HUMAN VACCINES & IMMUNOTHERAPEUTICS
2024, VOL. 20, NO. 1, 2306677
https://doi.org/10.1080/21645515.2024.2306677

Taylor & Francis
Taylor & Francis Group

BRIEF REPORT

OPEN ACCESS Check for updates

Individual predictors of vaccine hesitancy in the Italian post COVID-19 pandemic era

Carmelo M Vicario[a], Massimo Mucciardi[a], Giulia Faraone[a], Chiara Lucifora[b], Hannah M Schade[c], Alessandra Falzone[a], Mohammad A Salehinejad[c,g], Giuseppe Craparo[d], and Michael A Nitsche[c,e,f]

[a]Dipartimento di Scienze Cognitive, Psicologiche, Pedagogiche e Degli Studi Culturali, Università di Messina, Messina, Italy; [b]Dipartimento di Filosofia e Comunicazione, Università di Bologna, Bologna, Italy; [c]Department of Psychology and Neurosciences, Leibniz Research Centre for Working Environment and Human Factors, Dortmund, Germany; [d]Faculty of Human and Social Sciences, Kore University of Enna, Cittadella Universitaria, Enna, Italy; [e]University Clinic of Psychiatry and Psychotherapy and University Clinic of Child and Adolescent Psychiatry and Psychotherapy, Protestant Hospital of Bethel Foundation, University Hospital OWL, Bielefeld University, Bielefeld, Germany; [f]German Center for Mental Health (DZPG), Bochum, Germany; [g]School of Cognitive Sciences, Institute for Research in Fundamental Sciences, Tehran, Iran

ABSTRACT

A wide range of survey studies have explored vaccination hesitancy/resistance during the COVID-19 pandemic and provided evidence that this can be explained by several individual variables from the ideological, clinical, and socio-affective domain. However, evidence about which individual variables predict vaccine hesitancy in the post-pandemic state of COVID-19 is meager. We administered a battery of questionnaires to a group of 120 Italian participants with high and low scores on the adult vaccine hesitancy scale (aVHS) to investigate the predictive role of ideological (i.e. political orientation), clinical (i.e. anxiety, interoceptive accuracy), and socio-affective (i.e. alexithymia, disgust sensitivity/propensity, empathy) variables on vaccine hesitancy/resistance. This study provides evidence that lower interoceptive awareness and cognitive empathy are predictors of a greater hesitancy to get vaccinated in the post-pandemic COVID-19 state.

ARTICLE HISTORY
Received 1 November 2023
Revised 4 January 2024
Accepted 13 January 2024

KEYWORDS
Vaccination; vaccine hesitancy/resistance; interoception; cognitive empathy; logistic regression

Introduction

The COVID-19 pandemic has caused millions of deaths (over 6.9 million deceased people globally until September 2023.[1]

The development of SARS-CoV-2 vaccines was a turning point of historical importance in the fight against this virus and its devastating effects. However, hesitation and resistance to get vaccinated of a relevant part of the population (around 25%)[2,3] was a challenge in the fight against COVID-19.[4,5] The relevance of this topic is stressed by a report from the World Health Organization,[6] which identifies vaccine hesitancy and resistance as top public health threats.[6] Improved comprehension of the mental processes associated with a negative attitude toward vaccines is crucial to develop new strategies for promoting acceptance of vaccination. This will help to successfully control future pandemics that are expected to take place, partially as a consequence of climate change.[7]

The existing literature on vaccine hesitance and resistance focuses on explicit reasons provided by individuals for their opposition to a specific vaccine or vaccination programs in general and associated demographic factors.[8] In this connection, a recent study[9] suggests a predictive role of confidence in vaccines for the intention to get vaccinated. Moreover, additional key features that differentiate vaccine-hesitant and resistant individuals from those who are receptive to vaccines have been identified.[2,10,11] These include several personality characteristics and traits, including high levels of religiosity, paranoid tendencies, impulsiveness, low conscientiousness, low emotional stability, low empathy, and dogmatic thinking have been associated with greater vaccination hesitancy.[2,10,12–14] Furthermore, a study conducted by Hornsey et al.,[10] involving 24 nations, indicates that anti-vaccination attitudes are linked to high levels of disgust and fear toward blood and needles, along with a strong individualistic/hierarchical view of the world. Needle phobia appears to affect approximately 10% of the population,[15] and reduced fear extinction learning in individuals with larger hesitancy to vaccination might stabilize the latter.[16]

Other investigations identified ideological/social attitudes such as distrust toward authorities and/or experts (scientists), intolerance toward migrants, and political orientation as possible further predictors of vaccine hesitancy.[12,13] However, regarding political orientation, results are heterogeneous. Evidence related to the pandemic period postulates an association of a conservative political attitude with COVID-19-related vaccination hesitancy,[17] and this was also shown for Italy and other countries.[13,18] However, Engin and Vezzoni[19] did not find an impact of political conservatism on anti-vaccination beliefs during the COVID-19 pandemic.

The current study aimed to investigate and corroborate the predictive role of several variables, including some of those mentioned above, for vaccination attitudes in the absence of a pandemic health emergency. In addition, we explored possibly relevant psychological factors: alexithymia, anxiety, and interoceptive awareness. Alexithymia is the difficulty to identify and describe own emotions and the emotions of others,[20,21] which

CONTACT Carmelo M Vicario cvicario@unime.it Dipartimento di Scienze Cognitive, Psicologiche, Pedagogiche e Degli Studi Culturali, Università di Messina, Messina 98121, Italy.

Supplemental data for this article can be accessed on the publisher's website at https://doi.org/10.1080/21645515.2024.2306677

might be relevant for vaccine hesitancy.[22–24] The rationale for suggesting a predictive role of alexithymia in vaccine hesitancy is based on the concept that a lack of access to own emotions and emotional empathy compromises the ability to understand the emotional significance of protecting oneself and others from infection through vaccination. We moreover investigated the roles of trait and state anxiety, building upon and going beyond the previously established relevance of needle phobia for vaccine hesitancy.[25,26] Furthermore, we examined the role of interoceptive awareness - *interoceptive sensitivity*— as a correlate of vaccine hesitancy, in line with the somatic marker hypothesis[27] stating that decision making is influenced by biasing signals (somatic markers) arising from changes in the body. Interoception refers to a relatively large variety of bodily signals or sensations. A growing literature[28–30] suggests that changes in interoceptive states may be influenced by and/or affect numerous cognitive, affective, and social decision-making processes, such as visuo-spatial attention,[31] time perception,[32] and generosity.[33] Moreover, a recent study has shown that interoception sensitivity predicts political orientation.[34] Importantly, indirect evidence links interoception with vaccination and psychological consequences of the pandemic. Suzuki et al.[35] report that interoception predicts the psychological effect of the pandemic-caused lockdown on the population. Moreover, Elliott and Pfeifer[36] report that the score of some of the *Multidimensional Assessment of Interoceptive Awareness* (MAIA) subscales is related to anxiety about COVID-19. However, to the best of our knowledge, a direct investigation of the predictive role of interoception awareness on anti-vaccination attitudes is currently lacking.

Many of the currently published articles focus on data regarding COVID-19 vaccination hesitancy collected during the pandemic. However, knowledge about the interplay between ideological, socio-affective, and psychological factors on the one hand, and overall vaccination hesitancy on the other in the post-COVID-19 pandemic state is limited. Such an investigation is, however, timely, as it can provide an evidence-based update on predictive variables for anti-vaccination attitudes in the absence of an acute infectious emergency associated with an ongoing pandemic, which might be relevant for any type of vaccine. In line with these premises, our data were collected in the post-COVID-19 pandemic state according to the Italian decree-law of March 24, 2022, n. 24, and subsequent law decrees published in the *Gazzetta Ufficiale*. Data were collected between October and November 2022, when measures to counteract COVID-19 infections were much less stringent as during the pandemic (gradual elimination of the "green pass;" revocation of the obligation to wear a mask for some categories of people).

We expected to confirm the predictive role of political orientation, empathy, anxiety, disgust sensitivity/propensity for the general attitude toward vaccination, as reported for the COVID-19 vaccine during the pandemic.[26] We also predicted lower interoceptive awareness in individuals more hesitant to vaccination, in line with available evidence of lower interoceptive awareness in conservative individuals,[34] who are known to be more hesitant to vaccination.[18] Finally, we predicted higher alexithymic scores in individuals more hesitant to vaccination, in line with evidence for reduced empathy in alexithymia,[37] which is also known to be reduced in the context of high COVID-19 vaccine hesitancy.[14]

Method

Participants

Our study involved 120 participants (mean age = 25.65 ± 4.11 SD, age range 18–38 years), including 50 males, and 70 females. Sample size was a priori established based on a critical effect size of 0.4 (Cohen's *d*), a statistical power of *0.8* and an alpha error of *0.05*. Participants were university master students (or previous master students), also including part time students. The recruitment was carried out by a master student, who is a coauthor of the present study, as part of her thesis work. The student had access to a list of classmates and former classmates from her course, who were contacted through social platforms such as Facebook, Instagram, or WhatsApp, as well as via e-mail. Most of the participants resided in the southern area of Sicily (Italy). Tests could be completed either online or in person, depending on the preference of the participants. The average time required for completion of the entire test battery was approximately 45–50 minutes. No compensation was given to the participants and no time limits were set to complete the questionnaires. All participants gave their consent to participate in the study. The study was approved by the local ethics committee and conducted in agreement with the principles of the Declaration of Helsinki.

Instruments and procedures

For the assessment we used the *Adult Vaccine Hesitancy Scale* (aVHS)[38], the *State-Trait Anxiety Disorder Inventory* (STAI)[39]; the *Toronto Alexithymia Scale* (TAS-20)[40]; the *Multidimensional Assessment of Interoceptive Awareness* (MAIA)[41]; the *Interpersonal Reactivity Index* (IRI)[42] and the *Disgust Propensity and Sensitivity Scale-Revised* DPSS-R.[43] More details about these instruments and respective scorings are provided in supplemental materials (Table S1).

Data analysis

To explore the relation between the scores associated with an anti-vaccination attitude and the assessed ideological, socio-affective, and clinical variables, we first ran a group comparison between individuals more hesitant (aVHS score > 25) and less hesitant to vaccination. Statistical tests were applied (t-test vs. Mann-Whitney U test) depending on data distribution (normal vs not normal). Next, we constructed a binary response variable (called aVHS_rk) by the following procedure. We considered the value 25 as cutoff and thus if aVHS was less or equal to 25, aVHS_rk was encoded as 0, while if aVHS was larger than 25, aVHS_rk was encoded as 1. Once the binary response variable was constructed, we ran a stepwise logistic regression, a standard tool for modeling data with a binary response variable,[44] considering all ideological, socio-affective, and clinical variables as "potential predictors." The stepwise logistic regression automatically selects a reduced number of predictor variables for identification of the best

performing logistic regression model. For automatic selection of variables, we used entry (PIN) and removal (POUT) criteria with p-values of 0.05 and 0.10 respectively for the WALD test. In each step, the predictor with the smallest probability level less than 0.05 was entered into the model. After each entry, predictors already included in the model were tested for possible removal. The predictor with the largest probability larger than 0.10 was removed, and the model re-estimated. Predictors in the model were then evaluated again for removal. When no more predictors satisfied the removal criterion, covariates that were not part of the model were evaluated for entry. Stop criteria for model building were that no more variables met the PIN or POUT criteria, or the model was identical with the one in the previous mode. To identify the amount of correctly classified cases, and thus the quality of the model, a cutoff was established at a probability value of 0.5. If the probability of the model calculated for a subject was ≥ 0.5, the assigned value was 1, if it was lower, the assigned value was zero. This model allows to estimate the probability of vaccine hesitancy based on the values of the predictors. Finally, we calculated the association between the scores of the demographic factors age and sex and predictors for vaccine hesitancy. To this purpose we used no parametric statistical tests (i.e., Mann-Whitney U Test and Spearman rank-order correlation).

Results

Consistent with prior research,[2] 72.5% ($N = 87$) of our sample had an aVHS score ≤ 25. No gender difference was found between individuals with low and high aVHS scores ($X^2 = 0.870$, $p = .350$). Since the VHS scores were not normally distributed ($K\text{-}S$ d = 0.149, $p < .01$), non-parametric statistics (Mann-Whitney U test) were applied. The results document a lower score of the not distracting subscale of MAIA-2, and the cognitive empathy dimension of IRI, including the two respective subscales (i.e., perspective taking and fantasy), in more vaccine-hesitant individuals, compared to less hesitant individuals. Details of rank sum scores and respective statistical parameters for these and other variables of interest are reported in Table 1.

For the variables obtained in the present study, the stepwise logistic regression model identified the following predictors as statistically significant: "*Non distracting*" of the MAIA-2, and "*Cognitive Empathy*" of the IRI (See Table 2). Moreover, we

Table 1. Statistical comparison between participants with lower (≤25) and higher (>25) aVHS scores.

Variables	Rank Sum low aVHS	Rank Sum High aVHS	Median value low aVHS	Median Value High aVHS	U	Z	p-level
Age	5115.5	2144.5	25	26	1287.5	−0.869	0.3843
Politics	4971.5	2168.5	NA	NA	1230.5	−1.118	0.2631
STAI-tot	5306.0	1954.0	82	81	1393.0	0.249	0.8027
STAI-Y1	5217.5	2042.5	37	39	1389.5	−0.270	0.7868
STAI-Y2	5358.5	1901.5	42	43	1340.5	0.558	0.5766
TAS-20	5205.5	2054.5	41	40	1377.5	−0.340	0.7331
Difficulty describing feelings	5210.5	2049.5	12	13	1382.5	−0.311	0.7554
Difficulty identifying feelings	5378.5	1881.5	12	11	1320.5	0.675	0.4991
Externally oriented thinking	5055.0	2205.0	16	18	1227.0	−1.225	0.2204
MAIA	5146.0	2114.0	2.73	2.84	1318.0	−0.690	0.4898
Noticing	5033.5	2226.5	2.75	3	1205.5	−1.351	0.1764
Not distracting	5705.0	1555.0	2.66	2.33	994.0	2.594	0.0094*
Not worrying	5236.5	2023.5	2.66	2.66	1408.5	−0.158	0.8739
Attention regulation	5118.0	2142.0	2.71	3.14	1290.0	−0.855	0.3924
Emotional awareness	5284.5	1975.5	3.4	3.6	1414.5	0.123	0.9017
Self-regulation	5085.0	2175.0	2.5	2.75	1257.0	−1.049	0.2941
Body listening	5075.5	2184.5	2.33	2.66	1247.5	−1.104	0.2691
Trusting	5180.0	2080.0	3.63	3	1352.0	−0.490	0.6235
IRI	5584.5	1675.5	69	64	1114.5	1.8866	0.0592
Cognitive empathy	5634.5	1625.5	19	17	1064.5	2.1804	0.0292*
Perspective taking	5614.0	1646.0	19	16	1085.0	2.0600	0.0393*
Fantasy	5683.0	1577.0	38	31	1016.0	2.4655	0.0136*
Affective empathy	5500.0	1760.0	20	19	1199.0	1.3899	0.1645
Empathic concerns	5162.0	2098.0	12	12	1334.0	−0.5965	0.5508
Personal distress	5391.0	1869.0	32	31	1308.0	0.7493	0.4536
DPSSR tot	5264.0	1996.0	23	22	1435.0	0.0029	0.9976
DPSSR (P)	5111.0	2149.0	19	21	1283.0	−0.8962	0.3700
DPSSR (S)	5186.0	2074.0	42	44	1358.0	−0.4554	0.6487

*indicates significant results. Acronyms: **STAI** (state-trait anxiety inventory); **TAS** (Toronto alexithymia scale); **MAIA** (multidimensional assessment of interoceptive awareness); **IRI** (interpersonal reactivity index); **DPSSR** (disgust propensity and sensitivity scale-revised).

Table 2. Logistic regression estimates overall percentage correct = 71.7%; Hosmer and lemeshow test = 6.33#. Nagelkerke R square = 0.22 - final −2 log likelihood = 121.97 (LR-test**).

Variables in the equation	B	SE	WALD	df	OR-Exp(B)
Non distracting**	−0.557	0.245	5.550	1	0.562
Cognitive Empathy**	−0.060	0.027	5.046	1	0.942

#Not significant; *$p < .05$; **$p < .01$. B = estimator; SE = standard error; WALD = wald test; df = degree of freedom; OR-Exp(B)= odd ratio of B.

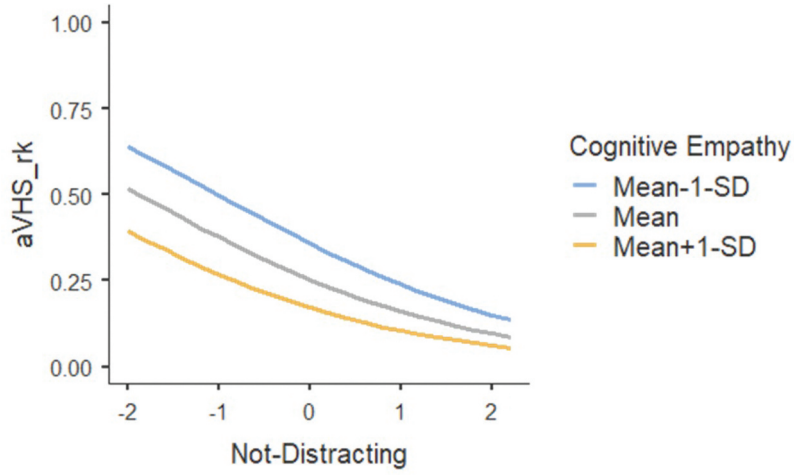

Figure 1. Probability profiles based on the "*Not-Distracting*" predictor by three levels (mean − SD, mean, mean + SD) of "*Cognitive Empathy*." The figure shows how the probability of aVhs_rk varies with the variation of "*Not-Distracting*" when we assume three levels of "*Cognitive Empathy*" (mean = 35.1, SD = 8.29). 3 levels were defined as follows for "*Cognitive Empathy*:" 35.1 − 8.29; 35.1; 35.1 + 8.29.

modeled the interaction effects between "Non distracting" and "Cognitive Empathy," but this model was less precise than the model proposed.

The likelihood ratio (LR) test was significant, indicating that the logistic model provided a better fit to the data than the intercept-only model. With a cutoff = 0.5, the probability of correct classification of all cases was 74.2%. Odds ratios (OR) in Table 2 suggest "not distracting" as main predictor the higher the score in this scale, the lower the hesitancy to vaccination (i.e., the aVHS_rk, Figure 1). Therefore, for each increase of one unit of *Not distracting*" (net amount of Cognitive Empathy), the OR decreases by 43.8%. (Figure 1).

The *Cognitive Empathy* predictor shows the same trend: the higher the cognitive empathy score, the lower the hesitancy to vaccination (i.e., the aVHS_rk, Figure 2). Similarly, an increase of one unit of "*Cognitive Empathy*" (net value of Not-Distracting) decreases OR by 5.8%. Figures 1 and 2 plot the probability profiles of aVHS_rk as a function of the predictors. Table S2 of the supplementary materials shows the details of the variables not included in the logistic regression model.

Finally, we investigated potential connections between demographic factors (specifically age and gender) and scores on variables associated with vaccine hesitancy, such as *cognitive empathy* and the *tendency not to distract oneself from sensations of pain or discomfort*. The Mann-Whitney U Test revealed a lower *cognitive empathy* score in male ($M = 2445.5$) compared to female ($M = 4814.5$) participants ($U = 1170.5$, $Z = 3.084$, $p = .002$). No significant gender difference was observed for the *factor distracting from pain* ($p = .251$). Additionally, a Spearman rank-order correlation indicated a negative relationship between age and the *cognitive empathy* score (r=-0.230, $p = .011$), while no significant correlation was found for the *factor distracting from pain* ($p = .252$).

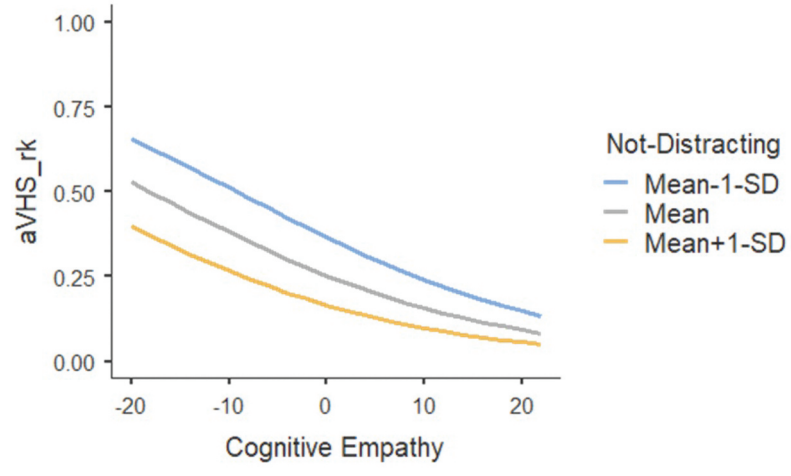

Figure 2. Probability profiles based on the "*Cognitive Empathy*" predictor by three levels (mean − SD, mean, mean + SD) of "*Not-Distracting*." The figure shows how the probability of aVhs_rk varies with the variation of "*Cognitive Empathy*" when we assume three levels of "*Not- Distracting*" (Mean = 2.52, SD = 0.919). 3 levels were defined as follows for "*Not-Distracting*:" 2.52 − 0.919; 2.52; 2.52 − 0.919.

Discussion

In this study we investigated the predictive role of several variables, spanning from ideological and socio-affective to psychological and clinical domains, for anti-vaccination attitudes in the COVID-19 post-pandemic era. Our objectives were twofold: first, to corroborate the predictive role of variables identified as relevant in prior studies, and second, to explore the role of variables that have not been studied in the context of vaccine hesitancy, specifically interoception and alexithymia. Consistent with our hypotheses, a group comparison analysis revealed a significant difference in interoceptive awareness and empathy between more and less vaccine-hesitant groups. For interoception, more vaccine-hesitant individuals exhibited a lower score on the *not distracting* subscale of the MAIA-2. Additionally, these individuals had a lower score on the *cognitive empathy* dimension of the IRI, including the two respective subscales of this dimension (i.e., *perspective taking and fantasy*).

The stepwise logistic regression model supports the importance of the *cognitive empathy* and *not distracting* indices as predictors of an anti-vaccination attitude. Consistent with previous investigations,[14] we observed that a high anti-vaccination attitude was associated with low *cognitive empathy* scores. Therefore, a lower *cognitive empathy* score was indicative for larger vaccination hesitancy. However, no significant results were found for *affective empathy*. The cognitive empathy index includes scores provided by the perspective taking and fantasy subscales. A low score in the perspective taking domain suggests a limited ability to understand and consider the perspectives, thoughts, and feelings of others. A low score in the fantasy subscale indicates a limited inclination toward imaginative experiences. Accordingly, one might speculate that high hesitancy/resistance to vaccination in people with low cognitive empathy reflects difficulties in imagining the negative consequences of not getting vaccinated for others and the self.

Regarding interoceptive awareness, our prediction and the results of the group comparison analysis for the "*not distracting*" subscale, which refers to the tendency to ignore or distract from sensations of pain or discomfort, were confirmed. Therefore, the lower the tendency to ignore or distract oneself from sensations of pain or discomfort, the more prominent the anti-vaccination attitude. The link between high vaccine hesitancy and a decreased capacity to ignore or distract oneself from sensations of pain or discomfort adds new insight to the field by suggesting the relevance of interoception as predictor of vaccination intention. This result can be interpreted as reduced tolerance to the temporary pain or discomfort associated with the needle puncture during vaccination. This is in line with recent evidence of reduced fear extinction learning in individuals more hesitant to vaccination,[16] as this index is known to correlate in the same way with neuropathic pain control.[45]

Contrary to our expectations and the current literature in the field,[21,27] political orientation, anxiety, and disgust sensitivity/propensity did not predict hesitancy/resistance to vaccination in the post COVID-19 pandemics state (see Table 1). This might be caused by the less stressful context of the post-pandemic situation compared to the pandemic phase, the relatively small sample size and thus insufficient power, or because the examined variables only predict COVID-19 vaccine hesitancy rather than being a general landmark/index of the attitude to vaccination, which was investigated in our study. Interestingly, the recent study by Candio et al.[13] report that political ideology plays a role in vaccine hesitancy in some countries and is moderated by individual income level. Citizens of poor countries were more likely to be hesitant against vaccination compared to those of rich ones. Since the economic situation in Italy improved after the reduction of the drastic containment measures implemented in the acute lockdown phase, it could be hypothesized that such economic improvement explains the missing impact of political orientation on vaccine hesitancy. Alternatively, the absence of a predictive impact of political orientation on vaccine hesitancy may be caused by the characteristics of our sample, which, on average, had a higher educational level and a younger age (for a discussion see also[46] compared to the general population. Finally, we found no evidence for links of alexithymia with vaccine hesitancy, contrary to our prediction. This suggests that difficulties to identify and describe own emotions and those of others do not represent a key predictor for post-pandemic vaccination attitudes.

Low cognitive empathy and a reduced capacity to distract oneself from pain could potentially be linked to some determinants of anti-vaccination attitudes reported in the scientific literature. For instance, low cognitive empathy might contribute to a stronger tendency toward conspiratorial thinking,[47] known to be associated with anti-vaccination attitudes.[48] Their more pronounced individualistic worldview[48] would bring individuals with low cognitive empathy to focus on perceived individual risks associated with vaccination and to put less emphasis on respective societal benefits.[49] A diminished ability to distract themselves from pain may help explain the heightened reactance to vaccination observed in individuals with a strong anti-vaccination attitude.[48] Those with a low capacity to distract themselves from pain might experience elevated levels of stress and discomfort.[50] This heightened stress and discomfort could potentially amplify their perception of vaccination as an imposition on personal freedom, making them more inclined to reject it.[48] A reduced ability to distract oneself from pain, indicative of higher stress and discomfort levels,[50] may also explain the increased susceptibility of individuals to spend more time on social media.[51] This heightened susceptibility could potentially make individuals more prone to the influence of social media, leading to increased exposure to misinformation about vaccines.

Some limitations of this study should be taken into account. This study is constrained by the relatively small sample size and an overall unbalanced proportion of male and female participants; however, no significant gender difference was observed in the respective participant subgroups (i.e., those with low and high aVHS scores). Moreover, the sample size of individuals with low and high aVHS score was not equivalent; however, the proportion of hesitant individuals (27.5%) aligns with that reported in the literature.[2] Lastly, the study did not include data on education and economic status, and the age of our sample may not be representative for the general

population, as the recruitment procedure focused on university students.

In conclusion, our study underscores the relevance of empathy and interoception as predictors of the attitude toward vaccination in the post-COVID-19 pandemic era. Future research, addressing the limitations outlined above, might contribute to a more comprehensive understanding of individual traits associated with vaccine hesitance/resistance. This knowledge is relevant to inform the development of more effective strategies for promoting vaccination, involving targeted interventions, mitigating misinformation, and adopting tailored communication approaches for individuals with specific traits. For example, it could be helpful to implement communicative strategies that increase cognitive empathy[52] to achieve better engagement of individuals with low empathy. Furthermore, considering that the lower the tendency to ignore or distract oneself from sensations of pain or discomfort, the more prominent the anti-vaccination attitude, it could be functional to provide activities or materials that help to distract individuals during the vaccination procedure from pain and discomfort, making vaccination more comfortable.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

MAN receives funding by Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)— [Project Number 316803389]—SFB 1280, project A6; CMV was supported by Ministero Istruzione Università e Ricerca (PRIN 2022, NextGenerationEU. Project code: 2022L3AALJ).

Ethics approval and consent to participate

Written Informed Consent was obtained from all the participants. The procedures were approved by the Local Ethics Committee of the Department of Cognitive, Psychological, Pedagogical and Cultural Studies (Approval n. COSPECS_07_2022) of University of Messina and complied with the ethical standards of the 1964 Declaration of Helsinki.

Consent for publication

Identifiable demographic information has been removed from this manuscript to ensure anonymity. Written informed consent was obtained to publish the information/images in an online open-access publication.

Availability of data and materials

The datasets are available from the corresponding author on request.

Authors contribution

CMV, MAN, CL, AF, GC conceived the study. GF performed data collection. CMV and MM performed the analyses. The first draft of the manuscript was written by CMV, with input from all authors. All authors approved the manuscript before submission.

References

1. World Health Organization. WHO coronavirus (COVID-19) dashboard . 2023. https://data.who.int/dashboards/covid19/cases.
2. Murphy J, Vallières F, Bentall RP, Shevlin M, McBride O, Hartman TK, McKay R, Bennett K, Mason L, Gibson-Miller Ja et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. Nat Commun. 2021;12(1):29. doi:10.1038/s41467-020-20226-9.
3. Neumann-Böhme S, Varghese NE, Sabat I, Barros PP, Brouwer W, van Exel J, Schreyögg J, Stargardt T. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. Eur J Health Econ. 2020;21(7):977–82. doi:10.1007/s10198-020-01208-6.
4. Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrachi M, Zigron A, Srouji S, Sela E. Vaccine hesitancy: the next challenge in the fight against COVID-19. Eur J Epidemiol. 2020;35(8):775–7. doi:10.1007/s10654-020-00671-y.
5. Kreps SE, Kriner DL. Resistance to COVID-19 vaccination and the social contract: evidence from Italy. NPJ Vaccines. 2023;8(1):60. doi:10.1038/s41541-023-00660-8.
6. World Health Organization. Regional Office for the Eastern Mediterranean. World Health Organization annual report 2019 WHO country office Lebanon: health for all. World Health Organization. Regional Office for the Eastern Mediterranean; 2020. https://apps.who.int/iris/handle/10665/333249.
7. Mora C, McKenzie T, Gaw IM, Dean JM, von Hammerstein H, Knudson TA, Setter RO, Smith CZ, Webster KM, Patz JA, et al. Over half of known human pathogenic diseases can be aggravated by climate change. Nat Clim Chang. 2022;12(9):869–875. doi:10.1038/s41558-022-01426-1.
8. Schmid P, Rauber D, Betsch C, Lidolt G, Denker ML. Barriers of influenza vaccination intention and behavior - a systematic review of influenza vaccine hesitancy, 2005 – 2016. PLoS One. 2017;12(1):e0170550. doi:10.1371/journal.pone.0170550.
9. Collini F, Bonaccorsi G, Del Riccio M, Bruschi M, Forni S, Galletti G, Gemmi F, Ierardi F, Lorini C. Does vaccine confidence mediate the relationship between vaccine literacy and influenza vaccination? Exploring determinants of vaccination among staff members of nursing homes in Tuscany, Italy, during the COVID-19 pandemic. Vaccines (Basel). 2023;11(8):1375. doi:10.3390/vaccines11081375.
10. Hornsey MJ, Harris EA, Fielding KS. The psychological roots of anti-vaccination attitudes: a 24-nation investigation. Health Psychol. 2018 Apr;37(4):307–15. doi:10.1037/hea0000586.
11. Alkeridy WA, Alquaydheb H, Almuhaidib S, Sindi NA, Aljasser A, Kow JK, Alqahtani AS. Determinants of vaccine hesitancy among home health care service recipients in Saudi Arabia. Vaccines. 2023;11:1436. doi:10.3390/vaccines11091436.
12. Huynh HP, Senger AR. A little shot of humility: intellectual humility predicts vaccination attitudes and intention to vaccinate against COVID-19. J Appl Soc Psychol. 2021;51(4):449–460. doi:10.1111/jasp.12747.
13. Candio P, Violato M, Clarke PM, Duch R, Roope LS. Prevalence, predictors and reasons for COVID-19 vaccine hesitancy: results of a global online survey. Health Policy (NY). 2023;137:104895. doi:10.1016/j.healthpol.2023.104895.
14. Pfattheicher S, Petersen MB, Böhm R. Information about herd immunity through vaccination and empathy promote COVID-19 vaccination intentions. Health Psychol. 2022;41(2):85–93. doi:10.1037/hea0001096.
15. Freeman D, Lambe S, Yu LM, Freeman J, Chadwick A, Vaccari C, Waite F, Rosebrock L, Petit A, Vanderslott S, et al. Injection fears and COVID-19 vaccine hesitancy. Psychol Med. 2023;53(4):1185–1195. doi:10.1017/S0033291721002609.
16. Vicario CM, Makris S, Culicetto L, Lucifora C, Falzone A, Martino G, Ferraioli F, Nitsche MA, Avenanti A, Craparo G. Evidence of altered fear extinction learning in individuals with high vaccine hesitancy during COVID-19 pandemic. Clin Neuropsychiatry. 2023;20(4):364–9. doi:10.36131/cnfioritieditore20230417.

17. Fridman A, Gershon R, Gneezy A, Capraro V. COVID-19 and vaccine hesitancy: a longitudinal study. a. 2021;16(4):e0250123. doi:10.1371/journal.pone.0250123.
18. Cadeddu C, Daugbjerg S, Ricciardi W, Rosano A. Beliefs towards vaccination and trust in the scientific community in Italy. Vaccine. 2020;38(42):6609–6617. doi:10.1016/j.vaccine.2020.07.076.
19. Engin C, Vezzoni C. Who's skeptical of vaccines? Prevalence and determinants of anti-vaccination attitudes in Italy. Popul Rev. 2020;59(2):156–179. doi:10.1353/prv.2020.0007.
20. Nemiah JC, Freyberger H, Sifneos PE. Alexithymia: a view of the psychosomatic process. Mod trends psychosom med. 1976;3:430.
21. Vicario CM, Scavone V, Lucifora C, Falzone A, Pioggia G, Gangemi S, Craparo G, Martino G, Ogden RS. Evidence of abnormal scalar timing property in alexithymia. PLoS One. 2023;18(1):e0278881. doi:10.1371/journal.pone.0278881.
22. Vicario CM, Martino G, Marcuzzo A, Craparo G. No evidence of perceptual pseudoneglect in alexithymia. Brain Sci. 2021;11(3):376. doi:10.3390/brainsci11030376.
23. Barchetta S, Martino G, Craparo G, Salehinejad MA, Nitsche MA, Vicario CM. Alexithymia is linked with a negative bias for past and current events in healthy humans. Int J Env Res Pub He. 2021;18(13):6696. doi:10.3390/ijerph18136696.
24. Coppini S, Lucifora C, Vicario CM, Gangemi A. Experiments on real-life emotions challenge Ekman's model. Sci Rep. 2023;13(1):9511. doi:10.1038/s41598-023-36201-5.
25. Ayala ES, Meuret AE, Ritz T. Treatments for blood-injury-injection phobia: a critical review of current evidence. J Psychiatr Res. 2009;43(15):1235–42. doi:10.1016/j.jpsychires.2009.04.008.
26. Bendau A, Plag J, Petzold MB, Ströhle A. COVID-19 vaccine hesitancy and related fears and anxiety. Int Immunopharmacol. 2021;97:107724. doi:10.1016/j.intimp.2021.107724.
27. Damasio AR, Tranel D, Damasio H. Somatic markers and the guidance of behavior: theory and preliminary testing. In: Levin HS, Eisenberg HM, Benton AL, editors. Frontal lobe function and dysfunction. New York: Oxford University Press; 1991. p. 217–29.
28. Palmer CE, Tsakiris M. Going at the heart of social cognition: is there a role for interoception in self-other distinction? Curr Opin Psychol. 2018;24:21–26. doi:10.1016/j.copsyc.2018.04.008.
29. Cazzato V, Vicario CM, Urgesi C. 'When hunger makes everything better looking!': the effect of hunger on the aesthetic appreciation of human bodies, faces and objects. BMC Psychol. 2022;10(1):98. doi:10.1186/s40359-022-00807-7.
30. Vicario CM, Kuran KA, Rogers R, Rafal RD. The effect of hunger and satiety in the judgment of ethical violations. Brain Cogn. 2018;125:32–36. doi:10.1016/j.bandc.2018.05.003.
31. Tian HH, Aziz AR, Png W, Wahid MF, Yeo D, Constance Png AL. Effects of fasting during ramadan month on cognitive function in Muslim athletes. Asian J Sports Med. 2011;2(3):145–53. doi:10.5812/asjsm.34753.
32. Vicario CM, Kuran KA, Urgesi C. Does hunger sharpen senses? A psychophysics investigation on the effects of appetite in the timing of reinforcement-oriented actions. Psychol Res. 2019;83(3):395–405. doi:10.1007/s00426-017-0934-y.
33. Kerry N, Loria RN, Murray DR. Gluttons for punishment? Experimentally induced hunger unexpectedly reduces harshness of suggested punishments. Adapt Hum Behav Physiol. 2019;5(4):352–70. doi:10.1007/s40750-019-00121-4.
34. Ruisch B, Von Mohr M, Naber M, Tsakiris M, Fazio R, Scheepers D. Sensitive liberals and unfeeling conservatives? Interoceptive sensitivity predicts political liberalism. Politics Life Sci. 2022;41(2):256–75. doi:10.1017/pls.2022.18.
35. Suzuki N, Yamamoto T, Uchiumi C, Sugaya N. Effects of interoceptive sensibility on mental health during the coronavirus disease 2019 pandemic. Int J Env Res Pub He. 2021;18(9):4616. doi:10.3390/ijerph18094616.
36. Elliott J, Pfeifer G. Relationship between interoceptive sensibility, age, and COVID-19 anxiety during the first national lockdown in the United Kingdom. Aging Ment Health. 2022 Oct;26(10):2112–2119. doi:10.1080/13607863.2022.2026878.
37. Jonason PK, Krause L. The emotional deficits associated with the dark triad traits: cognitive empathy, affective empathy, and alexithymia. Pers Indiv Differ. 2013;55(5):532–7. doi:10.1016/j.paid.2013.04.027.
38. Ledda C, Costantino C, Liberti G, Rapisarda V. The Italian version of the adult vaccine hesitancy scale (aVHS) for the working-age population: cross-cultural adaptation, reliability, and validity. Vaccines (Basel). 2022;10(2):224. doi:10.3390/vaccines10020224.
39. Spielberger CD, Gorsuch RL, Lushene RE. Manual for the state-trait anxiety inventory. Polo Alto (CA): Consulting Psychologists Press; 1970.
40. Bressi C, Taylor G, Parker J, Bressi S, Brambilla V, Aguglia E, Allegranti I, Bongiorno A, Giberti F, Bucca Mc et al. Cross validation of the factor structure of the 20-item Toronto alexithymia scale: an Italian multicenter study. J Psychosom Res. 1996;41(6):551–9. doi:10.1016/S0022-3999(96)00228-0.
41. Mehling WE, Acree M, Stewart A, Silas J, Jones A, Costantini M. The multidimensional assessment of interoceptive awareness, version 2 (MAIA-2). c. 2018;13(12):e0208034. doi:10.1371/journal.pone.0208034.
42. Davis MH. 1980). Interpersonal Reactivity Index (IRI) [Database record]. APA PsycTests. 10.1037/t01093-000.
43. Fergus TA, Valentiner DP. The disgust propensity and sensitivity scale-revised: an examination of a reduced-item version. J Anxiety Disord. 2009;23(5):703–10. doi:10.1016/j.janxdis.2009.02.009.
44. Hosmer D, Lemeshow S. Applied logistic regression. New York: Wiley; 1989.
45. Ji G, Yakhnitsa V, Kiritoshi T, Presto P, Neugebauer V. Fear extinction learning ability predicts neuropathic pain behaviors and amygdala activity in male rats. Mol Pain. 2018;14:1744806918804441. doi:10.1177/1744806918804441.
46. Murphy R, Pomerantz L, Kuruppumullage Don P, Sung Kim J, Long BA, Acharya B. Age and political leaning predict COVID-19 vaccination status at a large, multi-campus, public university in Pennsylvania: a cross-sectional survey. PLoS One. 2023;18(9):e0291974.
47. Gjoneska B. Conspiratorial beliefs and cognitive styles: an integrated look on analytic thinking, critical thinking, and scientific reasoning in relation to (dis)trust in conspiracy theories. Front Psychol. 2021;12:736838. doi:10.3389/fpsyg.2021.736838.
48. Hornsey MJ, Harris EA, Fielding KS. The psychological roots of anti-vaccination attitudes: a 24-nation investigation. Health Psychol. 2018;37(4):307–315. doi:10.1037/hea0000586.
49. YU H, Liu G. Advances in the studies on the relations among empathy, moral reasoning, perspective-taking and pro-social behaviors. Psychol Dev Educ. 2006;1:113–16.
50. Barcatta K, Holl E, Battistutta L, van der Meulen M, Rischer KM. When less is more: investigating factors influencing the distraction effect of virtual reality from pain. Front Pain Res (Lausanne). 2022;2:800258. doi:10.3389/fpain.2021.800258.
51. Satici B, Kayis AR, Griffiths MD. Exploring the association between social media addiction and relationship satisfaction: psychological distress as a mediator. Int J Ment Health Addiction. 2023;21(4):2037–51. doi:10.1007/s11469-021-00658-0.
52. Riess H. The science of empathy. J Patient Exp. 2017 Jun;4(2):74–7. doi:10.1177/2374373517699267.