Patient Preference and Adherence

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

Effectiveness of Group and Individual Counselling Interventions on COVID-19 Vaccination Intention Among Industrial Employees in Romania

Gheorghe Gindrovel Dumitra[1,*], Ancuța Ramona Camen[2,*], Florina Nechita[3], Mihail Cristian Pîrlog[4], Constantin Kamal[1], Carmen Adriana Dogaru[1], Mirela Radu[1], Elena Codruța Gheorghe[1], Elena Madalina Dumitrescu[5], Venera Cristina Dinescu[6], Roxana Surugiu[7], Carmen Nicoleta Oancea[7], Adina Turcu-Stiolica[8]

[1]Family Medicine Department, University of Medicine and Pharmacy of Craiova, Craiova, 200349, Romania; [2]Department of Occupational Medicine, University of Medicine, and Pharmacy of Craiova, Craiova, 200349, Romania; [3]Department of Medical Psychology, University of Medicine, and Pharmacy of Craiova, Craiova, 200349, Romania; [4]Department of Medical Sociology, University of Medicine, and Pharmacy of Craiova, Craiova, 200349, Romania; [5]Family Medicine and Home Care Department, University of Medicine and Pharmacy of Craiova, Craiova, 200349, Romania; [6]Department of Health Promotion and Occupational Medicine, University of Medicine and Pharmacy of Craiova, Craiova, 200349, Romania; [7]Department of Biochemistry, University of Medicine, and Pharmacy of Craiova, Craiova, 200349, Romania; [8]Pharmacoeconomics Department, University of Medicine and Pharmacy of Craiova, Craiova, 200349, Romania

*These authors contributed equally to this work

Correspondence: Roxana Surugiu; Carmen Nicoleta Oancea, Email roxana.surugiu@umfcv.ro; carmen.oancea@umfcv.ro

Introduction: Vaccine hesitancy remains a critical barrier to achieving widespread vaccination, particularly in settings with limited public trust and high exposure to misinformation. This study aims to measure the level of vaccine hesitancy, identifying the factors contributing to it, and to evaluate the effectiveness of two targeted interventions—group and individual counseling—designed to address vaccine hesitancy among employees in seven industrial companies in Romania during the Coronavirus disease 2019 (COVID-19) pandemics.

Methods: A total of 256 participants were included in the study, and interventions were delivered by family physicians and occupational medicine specialists trained in motivational interviewing (MI) techniques. Data on sociodemographic factors, vaccine hesitancy, and willingness to vaccinate were collected using a questionnaire and a Visual Analogue Scale (VAS) for vaccine willingness.

Results: Both interventions led to significant increases in willingness to vaccinate, with group counseling showing a 1.4-point increase on the VAS (p-value < 0.0001) and individual counseling showing a 1.5-point increase (p-value < 0.0001), though the differences between the two approaches were not statistically significant (p-value = 0.209). Key factors correlated with higher levels of vaccine hesitancy included younger age, lower education levels, marital status (single or divorced), having children, the presence of chronic diseases, a lack of general antivaccine beliefs, and a lack of trust in the natural origin of the novel coronavirus (SARS-CoV-2).

Conclusion: This study highlights the effectiveness of dual interventions involving family doctors and occupational medicine specialists in reducing COVID-19 vaccine hesitancy among industrial workers in Romania. Key factors influencing hesitancy included demographic characteristics (age, marital status) and social determinants (education level, anti-vaccine beliefs, parenthood, and chronic illness). The findings emphasize the role of trusted healthcare professionals in addressing these concerns through targeted communication strategies, such as motivational interviewing.

Keywords: COVID-19 vaccine, vaccine hesitancy, workers, Romania, questionnaire, motivational interview

Introduction

Since 2020, humanity has faced a huge public health challenge caused by the emergence of the SARS-CoV-2 virus in December 2019 in China. The disease called COVID-19, caused by the single-stranded RNA virus SARS-CoV-2, poses a significant global health challenge, with symptoms ranging from mild fever and cough to severe complications like acute respiratory distress syndrome (ARDS) and death.[1] In this context, the approval and availability of the COVID-19 vaccine represented hope for ending the pandemic.[2]

Received: 10 November 2024
Accepted: 28 March 2025
Published: 4 April 2025

Romania has one of the lowest COVID-19 vaccination rates among European Union (EU) member states. According to World Health Organization (WHO) data, only 42% of Romania's total population has completed the primary COVID-19 vaccination series, with only 9% having received at least one booster dose. In contrast, the EU regional average stands at 65% for full primary series coverage and 37% for booster doses.[3]

By December 15, 2021, the percentage of fully vaccinated individuals in Romania stood at 39% per 100 population.[4] Despite an extensive vaccination program implemented under the National Strategy for Vaccination against COVID-19, the pandemic had claimed 63,578 lives in Romania by March 1, 2022.[5,6]

The progress of the COVID-19 vaccination campaign in Romania faced significant challenges, primarily due to the low acceptance of vaccination within the population. This hesitancy can be attributed to the decline in public trust in vaccines, exacerbated by the widespread dissemination of misinformation through social networks and beyond[7,8]

Before the pandemic, Romania was facing a high degree of vaccine hesitancy, especially in the adult population and in individuals with special conditions. Between 2016 and 2019, Romania experienced a measles epidemic that resulted in 64 deaths and 17,533 measles cases recorded.[8–12] Of these cases, 77% occurred in individuals who were eligible for vaccination but either remained unvaccinated or had not completed the full vaccination schedule.[8] This epidemic unfolded despite prior predictions and the identification of the underlying causes for low vaccination coverage.[13]

The COVID-19 vaccination campaign in Romania commenced in December 2020, shortly after the vaccine became available at the EU level. Initially, the campaign prioritized healthcare workers, individuals with chronic diseases, and adults over 65 years old.[4,6] Vaccines were first administered in hospital-based centers, then transitioned to newly established community vaccination centers, eventually expanding to include family doctors' offices. It's important to highlight that the National Immunization Program in Romania had already been operating through maternity hospitals (for birth-related vaccines) and family doctors' offices (for other vaccines).[7]

The campaign progressed successfully until May - June 2021, at which point the segment of the population willing to get vaccinated had largely been exhausted. From that point forward, attention shifted to addressing the vaccine-hesitant population group.[4] Simultaneously, Romania experienced the third wave of COVID-19 in spring 2021, followed by a fourth wave in fall 2021, driven by the Delta variant. This resulted in a significant surge of severe cases, leading to overcrowded intensive care units and an increased number of deaths, particularly among unvaccinated individuals.[14,15]

By October 2021, a significant disparity in vaccination rates between Eastern European countries and their Western European counterparts had become evident and increasingly pronounced. The Romanian government acknowledged the shortcomings of the vaccination campaign, attributing its failure to the widespread dissemination of fake news and conspiracy theories on social media and online platforms.[16]

Throughout the pandemic, data revealed that public trust in medical professionals remained high, whereas trust in political figures and institutions fluctuated. Furthermore, there was some trust in employers, yet employee compliance with measures to limit the spread of the virus remained relatively low.[17–19] This underscores the important role healthcare workers play in increasing adherence, particularly when they engage in social prescription activities aimed at promoting intervention compliance.[20] In Romania, where general practitioners (GPs) typically work in private practice, they are particularly well-regarded and trusted by the general population, further reinforcing their influential role.[21]

A series of studies on perceptions, attitudes, and behaviors regarding COVID-19 vaccination indicate that credible voices capable of persuading unvaccinated individuals to receive the vaccine include employers, medical professionals, and family members. According to a study conducted by the Romanian Institute for Evaluation and Strategy (IRES) in September 2021, 37–46% of the unvaccinated general population acknowledged that they could be convinced to get vaccinated by doctors and healthcare professionals. Additionally, for 3–9% of this group, the employer was identified as the most credible source of influence. In other words, among those who express some openness to vaccination, the combined influence of medical personnel and employers accounts for approximately 40% of persuasive factors at the general population level. This effect is even more pronounced among employed individuals with children, where the combined influence of medical professionals and employers rises to 55%. Notably, this combination represents a significantly stronger cumulative persuasive factor compared to other channels previously employed, such as public authorities (1% influence on the general population), friends (4%), or religious figures (7%).[22,23]

According to the European Centre for Disease Prevention and Control (ECDC) and other studies vaccine hesitancy is defined as the "delay in acceptance or refusal of vaccines despite the availability of vaccination services". It is widely acknowledged that this phenomenon is complex, "context-specific, and varies across time, place, and vaccines".[24,25]

Subsequent studies conducted in Romania have demonstrated that the phenomenon of vaccines hesitancy has complex attitudinal roots, persists in the adult population for other vaccines (influenza vaccine) and remains a multifaceted challenge, with rural populations being disproportionately affected. It became essential to address key factors, such as distorted risk perception, fear of adverse effects and distrust in vaccines to improve vaccination coverage.[26] In this context, we proposed an intervention targeted at industrial settings, focusing on employees of large companies who exhibited vaccine hesitancy, which was also impacting work productivity. The interventions involved two distinct groups: one that participated in group facilitation sessions and another that received individualized approaches. Trained family physicians and occupational medicine specialists engaged employees using interpersonal communication (IPC) and motivational interviewing (MI) techniques tailored to each group's needs. Our goal was to assess the level of vaccine hesitancy, identifying the factors contributing to it, and measure the effectiveness of our proposed interventions.

Materials and Methods

The study was conducted in Romania across seven industrial companies in Craiova, Dolj county during the period of November 1–30, 2021. Dolj County, located in southern Romania, is one of the country's 41 administrative counties, along with the capital, Bucharest. It plays a significant role in the region's economic and healthcare landscape, making it a relevant setting for this study. As part of this interventional study, we used a new tool to assess COVID-19 vaccine hesitancy in Romania - RO-CVH[22,27] and implemented two distinct interventions: one targeting groups (Group 1) and the other focusing on individuals (Group 2). The counseling services were provided by a selected group of physicians, consisting of five occupational medicine specialists working within the designated industrial units and eight volunteer family doctors based in Craiova.

Family physicians and occupational medicine physicians, who had been trained in interpersonal communication (IPC) and motivational interviewing (MI) techniques, were selected to carry out the interventions. Notably, the training, held on October 22–23, 2021, was organized by *Center for Health Policies and Services* (CHPS) in collaboration with the University of Medicine and Pharmacy Craiova, with participation from WHO representatives. The role of the physicians was to distribute the pre- and post-counseling questionnaire. Counseled people who were hesitant completed the questionnaire without assistance. Physicians were randomly assigned so that each performed approximately equal numbers of activities in the 2 types of interventions.

The study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Craiova, Romania (no. 174/29.10.2021).

Sample Size

We calculated a post-hoc power by Wilcoxon signed-rank test (matched pairs) using G*Power 3.1 software (Franz Faul, Universitat Kiel, Germany). Based on the current results ($N = 128$, $\mu1 = 5.2$, $\mu2 = 6.6$, $SD1 = 3.5$, $SD2 = 3.3$, $\alpha = 0.5$), a post-hoc power of >0.99 was yielded, which indicated an adequate power of our study to detect a difference between groups.

Data Collection

We implemented the intervention across seven industrial units in Dolj County, with their consent. These companies were selected with a high number of unvaccinated personnel and good accessibility to vaccination. Thus, seven companies from the South-West of Romania were included, all of which had access to a dedicated COVID-19 vaccination center.

Most of these companies are located in Craiova, Dolj County, on the Ford platform. The Ford platform is an automotive manufacturing facility, which serves as a significant industrial and economic hub in the region and includes: Espack, Aba Jiu, ILRU, Kautex, Kirchoff, Magna, and Romsilva.

Employees who accepted to take part in the counseling sessions and agreed to complete the questionnaire were included in the study. They were randomly assigned between the 2 groups. Employees who had already received the COVID-19 vaccine were excluded from the study. No missing data was obtained.

The intervention included 128 individual vaccination counseling sessions for 128 unvaccinated employees using the motivational interviewing method (intervention 2 in group 2) and 12 group discussion meetings for another 128 unvaccinated employees using the motivational interviewing method (intervention 1 in group 1). In total, 256 unvaccinated employees benefited from vaccination counseling using the motivational interviewing method.

Questionnaire Development - Evaluation

The Romanian COVID-19 Vaccine Hesitancy (RO-CVH) questionnaire included 16 items, with items rated on a 5-point Likert scale: 1 = "Strongly disagree", 2 = "Disagree", 3 = 'Neutral", 4 = "Agree" and 5 = "Strongly agree". COVID-19 vaccine hesitancy score was calculated using the questionnaire, whose value is influenced by 3 factors: Factor 1 (Confidence in information regarding the COVID-19), Factor 2 (Safety and efficacy of the COVID-19 vaccine), and factor 3 (COVID-19 vaccination is a way of controlling the people). Higher scores indicate greater hesitancy (Supplementary Table 1).[27]

A Visual Analogue Scale (VAS) tool was used to evaluate the COVID-19 vaccine willingness from 0 to 10, where 0 = "No COVID-19 vaccination willingness" and 10 = "Full COVID-19 vaccination willingness". We noted Score 0 the baseline value of VAS and Score 1 the VAS value after intervention. Spearman coefficients correlation between questionnaire scores and VAS score were evaluated.

Motivational Interview - Technique

At the level of each of the six participating companies, two general groups were established for the two groups (the approach through the individual counseling session and the approach through the facilitation of the group discussion). The activity took place between November 1–30, 2021 and consisted of supporting 20 individual sessions and 2 group discussion meetings for each company included in the study (with approximately 10 participants/meeting).

Doctors were trained to follow the stages of the motivational interview for vaccination during the counseling if certain myths or misinformation related to the COVID-19 vaccination are identified, which fuel hesitation to vaccinate. Thus, although the first impulse may be to intervene immediately in a corrective manner, it was recommended to go through the following steps:

1. Do not immediately interrupt the person to correct them and do not display strong emotions or disapproval
2. Listen to the person until the end, as it is possible to identify more inaccurate information or misinformation
3. Apply the V-O-V technique (verify-offer-verify). The first step of the V-O-V technique: ask permission before providing the correct information ("do you allow me/ do you agree/ do you want to provide you with some clarifications related to this topic?"), then provide the information following the technique of addressing misinformation
4. Apply the second step of the V-O-V technique: provide correct information. At this point, the technique for addressing disinformation is applied by going through the following steps:
   a. the correct version is presented in a short, clear sentence,
   b. the myth/disinformation is warned,
   c. why it contains errors is explained (the reason why the information was considered correct the first time, the arguments why it is wrong, and what is the correct alternative),
   d. finally, the correct version of the information is repeated, in a sentence that is as clear and concise as possible).
5. Check what the person understood from the information presented and how they explain these explanations in their own words.[22]

Statistical Analysis

All analysis were performed in GraphPad Prism 10.3.1 (GraphPad Software, San Diego, CA, USA). Descriptive analysis was done for continuous (mean, standard deviation - SD, median, interquartile range - IQR) and categorical (frequencies, percentages) variables. A two-sided *t*-test or Mann–Whitney test or Wilcoxon signed-rank test (matched pairs) was used to compare continuous variables, whereas for comparing categorical variables we used Chi-squared ($\chi 2$) test of Fisher's exact test. The existence of statistical correlations between the different variables was assessed using Spearman's coefficients (weak correlation, |rho|=0,2–0,4; moderate correlation, |rho|=0,4–0,6; strong correlation, |rho|=0,6–0,8; very strong correlation, |rho|=0,8–1). A two-sided p less than 0.05 was considered to indicate a statistically significant difference.

The heatmap was created based on the correlation matrix after performing a nonparametric, two-tailed Spearman correlation analysis. The color gradient ranged from green, indicating the highest value of the Spearman's coefficients rho, to magenta, representing the lowest value of the Spearman's coefficients rho. Each cell was labeled with its corresponding value of the Spearman's rho.

We performed linear regression examining the relationship between COVID-19 vaccination hesitation (dependent variable, calculated as a score with the COVID-19 vaccine hesitancy questionnaire)[22] and the independent variables (age, gender, marital status, education, having children, having chronic diseases, antivaccine general attitude, vaccine origin). Preliminary conditions were first checked (Durbin-Watson test for autocorrelation in the residuals, multicollinearity using the Variance Inflation Factor (VIF), homoscedasticity to ensure the reliability of the regression coefficients. Homoscedasticity was assessed using a scatterplot of regression standardized predicted values against regression standardized residuals. The model summary and ANOVA test were evaluated to verify the overall significance of the regression model.

Results

Sociodemographic Characteristics

In total, 256 participants (128 participants in Group 1 and 128 participants in Group 2) were included in the study and their baseline demographics and characteristics were summarized for the two groups in Table 1. The mean age was 41.3 years old, with a range of (19–64) and no differences between the two groups. Male participants were more numerous than female participants, but without differences between the two groups. A small percentage of participants were singles or divorced (28.1%) with the same distribution in the two groups. The education level of most of them (70.3%) were high school or below. The majority (64.1%) lived in urban areas. No significant differences were found between the two groups of participants (Table 1).

Table 1 The Socio-Demographic Characteristics of the Participants Among the Two Interventions.

Characteristics	Total (n=256)	Intervention1 (n=128)	Intervention2 (n=128)	p-value
Age (years)	41.3±11.1	41.3±10.7	41.3±11.6	0.985
Mean±SD, median (IQR)	41 (33–50)	39 (34–49)	42.5 (31.2–50)	
Gender, males, n (%)	177 (69.1%)	88 (68.8%)	89 (69.5%)	1.00
Marital status				0.211
Married	184 (71.9%)	87 (68%)	97 (75.8%)	
Singles/Divorced	72 (28.1%)	41 (32%)	31 (24.2%)	
Educational level				0.079
Elementary school	18 (7.0%)	5 (3.9%)	13 (10.2%)	
High school	162 (63.3%)	79 (61.7%)	83 (64.8%)	
University degree	55 (21.5%)	34 (26.6%)	21 (16.4%)	
Master/PhD	21 (8.2%)	10 (7.8%)	11 (8.6%)	
Residence place				0.09
Urban	164 (64.1%)	89 (69.5%)	75 (58.6%)	
Rural	92 (35.9%)	39 (30.5%)	53 (41.4%)	
Having children, yes	181 (70.7%)	90 (70.3%)	91 (71.1%)	1.00
Having chronic disease, yes	46 (18%)	15 (11.7%)	31 (24.2%)	0.014*
Previous COVID-19 diagnosis, yes	47 (18.4%)	23 (18%)	24 (18.8%)	1.00
Relatives with COVID-19, yes	132 (51.6%)	72 (56.3%)	60 (46.9%)	0.169
Severity of the disease, yes	25 (9.8%)	15 (11.7%)	10 (7.8%)	0.40
Natural origin of the COVID-19 vaccine, yes	68 (26.6%)	32 (25%)	36 (28.1%)	0.671
Annual flu vaccine, yes	36 (14.1%)	18 (14.1%)	18 (14.1%)	1.00
Anti-vaccination beliefs in general, yes	44 (17.2%)	23 (18%)	21 (16.4%)	0.869

Note: *p-value<0.05.
Abbreviation: SD, standard deviation.

https://doi.org/10.2147/PPA.S500640

The respondents had relatives or friends that were diagnosticated with COVID-19 (n=132, 51.6%) and, within them, 18.9% (n=25) had severe COVID-19 (requires hospitalization or admission to intensive care unit) or died from COVID-19. Also, only a percentage of 26.6% (n=68) believed COVID-19 had natural source from animals, whereas the rest of the participants (n=188, 73.4%) believed COVID-19 was created by humans. The respondents with low educational level (elementary school or high school) had a low willingness to take COVID-19 vaccine compared with the respondents with high educational level (university degree or master/PhD) (mean (±SD), median (IQR): 4.42 (±3.19), 5 (2–7) vs 6.08 (±3.41), 6 (3–10)).

Effectiveness of Interventions on Vaccine Hesitancy and Key Survey Dimensions Between Groups

The level of hesitancy was not different between the two groups (mean±SD, 0.6±0.1). Factor 1, representing confidence in information regarding COVID-19, influenced more the level of hesitancy (mean±SD, 18.9±4.7 in Group 1 and 18.6±5.3 in Group 2, with no significant difference between the groups, p-value = 0.373). Factor 2, related to the perceived safety and efficacy of the COVID-19 vaccine, had no significant difference between the groups, p-value = 0.906 (mean±SD, 17.2±6.1 in Group 1 and 17.3±6.2 in Group 2). Significant differences were observed for Factor 3, linked to beliefs about vaccination being a means of control, though it had the least overall impact on hesitancy (mean±SD, 6.9±2.7 in Group 1 and 6.2±2.4 in Group 2) (Figure 1).

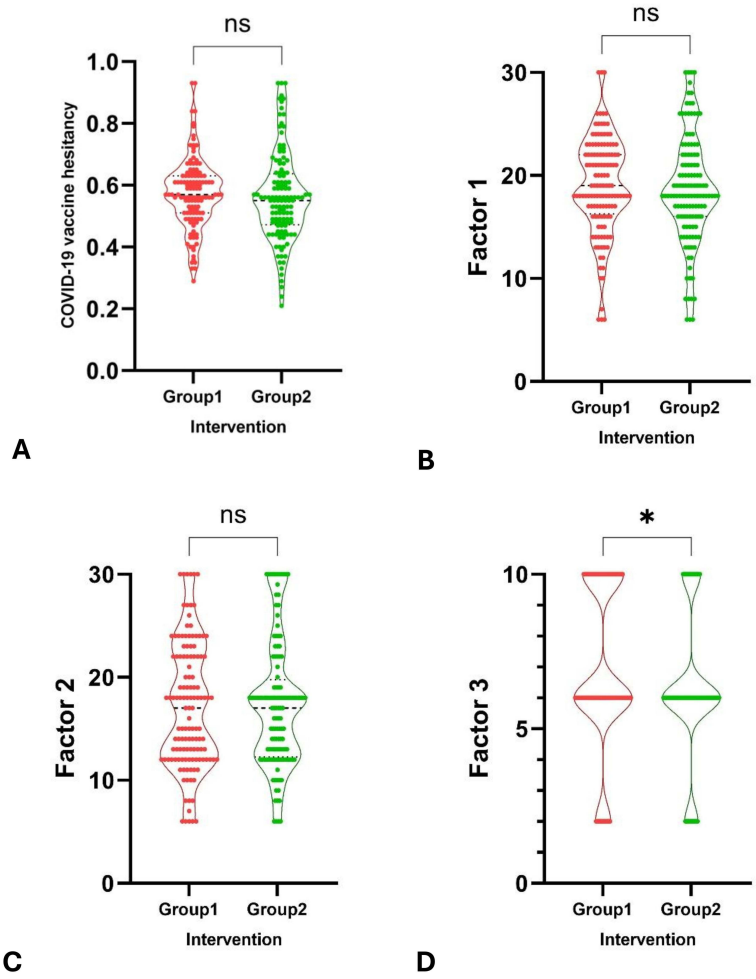

Figure 1 Violin plots comparing COVID-19 vaccine hesitancy and the three key categories of factors between Group 1 (red – group intervention) and Group 2 (green – individual intervention) post-intervention. (**A**) Distribution of vaccine hesitancy scores. (**B**) Distribution of Factor 1, which assesses confidence in the information regarding COVID-19. (**C**) Distribution of Factor 2, evaluating perceptions of vaccine safety and efficacy. (**D**) Distribution of Factor 3, which addresses concerns about vaccination being a form of control. A significant difference is observed only in Factor 3 (p = 0.023), while no significant differences were found for the other factors. *p-value<0.05.

Comparison of Intervention Types on Vaccine Willingness and Perceived Hesitancy Factors

The interventions in both groups were successful, we cannot say that one was better than the other (p-value = 0.209). Better, but not significantly different responses, were obtained for individual interventions (mean±SD difference of VAS score before and after interventions in Group 1 vs Group 2, 1.4±2.3 vs 1.5±2.0). A number of 66 (51.6%) workers from Group 1 did not change their beliefs regarding their willingness to COVID-19 vaccinate, whereas only 52 (40.6%) workers were in Group 2. The results are expressed as mean ± standard deviation (SD) and median with interquartile ranges (IQR) (Table 2).

In addition, the same results are sustained by the violin plot in Figure 2 suggesting that there was no significant difference between the two groups in terms of the overall change in willingness ($p > 0.05$), meaning that both intervention types were equally effective (Figure 2).

The responses regarding the COVID-19 hesitancy were significantly different after each intervention. In both groups, the workers increased their willingness to take COVID-19 vaccine after the intervention, as shown in Figure 3. At baseline, the workers from Group 1 considered a mean±SD willingness to take COVID-19 vaccine 5.2±3.5 and changed into 6.6±3.3 after intervention (****p-value < 0.0001). In the Group 2, the mean±SD of willingness to take COVID-19 vaccine significantly increased from 4.6±3.1 to 6.2±3.3 (****p-value < 0.0001) (Figure 3).

Determinants of COVID-19 Vaccine Hesitancy

Our regression model was statistical significant, F (9242) = 13.383, p-value < 0.001), but only 33.2% of the variance in COVID-19 vaccine hesitancy was explained by the independent variables in our model. While this is a moderate effect size, it

Table 2 The Baseline (Score 0) and Post-Intervention (Score 1) Results of COVID-19 Vaccine Hesitancy and Related Factors Among Participants from the Two Intervention Groups. The COVID-19 Vaccine Willingness Was Measured from 0 to 10, Where 0 = "No COVID-19 Vaccination Willingness" and 10 = "Full COVID-19 Vaccination Willingness". Hesitancy Score Was Measured Using the Romanian Validated Questionnaire.[21]

Characteristics	Total (n=256)	Intervention1	Intervention2	p-value
Score 0				0.214
Mean±SD	4.9±3.3	5.2±3.5	4.6±3.1	
Median (IQR)	5 (2–8)	5 (2–9)	5 (2–7)	
Score 1				0.247
Mean±SD	6.4±3.3	6.6±3.3	6.2±3.3	
Median (IQR)	7 (4–10)	7 (5–10)	7 (4–9)	
Difference Score (Score 1 - Score 0)				0.209
Mean±SD	1.5±2.1	1.4±2.3	1.5±2.0	
Median (IQR)	1 (0.0–3.0)	0.0 (0.0–3.0)	1.0 (0–3)	
Factor 1				0.373
Mean±SD	18.8±4.9	18.9±4.7	18.6±5.3	
Median (IQR)	18 (16–22)	19 (16.3–22)	18 (16–22)	
Factor 2				0.906
Mean±SD	17.2±6.1	17.1±6.1	17.3±6.2	
Median (IQR)	17 (12–22)	17 (12–22)	17 (12.3–19.8)	
Factor 3				0.023*
Mean±SD	6.6±2.5	6.9±2.7	6.2±2.4	
Median (IQR)	6 (6–10)	6 (6–10)	6 (6–6)	
Hesitancy Score				0.146
Mean±SD	0.6±0.1	0.6±0.1	0.6±0.1	
Median (IQR)	0.6 (0.5–0.6)	0.6 (0.5–0.6)	0.5 (0.5–0.6)	

Note: *p-value<0.05.
Abbreviation: SD, standard deviation.

https://doi.org/10.2147/PPA.S500640

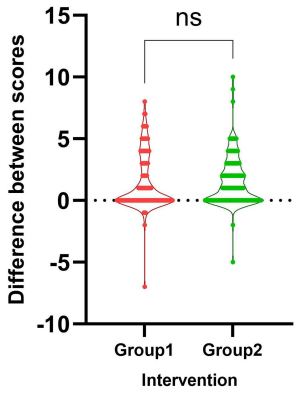

Figure 2 Violin plot comparing the difference between baseline and post-intervention willingness to take the COVID-19 vaccine for Group 1 (red) and Group 2 (green). The distribution of score differences shows no statistically significant difference (ns) between the two intervention groups, indicating that both interventions resulted in similar overall changes in willingness to take the vaccine.

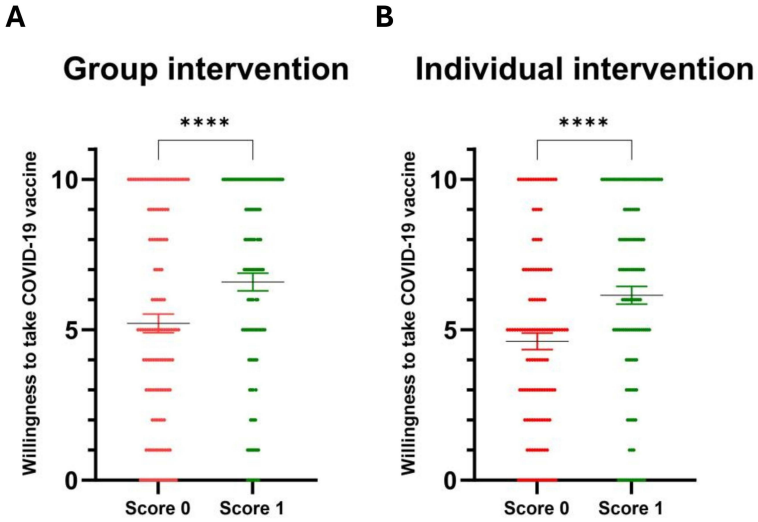

Figure 3 Dot plots comparing the willingness to take the COVID-19 vaccine before and after interventions. In (**A**), the group-based intervention shows a significant increase in vaccine willingness, with the median score rising from 5.2 before the intervention to 6.6 after ($p < 0.0001$). In (**B**), the individual-based intervention also resulted in a significant increase in willingness, with the median score increasing from 4.6 before the intervention to 6.2 after ($p < 0.0001$). Each dot represents a participant's score, and the lines indicate the median willingness scores. ****p-value<0.0001 (Wilcoxon matched-pairs signed rank test); Score 0, the willingness to take COVID-19 vaccine before intervention; Score 1, the willingness to take COVID-19 vaccine after intervention.

indicates that other factors not included in the model may also influence vaccination hesitation. The preliminary condition checks (Durbin-Watson - DW=0.68, VIF<2.4 for all independent variables, homoscedasticity – the residuals were randomly scattered around zero with no clear pattern) confirmed that the assumptions of linear regression were met, supporting the validity of our results. Age was a significant predictor of vaccination hesitation ($B = -0.003$, p-value < 0.001), indicating that older individuals were less hesitant about vaccination. Antivaccine attitude was a significant predictor of vaccination hesitation ($B = -0.098$, $p < 0.001$), suggesting that stronger anti-vaccine attitudes were linked to lower hesitation (or higher acceptance). Vaccine origin was a significant predictor ($B = 0.088$, $p < 0.001$), indicating that concerns about vaccine origin were linked to higher hesitation. Education was a significant factor that influenced vaccine hesitancy, less educated participants were more hesitant ($B = -0.017$, p-value = 0.047). Marital status was another significant factor, single or divorced participants were more hesitant in COVID-19 vaccination ($B = -0.006$, p-value = 0.039). Having children was a factor that increased COVID-19 vaccine hesitancy ($B = 0.232$, p-value = 0.041). Participants with chronic diseases had higher COVID-19 vaccine hesitancy ($B = 0.016$, p-value = 0.032). Gender ($B = 0.002$, p-value = 0.862) and environment ($B = 0.011$, p-value = 0.429) were not statistically significant predictors of COVID-19 vaccination hesitation. The results are presented in Table 3.

The same results were obtained using the heatmap presented in the Supplementary Figure 1.

Table 3 Regression Analysis of Factors Influencing COVID-19 Vaccine Hesitancy

Independent Variable	B (Coefficient)	p-value
Age	−0.003	< 0.001****
Antivaccine Attitude	−0.098	< 0.001****
Vaccine Origin	0.088	< 0.001****
Education	−0.017	0.047*
Marital Status	−0.006	0.039*
Having Children	0.232	0.041*
Chronic Diseases	0.016	0.032*
Gender	0.002	0.862
Environment	0.011	0.429

Notes: ****p-value<0.01; *p-value<0.05.

Discussion

Our findings highlight the importance of targeted interventions that significantly improved willingness to take the COVID-19 vaccine. In Group 1 (group intervention), willingness increased from 5.2 ± 3.5 to 6.6 ± 3.3 ($p < 0.0001$), while in Group 2 (individual intervention), it increased from 4.6 ± 3.1 to 6.2 ± 3.3 ($p < 0.0001$), without demonstrating significant differences between the two approaches. Additionally, our regression model was statistically significant, explaining 33.2% of the variance in COVID-19 vaccine hesitancy. While this represents a moderate effect size, it suggests that additional factors not included in the model may also influence vaccination hesitation. Key predictors of hesitancy included age, with older individuals showing less hesitation, and anti-vaccine attitudes, where stronger anti-vaccine beliefs were associated with lower hesitation. Concerns about vaccine origin were linked to higher hesitancy. Additionally, lower education levels, marital status (single or divorced), having children, and the presence of chronic diseases were associated with increased hesitancy. Gender and environmental factors were not significant predictors. These findings highlight the importance of demographic and attitudinal factors in understanding COVID-19 vaccine hesitancy.

In our study, the demographic data show no significant differences between the two groups where interventions were applied, allowing us to conclude that the underlying reasons for vaccine hesitancy in the employees across seven industrial units were similar. To combat vaccine hesitancy, we first identified the individual causes behind this phenomenon. A mixed team, composed of a family physician and an occupational medicine specialist, was employed to implement the intervention. We opted for this structure because various surveys consistently demonstrate a high level of trust in healthcare workers, especially family doctors.[28,29] The occupational doctor was included due to their close relationship with employees in industrial settings, built through regular health evaluations.[23,30]

We emphasize the importance of trust in healthcare professionals. The sustained high level of trust in medical staff during the pandemic suggests that they play a crucial role in promoting vaccine acceptance.[31,32] Utilizing this trust through targeted interventions is a potent strategy for overcoming vaccine hesitancy and improving vaccination rates.

The analysis of the determinants of vaccine hesitancy reveals a complex interplay of socio-demographic, psychological, and contextual factors. Our findings, showing that younger individuals, those with lower education levels, and individuals with children were more likely to be vaccine-hesitant, align with observations from other studies.[33–35] These groups might require tailored communication strategies that address their specific concerns and barriers to vaccination.

An alarming finding of our study is the strong association between vaccine hesitancy and the belief that COVID-19 was of non-natural origin. This perception was identified as a significant driver of vaccine hesitancy even before the vaccination campaign began.[36] This underscores the pervasive influence of misinformation and conspiracy theories in shaping vaccine attitudes. Therefore, effective public health communication strategies are urgently needed to counteract misinformation and promote evidence-based information on vaccines.[2]

Despite high levels of trust in employers, our study revealed relatively low compliance with public health measures, a finding that echoes previous studies on poor adherence to vaccination programs and protective measures among those

with low trust in authorities.[37] This suggests that vaccine promotion efforts must involve a multi-faceted approach combining clear communication, trust-building, and addressing individual concerns.

Interestingly, in our study, patients with chronic illnesses exhibited higher levels of vaccine hesitancy. Although these patients face increased risks of severe COVID-19 complications,[38–40] their hesitation may be explained by fear of the vaccine exacerbating their underlying health conditions. This is consistent with literature showing that patients with cancer, autoimmune diseases, or other serious comorbid conditions exhibit increased vaccine hesitancy.[40] However, other studies indicate that patients with multiple comorbidities are three times more likely to intend to vaccinate,[41] suggesting that the fear of worsening comorbidities may be a particular concern in industrial settings, overshadowing the risk of severe disease progression.

The negative correlation between high COVID-19 vaccine hesitancy and the absence of general anti-vaccine beliefs can be explained by the unique context of the COVID-19 pandemic and the distinct nature of the decisions individuals faced. Unlike routine vaccinations, which are often influenced by long-held beliefs or inherited attitudes, the COVID-19 vaccine decision was unprecedented and highly personal. Many individuals who do not typically oppose vaccines in general may have hesitated specifically toward the COVID-19 vaccine due to factors such as the rapid development of the vaccine, concerns about its novelty, or the overwhelming volume of information and misinformation circulating during the pandemic. In other words, the hesitancy observed in this group was not rooted in a broader anti-vaccine ideology but rather in situational factors specific to the COVID-19 context. These individuals, who might otherwise trust and accept vaccines, were confronted with a unique set of uncertainties and pressures that led to hesitation. This highlights how vaccine attitudes can be context-dependent and influenced by external circumstances, even among those who do not hold general anti-vaccine beliefs. The COVID-19 pandemic, as a global crisis, created a decision-making environment that diverged significantly from routine vaccination scenarios, leading to unexpected patterns of hesitancy.[24,42]

Overall, the study provides valuable insights into vaccine hesitancy and the effectiveness of interventions in an industrial setting in Romania. The significant increase in willingness to receive the COVID-19 vaccine following both group and individual interventions underscores the potential of targeted communication strategies (in our intervention using MI) to overcome vaccine hesitancy. These findings support growing evidence that interventions delivered by trusted healthcare professionals, when tailored to specific populations, can promote vaccine acceptance.[20,21] Some studies have shown that this relationship is also observable in the case of accepting the COVID-19 vaccine[22] and others have demonstrated this association even before the onset of the pandemic referring to vaccination in general.[28]

The observation that individual interventions yielded slightly better results, albeit not statistically significant, warrants further investigation. It's plausible that individual interactions allow for more personalized communication and address specific concerns more effectively. Some authors have concluded that individual interventions tend to be more effective; however, they do not specify the context or environment in which these interventions were conducted.[24] Nevertheless, dialogue-based and multicomponent interventions have proven to be the most effective strategies for addressing and reducing vaccine hesitancy.[24,29]

The results should be interpreted in the context of our use of the motivational interviewing (MI) technique, employed after the healthcare professionals involved underwent prior training. MI was selected because it had shown promising results in previous studies, where it was reported to produce favorable outcomes.[23,30–32] More recently, MI has also demonstrated effectiveness in the context of COVID-19 vaccination.[33] Thus, the success of this intervention cannot be attributed solely to one element of the process but should be seen as the result of a holistic, multi-layered approach—either through group facilitation or individual counseling utilizing MI.

Additionally, our evaluation used the Visual Analogue Scale (VAS) to measure the intention to vaccinate. The VAS tool has been valuable for understanding where an individual is on the spectrum of decision-making regarding vaccination, as explained by the Prochaska and Di Clemente model.[34] This model suggests that individuals move through stages—precontemplation, contemplation, decision, and action—before reaching the point of taking the vaccine. As such, the success of interventions often lies in gradually moving individuals toward the "action" stage, which might require repeated, layered interventions.[34,35] This model has been used effectively in interventions promoting other vaccines, including the HPV vaccine.[32,36]

Overall, the study contributes to the understanding of vaccine hesitancy and its determinants in the Romanian context. It highlights the potential of workplace interventions in promoting vaccine uptake and emphasizes the importance of

addressing misinformation and building trust. The findings have important implications for public health practitioners and policymakers in their efforts to combat vaccine hesitancy and improve vaccination rates.

While this study offers valuable insights into COVID-19 vaccine hesitancy and the effectiveness of interventions in an industrial setting, it is essential to acknowledge its limitations. The study was conducted in a specific region of Romania and focused on industrial workers. The findings may not be generalizable to other populations or settings. Further research is needed to assess the effectiveness of similar interventions in different contexts, such as rural areas or among healthcare professionals. In the same time, the study relied on self-reported data, which may be subject to recall bias or social desirability bias. Participants might have over-reported or under-reported certain behaviors or attitudes, potentially affecting the accuracy of the findings. We assessed the immediate impact of the interventions. Long-term follow-up is needed to evaluate the sustainability of their effects and whether they translate into actual vaccination behavior. In our approach we focused on a specific set of factors influencing vaccine hesitancy. Other factors, such as cultural beliefs, religious values, or political affiliations, political context, might also play a role and warrant further investigation. Not at the least, the study was conducted in Romania, a country with a unique socio-political context and healthcare system. The findings may not be directly applicable to other countries with different cultural and healthcare landscapes.

Conclusions

This study demonstrates the effectiveness of dual interventions— delivered by both teams of family doctors and occupational medicine specialists — in reducing COVID-19 vaccine hesitancy and increasing intention to vaccinate among industrial workers in Romania. The presence of trusted healthcare professionals within familiar settings enhances engagement, while the industrial environment amplifies peer influence, necessitating credible medical guidance to counter misinformation.

Targeted motivational interviewing (MI) strategies, whether in group or individual formats, significantly increased vaccine acceptance. Key factors influencing hesitancy included demographic aspects (age, marital status) and social determinants (education, anti-vaccine beliefs, parenthood, and chronic illness), underscoring the need for tailored, trust-building approaches to improve vaccination rates.

Despite limitations, the findings offer valuable public health insights, highlighting the necessity of clear, targeted communication strategies. Future research should assess the long-term impact and sustainability of these interventions, while also exploring broader determinants of vaccine hesitancy across diverse populations. Additionally, further research is needed to understand the complex interplay of factors that contribute to vaccine hesitancy in different populations and settings.

Implications

The study has important implications for public health policy and practice. It suggests that workplace interventions can be a valuable tool to address vaccine hesitancy and improve vaccination rates. Healthcare professionals, employers, and policymakers should collaborate to develop and implement effective interventions tailored to specific populations and settings.

Institutional Review Board Statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee from the University of Medicine and Pharmacy of Craiova, Romania (no. 174/29.10.2021).

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding authors on reasonable request.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Acknowledgments

We want to express special thanks to World Health Organization Office for Romania, Dr Dana Fărcăsanu and Mirela Mustață from CPSS and to intervenient physicians: Roxana Delureanu, Edi Oprea, Voni Calinescu, Maria Duta, Magda Mateica, Narcisa Nicoli.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This research was funded by University of Medicine and Pharmacy of Craiova, Romania and the Center for Health Policies and Services (Romania), grant number 26/45C/02.11.2021. The Article Processing Charges were funded by the University of Medicine and Pharmacy of Craiova, Romania.

Disclosure

The authors declare no conflicts of interest in this work.

References

1. Duta TF, Rizki DR, Purnama A, et al. Essential oil for COVID-19 management: a systematic review of randomized controlled trials. *Narra X*. 2023;1(2):e93. doi:10.52225/narrax.v1i2.84
2. Dascalu S, Geambasu O, Covaciu O, et al. Prospects of COVID-19 vaccination in Romania: challenges and potential solutions. *Front Public Health*. 2021;9. doi:10.3389/fpubh.2021.644538
3. COVID-19 vaccines | WHO COVID-19 dashboard. Datadot. Available from: https://data.who.int/dashboards/covid19/vaccines?m49=642&n=o. Accessed July 27, 2024).
4. COVID-19 Vaccine Tracker | European Centre for Disease Prevention and Control. Available from: https://vaccinetracker.ecdc.europa.eu/public/extensions/COVID-19/vaccine-tracker.html#national-ref-tab. Accessed July 27, 2024).
5. Túri G, Kassay J, Virág A, Dózsa C, Horváth K, Lorenzovici L. Riding the pandemic waves—lessons to be learned from the COVID-19 crisis management in Romania. *Trop Med Infect Dis*. 2022;7(7):122. doi:10.3390/tropicalmed7070122
6. STRATEGIE. Portal Legislativ. Available from: https://legislatie.just.ro/Public/DetaliiDocumentAfis/234095. AccessedJuly 27, 2024).
7. Bălan A, Bejan I, Bonciu S, Eni CE, Ruță S. Romanian medical students' attitude towards and perceived knowledge on COVID-19 vaccination. *Vaccines*. 2021;9(8):854. doi:10.3390/vaccines9080854
8. Dube E, Pistol A, Stanescu A, et al. Vaccination barriers and drivers in Romania: a focused ethnographic study. *Eur J Public Health*. 2022;33(2):222–227. doi:10.1093/eurpub/ckac135
9. Viața Medicală. Măsuri de limitare a epidemiei de rujeolă - Viața Medicală. Viața Medicală. Available from: https://www.viata-medicala.ro/masuri-de-limitare-a-epidemiei-de-rujeola-12598. (Accessed July 27, 2024).
10. Centrul National de Supraveghere si Control al Bolilor Transmisibile. *SITUATIA RUJEOLEI in ROMANIA LA DATA de 30.11.2018*. 2018.
11. Ce am invatat din epidemia de rujeola? What have we learnt from the measles outbreak?. Available from: https://scholar.google.com/citations?view_op=view_citation&hl=ro&user=BPzxcBQAAAAJ&pagesize=80&citation_for_view=BPzxcBQAAAAJ:Wp0gIr-vW9MC. (Accessed July 27, 2024).
12. Dascalu S, Hackländer K, Faber V, Taylor N, Auer H, Duscher GG. Measles epidemics in Romania: lessons for public health and future policy. *Front Public Health*. 2019;7:7. doi:10.3389/fpubh.2019.00098
13. Kriss JL, Stanescu A, Pistol A, Butu C, Goodson JL. The world health organization measles programmatic risk assessment tool—Romania, 2015. *Risk Anal*. 2016;37(6):1096–1107. doi:10.1111/risa.12669
14. Briciu V, Topan A, Calin M, Dobrota R, Leucuta D-C, Lupse M. Comparison of COVID-19 severity in vaccinated and unvaccinated patients during the delta and omicron wave of the pandemic in a Romanian tertiary infectious diseases hospital. *Healthcare*. 2023;11(3):373. doi:10.3390/healthcare11030373
15. Mărcău F-C, Purec S, Niculescu G. Study on the refusal of vaccination against COVID-19 in Romania. *Vaccines*. 2022;10(2):261. doi:10.3390/vaccines10020261
16. Badea M. CNN: cum au ajuns România și Bulgaria să aibă cele mai mici rate de vaccinare din UE. Trecutul comunist. Digi24. Available from: https://www.digi24.ro/stiri/externe/cnn-cum-au-ajuns-romania-si-bulgaria-sa-aiba-cele-mai-mici-rate-de-vaccinare-din-ue-trecutul-comunist-este-una-din-cauze-1687669. Accessed July 27, 2024).
17. Romania: trust in healthcare system during COVID-19 pandemic 2020 | statista. Statista. Available from: https://www.statista.com/statistics/1114365/romania-trust-in-healthcare-system-during-covid-19-pandemic/. Accessed July 27, 2024).
18. Radu B. Trust in public institutions and compliance with measures against COVID-19 pandemic. case study on metropolitan area of cluj, Romania. *Transylv Rev Adm Sci*. 2021;63 E:128–150. doi:10.24193/tras.63e.7

19. Bârgăoanu A, Corbu N, Buturoiu R, Durach F. Managing the COVID-19 pandemic: predictors of trust in institutions in Romania. *Kybernetes*. 2021;51(7):2398–2415. doi:10.1108/k-12-2020-0913
20. Surugiu R, Iancu MA, Lăcătus AM, et al. Unveiling the presence of social prescribing in Romania in the context of sustainable healthcare—a scoping review. *Sustainability*. 2023;15(15):11652. doi:10.3390/su151511652
21. Kurpas D, Stefanicka-Wojtas D, Shpakou A, et al. The advantages and disadvantages of integrated care implementation in Central and Eastern Europe – perspective from 9 CEE countries. *Int J Integrated Care*. 2021;21:4. doi:10.5334/ijic.5632
22. Implementing interventions aiming at increasing the demand for COVID-19 vaccination in Romania. Available from: https://cpss.ro/assets/files/reports/reports-53/22.12_Final%20report.pdf. (Accessed September 18, 2024.).
23. Percepții, atitudini și comportamente cu privire la vaccinarea COVID-19. Available from: https://ires.ro/uploads/articole/ires_pac_vaccinare-covid-19_sondaj-national_sept-2021_romania-curata_prezentare.pdf. Accessed July 27, 2024).
24. *Vaccine hesitancy*. European Centre for Disease Prevention and Control. Available from: https://www.ecdc.europa.eu/en/immunisation-vaccines/vaccine-hesitancy. Accessed July 27, 2024).
25. Hassan W, Kazmi SK, Tahir MJ, et al. Global acceptance and hesitancy of COVID-19 vaccination: a narrative review. *Narra J*. 2021;1(3):e57. doi:10.52225/narra.v1i3.57
26. Dumitra GG, Alexiu SA, Sănduțu D, et al. Segmenting attitudes toward vaccination – behavioral insights into influenza vaccination refusal in Romania. *GERMS*. 2024;14(4):362–374. doi:10.18683/germs.2024.1446
27. Turcu-Stiolica A, Boicea A, Nechita F, et al. Development and validation of a questionnaire to measure COVID-19 Vaccine hesitancy within the Romanian industrial laborers. *Front Public Health*. 2025;13. doi:10.3389/fpubh.2025.1482778
28. Williamson LD, Thompson KM, Ledford CJW. Trust takes two…. *J Am Board Family Med*. 2022;35(6):1179–1182. doi:10.3122/jabfm.2022.220126r1
29. Piccoliori G, Barbieri V, Wiedermann C, Engl A. Special roles of rural primary care and family medicine in improving vaccine hesitancy. *Adv Clin Exp Med*. 2023;32(4):401–406. doi:10.17219/acem/162349
30. Societatea Nationala de Medicina Familiei. Available from: https://snmf.ro/2019/03/10/atitudinea-populatiei-fata-de-vaccinuri-si-vaccinare-sondaj-de-opinie-inscop-research/. (Accessed July 27, 2024).
31. Viskupič F, Wiltse DL, Meyer BA. Trust in physicians and trust in government predict COVID-19 vaccine uptake. *Social Sci Q*. 2022;103(3):509–520. doi:10.1111/ssqu.13147
32. Klein LM, Habib DRS, Edwards LV, et al. Parents' trust in COVID-19 messengers and implications for vaccination. *Am J Health Promotion*. 2023. doi:10.1177/08901171231204480
33. Bergen N, Kirkby K, Fuertes CV, et al. Global state of education-related inequality in COVID-19 vaccine coverage, structural barriers, vaccine hesitancy, and vaccine refusal: findings from the global COVID-19 Trends and Impact Survey. *Lancet Glob Health*. 2023;11(2):e207–e217. doi:10.1016/s2214-109x(22)00520-4
34. Tang S, Liu X, Jia Y, et al. Education level modifies parental hesitancy about COVID-19 vaccinations for their children. *Vaccine*. 2023;41(2):496–503. doi:10.1016/j.vaccine.2022.11.060
35. Khatrawi EM, Sayed AA. The reasons behind COVID-19 vaccination hesitancy among the parents of children aged between 5 to 11 years old in Saudi Arabia. *Int J Environ Res Public Health*. 2023;20(2):1345. doi:10.3390/ijerph20021345
36. Salali GD, Uysal MS. COVID-19 vaccine hesitancy is associated with beliefs on the origin of the novel coronavirus in the UK and Turkey. *Psychol Med*. 2020;52(15):3750–3752. doi:10.1017/s0033291720004067
37. Jennings W, Valgarðsson V, McKay L, Stoker G, Mello E, Baniamin HM. Trust and vaccine hesitancy during the COVID-19 pandemic: a cross-national analysis. *Vaccine*. 2023;14:100299. doi:10.1016/j.jvacx.2023.100299
38. Pinoşanu EA, Surugiu R, Burada E, et al. Oxidative stress and antioxidant defense mechanisms in acute ischemic stroke patients with concurrent COVID-19 infection. *Int J Mol Sci*. 2023;24(23):16790. doi:10.3390/ijms242316790
39. Pinoşanu EA, Burada E, Pîrşcoveanu D, et al. Predictive value of pulmonary involvement in stroke patients co-infected with COVID-19. *Curr Health Sci J*. 2023;49(4):536–545. doi:10.12865/CHSJ.49.04.9 Epub 2023 Dec 29.
40. Tsai R, Hervey J, Hoffman K, et al. COVID-19 vaccine hesitancy and acceptance among individuals with cancer, autoimmune diseases, or other serious comorbid conditions: cross-sectional, internet-based survey. *JMIR Public Health and Surveillance*. 2021;8(1):e29872. doi:10.2196/29872
41. Mehari EA, Mekonen TG, Adugnaw MT, Abdela OA. Prevalence of COVID-19 vaccine hesitancy and its associated factors among chronic disease patients in a resource limited setting in Ethiopia: a cross-sectional study. *Adv Public Health*. 2023;2023:1–11. doi:10.1155/2023/1776205
42. Hasanzad M, Namazi H, Larijani B. COVID-19 anti-vaccine attitude and hesitancy. *J Diab Metab Disord*. 2022;22(1):1–4. doi:10.1007/s40200-022-01018-y