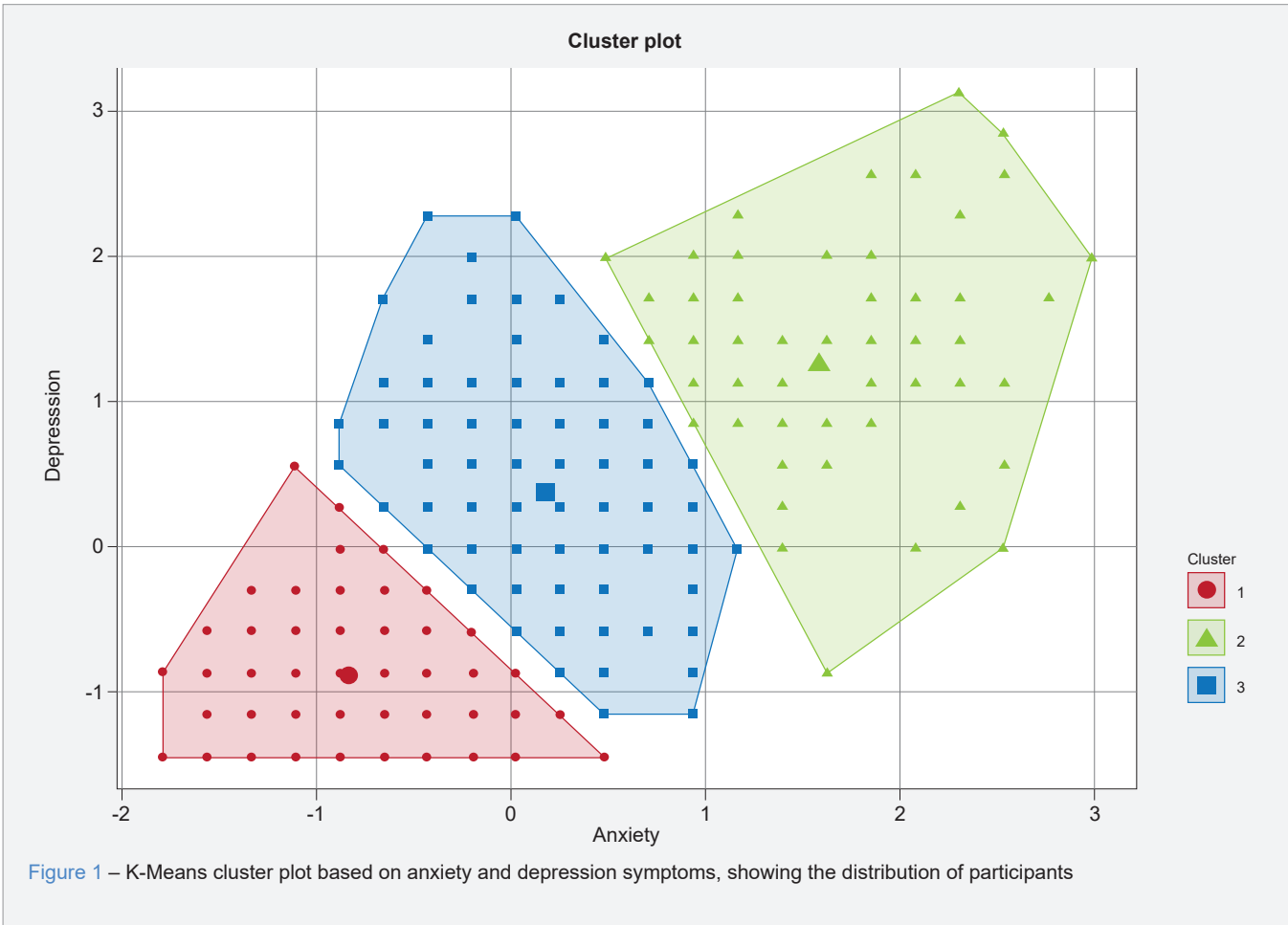
Figure 1 – K-Means cluster plot based on anxiety and depression symptoms, showing the distribution of participants
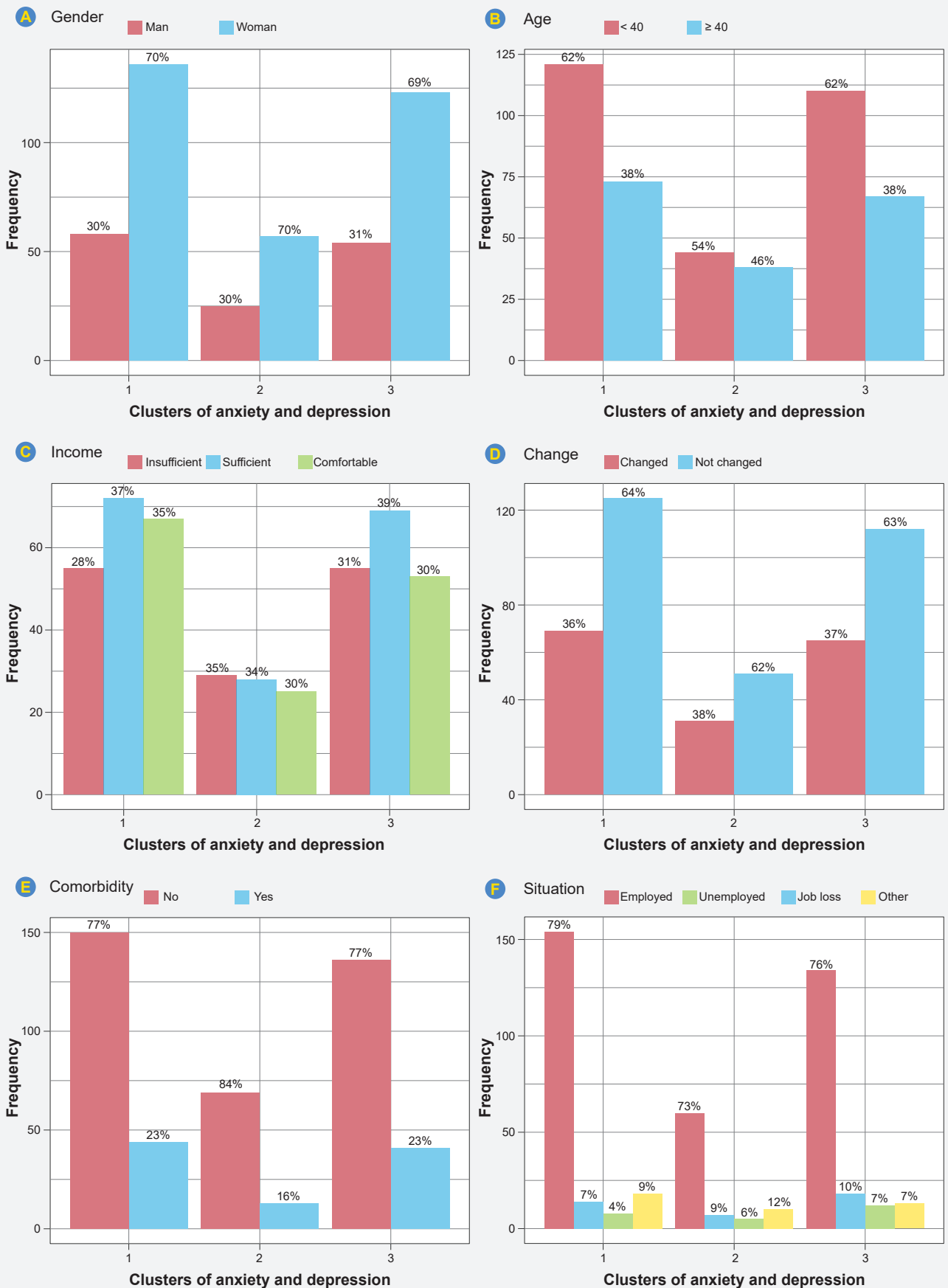
Figure 2 – Barplots between the anxiety and depression symptoms clusters and sociodemographic variables
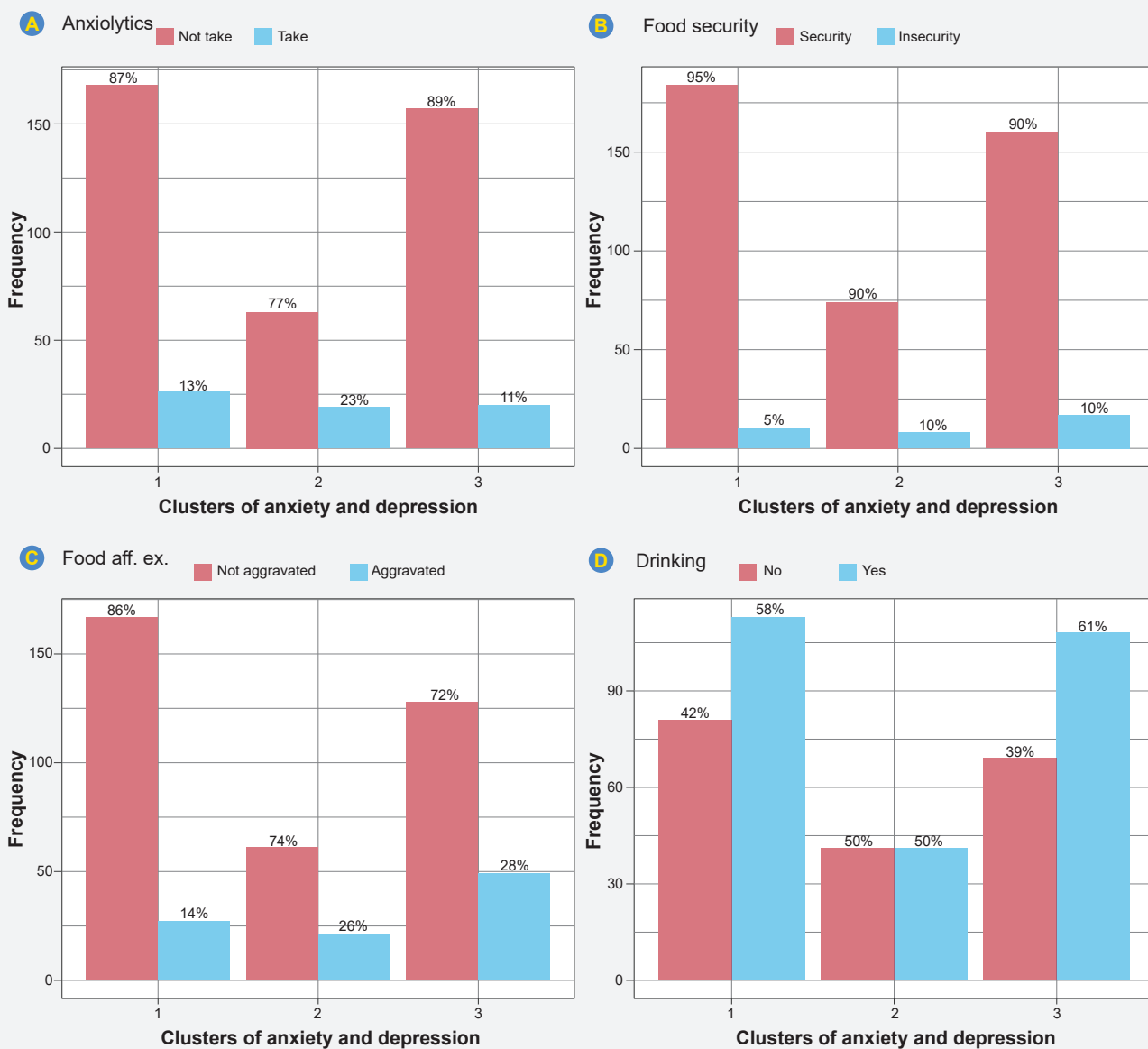
Figure 3 – Barplots between the anxiety and depression symptoms clusters and behavioral and food security variables