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Evidence of the psychological effects of pseudoscientific information about COVID-19 on rural and urban populations

Abstract

This research aims to analyze the effects of pseudoscientific information (PI) about COVID-19 on the mental well-being of the general population. A total of 782 participants were classified according to the type of municipality in which they lived (rural municipalities and urban municipalities). The participants answered psychometric questionnaires that assessed psychological well-being, pseudoscientific beliefs and the ability to discriminate between scientific and pseudoscientific information about COVID-19. The results indicated the following:

the greater the ability to discriminate between false information and true information, the greater the levels of psychological well-being perceived by the participant. The ability to discriminate predicts up to 32% of psychological well-being only for subjects living in rural municipalities. Residents in urban municipalities showed lower levels of well-being than residents in rural municipalities. It is concluded that new social resources are needed to help the general population of urban municipalities discriminate between pseudoscientific and scientific information.

Keywords: COVID-19; rural municipalities; SARS-CoV-2; Psychological Well-being; Pseudoscientific Information.

1. Introduction

Pseudoscientific beliefs are systems of meanings that accept the existence of impossible facts or contents according to the epistemological bases of the scientific method (e.g., [Blancke et al., 2020](#); [Schiele, 2020](#)). Similarly, pseudoscientific information (hereafter PI) refers to references and news that promote false scientific content (e.g., [Escolà-Gascón et al., 2020](#); [Tsai et al., 2012](#)). False scientific content is not supported by evidence from academic research (for this reason, it is considered "false") (e.g., [Matute et al., 2011](#); [Sugavanam and Natarajan, 2020](#)).

In summary, there are three main reasons for creating pseudoscientific information: (1) the subjective misinterpretation of an event or an experience, which acquires a meaning that differs from its formal characteristics (e.g., [Lange et al., 2017](#); [Mohr et al., 2019](#)). These misinterpretations are called cognitive biases or causal illusions (e.g., [Matute et al., 2015](#); [van Elk, 2019](#)). (2) The presence of a system of meanings whose contents are magical and irrational (e.g., [Boudry et al., 2014](#); [Irwin et al., 2013](#)). These two characteristics represent the foundations of pseudoscientific beliefs (e.g., [Rogers et al., 2017](#)). (3) The intentional desire for secondary benefits, which usually has an economic or mercantilist purpose (e.g., [Reber and Alcock, 2020](#)). In this case, the pseudoscientific belief is a deliberate invention that encourages the buying and selling of alternative therapies (see [Houran et al., 2020](#); [Metin et al., 2020](#) for a review).

Although the causal factors of pseudoscientific information are complex to analyze (e.g., [Fasce and Picó, 2018](#)), it is important to know the relationship between pseudoscientific beliefs, pseudoscientific information, and people's quality of life (e.g., [Escolà-Gascón, 2020a, 2020b](#)). In this research, the effects of pseudoscientific beliefs and pseudoscientific information related to COVID-19 on people's mental health during the period of coronavirus crisis are analyzed. To what extent does pseudoscientific information about COVID-19 affect us? Can the general population differentiate a scientific news item from another pseudoscientific item?

1.1. Theoretical background concerning pseudoscientific information

When information is classified as "pseudoscientific", it loses rational credibility (e.g., [Matute et al., 2015](#); [Pigliucci and Boudry, 2013](#)). This expression means that the news lacks scientific and rational foundations. However, [Acunzo et al. \(2020\)](#) observed that subjects who

are believers in the paranormal tend to interpret certain extraordinary experiences as "paranormal phenomena" - see the concept of anomalous experiences in Irwin et al. Paranormal beliefs represent a type of pseudoscientific belief that attributes supernatural causes to certain extraordinary experiences (see [Crowe and Miura, 1995](#); [Lobato et al., 2014](#)). These findings have the following implication: despite the loss of rational credibility, if the subject has pseudoscientific beliefs, he or she will accept as valid the information classified as "pseudoscientific" (e.g., [Mikušková, 2018](#); [Wahbeh et al., 2020](#)). Thus, belief systems condition the management and use of pseudoscientific information by each person (e.g., [Betsch et al., 2020](#); [Perez-Navarro and Martinez-Guerra, 2020](#)).

What some researchers wonder is what use and with what criteria the general population discriminates scientifically-based information from pseudoscientific information (e.g., [Aleixandre-Benavent et al., 2020](#)). Some research has shown that people do not possess sufficient skills or knowledge to discriminate between scientific and pseudoscientific information (e.g., [Jupe and Denault, 2019](#)). This evidence indicates that pseudoscientific beliefs have a fundamental role and can foster the credibility confidence attributed to PI (e.g., [Irwin, 2009](#)). However, not having pseudoscientific beliefs does not protect people from PI (e.g., [Zaboski and Theriault, 2019](#)). It is also possible to mistakenly accept a PI as scientific data, believing it to be evidence-based (e.g., [Matute et al., 2015](#)).

According to [Denault and Jupe \(2017\)](#), pseudoscientific information can generate bad decisions that endanger the justice and integrity of the individual (see also [Li et al., 2018](#)). The health consequences of PI were investigated earlier, and the following effects can be found: (1) PI confuses and increases anxiety levels in the general population (e.g., [Bensley et al., 2019](#)). (2)

Pseudoscientific beliefs and PI lead to problematic changes in people's lifestyles (e.g., [Imber-Black, 2020](#)). An updated example related to the COVID-19 crisis is the changes in diet and nutrition that some people made intending to achieve "spiritual healing" (e.g., [Freire, 2020](#); [Mattioli et al., 2020](#)). In the context of social quarantine, numerous irrational behaviors resulting from collective panic and the effects of pseudoscientific information were also observed during the first months of the pandemic (e.g., [Escolà-Gascón et al., 2020](#); [Khan et al., 2020](#)). The most frequent behavior (and one that was observed in many Western countries) was the compulsive purchase of hygiene products (especially toilet paper), which were sold out in supermarkets although there was no risk of shortage (e.g., [Pagano et al., 2020](#); [Zhou et al., 2020](#)). However, in other countries such as India, some people relied on pseudoscientific treatments against coronavirus and took cow urine to prevent infection (e.g., [Singh, 2020](#)). Other factors that are cultural and religious also play a role in this type of situation. For example, in India, cows are sacred animals, and urine intake could be explained not so much by a pseudoscientific issue but rather by a religious attribution (e.g., [Iqbal et al., 2020](#)). In any case, these examples are only intended to illustrate the diversity of the influence of pseudoscientific beliefs and PI on the behavior of the general population.

To protect the patient, health professionals should be aware of and informed about the hoaxes and PIs related to COVID-19 (see [Escolà-Gascón et al., 2020](#)). Thus, this kind of false news about coronavirus should be medically and politically addressed not because they are "pseudoscientific beliefs", but because their misuse can put people's health at risk (e.g., [Deville and Lohr, 2008](#); [March and Springer, 2019](#)). Similarly, knowing the way of thinking associated with pseudoscientific beliefs and the use of pseudoscientific information can facilitate the

understanding of why some subjects commit these kinds of decisions or behaviors and others do not (e.g., drinking cow urine) (see [Ross et al., 2017](#)).

As can be deduced, the more popular the content of pseudoscientific news, the greater the social impact it will have on people (e.g., [Pulido et al., 2020a](#); [Pulido et al., 2020b](#)). This means that the consequences of PIs related to COVID-19 may generate dysfunctional and psychopathological social behaviors, which would not facilitate citizen obedience to preventive hygiene, health, and medical safety standards (e.g., [De Sousa et al., 2020](#)).

There is a crucial point in this object of study (i.e., pseudoscientific information) that cannot be forgotten: in the psychiatric context, the problem is not whether the patient has pseudoscientific beliefs (e.g., [Escolà-Gascón et al., 2020](#)). It is the patient's use of such beliefs to interpret environmental inputs and make decisions (e.g., [Lawrence, 2016](#)). For this reason, it is not a matter of judging belief systems in clinical terms, since each patient is free to believe whatever he or she wishes (see [Thalbourne and Storm, 2019](#)). It is the management and dysfunctional handling by the patient of his belief system that must be analyzed and addressed in therapeutic terms (see [Irwin, 2009](#)).

1.2. Objectives and hypotheses

According to the theoretical background described in the previous section, this research aims to analyze the psychopathological and dysfunctional impact of the use of pseudoscientific information on COVID-19. Taking into account the excess information about Coronavirus (e.g., [Innerarity and Colomina, 2020a](#)), it is intended to test whether the population (based on their knowledge and beliefs) is able to discriminate between the pseudoscientific news about COVID-19 and news that has scientific support. Likewise, the main debate is also based on the following

question: what implications do and will misuse of pseudoscientific information have for the population?

We start from the general hypothesis that pseudoscientific beliefs will be correlated and will predict errors in discrimination between true information and pseudoscientific information on COVID-19. In parallel, the following hypothesis is also raised: successes in discriminating false news about COVID-19 will positively predict the psychological well-being of people.

2. Methods

2.1. Participants

A total of 782 participants collaborated in this research. Of these, 49.9% were men, and 50.1% were women. All subjects were of legal age (mean= 34.39; standard deviation= 9.569) and came from urban (47.7%) and rural (52.3%) environments. The participants declared that they were not in psychiatric treatment and signed a written informed consent authorizing their collaboration in this study. The data collected were recorded anonymously.

2.2. Materials

2.2.1. Spanish adaptation of the *Psychological Well-Being Scales (PWBS)*

The PWBS is a questionnaire originally developed by [Ryff \(1989\)](#) that measures the psychological well-being of the subject. The Spanish version comprises 29 items that measure 6 dimensions: (1) self-acceptance (SA), (2) positive relations (PR), (3) autonomy (AU), (4) management of environment (ME), (5) life purpose (LP) and (6) personal growth (PG). The answers are coded with a graduated scale ranging from 1 ("strongly disagree") to 6 ("strongly agree"). The higher the scores, the more psychological well-being the participant will present.

The psychometric properties of the PWBS were examined several times and were satisfactory in all cases (see [van Dierendonck, 2004](#)). Specifically, in the Spanish version validated by [Díaz et al. \(2006\)](#), the reliability indices based on the internal consistency of the responses were very high (>0.7) in all dimensions of the PWBS. This version was the one used in this study.

2.2.2. Australian Sheep-Goat Scale (ASGS)

The ASGS scale consists of 18 items that examine pseudoscientific beliefs focused on paranormal experiences. The ASGS scale was initially proposed by [Thalbourne \(1981\)](#), and the answers can be coded in several ways. In this research, we opted for the recommendation of [Drinkwater et al. \(2018\)](#), who distinguish three categories: 2= "true" (should be marked when the subject believes that he/she has lived the experience that the item expresses); 1= "I doubt my answer" (should be marked when the subject is unsure about his/her answer); and 0= "false" (should be marked when the subject believes that he/she has not lived the experience that the item expresses). The psychometric benefits of the ASGS show evidence of its validity, and it has a total reliability index greater than 0.8 (see [Drinkwater et al., 2018](#)). The Spanish version of the ASGS was developed by Escolà-Gascón and Lance Storm, although it is still under development. Because it has not yet been published, the ASGS questionnaire used in this study is attached as supplementary material.

2.2.3. Discrimination Cognitive test between true and pseudoscientific information about coronavirus

This test was created for the purpose of evaluating each participant's ability to discriminate between scientific and pseudoscientific information on IDOC-19. It is an optimal performance test formed by 18 statements that gather different types of information about

coronavirus. The participant must indicate if the contents of each item are supported by scientific evidence. In this test, there are three types of answer options: "yes" (the content is scientifically proven and true); "?" (there is not enough scientific evidence to determine if it is true); and "no" (the content of the sentence is not scientific and is false). If the participant is correct in his/her choice of answer, 1 point is added. If the participant fails to choose his/her answer, 0 points are added. Errors were not penalized in this test, and participants had to answer all questions. The contents of the items were based on the list of hoaxes about COVID-19 published by the [World Health Organization \(2020\)](#). Table 1 shows the items in this test with the correct answers for each of them.

Table 1. *Experimental questions about COVID-19 based on contents published by the [World Health Organization \(2020\)](#).*

| N° | Questions | R |
|----|---|---|
| 1 | The coronavirus can be transmitted through mosquito bites. | ? |
| 2 | Coronaviruses can be deadly at any age. | Y |
| 3 | Coronaviruses can be cured with antibiotics. | N |
| 4 | Coronaviruses can cause diarrhea. | ? |
| 5 | Coronavirus can be prevented through vaccination. | Y |
| 6 | Coronavirus can be a chronic disease. | ? |
| 7 | Coronaviruses can cause flu-like symptoms. | Y |
| 8 | Coronaviruses can spread through the air over long distances. | N |
| 9 | Coronaviruses can be spread through physical contact. | Y |
| 10 | Coronaviruses can spread more quickly through electromagnetic fields. | N |
| 11 | Coronavirus can be transmitted through dogs and cats. | ? |
| 12 | Coronavirus can make your nails grow faster. | N |

| | | |
|----|--|---|
| 13 | Coronavirus can cause pneumonia. | Y |
| 14 | Coronavirus can cause a loss of smell. | ? |
| 15 | Coronavirus can be a mutation of the AIDS virus. | N |
| 16 | Coronavirus can cause coughing. | Y |
| 17 | Coronavirus can be prevented by taking stimulant substances. | N |
| 18 | The coronavirus may mutate in the future and be more lethal. | ? |

Note: R= correct answer; Y= yes; N= no; ?= content not verifiable.

2.3. Procedure

The design of this research is correlational. Participants were recruited through social networks and media. The questionnaires were digitized and sent online in bulk to several Spanish Facebook and Whatsapp groups. The subjects who wanted to participate had to access the link. The answers were automatically recorded in a raw data matrix that was later refined. The purging of the data consisted of classifying whether the participants resided in a rural or urban environment. To do this, the name of the municipality in which each participant had their first or only residence was asked. We also asked what type of housing was the first residence. This concept should be understood as the housing in which a subject resides regularly and continuously.

2.3.1. Inclusion criteria and sampling

The sampling in this study was not probabilistic. We used the urban indicators of the [National Institute of Statistics from Spain \(2020\)](#) that determine which environments are considered urban and which are considered rural. Although several criteria can be used, in this research, the rule was chosen according to the number of inhabitants in the community (with more than 10,000 inhabitants, the municipality is considered a city). The type of housing was

also taken into account: (a) collective housing (block of apartments) and (b) single-family housing (house with or without a garden). The classification criteria were as follows:

[1] For RURAL environments. The setting was considered rural only when the number of inhabitants was less than 10,000 and the participant resided in a single-family home.

[2] For URBAN settings. The setting was classified as urban when the number of inhabitants of the municipalities exceeded 10,000 and the participant resided in a collective home.

Then, taking into account this information, the criteria for the inclusion of the sample were developed. Specifically, the participants should:

[1] Be of legal age.

[2] Not being in official psychiatric treatment.

[3] Meet one of the following 2 conditions for residence: (a) residence in a city (>10,000 inhabitants) and in a collective dwelling; or (b) residence in a town (<10,000 inhabitants) and in a single-family dwelling.

Participants who did not meet these inclusion criteria were removed from the original data matrix. In total, 11 subjects did not meet the criteria [2], and 109 subjects did not meet the criteria [3]. All subjects were of legal age. Finally, the sample was formed by the 782 subjects described in subsection 2.1. ("participants").

2.4. Statistical analysis

The data were processed with the statistical program JAMOVİ, which uses the R code and is free of charge (see The Jamovi Project, 2020). *Simple regression models* were applied to quantify and predict perceived psychological well-being. Pseudoscientific beliefs and the degree

of discrimination of pseudoscientific information were the predictor variables. The 6 dimensions related to psychological well-being were the dependent or criterion variables.

Student's t-test and its nonparametric version (*Mann-Whitney's U test*) were also used to analyze whether differences in scores between residents of rural and urban environments were significant. As a complement, a *Bayesian* estimate was applied to characterize the ex-post distribution regarding the probability that the alternative hypothesis (H_1) fits the observed data (D). This probability is mathematically represented as $P(H_1|D)$ and can be obtained from the estimation of the Bayes factor in favor of H_1 (henceforth BF_{10}):

$$BF_{10} = \frac{P(D|H_1)}{P(D|H_0)}$$

On the one hand, $P(D|H_1)$ is the probability that the observed data reproduce the distribution associated with the alternative hypothesis. On the other hand, $P(D|H_0)$ is the probability that the observed data reproduce the distribution associated with the null hypothesis. The main problem is that in classical frequency contrasts, $P(D|H_1)$ is not known, so $P(H_1|D)$ cannot be estimated. On the other hand, in Bayesian statistics, when the probabilities fixed *a priori* are adjusted to 50% (this means that the null hypothesis and the alternative hypothesis have the same probability of being true), the value of BF_{10} can be transformed to the probability metric, and $P(H_1|D)$ is obtained as follows:

$$P(H_1|D) = \frac{BF_{10}}{BF_{10} + 1}$$

This is possible because the BF_{10} is in an odds metric (although it is not technically an odds).

Therefore, the critical level of classical frequency contrasts will only report $P(D|H_0)$.

However, if the data do not fit the distribution given by H_0 (i.e., $p < 0.001$), it does not mean that

H_1 is valid or true. The degree of certainty between H_1 and the data (D) is only quantified in terms of probability by $P(H_1|D)$. Then, $P(H_1|D)$ represents a statistical estimate that indicates to what extent H_1 is true based on the observed data.

3. Results

3.1. Descriptive statistics and correlation matrices

The descriptive statistics of the variables analyzed are presented in Table 2.

Table 2. *Descriptive statistics for each group and variable.*

| Measured variables | Residents in <u>urban</u> <u>environments</u> (n= 373) | | Residents in <u>rural</u> <u>environments</u> (n= 409) | |
|--|--|--------------------|--|--------------------|
| | Mean | Standard deviation | Mean | Standard deviation |
| Pseudoscientific beliefs (ASGS) | 18.05 | 10.58 | 15.98 | 9.861 |
| Number of correct answers regarding to COVID-19 exam | 8.13 | 5.026 | 10.82 | 4.982 |
| Self-acceptance (PWBS) | 12.62 | 5.527 | 14.45 | 5.917 |
| Positive relations (PWBS) | 16.19 | 6.268 | 17.58 | 6.514 |
| Autonomy (PWBS) | 22.62 | 6.828 | 25.18 | 7.089 |
| Management of environment (PWBS) | 19.23 | 6.016 | 20.93 | 6.129 |
| Life purpose (PWBS) | 15.36 | 6.391 | 15.32 | 5.824 |

| | | | | |
|------------------------|------|------|------|-------|
| Personal growth (PWBS) | 8.46 | 2.98 | 9.33 | 3.235 |
|------------------------|------|------|------|-------|

Note: ASGS= Australian Sheep-Goat Scale; PWBS= Psychological Well-Being Scales.

To check if it was convenient to apply the regression models, Pearson's linear correlations between the variables in Table 2 were calculated. The correlations are shown in Tables 3 (for subjects living in urban environments) and 4 (for subjects living in rural environments).

Table 3. *Pearson's correlation matrix for residents in urban environments (n= 373).*

| | ASGS | CA-PI | SA | PR | AU | ME | LP | PG |
|-------|---------|--------|--------|--------|--------|--------|--------|----|
| ASGS | | | | | | | | |
| CA-PI | -0.745* | | | | | | | |
| SA | 0.057 | 0.177* | | | | | | |
| PR | 0.051 | 0.155 | 0.2* | | | | | |
| AU | -0.051 | 0.28* | 0.305* | 0.254* | | | | |
| ME | -0.059 | 0.289* | 0.246* | 0.195* | 0.317* | | | |
| LP | 0.216* | -0.014 | 0.194* | 0.245* | 0.241* | 0.144 | | |
| PG | -0.093 | 0.311* | 0.215* | 0.211* | 0.307* | 0.208* | 0.231* | |

Note: *p<0.001. ASGS= scores related to the pseudoscientific beliefs; CA-PI= correct answers regarding to COVID-19 pseudoscientific information exam; SA= self-acceptance; PR= positive relations; AU= autonomy; ME= management of environment;

LP= life purpose; PG= personal growth.

Table 4. *Pearson's correlation matrix for residents in rural environments (n= 409).*

| | ASGS | CA-PI | SA | PR | AU | ME | LP | PG |
|-------|---------|--------|--------|--------|--------|--------|--------|----|
| ASGS | | | | | | | | |
| CA-PI | -0.372* | | | | | | | |
| SA | 0.046 | 0.57* | | | | | | |
| PR | 0.062 | 0.515* | 0.508* | | | | | |
| AU | 0.09 | 0.467* | 0.386* | 0.539* | | | | |
| ME | 0.098 | 0.501* | 0.558* | 0.514* | 0.474* | | | |
| LP | 0.024 | 0.483* | 0.491* | 0.421* | 0.451* | 0.41* | | |
| PG | 0.059 | 0.558* | 0.513* | 0.47* | 0.497* | 0.535* | 0.448* | |

Note: *p<0.001. ASGS= scores related to the pseudoscientific beliefs; CA-PI= correct answers regarding to COVID-19 pseudoscientific information exam; SA= self-

acceptance; PR= positive relations; AU= autonomy; ME= management of environment; LP= life purpose; PG= personal growth.

Table 3 indicates that the pseudoscientific beliefs and the dimensions of psychological well-being are independent of each other (except for the LP dimension, which is positively associated with ASGS scores). The negative correlation between ASGS and CA-PI scores indicates that the more pseudoscientific beliefs a subject has, the less successful he/she will be on the CA-PI test. Similarly, the dimensions of psychological well-being are positively correlated with the scores obtained in the COVID-19 test. Therefore, the better the subject knows how to discriminate between the quality of the COVID-19 information, the greater the psychological well-being he/she will present. This trend is also replicated in the correlation matrix in Table 4.

According to the hypotheses raised, the null hypothesis of independence between ASGS and CA-PI is rejected, and the research hypothesis raised in the introduction is maintained. Likewise, the alternative hypothesis is also maintained, as the hits correlate positively with the scales of psychological well-being.

The correlations in Tables 3 and 4 suggest that it appears convenient to apply several regression models using only the variables AU, ME, LP, PG, ASGS and CA-PI. For the group of rural residents, the SA and PR variables were also included. The other variables do not show sufficiently high correlations to fit a regression-prediction model.

3.2. Regression models

The regression models were adjusted as follows: the ASGS and CA-PI variables were set as predictor variables, and the AS, PR, AU, ME, LP, and PG scales were the criteria variables. Multivariate canonical regression was ruled out because of the number of false positives it

produces (see [Pardo and San Martín, 2015](#)). Tables 5 and 6 show the regression models and the explained variance obtained (R^2).

Table 5. Regression model using “enter method” for residents in urban environments ($n=373$). Criteria variables= AU, ME and PG; Predicting variable= CA-PI. ASGS was also used to predict LP scores.

| Criteria variables | Predicting variable= CA-PI | | | | |
|--------------------|----------------------------|---------------|-----------|-------|---------|
| | B | s.e. | β_z | R^2 | F |
| AU | 0.380* (19.530) | 0.068 (0.647) | 0.28* | 0.078 | 31.547* |
| ME | 0.346* (16.420) | 0.059 (0.569) | 0.289* | 0.084 | 33.804* |
| PG | 0.185* (6.957) | 0.029 (0.280) | 0.311* | 0.094 | 39.776* |

| Criteria variables | Predicting variable= ASGS | | | | |
|--------------------|---------------------------|---------------|-----------|-------|---------|
| | B | s.e. | β_z | R^2 | F |
| LP | 0.130* (13.012) | 0.029 (0.549) | 0.216* | 0.047 | 18.123* |

Note: * $p < 0.001$; β = regression coefficients; β_z = standardized regression coefficients (these values are equal to the Pearson’s linear correlations); R^2 = explained variance per criterion variable; F= Fisher’s test that contrasts if observed changes in R^2 are significant; ASGS= scores related to the pseudoscientific beliefs; CA-PI= correct answers

regarding to COVID-19 pseudoscientific information exam; AU= autonomy; ME= management of environment; LP= life purpose; PG= personal growth. **Constants and the errors associated with each constant are located in brackets.**

Warning: SA (Self-Acceptance) and PR (positive relations) were discarded as criteria variables because linear correlations regarding ASGS and CA-PI were not significant.

Table 6. Regression model using “enter method” for residents in rural environments (n= 409). Criteria variables= SA, PR, AU, ME, LP and PG; Predicting variable= CA-PI.

| Criteria variables | Predicting variable= CA-PI | | | | |
|--------------------|----------------------------|---------------|-----------|-------|----------|
| | B | s.e. | β_z | R^2 | F |
| SA | 0.676* (7.130) | 0.048 (0.578) | 0.570* | 0.323 | 195.388* |
| PR | 0.673* (10.298) | 0.056 (0.662) | 0.515* | 0.263 | 146.888* |
| AU | 0.664* (17.994) | 0.062 (0.743) | 0.467* | 0.216 | 113.345* |
| ME | 0.617* (14.253) | 0.053 (0.628) | 0.501* | 0.25 | 136.717* |
| LP | 0.564* (9.216) | 0.051 (0.604) | 0.483* | 0.231 | 123.653* |
| PG | 0.362* (5.415) | 0.027 (0.318) | 0.558* | 0.31 | 184.101* |

Note: *p<0.001. β = regression coefficients; β_z = standardized regression coefficients (these values are equal to the Pearson’s linear correlations); s.e.= standard error related to regression coefficients; R^2 = explained variance per criterion variable; F= Fisher’s test that contrast if observed changes in R^2 are significant; ASGS= scores related to the pseudoscientific beliefs; CA-PI= correct answers regarding to COVID-19 pseudoscientific information exam; SA= self-acceptance; PR= positive relations; AU= autonomy; ME=

management of environment; LP= life purpose; PG= personal growth. **Constants and the errors associated with each constant are located in brackets.**

Warning: ASGS was discarded as predicting variable because linear correlations regarding PWBS's dimensions were not significant.

The most significant predictions are seen in the group of rural residents. Specifically, the COVID-19 test scores that contribute most to psychological well-being are observed for the SA and PG variables. The rest of the dependent variables are predicted with a weight between 21% and 26%.

The results of the group of urban residents indicate that the discrimination of false news about COVID-19 only contributes to psychological well-being between 7% and 8%. Although these values are significant, they differ from the predictions made for the group of rural residents. This decrease in the R^2 weights of the urban group could be explained by the fact that the average test score of this group is lower than the scores of the rural group. This suggests a comparison between the means associated with the dependent variables measured for the urban group and the rural group.

3.3. Intergroup analysis and Bayesian inference

Table 7 presents the comparison between the rural and urban group averages. Cohen's d was also included as a measure of effect size and the Bayesian inference for $P(H_1|D)$.

Table 7. Means comparison between rural and urban environment groups.

| | Welch's t test | Mann-Whitney's U test | Cohen's d | BF_{10} (% error) | $P(H_1 D)$ |
|-------|---------------------|--------------------------|--------------|--|------------------------|
| ASGS | -2.816 | 67,174 | -0.202 | 3.9525 (4.63e-7) | 0.7980 → 79.80% |
| CA-PI | 7.493* | 53,192* | 0.536 | 3.21e+10= 18.725 (6.64e-17) | 0.9493 → 94.93% |

| | | | | | |
|----|---------------|----------------|--------------|---|-----------------|
| SA | 4.474* | 62,272* | 0.319 | 12,46.0124 (1.60e-9) | ~1 |
| PR | 3.049 | 66,710 | 0.218 | 7.3748 (2.51e-7) | 0.8805 → 88.05% |
| AU | 5.140* | 60,427* | 0.367 | 27,140.6013 (7.53e-11) | ~1 |
| ME | 3.897* | 64,036* | 0.278 | 127.8726 (1.52e-8) | ~1 |
| LP | -0.101 | 75,644 | -0.007 | 0.0804 (2.04e-5) | 0.0744 → 7.44% |
| PG | 3.944* | 64,060* | 0.281 | 146.2673 (1.33e-8) | ~1 |

Note: * $p < 0.001$. BF_{10} = Bayes factor in favor to the alternative hypothesis; $P(H_1|D)$ = probability that the alternative hypothesis fit the data; ASGS= scores related to the pseudoscientific beliefs; CA-PI= correct answers regarding to COVID-19 pseudoscientific information exam; SA= self-acceptance; PR= positive relations; AU= autonomy; ME= management of environment; LP= life purpose; PG= personal growth.

Significant differences were observed for the variables CA-PI, SA, AU, ME, and PG, with a risk of error lower than 0.001. For all the above variables, the group of residents in rural areas obtained higher scores than the group of residents in urban areas. Thus, psychological well-being is better in rural residents. The same happens with the hits (CA-PI); subjects who live in rural towns are better informed about COVID-19 than subjects who live in large cities. This conclusion is supported by BF_{10} (>10) and $P(H_1|D)$: the probability that H_1 fits the observed data was 99.99%.

4. Discussion

The purpose of this research was to analyze the influences of pseudoscientific beliefs and false information about COVID-19 on people's mental health. Participants were classified according to their area of residence (rural or urban). The results indicated the following: the

better the pseudoscientific news is discriminated from scientists, the better the psychological well-being indexes are obtained. This tendency is more clearly observed in the group of subjects who reside in rural areas. However, on a general level, pseudoscientific beliefs are not related to psychological well-being. Likewise, the results indicated that subjects residing in rural areas tended to have higher scores in the discrimination of pseudoscientific news and psychological well-being variables.

The interpretation of the results is based on the following point: what implications do these results have on people's mental health? The following questions could also be raised: Why do rural residents discriminate against PI more effectively than urban residents? Why are the correlation predictions between psychological well-being scales and pseudoscience information (PI) discrimination scores higher or more efficient in the rural group than the urban group?

4.1. Implications of the pseudoscientific information of the COVID-19 on mental health

The results obtained allow us to conclude that mental health can be at risk when people do not correctly distinguish between pseudoscientific information and scientific information about COVID-19. Subjects living in rural areas presented higher psychological well-being scores than those living in urban areas. This means that rural residents are better protected against the effects of the pseudoscientific information about COVID-19 than are residents of large cities. Therefore, according to the results, the chances of mental health being at risk or getting worse will be especially generalizable for subjects living in large cities. This interpretation is based on the analyses made, but it conflicts with *social isolation theory*. This theory is part of environmental psychology and states that subjects living in less populated geographical areas

present more pseudoscientific beliefs than subjects living in large cities (see [Escolà-Gascón et al., 2020](#); [Irwin, 2009](#)).

One of the possible arguments that could justify the above paradox is based on the influence of two possible variables: (A) the quality of the information accessed (see [Pulido et al., 2020a](#); [Pulido et al., 2020b](#)) and (B) the use of pseudoscientific beliefs or the decisions made by each subject about what he or she decides to believe or not believe (see [Lawrence, 2016](#)).

Considering point "A", there is speculation that rural residents are not more informed than city residents, but they are better served and seem to pay more attention to official health information about coronavirus. The information present in the villages may be of better quality because their residents have selective filters of the information that are not so present in the big cities. These filters would "select" the most plausible information with respect to official sources and transmit it to local residents. A simple example of these filters is the intermediary or local media (see [Innerarity and Colomina, 2020a](#)). In contrast, large cities are dominated by national and global communication systems, neglecting the dissemination of municipal information (e.g., [Innerarity and Colomina, 2020b](#)). This interpretation is also based on the report by [Grover et al. \(2020\)](#), who also warned about the mental health risks during the COVID-19 pandemic. This point would also explain why rural residents are more discriminating against pseudoscientific information.

According to point "B", it is important to differentiate between the "act of believing in pseudosciences" and the "act of making pseudoscientific decisions" (see [Irwin et al., 2013](#)). These two "acts" represent two different dimensions that form "pseudoscientific meanings" and "pseudoscientific attributions" (causal illusions) (see [Matute et al., 2015](#)). By way of example,

the first dimension would allow us to assume the belief that homeopathy can be beneficial in the treatment of coronavirus (assuming homeopathy as an example of pseudoscience); the second dimension would be observed when someone who has been treated with homeopathy and has suffered from COVID-19 would say: "I have been cured because of the homeopathic treatment". In scientific discourse, causal claims are only acceptable when experimental methodology is used (see [Pardo and San Martin, 2015](#)). Considering the successes of the COVID-19 test (see Tables 1 and 2), rural residents do not tend to make as many pseudoscientific causal claims as the urban group does. However, analysis of pseudoscientific beliefs indicates that the differences were not significant between the two groups. This result invites the hypothesis that it is the causal illusions related to pseudoscience (and not the pseudoscientific beliefs themselves) that are the variable that truly is a psychopathological risk for people's mental health (see [Matute et al., 2011](#)). Therefore, the "act of believing" or the pseudoscientific belief itself does not represent a health risk; it is the person's use of this belief (in this case, a use based on causal illusions) that proves to be a psychopathological risk. Furthermore, taking into account the contributions of [Pérez-Navarro et al. \(2020\)](#) and [Escolà-Gascón et al. \(2020\)](#), it is possible to infer that this psychopathological risk is essentially related to the symptoms related to the spectrum of psychoses.

A curious result is the R^2 coefficients of the self-acceptance (SA) and personal growth (PG) scales. These two dimensions were the ones that gave the highest correlation coefficients. The psychological and clinical model that could best explain these results is the stress reduction theory (from now on SRT) (see [Huang et al., 2020](#)). This theory assumes that rural environments with harmless natural elements produce pleasant emotional reactions that eventually reduce

the stress perceived by the subject (see also [Ulrich et al., 1991](#)). The question that arises from the results and the SRT is whether stress could be a mediating variable between pseudoscientific causal attributions and psychological well-being. Therefore, according to the SRT, it is likely that the stress levels of rural residents are the factor that could explain the increase in SA and PG correlations.

4.2. Limitations

One of the main limitations is related to the generalizability of the results. Considering that the sampling was not probabilistic and that the correlations between psychological well-being and pseudoscientific news discrimination were higher for the rural group, the generalizability of the regression models should be limited to subjects living in towns or rural areas. Thus, further research is needed to focus on the effects of pseudoscientific attributions on the psychological well-being of residents in large cities.

As a second limitation, it is important to note that, unlike [Escolà-Gascón et al. \(2020\)](#), in this research, the psychopathological risks related to psychosis were not evaluated using psychometric tests. It was decided to evaluate psychological well-being on the understanding that this study could be complemented with the results obtained by [Escolà-Gascón et al. \(2020\)](#). In this line, it would be necessary for future research to relate (if possible through the models of the structural equations) the levels of psychological well-being, the risk factors measured by [Escolà-Gascón et al. \(2020\)](#), and the pseudoscientific attributions by examining the COVID-19 of Table 1.

Finally, it should also be mentioned that the distinction between subjects who lived in rural areas and those who lived in urban areas did not take into account the presence of green

spaces, private gardens, or playgrounds. For statistical purposes, a subject living in a city may have his apartment near a green space that he usually frequents. How these urban elements could influence the levels of psychological well-being of people is a possible strange or moderating variable to take into account in future research. In this study, the criteria of the [National Institute of Statistics from Spain \(2020\)](#) were used as objective governmental criteria, and they are not incorrect. However, the more variables that can be controlled or neutralized, the greater the external validity of the research and the more reliable the results.

4.3. Conclusions

The following conclusions were reached in this research: (1) pseudoscientific beliefs are not related to perceived psychological well-being. Therefore, it is likely that in themselves, they do not represent a risk for the mental health of individuals. (2) Knowing how to correctly discriminate between scientific and pseudoscientific information on COVID-19 allows us to predict between 20% and 32% of the perceived psychological well-being of residents in rural areas. The more difference there is between scientific and pseudoscientific information, the easier it will be for the general population to make effective and safe decisions that will promote their sense of subjective well-being. (3) Rural residents have fewer pseudoscientific beliefs than urban subjects. This challenges social isolation theory as a model for the production of irrational beliefs when a person resides in a rural location with a small population. (4) The mental health of urban subjects is more vulnerable than the health of rural residents. New intermediaries in the media are needed to prevent the *denial beliefs* (i.e., denying that the COVID-19 disease exists) of subjects who misuse pseudoscientific beliefs.

The results of this research show that the use of pseudoscientific beliefs is a variable that conditions and can negatively affect people's psychological health. International and governmental organizations should provide social resources that allow residents of large cities to know what information is scientific (and therefore reliable) and what is not.

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