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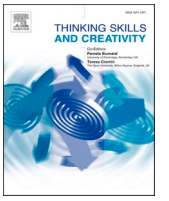

Critical thinking predicts reductions in Spanish physicians' stress levels and promotes fake news detection

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ABSTRACT

The prevalence of pseudoscientific beliefs and fake news increased during the coronavirus crisis. Misinformation streams such as these potentially pose risks to people's health. Thus, knowing how these pseudoscientific beliefs and fake news impact the community of internists may be useful for improving primary care services. In this research, analyses of stress levels, effectiveness in detecting fake news, use of critical thinking (CP), and attitudes toward pseudosciences in internists during the COVID-19 crisis were performed. A total of 1129 internists participated. Several multiple regression models were applied using the forward stepwise method to determine the weight of CP and physicians' attitudes toward pseudosciences in predicting reductions in stress levels and facilitating the detection of fake news. The use of critical thinking predicted 46.9% of the reduction in stress levels. Similarly, skeptical attitudes and critical thinking predicted 56.1% of the hits on fake news detection tests. The stress levels of physicians during the coronavirus pandemic were clinically significant. The efficacy of fake news detection increases by 30.7% if the individual was a physician. Study outcomes indicate that the use of critical thinking and skeptical attitudes reduce stress levels and allow better detection of fake news. The importance of how to promote critical and skeptical attitudes in the field of medicine is discussed.

1. Introduction

In general terms, "fake news" is content that is disseminated in the form of real news through digital and conventional means of communication and lacks objective evidence to demonstrate the veracity of the information disclosed (Molina, Sundar, Le & Lee, 2019; Pennycook & Rand, 2021). More specifically, in the field of health sciences and research, fake news is content related to medicine and the treatment of diseases that do not have proven scientific evidence. (Merchant & Asch, 2018; Treharne & Papanikitas, 2020). In this context, fake news uses scientific appearance to generate trust and can accordingly influence the general population (Waszak, Kasprzycka-Waszak & Kubanek, 2018). Scientific appearance can be defined as the attempt to make an argument appear scientific when it is not (Strudwicke & Grant, 2020). Scientific appearance is also a common practice in alternative therapies, which are considered a type of pseudoscience (Li, Forbes & Byrne, 2018). Specifically, in the field of medicine, pseudosciences are treatments or interventions with therapeutic purposes that lack the necessary scientific evidence to guarantee their effectiveness, efficiency and safety for the patient (Zaboski & Therriault, 2019). Although the concept of pseudoscience is broader (Bunge, 1991), this paper focused on its definition as applied to medicine and alternative or complementary therapies.

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The coronavirus crisis has contributed to greater endorsement of pseudoscience, fake news, and pseudoscientific beliefs in the general Western population (Á Escolà-Gascón, Marín, Rusiñol & Gallifa, 2020). This correlates with an increase in the number of diagnosed psychiatric disorders (Taquet, Luciano, Geddes & Harrison, 2021). Collectively, these factors suggest that pseudoscience and fake news negatively influence people's decisions, behavior, and health (Carrieri, Madio & Principe, 2019). In addition, fake news fosters confusion and perceptions of ambiguity. There is sufficient evidence that positively relates anxiety responses to perceptions of uncertainty (Waszak et al., 2018). Moreover, in some studies perception of uncertainty has generated magical and irrational behaviors, which can further intensify anxiety levels (Á Escolà-Gascón et al., 2020; Pennycook & Rand, 2021). Along these lines, there are rational and empirical reasons to expect an increase in anxiety levels (this psychiatric variable is the most prevalent in the general population) when people fail to identify fake news. If a person does not know how to distinguish true from false scientific evidence, ensuing uncertainty is likely to produce greater anxiety. This supposition is commensurate with previous research reporting associations between pseudoscientific information and non-discrimination of fake news. In this sense, to prevent the effects of misinformation it is necessary to identify intervening variables. This is true not only in the general population but also in groups of health professionals affected by the pandemic (Marco-Franco, Pita-Barros, Vivas-Orts, González-de-Julián & Vivas-Consuelo, 2021).

The factors that fostered this systematic increase can be classified and understood in three large groups. First, three factors related to the digital consumption of information were identified: (1) The acceleration of online work (Tokarchuk, Gabriele & Neglia, 2021); (2) disintermediation (refers to the extinction of those media or resources that allow information to be filtered and act as intermediaries between public opinion and scientifically proven facts) (Escolà-Gascón, Marín, Rusiñol & Gallifa, 2021); and (3) infodemia, which was recognized by the World Health Organization (WHO) as a serious problem during the coronavirus (Á Escolà-Gascón, Marín, Rusiñol & Gallifa, 2020). Second, it is also necessary to highlight four very important medical factors: (1) the saturation of the number of patients in some health centers and hospitals (Willan, King, Jeffery & Bienz, 2020); (2) the lack of human resources or health personnel (Luceño-Moreno, Talavera-Velasco, García-Albuerne & Martín-García, 2020); (3) the lack of infrastructures, spaces and medical resources to treat the sick (Cano-Valderrama et al., 2020); and (4) the lack of materials for the protection of the health and/or administrative personnel working in hospitals (Chen & Huang, 2020). As a third point, it is necessary to address political-social and economic factors: (1) the systematic closure of borders with other countries (Á Escolà-Gascón et al., 2020); (2) the various restrictions applied on travel, ranging from zone confinements to the cancelation of international travel (Neuburger & Egger, 2020); (3) capacity limitations for certain establishments related to gastronomy, hospitality and leisure (Dube, Nhamo & Chikodzi, 2020); and (4) the closure of companies and temporary layoffs of workers (called in Spain *Expedientes de Regularización Temporal de Empleo*) (Tu, Li & Wang, 2021).

All these factors have affected the levels of well-being and changed people's lifestyles (Á Escolà-Gascón et al., 2020). Pseudoscientific information and pseudosciences are no strangers to these factors, and many people have used fake news or alternative therapies as an internal psychological resource to (1) gain a greater sense of control (Šrol, Ballová Mikušková & Čavojová, 2021), (2) reduce stress levels in the face of the uncertainty caused by the coronavirus crisis (Á Escolà-Gascón et al., 2020), and (3) find meanings that allow them to speculate about the causality of everything that happened and is happening within this framework of the pandemic crisis (Escolà-Gascón, 2020). This irrational search for meanings is called causal illusions and is a common psychological response to situations of maximum uncertainty (Matute et al., 2015).

There is some evidence showing how critical thinking can be a useful psychological resource to combat fake news and pseudoscience in an effective way (Bronstein, Pennycook, Bear, Rand & Cannon, 2019; Wilson, 2018). Critical thinking can be defined in two ways. First, it can be understood as a psychological tendency or predisposition of an individual to collate, analyze and question both the information in a message and its source (Clifford, Boufal & Kurtz, 2004). This definition frames critical thinking as a stable trait or as a soft skill of the personality (Dwyer, Hogan & Stewart, 2014; Hwang, Yen, Lee, Huang & Tseng, 2010). Second, critical thinking can also be defined as a skill or aptitude based on analytical styles of cognitive reasoning (see dual process theory (De Neys & Pennycook, 2019)). In this case, critical thinking should be understood as a quality underlying the concept of hard skills or intelligence (Wechsler et al., 2018). The advantage of both approaches is that they can be modified and adapted in behavioral terms (through nonclinical psychological interventions) according to the needs of each individual (Bago, Rand & Pennycook, 2020; Schmaltz, Jansen & Wenckowski, 2017).

The main objective of this research was to determine the impact of fake news and pseudosciences on primary care physicians (internists) and emergency physicians (as the two groups of health professionals working on the first lines of diagnosis). Specifically, two specific objectives were also defined: (1) to measure the relationship between predisposition to pseudosciences (focusing only on those related to complementary therapies in medicine) and the stress levels of healthcare professionals and (2) to measure the degree of critical thinking of physicians (understood as a personality trait or soft skill) and quantify how they affect the ability of physicians to detect fake news related to the coronavirus. Therefore, the variables analyzed were the following: predisposition to pseudoscience, detection of fake news, stress levels and levels of critical thinking.

2. Methods

2.1. Participants

The sample consisted of 1129 volunteer physicians (63% male and 37% female). All of them were aged between 29 and 57 years (mean = 42.94 and standard deviation = 8.529). The physicians in this sample came from 5 different Spanish communities: 32% of the physicians lived in Catalonia, 26% worked in the community of Madrid, 18% lived in the Community of Valencia, 13% lived in Andalusia, and 11% worked in the community of Aragon. Due to the COVID-19 pandemic, the 1129 volunteers were classified into

three groups or specialties: 628 were internists or primary care physicians; 133 were physicians specializing in emergency medicine; and 368 were physicians who had different specialties but who, due to the coronavirus crisis, had to join forces and temporarily practice as internists.

All physicians in this sample participated on a voluntary basis, and their personal data were not recorded. Thus, their participation was completely anonymous. To avoid possible conflicts of interest, the data of the health centers or hospitals in which they worked were also not recorded. However, before answering the assessment tests, the participants signed an online informed consent form explaining this study (this means that they clicked on the acceptance box authorizing their voluntary collaboration with the research).

2.2. Assessment tests

2.2.1. Critical thinking disposition scale (CTDS)

The CTDS is a psychometric self-reported questionnaire composed of 11 items that assess an individual's predisposition to develop and use critical thinking. The items can be classified into two dimensions: critical openness (this dimension is composed of 7 items) and reflective skepticism (this dimension is composed of 4 items). Responses are coded using a Likert scale ranging from 1 (meaning "strongly disagree") to 5 (meaning "strongly agree"). The validity and reliability of this scale were satisfactory both in its original version (Sosu, 2013) and in adaptations to other cultures and populations (Yuan, Liao, Wang & Chou, 2014). The Spanish version of Bravo et al. (2020) was used in this study (Bravo, Galiana, Rodrigo, Navarro-Pérez & Oliver, 2020). The reliability of the scores with the responses obtained in this study was satisfactory (alpha coefficients >0.8).

2.2.2. Medical adaptation of the psychologists' attitudes toward complementary and alternative therapies (PATCAT) questionnaire

The PATCAT is a self-reported questionnaire that measures attitudes and the degree of predisposition to alternative and complementary therapies. Initially, this scale was developed in the field of clinical psychology to determine to what degree psychologists and psychiatrists tolerated the inclusion of pseudosciences in conventional mental health treatments (Wilson & White, 2007). Prior to this research, a search of major databases was conducted to find any scales measuring physicians' attitudes toward pseudosciences specializing in alternative/complementary therapies. No specific instrument for this purpose adapted to Spanish was found. Therefore, in this study, we adjusted the PATCAT scale to the context of internal and emergency medicine. For this purpose, we used the revision of the PATCAT by Wilson, White and Obst (2011), which also contemplates that further adaptations to other healthcare contexts can be derived. The validity and reliability of this scale are good (Wilson & White, 2007; Wilson et al., 2011). The Spanish adaptation with all psychometric properties will be addressed in another manuscript. However, Table 1 specifies the changes we made in the items.

The separation lines in Table 1 are used to identify the dimensions or factors that allow the PATCAT to be evaluated. The dimensions are as follows (in order according to the separation in Table 1): knowledge of alternative therapies, acceptance of alternative therapies, and skeptical attitude toward alternative therapies. Responses were coded with a graduated scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). The reliability indices of the scores of this sample were excellent (alpha coefficient >0.85).

2.2.3. Spielberger's 20-item state-trait anxiety inventory (STAI)

The STAI is an internationally known psychometric test for measuring anxiety and stress levels. It was originally developed by Spielberger, Gorsuch and Lushene (1970). The STAI measures the degree of anxiety from two perspectives and dimensions: (1) trait-type anxiety (it has 20 items) and state-type anxiety (this dimension also has 20 items). The participant must indicate how often he/she feels the symptoms specified in each item on a scale ranging from 0 (which means "nothing") to 3 (which means "very much"). In this research, the STAI publication edited by TEA Ediciones, S.A.U. was used. (Spielberger, Gorsuch & Lushene, 2015). In this version, the validity and reliability indices of both forms of the STAI were excellent. Considering the objectives of this research, only the

Table 1
Items adapted from the PATCAT psychology scale to the field of medicine.

Original items (Wilson & White, 2007; Wilson et al., 2011)	Spanish translation (changes to the medical field are marked **in bold**).
Psychology professionals should be able to advise their clients about commonly used complementary therapeutic methods.	Los profesionales de la **salud** deben ser capaces de asesorar a sus clientes sobre los métodos terapéuticos complementarios más utilizados.
Information about complementary therapeutic practices should have been included in my psychology degree curriculum.	La información sobre las prácticas terapéuticas complementarias debería haberse incluido en el plan de estudios de mi carrera de **medicina.**
Knowledge about complementary therapies is important to me as a psychology student/practicing psychologist.	El conocimiento de las terapias complementarias es importante para mí como estudiante de **medicina y/o médico en ejercicio.**
Clinical care should integrate the best of conventional and complementary practices.	La atención clínica debe integrar lo mejor de las prácticas convencionales y complementarias.
Complementary therapies include ideas and methods from which conventional psychotherapy could benefit.	Las terapias complementarias incluyen ideas y métodos de los que podría beneficiarse **los tratamientos convencionales.**
A number of complementary and alternative approaches hold promise for the treatment of psychological conditions.	Una serie de enfoques complementarios y alternativos son prometedores para el tratamiento **de enfermedades.**
Complementary therapies should be subject to more scientific testing before they can be accepted by psychologists.	Las terapias complementarias deberían someterse a más pruebas científicas antes de ser aceptadas por la **comunidad médica.**
Complementary therapies can be dangerous in that they may prevent people from obtaining proper treatment.	Las terapias complementarias pueden ser peligrosas, ya que pueden impedir que las personas reciban un tratamiento adecuado
Complementary therapy represents a confused and ill-defined approach.	La terapia complementaria representa un enfoque confuso y mal definido.
Complementary medicine is a threat to public health.	La medicina complementaria es una amenaza para la salud pública.

dimension assessing state-type stress was applied. This type of stress refers to variable anxiety dependent on the circumstances experienced by the subject (this type does not represent a personality trait). This was chosen because it was intended to measure and know the stress levels of the physicians contextualized within the situation of the coronavirus crisis. In fact, order to facilitate statistical inferences regarding the scores of this scale, the Spanish scores transformed to percentiles was used as a reference. Specifically, the 80th percentile was used as the threshold.

2.2.4. *Discrimination cognitive test between true and pseudoscientific information about coronavirus*

This protocol is a test that was developed by Escolà-Gascón et al. (2021). It aims to assess the cognitive ability to discriminate between pseudoscientific information (fake news) and scientifically proven information related to the coronavirus. Participants had to specify by means of 3 response alternatives whether the content of each item possessed or lacked scientific evidence. The response alternatives were the following: "yes" (the content is scientifically proven and true), "?" (there is insufficient scientific evidence to determine if it is true), and "no" (the content of the sentence is not scientific and is false). Each time the participant chose the correct answer, one point was added. In total, there were 18 items. The items of this test can be found in the open access publication of (Escolà-Gascón, 2021).

2.3. *Procedures*

The design of this research was correlational and was based on the application of different surveys and online assessment tests. Considering the results of the research by Á Escolà-Gascón et al. (2020) published in Globalization & Health, it was decided to continue and extend the data collection to include health professionals, internists and emergency physicians.

Data collection was conducted between November 2020 and May 2021. The sampling had the same duration as the second state of alarm in Spain, which started on November 9, 2020 and ended on May 9, 2021. Access or collection of the sample was performed through two forms of contact:

(1) **Direct methods.** In this case, physicians who were active in the practice of internal medicine and emergency medicine were contacted directly by email. Physicians were also contacted directly by cell phone, and questionnaires were sent by WhatsApp. On other occasions, face-to-face meetings were held with the participating physicians to explain the full scope of this research and thus stimulate their involvement.

(2) **Indirect methods.** In this type of strategy, the researcher did not have direct contact with the physicians and sought the help of intermediaries. The main intermediaries were the following: a) medical students who were performing internships and had direct contact with the physicians in their department, b) administrative staff of the healthcare centers (including orderlies in

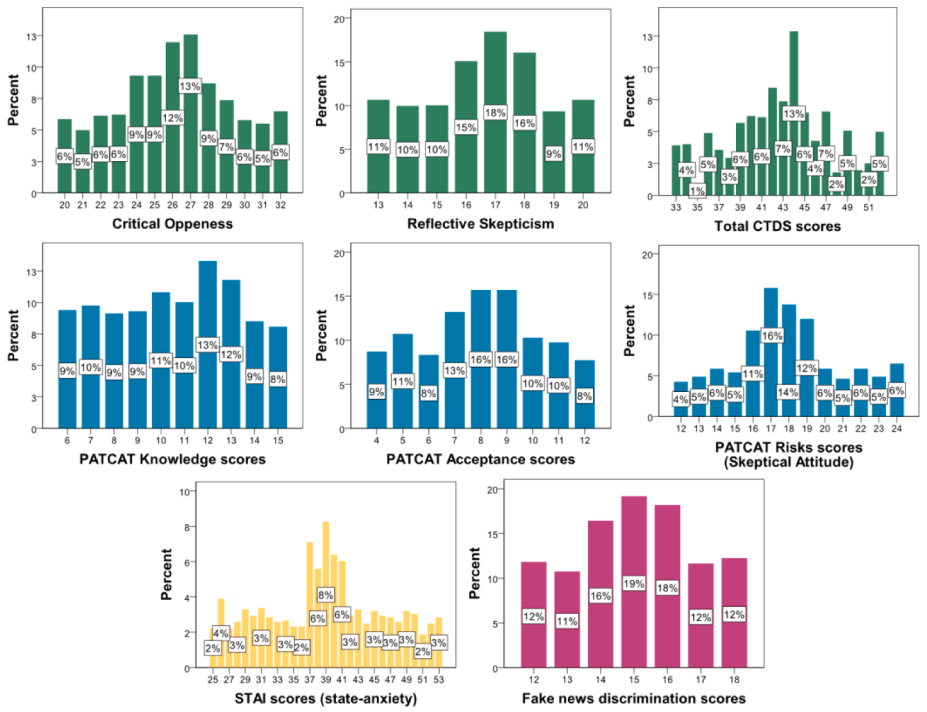

Fig. 1. Bar graphs based on physician proportions for each measured dependent variable score. In the state-type stress graph (yellow color) and the total CTDS score graph (green color), not all percentages could be included due to a lack of space. These percentages are only an orientation.

the case of hospital centers), c) nonmedical healthcare staff (e.g., nurses, assistants and healthcare technicians), and d) physicians who were also encouraged to forward the survey both by WhatsApp and email to other colleagues with the same specialty. This generated an online viral chain effect that facilitated the dissemination of the survey.

In order to detect false positives (i.e., participants who claimed to be medical students or health professionals but were not licensed physicians) in the online survey, there were two extra categories in addition to the specialties/groups highlighted in the 2.1 Participants section. These control categories were "studying medicine" and "I am a nonmedical health professional". All participants who checked this category answered the questionnaires, but their data were not incorporated in this study to avoid generating noise in the raw data matrix. A total of 191 cases that checked one of these boxes were discarded.

2.4. Statistical analysis

Data were processed with the R programming language through JASP support (R Core Team, 2021). The SPSS® statistical package was also used to generate the graphs. Descriptive statistics were calculated for the variables measured, and several multiple regression models were tested. The regression models aimed to determine which variables predicted stress levels and the ability to detect fake news for the physicians. Due to the sample size and the mathematical principles of the central limit theorem (Johnson, 2004), statistical normality conditions were assumed. Parameter estimation was performed using the residual least squares procedure. The forward stepwise method was used to specify the inclusion/exclusion of predictor variables. This method is recommended in statistics to fit parsimonious and ecological models when working with multiple predictor variables. In this way, the estimates of the explained variance and forecasts would be more consistent, and possible false positives would be avoided. Finally, a 1% risk of error was used.

3. Results

3.1. Graphical description of the variables and measures of central tendency

The distribution of the scores of the variables measured is shown in Fig. 1. The bar graphs are based on percentages to facilitate the interpretation and visibility of the data. Descriptive statistics for the entire sample and for each physician group or category are given in Tables 2 and 3 provide the descriptive statistics separating the participants by autonomous community.

Results in Tables 2 and 3 indicated that the means between groups were not different from each other for most of the dependent variables. The only exception that did have minimal significant effects was observed in the variable skeptical attitude toward alternative therapies ($F = 8.173$, df $= 2$, $p < 0.001$, and partial eta squared $= 0.014$). More specifically, differences were found between the means of Catalonia and Madrid ($p_{Bonferroni} = < 0.001$). For the other combinations of means and variables, no significant differences were observed. This means that internists and emergency physicians had similar levels of critical thinking and were subjected to the same equivalent levels of stress.

3.2. Multiple regression analysis

As a preliminary step to the regression, Table 4 shows the linear correlations between the variables.

As seen in Table 4, there were very high correlations that suggest the possibility of linearly combining a regression. The variables were set considering the evidence provided by the authors cited in the introduction (Bago et al., 2020; Bronstein et al., 2019; Carrieri et al., 2019; Á Escolà-Gascón et al., 2020, 2020; Schmaltz et al., 2017; Wilson, 2018), and the dimensions of the critical thinking scale

Table 2
Descriptive statistics (means and standard deviations) of the variables measured according to the type of physician.

	Minimum and maximum values	Internist physician	Intensive care physician	Physicians with other specialties	Total values
Critical Openness	7–35	25.98 (3.056)	26.85 (3.101)	26.05 (3.805)	26.10 (3.332)
Reflective Skepticism	4–20	16.59 (1.977)	16.86 (1.997)	16.50 (2.366)	16.59 (2.114)
Total Critical Thinking scores	11–55	42.57 (4.509)	43.71 (5.000)	42.55 (5.535)	42.70 (4.933)
Knowledge of alternative therapies	3–21	10.42 (2848)	10.75 (2.917)	10.60 (2.555)	10.52 (2.764)
Acceptance of alternative therapies	3–21	8.07 (2.476)	7.94 (2.386)	7.89 (2.089)	8 (2.345)
Skeptical Attitude toward alternative therapies	4–28	17.76 (3.188)	18.98 (3.237)	17.98 (3.031)	17.98 (3.163)
STAI - Stress levels	0–60	39.17 (7.620)	37.71 (7.449)	38.88 (7.318)	38.90 (7.51)
Ability to detect fake news	0–18	15 (1.724)	15.40 (1.749)	15 (2.054)	15.05 (1.844)

Note: Standard deviations are shown in parentheses.

Table 3
Descriptive statistics (means and standard deviations) of the variables measured according to the Spanish communities.

	Minimum and maximum values	Catalonia	Madrid	Valencian community	Andalucia	Aragón
Critical Openness	7–35	25.98 (3.223)	26.55 (3.346)	26.15 (3.290)	25.65 (3.259)	25.84 (3.678)
Reflective Skepticism	4–20	16.66 (2.027)	16.82 (2.177)	16.48 (2.116)	16.37 (2.027)	16.27 (2.262)
Total Critical Thinking scores	11–55	42.64 (4.713)	43.38 (4.835)	42.64 (4.879)	42.02 (4.965)	42.11 (5.674)
Knowledge of alternative therapies	3–21	10.40 (2.787)	10.51 (2.825)	10.61 (2.754)	10.79 (2.663)	10.41 (2.698)
Acceptance of alternative therapies	3–21	7.92 (2.320)	7.87 (2.234)	8.19 (2.469)	8.10 (2.434)	8.09 (2.375)
Skeptical Attitude toward alternative therapies	4–28	17.90 (3.069)	18.33 (3.104)	17.88 (3.318)	17.73 (3.032)	17.81 (3.439)
STAI - Stress levels	0–60	39.11 (7.379)	37.69 (7.109)	39.24 (7.733)	39.69 (7.630)	39.75 (8.071)
Ability to detect fake news	0–18	15.03 (1.734)	15.20 (1.961)	14.99 (1.766)	14.96 (1.801)	14.96 (2.038)

Note: Standard deviations are shown in parentheses.

Table 4
Matrix of the correlations between variables for the purpose of applying multiple regression models.

	1	2	3	4	5	6	7
1. Critical openness	—						
2. Reflective skepticism	0.622*	—					
3. Total critical thinking scores	0.942*	0.849*	—				
4. Knowledge of alternative therapies	−0.155*	−0.187*	−0.185*	—			
5. Acceptance of alternative therapies	−0.445*	−0.445*	−0.491*	0.260*	—		
6. Skeptical Attitude toward alternative therapies	0.686*	0.654*	0.744*	−0.198*	−0.501*	—	
7. STAI–Stress levels	−0.624*	−0.614*	−0.685*	0.227*	0.496*	−0.622*	—
8. Ability to detect fake news	0.643*	0.670*	0.721*	−0.144*	−0.450*	0.657*	−0.591*

Note: * $p < 0.001$. **Correlations that were considered to fit the regression models are highlighted in bold.**

and the dimensions of the pseudoscience attitude scale were used as predictor variables. Stress levels and the ability to detect fake news were specified as criterion variables. Tables 5 and 6 present the estimated regression coefficients, the errors and the estimate of the variance explained.

Results in Table 5 indicated that critical thinking total scores predicted a decrease in stress levels of 46.9%. This means that critical thinking acts as a functional psychological mechanism to contain stress in the sampled physicians. The increases in explained variance that occur with the inclusion of skeptical attitudes and the ability to detect fake news are not very high, but it was significant. In total, model 3 explained 50.6% of the reduction in stress levels.

The results in Table 6 show that reflective skepticism is a variable that explained up to 44.8% of the success in the test of skills to detect fake news. However, model 3 (including the variables skeptical attitudes and critical openness) explained 56.1% of the increase in the number of hits in the detection of fake news.

It was concluded that critical thinking and skeptical attitudes represent two very significant predictor variables for enhancing fake news detection and containing perceived stress levels.

Table 5
Regression models with forward stepwise method on the stress variable.

M	Predictor variables included with decreasing correlation relative to the stress variable.	Constant	Unstandardized regression coefficients β	Errors	β_z	R^2 (standard errors)	R^2 change	Fisher's F change
1	Critical thinking total scores (CTDS)	83.410	−1.042*	0.033	−0.685*	0.469 (5.476)	–	994.562*
2	Critical thinking total scores (CTDS)	81.986	−0.757*	0.048	−0.497*	0.496	Δ0.028	63.517*
	Skeptical Attitude (PATCAT)		−0.598*	0.075	−0.252*	(5.330)		
3	Critical thinking total scores (CTDS)	84.359	−0.639*	0.054	−0.420*	0.506	Δ0.010	22.625*
	Skeptical attitude (PATCAT)		−0.503*	0.077	−0.212*	(5.280)		
	Fake news detection scores		−0.606*	0.127	−0.149*			

Note: * $p < 0.01$, M = models, β_z = standardized regression coefficients, and R^2 = adjusted explained variance for each model.

Table 6
Regression models with forward stepwise method on the fake news detection scores.

M	Predictive variables included with an increasing correlation in relation to the detection of fake news.	Constant	Unstandardized regression coefficients		β_z	R^2 (standard errors)	R^2 change	Fisher's F change
			β	Errors				
1	Reflective skepticism (CTDS)	5.358	0.584*	0.019	0.670*	0.448 (1.370)	–	917.231*
2	Reflective skepticism (CTDS)	4.968	0.366*	0.023	0.420*	0.532 (1.262)	Δ0.084	201.576*
	Skeptical attitudes (PATCAT)		0.223*	0.016	0.382*			
3	Reflective skepticism (CTDS)	3.730	0.300*	0.024	0.344*	0.561 (1.222)	Δ0.030	76.639*
	Skeptical attitudes (PATCAT)		0.152*	0.017	0.260*			
	Critical openness (CTDS)		0.138*	0.016	0.250*			

Note: * $p < 0.01$, M = models, β_z = standardized regression coefficients, and R^2 = adjusted explained variance for each model.

4. Discussion

The objectives of this research were to determine the impact of the detection of fake news on internists and emergency physicians and their opinions on pseudoscience in the field of health. The stress levels associated with the circumstances of the COVID-19 crisis and their relationship with critical thinking were also measured. The results obtained indicated that the mean value of hits in the detection of fake news in physicians was ~15. Variables related to critical thinking and skeptical attitudes allow the prediction of the detection of fake news and can be useful psychological resources to reduce stress levels in healthcare personnel. What these results imply in statistical terms for the community of internists is discussed below.

4.1. Do physicians effectively detect fake news?

Fig. 1 gives an indicative estimate that only 12% of the physicians surveyed answered all the questions on the detection of fake news correctly (the test had 18 questions). However, 61% of the physicians answered 15 (average value) or more questions correctly. This could be interpreted as follows: 61% of internists and emergency medicine physicians correctly discriminated between scientific information on COVID-19 and pseudoscientific information or fake news. Please note that the number of correct scores fluctuates between 0 and 18 points. A score of 9 is the minimum threshold for passing this exam. In this sense, all the physicians in the sample obtained 12 points or more on this exam, which means that all of them passed this evaluation test. If we compare the average scores of the physicians with the scores of the subjects without medical training (see the publications of (Escolà-Gascón, 2021; Escolà-Gascón et al., 2021)), we can conclude that the scores of the physicians are much higher. In fact, specifically, the mean scores of the individuals without medical training who answered this test on fake news ranged between 8.13 and 10.82. These differences were to be expected considering that the scientific training of physicians on the coronavirus is greater than the training received by an individual who did not study medicine.

By approximately knowing the average values of the nonmedically trained population, the rate of increase can be quantified and estimated as follows:

$$\Delta\widehat{f}_{Hits} = \frac{\widehat{f}_{HP} - \left(\frac{\widehat{f}_{HG_1} + \widehat{f}_{HG_2}}{2}\right)}{f_K} = \frac{15 - \frac{8.13+10.82}{2}}{18} = \frac{15 - 9.475}{18} = 0.307$$

Therefore, doctors detect fake news approximately 30.7% more often than people without scientific medical training. The most interesting aspect of the regression models applied is the following: by promoting increases in the variables reflective skepticism, skeptical attitudes and critical openness, the detection of fake news would improve, and there would be fewer risks associated with people's public health. This is in the same line and coincides with evidence from prior research (Bago et al., 2020; Bronstein et al., 2019; Schmaltz et al., 2017; Wilson, 2018).

4.2. Implications of stress levels and attitudes toward pseudosciences

STAI scores ranged from 0 to 60 points. According to Fig. 1, the most frequent scores observed in the medical sample were values 37, 38, 39, 40 and 41. Considering the overall mean obtained (38.90) and the STAI scales for the Spanish population published by TEA Ediciones, S.A.U. (Spielberger et al., 2015), any value above 37 points is equivalent to a score of 8 or more points (out of 10). This corresponds to typical scores (z) equal to or greater than +1, indicating that stress levels were clinically significant. Following the interpretation of Fig. 1, more than 50% of the sample scored above 37 points. Therefore, the stress levels of the physicians were high during the second state of alarm called in Spain. These figures are high considering that during the second state of alarm, the health centers were not as saturated as in the initial phases of the coronavirus pandemic. Following this logic, stress levels should not have

been so high. This means the following: hypothetically, it is possible that these results reflect accumulated stress levels since the beginning of the coronavirus pandemic in Europe (March 2020). Then, this would represent a persistent malaise in the medical community that could gradually diminish as the COVID-19 crisis subsides.

Regression analyses predicted reductions in stress levels as critical thinking and skeptical attitudes increased with a weight of more than 50% of the variance. This is very important because it means that critical thinking and skeptical attitudes can be learning mechanisms that can also be used to reduce stress levels in the healthcare professional community (and not just to optimize fake news detection). It is not incorrect to say that by stress levels would also be reduced by providing adequate material means and healthcare resources (as the quality of professional practice and work of physicians would improve). However, such resources are not always available; and on certain occasions, only psychological strategies or techniques that allow the clinician to contain his or her discomfort can be applied. According to the results obtained, it is possible to hypothesize that in this type of situation, critical thinking and skeptical attitudes could be part of the psychological strategies used to combat stress.

In addition, there are several reasons and epistemological foundations that also support this proposition about the efficacy of critical thinking and skeptical attitude towards alternative medicine to promote reductions in stress levels: critical thinking can be useful and positive in reducing stress levels because it allows us to reflect on and question the value of anxiety-generating stimuli (such as pseudoscientific information or fake news). Moreover, critical thinking could help to recode the perception of uncertainty derived from the excess of fake news related to the coronavirus. Perceived uncertainty would be reduced because the individual, by putting critical thinking into practice, would be able to identify reasons that allow him/her to reject false information or to resolve with reasons the uncertainty he/she feels (as presented in the introduction).

In relation to physicians' perception of pseudosciences, it is important to highlight the predominance of conservative attitudes. The scores on the knowledge of alternative therapies and acceptance of alternative therapies scales obtained low overall mean values (as shown in Fig. 1, 37% and 41% of the physicians scored below the means of these scales, respectively). Although the remainder of the physicians obtained scores above the mean, only 8% of the physicians obtained maximum scores of 12 and 15 (when the maximum score for these two scales was 21 points). Moreover, these two scales showed negative correlations with respect to the other variables (between −0.155 and −0.445), which can be interpreted as evidence in favor of the logic of (Bronstein et al., 2019). The reason for this interpretation is the following: critical thinking and skeptical attitudes are part of analytical information processing, and the research provided by Bronstein et al., (2019) shows that pseudoscientific beliefs imply having low levels of analytical thinking.

4.3. Limitations and conclusions of the study

The limitations of this research can be summarized in four main points: (1) the research design was not experimental, and therefore, the results should not be understood or interpreted in causal terms. (2) The data collection period was extensive; and during that time, the stressful circumstances related to COVID-19 could have changed (even if the alarm state was maintained). The fact that the physicians came from different autonomous communities adds variability related to the circumstances of each of these communities. Thus, it is possible that the saturation of Catalonian hospitals was not the same as the saturation observed in Andalusian hospitals. This limitation does not invalidate the results of the investigation since the differences between the means according to each community were not significant. Therefore, this would be noninfluential variability in this sample. However, in future research and systematic reviews, this observation should be considered. (3) Another limitation related to COVID-19 is the statistical difficulty in knowing whether the observed effects were a product of coronavirus crisis conditions rather than predictor variables. What is certain is that the COVID-19 crisis was an unavoidable condition during the data collection period (as with other investigations during this time). Considering this limitation, it is important to keep in mind the following: the main purpose of the research was to measure during the second stage of the COVID-19 crisis several psychological and clinical variables in Spanish physicians. The effects observed in the regression models may be supported by previous publications (which are cited in the introduction), but due to the pandemic crisis condition, these results should not be considered as confirmatory evidence. Future replication of these findings under more balanced psychosocial conditions will be necessary. (4) Finally, the sample of physicians was exclusively Spanish. Although the size was not a problem, generalization of the results to physicians from other countries should be made with caution. Cultural, political and economic differences could generate variations with results different from those obtained in this investigation.

In conclusion, the following contributions of this manuscript stand out: (1) Internists discriminate fake news related to the coronavirus 30.7% better than individuals in the general population. (2) The detection of fake news can be predicted and optimized by encouraging critical thinking and skeptical attitudes. (3) Physicians' stress levels were clinically significant during the coronavirus crisis. These results warn of the need to care for and protect the professional quality of Spanish physicians. (4) Stress levels can also be predicted and reduced by encouraging critical thinking and skeptical attitudes. (5) Finally, physicians' attitudes toward knowledge and acceptance of pseudosciences were conservative. However, there was no tendency toward total denial of pseudosciences and how to collaborate with them so that they do not represent a risk to public health.

Ethics approval and consent to participate

The Committee of Ethical Guarantees of Ramon Llull University, (Barcelona, Spain) reviewed, favorably evaluated and approved this research. Likewise, the procedures of this study adhere to the Spanish Government Data Protection Act 15/1999 and the Declaration of Helsinki of 1975, revised in 2013.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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CRediT authorship contribution statement

Álex Escolà-Gascón: Conceptualization, Data curation, Formal analysis, Writing – original draft. **Neil Dagnall:** Supervision. **Josep Gallifa:** Supervision.

Declaration of Competing Interest

The authors confirm that there are no known conflicts of interest associated with this publication.

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