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# COVID-19 Vaccine Hesitancy Demographics in Iran: Sequential Mediation Model Through Mistrust in Science and Belief in COVID-19 Vaccine Conspiracy Theories

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## Abstract

*Understanding COVID-19 vaccine hesitancy could help future public health messaging. In this study we planned to study the sociodemographic determinants of COVID-19 vaccine hesitancy, as well as the sequential mediation relationship between sociodemographic variables and vaccine hesitancy, through mistrust in science and belief in COVID-19 vaccine conspiracy theories. This is a cross-sectional study conducted during the COVID-19 outbreak, between 23rd September and 29th December 2021 on 701 Iranian people. Participants were reached via various social media platforms and data were collected with an online survey using Google forms. Completed questionnaires were obtained and analyzed using logistic regression analysis and PROCESS Macro at significance level of 0.05 using SPSS. Current study demonstrates that 92.45% of participants were eager to be vaccinated or have already been vaccinated at the time of data collection. Low education, having background medical condition and belief in traditional complementary and alternative medicine are significantly correlated with vaccine hesitancy. Moreover, Logistic regression results showed that having background medical condition and belief in traditional complementary and alternative medicine significantly predict the COVID-19 vaccine hesitancy. In addition, education and belief in traditional complementary and alternative medicine indirectly affect COVID-19 vaccine hesitancy as they influence mistrust in science and belief in COVID-19 vaccine conspiracy theories. This research indicates the critical role that trust in science plays as the mediator between vaccine hesitancy and its predictors. In addition, low-educated people and traditional complementary and alternative medicine believers should be given special importance when developing interventions for tackling the COVID-19 vaccine hesitancy problem.*

**Keywords:** Conspiracy theories; COVID-19 vaccine hesitancy; Demographics; Education; Mistrust in science; Traditional Complementary and alternative medicine

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## Introduction

Global efforts to mitigate the impact of the pandemic and reduce its health and socioeconomic negative consequences are based in large part on prevention efforts (Calina et al., 2020; Nicola et al., 2020). Thus, enormous efforts have been made by the scientific and pharmaceutical industries, with the support of governments, to develop effective and safe vaccines against SARS-CoV-2 . Despite the enormous efforts that have been made to develop successful COVID -19 vaccines, a major obstacle can be seen in the hesitant attitude toward the approved and prospective COVID -19 vaccines.

Vaccine hesitation refers to delay in acceptance or refusal of vaccination notwithstanding the availability of vaccination services . The acceptance of vaccination is influenced by factors such as complacency, convenience, and confidence .

Based on previous research, vaccine hesitancy is a frequent phenomenon globally, with diversity in the claimed reasons behind refusal of vaccine uptake (Health, 2019; Lane, MacDonald, Marti, & Dumolard, 2018; Wagner et al., 2019).

The newest estimations on COVID-19, pointed out a range of 60–75% immune persons that would be necessary to cease the forward transmission of the virus and community spread of the virus (Anderson, Vegvari, Truscott, & Collyer, 2020; Billah, Miah, & Khan, 2020; Britton, Ball, & Trapman, 2020). Vaccine hesitancy, however, could be a major factor impeding the successful management of the present COVID-19 pandemic. Thus, estimates of vaccine acceptance rates can be used to plan actions and intervention measures required to increase awareness and reassure people about the safety and benefits of vaccines, which would help to control the spread of the virus and mitigate the negative effects of this unprecedented pandemic (Habersaat et al., 2020; Weintraub, Subramanian, Karlage, Ahmad, & Rosenberg, 2021). The evaluation of attitudes and acceptance rates of COVID-19 vaccinations can aid in the initiation of communication initiatives that are crucial for enhancing public confidence in health authorities .

Immunization programs are only successful when acceptance and coverage rates are high. Addressing vaccination hesitancy while delivering billions of doses throughout the globe is and will remain one of the greatest public health risk communication endeavors ever. As a result, it is essential to comprehend the reasons why certain portions of the population are more reluctant than others to accept the vaccine and to account for those reasons when designing distribution and communication programs.

Vaccine hesitancy is expected to differ based on demographic characteristics, educational status, and prior exposure to diseases and vaccines .

Prior to the release of the COVID-19 vaccine, researchers examined the association between vaccine reluctance and demographic characteristics (Ahmed, Quinn, Hancock, Freimuth, & Jamison, 2018; Galarce, Minsky, & Viswanath, 2011; Gerussi et al., 2021; Hwang, 2020; Kwok et al., 2021; Ryan, Filipp, Gurka, Zirulnik, & Thompson, 2019; Suryadevara, Bonville, Rosenbaum, & Domachowske, 2014). Findings relating demographic variables were inconsistent (Karpman, Kenney, Zuckerman, Gonzalez, & Courtot, 2021; SteelFisher, Blendon, & Caporello, 2021; Viswanath et al., 2021). For instance, Viswanath showed that those who were younger were more likely to be vaccination hesitant than those who were older, whereas Karpman found that those 35–49 were more probable to be vaccine hesitant, compared to either older or younger groups . Findings involving gender were equally mixed, with several studies suggesting that women were more likely to be vaccine hesitant, others finding the opposite, and some finding no link . Similarly, contradictory were the findings on education level (Khubchandani et al., 2021; Olagoke, Olagoke, & Hughes, 2021; Viswanath et al., 2021).

In addition, the Middle East had one of the lowest COVID-19 vaccine acceptance rates worldwide. Kuwait had the lowest acceptance rate (23.6%), followed by Jordan (28.4%), Saudi Arabia (64.7%), and Turkey (66%) (Al-Mohaithef & Padhi, 2020; Salali & Uysal, 2020; Sallam et al., 2021). Such low acceptance rates can be attributed to the pervasiveness of conspiratorial views in the region, resulting in a negative attitude toward vaccination (Hornsey, Lobera, & Díaz-Catalán, 2020; Sallam, Dababseh, Yaseen, Al-Haidar, Ababneh, et al., 2020; Sallam, Dababseh, Yaseen, Al-Haidar, Taim, et al., 2020).

Research on vaccine hesitancy in Iran has been focused on specific samples, such as MS patients and healthcare workers . A national study on the Iranian public, showed the negative relationship of education level and acceptance rate, that adds to the contradictory literature . Thus, there is a need for a deeper knowledge of the frequency of vaccine hesitancy in Iran communities and its correlations with demographic variables. This study examined the association between sociodemographic characteristics and vaccine hesitancy in Iran general public, and how sociodemographic could affect vaccine hesitancy through belief in COVID-19 vaccine related conspiracy theories. Therefore, in the first place we examined the relationship of sociodemographic variables with vaccination hesitancy and the predictive power of each sociodemographic factors.

Moreover, belief in medical conspiracy theories have been shown to be correlated with individual differences such as education , gender, age, and religiousness on the one hand. On the other hand, it is shown that those who believe the conspiracy theories about COVID-19 are less likely to adopt behaviors. Specifically, conspiracy theories have been a significant predictor of vaccine hesitancy and vaccine propensity (Jennings et al., 2021; Jolley & Douglas, 2014; McCarthy, Murphy, Sargeant, & Williamson, 2022; Simione, Vagni, Gnagnarella, Bersani, & Pajardi, 2021). Hence, we can hypothesize that individual differences could affect vaccine hesitancy through mediating role of belief in COVID-19 vaccine conspiracy theories.

In addition, vaccine conspiracy theories are influenced by mistrust . Indeed, science mistrust raises the impact of conspiracy theories. In other words, mistrust in science could lead to forming a foundation in which conspiracy theories can grow. Therefore, it is probable that there is a sequential mediating path between sociodemographic variables and vaccine hesitancy, through mistrust in science and COVID-19 vaccine conspiracy theories. Hence, in the second place we examined the sequential mediation chain between sociodemographic variables and vaccine hesitancy, through mistrust in science and belief in COVID-19 vaccine conspiracy theories.

## Method

*Study design*

The study was a cross-sectional web-based investigation that was conducted between 23rd September 2021 and 29th December 2021. It was the time when COVID-19 vaccination had been initiated for health-care workers, people with underlying medical conditions and special professions that were at the higher risk of infection. In fact, the public vaccination had not been initiated; however, it was started in the middle of data collection.

*Sampling and data collection*

The present research sample was selected from the target population between 23rd September 2021 and 29th December 2021. Data was collected through social network applications such as Instagram and online messengers such as WhatsApp and Telegram. The questionnaire would send to the research sample via these online tools. Finally, 701 completed and analyzable questionnaires were obtained which is adequate based on Cochran's sample size formula for infinite population, with 0.95 confidence level. The inclusion criteria were as follows: age between 18 and 70 years old, residency in Iran in 2021 in any form (native, permanent resident, temporary or illegal), having sufficient proficiency in the Persian language, and having access to social networks applications and online messengers. The age-related inclusion criteria were set because most of the people above 70 in this country are not as digitally literate to participate in an online survey individually and need other people's help, which could lead to obtaining biased data.

*Measures*

*Demographic questionnaire:* consisting of age (year), gender (female/male), marital status (married/single/divorced), education (under diploma/diploma/associate's degree/bachelor degree/master's degree/Ph.D. and higher), Covid-19 history (yes/no), family infection history (yes/no), family members death due to COVID-19 history (yes/no), underlying medical condition (such as diabetes, asthma, heart disease and etc.) (no/yes). In addition, religiosity and belief in traditional complementary and alternative medicine (TCAM) were assessed on 10-point scale. The statement for religiosity was "*on a scale of 1 to 10, determine how much you consider yourself a religious person*" (1 = not at all, 10 = very much). Also, belief in TCAM was examined by the statement "*on a scale of 1 to 10, determine how much you believe in traditional complementary and alternative medicine*" (1= I do not believe at all, 10=strongly believe).

*Attitudes toward COVID-19 vaccine:* Vaccine hesitancy was assessed with the attitudes toward COVID-19 vaccine scale that was used in Nazli et al study. It was a 1-item scale that ask participants to determine which one of the following statements are true about them: *I trust the positive effects of the vaccine and want to get vaccinated, I am unsure about the positive effects of the vaccine but want to get vaccinated, I am unsure about the positive effects of the vaccine and I do not want to get vaccinated, I think the vaccine will have negative effects/will be ineffective and I do not want to get vaccinated.*

*Beliefs in anti-vaccine conspiracy theory inventory:* This questionnaire has 8 items (such as "Vaccines are harmful, and this fact is covered up"). Participants should indicate their level of agreement with each statement on a 7-point scale (1 = strongly disagree, 7 = strongly agree). The internal consistency reliability of this questionnaire was as 0.85 in the original study and 92.7 in the current study. In the current research, the word "vaccine" has been changed to "coronavirus vaccine" in each statement in order to specifically measure conspiracy theories about this vaccine.

*Beliefs on COVID-19 inventory:* mistrust in medical science was measured through the questionnaire of beliefs related to COVID-19 . In this inventory the participants are asked to give their opinion on each of the statements of this questionnaire on a 5-point Likert scale (from completely agree = 5 to completely disagree=1) to rank. The scale of mistrust in scientific research and medical science has 5 statements, such as, "*I think that research and medical science are not capable of giving us adequate measures to deal with COVID-19*". The internal consistency reliability of this questionnaire was as 0.53 which shows a moderate reliability.

*Statistical analysis*

Statistical analysis was performed using IBM SPSS v26.0 for Windows. Statistical significance was considered for $p < 0.050$. Spearman correlations were calculated to measure the strength and direction of the association between vaccine hesitancy and demographic variables. A subsequent logistic regression was then conducted to determine the demographic factors associated with COVID-19 vaccine hesitancy and the predictive power of each variable in predicting vaccine hesitancy. Age, gender, education, COVID-19 history, family infection history, family members death history, underlying medical condition, religiosity, and belief in TCAM were included as predictive variables in the logistic regression model. To perform the logistic regressions vaccine hesitancy was dichotomized into "yes" (those that answered "*I trust the positive effects of the vaccine and want to get vaccinated*", and "*I am unsure about the positive effects of the vaccine but want to get vaccinated*") and "no" (those that answered "*I do not want to get vaccinated, I think the vaccine will have negative effects/will be ineffective*", and "*I do not want to get vaccinated*"). Indeed, vaccine hesitancy scores were dichotomized based on the participants final act or decision, regardless of their level of uncertainty.

Based on the results of Spearman correlations and logistic regression analysis, we performed sequential mediation analysis (Model 6) using PROCESS v.4.1 macro in SPSS v26.0. Variables that were associated with vaccine hesitancy entered into sequential mediation models as independent variables to explore their effect mechanisms on vaccine hesitancy. We chose sequential mediation models because, based on the literature, a chain of relationships was identified. Therefore, mistrust in medical science and beliefs in anti-vaccine conspiracy theory entered the sequential mediation model as Mediator 1 and Mediator 2, respectively.

*Ethics approval*

The study was approved by the Research Ethical Committee of Isfahan University of Medical Sciences (ethics code No:IR.MUI.NUREMA.REC.1401.120).

*Results*

701 individuals completed the survey (see participants characteristics in Table 1). Most participants were females (65%, *n* = 456), having a bachelor university degree (46.5%, n=326), single (64.6%, *n* = 453), with no history of COVID-19 infection (57.1%, *n* = 400), having the family member's COVID-19 infection history (79.9%, *n* = 560), and without the history of family member's death due to the COVID-19 infection. 92.9% of participants did not have any underlying medical conditions. Also, age mean was 32.2.

Most of the participants stated that they trust the positive effects of COVID-19 vaccine and wants to get vaccinated (58.63%, *n* = 411). Also, 237 participants stated that they want to receive the vaccine, while they do not trust its positive effects (33.81%, *n* = 237). 53 participants stated that they will not get the vaccine, whether they were unsure about its positive effects (4.7%, *n* = 33) or thought that the vaccine will have negative effects (2.85%, *n* = 20).

Spearman correlation coefficients in tables 1a and 1b show that education, having background medical condition and believe in TCAM are significantly correlated with vaccine hesitancy. Correlation coefficients indicate the negative relationship of education and positive relationship of believe in TCAM with hesitation of getting vaccinated. As code 1 represents the "no" response and code 2 represents the "yes" response to having underlying medical condition, it is adversely correlated with vaccine hesitancy. In other words, if people have underlying medical condition, they are less likely to have hesitancy.

Binominal regression model results for vaccine hesitancy are shown in Table 2. Positive $\beta$ estimates represent greater degree of hesitancy and negative $\beta$ estimates represent less hesitancy. We converted vaccine hesitancy to a dichotomous variable, based on which code 1 represents individuals who will get the COVID-19 vaccine or have received it, regardless on their trust to the vaccine. Also, code 2 represents participants who will not get vaccinated or have not been vaccinated.

Results demonstrate that underlying medical condition is a significant predictor of vaccine hesitancy ($\beta$ = -1.126, *95% CI* =.145; .723, $p$ = .006). Since the $\beta$ estimate is negative,

**Tab. 1a**. Bivariate associations between socio-demographic characteristics and COVID-19 vaccine hesitancy

| | | *Trusts the positive effects of the vaccine and wants to get vaccinated* | | *Unsure about the positive effects of the vaccine but wants to get vaccinated* | | *Unsure about the positive effects of the vaccine and does not want to get vaccinated* | | *Thinks the vaccine will have negative effects/will be ineffective and does not want to get* | | *total* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ***n*** | ***%*** | ***n*** | ***%*** | ***n*** | ***%*** | ***n*** | ***%*** | ***n*** | ***%*** | ***r*** | ***p*** |
| *Gender* | *Male* | *140* | *34.1* | *83* | *35.0* | *12* | *36.4* | *10* | *50.0* | *245* | *34.95* | *-.029* | *.438* |
| | *Female* | *271* | *65.9* | *154* | *65.0* | *21* | *63.6* | *10* | *50.0* | *456* | *65.05* | | |
| *Education* | *Under diploma* | *5* | *1.2* | *3* | *1.3* | *2* | *6.1* | *1* | *5.0* | *11* | *1.57* | *-.102* | *.007* |
| | *Diploma* | *58* | *14.1* | *44* | *18.6* | *7* | *21.2* | *5* | *25.0* | *114* | *16.26* | | |
| | *Associate* | *21* | *5.1* | *16* | *6.8* | *1* | *3.0* | *1* | *5.0* | *39* | *5.56* | | |
| | *Bachelor* | *192* | *46.7* | *114* | *48.1* | *11* | *33.3* | *9* | *45.0* | *326* | *46.50* | | |
| | *Masters* | *99* | *24.1* | *51* | *21.5* | *9* | *27.3* | *4* | *20.0* | *163* | *23.25* | | |
| | *Ph.D. and higher* | *36* | *8.8* | *9* | *3.8* | *3* | *9.1* | *0* | *0.0* | *48* | *6.85* | | |
| *Marital status* | *Single* | *274* | *66.7* | *144* | *60.8* | *22* | *66.7* | *13* | *65.0* | *453* | *64.62* | *.048* | *.201* |
| | *Married* | *134* | *32.6* | *86* | *36.3* | *11* | *33.3* | *7* | *35.0* | *238* | *33.95* | | |
| | *Separated* | *3* | *0.7* | *7* | *3.0* | *0* | *0.0* | *0* | *0.0* | *10* | *1.43* | | |
| *Covid-19 history* | *Yes* | *175* | *42.6* | *104* | *43.9* | *13* | *39.4* | *9* | *45.0* | *301* | *42.94* | *-.006* | *.867* |
| | *No* | *236* | *57.4* | *133* | *56.1* | *20* | *60.6* | *11* | *55.0* | *400* | *57.06* | | |
| *Family infection history* | *Yes* | *335* | *81.5* | *182* | *76.8* | *27* | *81.8* | *16* | *80.0* | *560* | *79.89* | *.042* | *.269* |
| | *No* | *76* | *18.5* | *55* | *23.2* | *6* | *18.2* | *4* | *20.0* | *141* | *20.11* | | |
| *Family member death history* | *Yes* | *135* | *32.8* | *74* | *31.2* | *12* | *36.4* | *5* | *25.0* | *226* | *32.24* | *.015* | *.695* |
| | *No* | *276* | *67.2* | *163* | *68.8* | *21* | *63.6* | *15* | *75.0* | *475* | *67.76* | | |
| *Underlying medical condition* | *No* | *389* | *94.6* | *219* | *92.4* | *27* | *81.8* | *16* | *80.0* | *651* | *92.9* | *-.103* | *.006* |
| | *Yes* | *22* | *5.4* | *18* | *7.6* | *6* | *18.2* | *4* | *20.0* | *50* | *7.1* | | |
| | *Total* | *411* | *100* | *237* | *100* | *33* | *100* | *20* | *100* | *100* | *100* | | |

**Tab. 1b**. Bivariate associations between socio-demographic characteristics and COVID-19 vaccine hesitancy

| | ***M*** | ***SD*** | ***M*** | ***SD*** | ***M*** | ***SD*** | ***M*** | ***SD*** | ***M*** | ***SD*** | ***r*** | ***p*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Age* | *29.49* | *10.32* | *35.84* | *88.84* | *32.52* | *9.19* | *30.85* | *11.66* | *32.2* | *52.06* | *.070* | *.065* |
| *TCAM* | *4.41* | *2.49* | *4.83* | *2.63* | *5.67* | *2.53* | *6.70* | *2.87* | *5.4* | *2.59* | *.136* | *<.001* |
| *Religious tendency* | *4.11* | *2.59* | *4.26* | *2.57* | *4.03* | *2.98* | *5.75* | *3.37* | *4.5* | *2.64* | *.041* | *.284* |

**Tab. 2**. Binominal regression model results for vaccine hesitancy

| | | | | 95% C.I. for OR | |
|---|---|---|---|---|---|
| | β | Sig. | OR | Lower | Upper |
| gender (m/F) | .288 | .374 | 1.334 | .707 | 2.516 |
| age | .000 | .949 | 1.000 | .995 | 1.006 |
| education | | | | | |
| under diploma | 1.141 | .240 | 3.130 | .467 | 20.970 |
| diploma | .213 | .761 | 1.237 | .314 | 4.875 |
| associate | -.361 | .706 | .697 | .107 | 4.545 |
| bachelor | -.217 | .740 | .805 | .224 | 2.895 |
| master | .149 | .825 | 1.161 | .310 | 4.352 |
| Ph.D. and higher | Ref. | .544 | | | |
| Covid-19 history (Yes/No) | -.126 | .690 | .881 | .474 | 1.638 |
| family infection history (Yes/No) | .266 | .510 | 1.305 | .591 | 2.884 |
| family death history (Yes/No) | -.047 | .885 | .954 | .508 | 1.795 |
| underlying medical condition (Yes/No) | -1.126 | .006 | .324 | .145 | .723 |
| TCAM | .205 | .001 | 1.228 | 1.093 | 1.379 |
| religious tendency | -.017 | .776 | .983 | .875 | 1.105 |
| Constant | -2.756 | .002 | .064 | | |

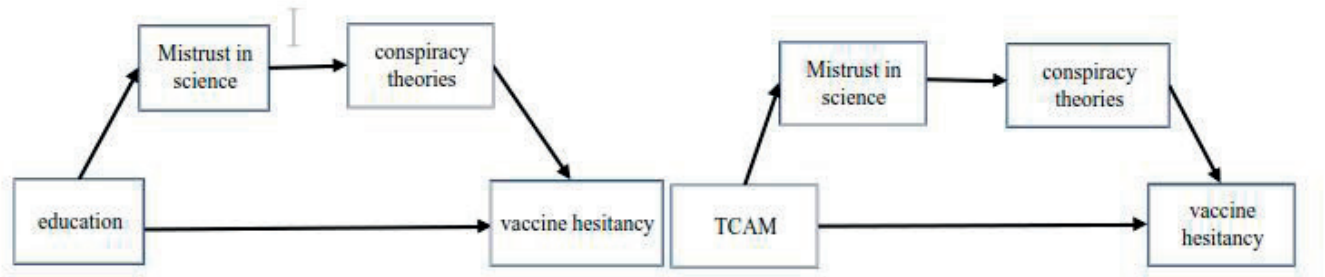
individuals with underlying medical background are less likely to be vaccine hesitant. There were also significant differences in vaccine hesitancy by belief in TCAM ($\beta$ = .205, *95% CI* = 1.093; 1.379, $p$ = .001). The more people believe in TCAM, the more probable they are to refuse vaccines. Education which had a significant correlation with vaccine hesitancy, turned out to be a non-significant predictor of vaccine hesitancy in logistic regression model. It seems that including other variables in the model caused the $\beta$ estimation of education to become insignificant. Furthermore, there was no significant difference in vaccine hesitancy between men and woman ($\beta$ = .288, *95% CI* = .707; 2.516, $p$ = .374). Also, having the history of COVID-19 infection, family member's infection history, family member's death, age and religious tendency were not significant predictors of vaccine hesitancy.

In addition, the study hypothesizes were tested through a sequential mediation model which are displayed in figure 1. The SPSS process bootstrap was performed for resampling, which was 5000 in number.

The total direct effect of education on vaccine hesitancy was negative and insignificant ($\beta$ = -.0001, $t$ = -.0062, $p$ > .05). However, the indirect effect of education on vaccine hesitancy through hypothesized mediators were significant (*effect* = -.068, *LLCI*= -.096, *ULCI*= -.042), providing support for our hypothesis, as shown in Table 3. The results of model 1 indicate that education and mistrust in science are significantly related ($\beta$ = -.4109, $t$ = -4.5350, $p$ < .05). In the second model, the impact of two predictors was seen as significant on anti-vaccine conspiracy theories. The significant value for both was .0001, which shows that the relationships were significant, as shown in Table 3. Based on model 3, the impact of predictors on vaccine hesitancy, except for education, are positive and significant (Table 3). The results show that mistrust in science and belief in COVID-19 vaccine conspiracy theories fully mediate the effect of education on vaccine hesitancy.

Furthermore, findings show the positive and significant indirect effect of TCAM on vaccine hesitancy (*effect* = .05, *LLCI* = .037, *ULCI* = .065), while its direct effect is insignificant ($\beta$ = -.0024, $t$ = -.256, $p$ > .05). The results also show that TCAM is' related to mistrust in science and belief in vaccine conspiracy theories ($\beta$ = .316, $t$ = 8.013, $p$ < .001; $\beta$ = 1.260, $t$ = 17.78, $p$ < .001 respectively), but not related to the outcome variable. The results provide support for full mediation role of mistrust in science and belief in conspiracy between the relationship of TCAM on vaccine hesitancy. In other words, mistrust in science and belief in COVID-19 anti-vaccine conspiracy theories fully meditate the relationship between belief in traditional complementary and alternative medicine and vaccine hesitancy.

**Fig. 1**. Sequential mediation models for vaccine hesitancy with the predictor role of education and alternative medicine



**Tab. 3a.** Results of sequential mediation for vaccine hesitancy

| Outcome | Predictor | B | se | t |
|---|---|---|---|---|
| MSTS | | | | |
| | constant | 16.4255 | .3723 | 44.1173** |
| | EDU | -.4109 | .0906 | -4.5350** |
| ANTVC | | | | |
| | constant | -.1421 | 1.3303 | -.1068 |
| | EDU | -.5574 | .1688 | -3.3013** |
| | MSTS | 1.3225 | .0695 | 19.0371** |
| VH | | | | |
| | constant | -.0235 | .1585 | -.1482 |
| | EDU | -.0001 | .0203 | -.0062 |
| | MSTS | .0564 | .0102 | 5.5280** |
| | ANTVC | .0410 | .0045 | 9.0892** |

Note. **. Correlation is significant at the 0.01 level (2-tailed), EDU=education, MSTS= mistrust in science, ANTVC= belief in COVID-19 anti-vaccine conspiracy theories, VH=vaccine hesitancy

**Tab. 3b.**

| Outcome | Predictor | B | se | t |
|---|---|---|---|---|
| MSTS | | | | |
| | constant | 13.3255 | .2112 | 63.1091** |
| | TCAM | .3166 | .0395 | 8.0133** |
| ANTVC | | | | |
| | constant | -3.1946 | 1.0242 | -3.1190** |
| | TCAM | .3795 | .0774 | 4.9040** |
| | MSTS | 1.2605 | .0709 | 17.7799** |
| VH | | | | |
| | constant | -.0217 | .1240 | -.1749 |
| | TCAM | -.0024 | .0095 | -.2558 |
| | MSTS | .0568 | .0103 | 5.5238** |
| | ANTVC | .0412 | .0046 | 9.0539** |

Note. **. Correlation is significant at the 0.01 level (2-tailed), MSTS= mistrust in science, ANTVC= belief in COVID-19 anti-vaccine conspiracy theories, TCAM= belief in traditional complementary and alternative medicine, VH=vaccine hesitancy

Thus, education decreases vaccine hesitancy as it negatively affects mistrust in science and belief in COVID-19 vaccine conspiracy theories. Also, belief in TCAM has positive relationship with vaccine hesitancy, as it increases the mistrust in science and belief in COVID-19 vaccine conspiracy theories. Overall, higher levels of education decrease mistrust in science, lower levels of mistrust in science reduces belief in conspiracy theories that eventually leads to reducing vaccine hesitancy. Furthermore, TCAM increases mistrust in science, higher level of mistrust in science increases belief in COVID-19 vaccine conspiracy theories, and higher levels of belief in COVID-19 vaccine hesitancy theories increases vaccine hesitancy.

## Discussion

Vaccine hesitancy has been a phenomenon that has made a negative contribution to the global health. World Health Organization considered vaccine hesitancy as a dire threat to the public health, during the infectious diseases' epidemics and pandemics, such as outbreaks of measles and pertussis (Benecke & DeYoung, 2019; Borba, Vidal, & Moreira, 2015; Gangarosa et al., 1998; Phadke, Bednarczyk, Salmon, & Omer, 2016; L. Wong, Wong, & AbuBakar, 2020). Despite the unprecedented bounces in creating efficient and safe COVID-19 vaccines, controlling this pandemic could be hindered or limited by vaccine hesitancy. Therefore, examining people's attitudes toward COVID-19 vaccines and their acceptance levels could aid in planning for measures and interventions required for enhancing public trust and assuring them about the vaccine effectiveness and safety. This would be advantageous in terms of curbing the virus spread and maximizing the positive results of vaccine development efforts. This study shows that sociodemographic factors are not significant predictors of COVID-19 vaccine hesitancy, except for education, tendency toward TCAM and having the underlying medical condition. This research indicates the critical role that trust in science plays as the mediator between vaccine hesitancy and its predictors. Indeed, due to its association with belief in conspiracy theories, trust in science would play a key role in hindering the destructive consequences of vaccine hesitancy.

Current study demonstrates that 92.45% of Iranians are eager to be vaccinated or have already been vaccinated, even

though 33.81% of them are not sure about the vaccine's positive effect. On the other hand, 7.55% of Iranian public are reluctant to get vaccinated, since they either are not sure about the vaccine positive impacts (4.7%) or they think that vaccine will have negative effects (2.85%). Compared to a similar Iranian study in May 2021 , that showed 30% vaccine hesitancy rate, Iranians' vaccine hesitancy has declined significantly during September to December 2021. This mitigation is also seen in the comparison of current study with health-care workers who had been assessed in February to March 2021 . In addition, another Iranian study among MS patients that was performed in the same time period as this research , showed the vaccine hesitancy rate of 6.9%. These comparisons show that people's reluctance to vaccines has been dropped after the initiation of public vaccination, since the public vaccination enabled people to directly observe the possible consequences and side effects of vaccine in vaccinated people.

Furthermore, compared to other countries in middle east, which were among the regions with the lowest COVID-19 vaccine acceptance rate , Iranians are the less vaccine hesitant people in the Middle east. Kuwait, Jordan, Saudi Arabia and Turkey had acceptance rate of 23.6%, 28.4%, 46.7% and 66% respectively) (Al-Mohaithef & Padhi, 2020; Salali & Uysal, 2020; Sallam et al., 2021). Since these low rates have been attributed to widespread belief in conspiracy theories in the region , it could be concluded that Iranians are less likely to embrace conspiracy theories around the COVID-19 vaccines, compared to other countries in the middle east. In fact, Iran vaccine acceptance rate is more similar to East and South East Asia which is more than 90% in Indonesia, Malaysia and one study from china (Harapan et al., 2020; Wang et al., 2020; L. P. Wong, Alias, Wong, Lee, & AbuBakar, 2020). These low rates of vaccine hesitancy have been related to the stronger confidence in vaccine safety and effectiveness in Asia , as well as strong trust in governments . The first reason could be attributed to the high acceptance rate in Iran, but not the later one, due to the low reception rate of made in Iran COVID-19 vaccines, such as COVIran Barekat . The acceptance rate in Iran is also higher than European countries (La Vecchia, Negri, Alicandro, & Scarpino, 2020; Lazarus et al., 2021; Neumann-Böhme et al., 2020) and Russia, Latin America, African countries, United states and Canada, whereas the difference between study measures and sampling should be considered in the interpretation of findings.

In line with previous studies (Piltch-Loeb et al., 2022; Ren et al., 2018; Shapiro et al., 2018; Ullah, Khan, Tahir, Ahmed, & Harapan, 2021; Wagner, Shotwell, Boulton, Carlson, & Mathew, 2021), higher educated people were less probable to be vaccine hesitant. This indicated that higher education levels are associated with more positive attitudes toward vaccines . However, some studies in the US and Iran found the opposite relationship direction, where more educated people are more vaccine hesitant. As other studies stated, there is not a uniform association between sociodemographic factors and vaccine hesitancy which could stem from disparate socio-cultural aspects. However, inconsistency with the Iranian research might be owing to the different time of data collection. In other words, it appears that with the existence of the concrete evidence and immediate experiences with COVID-19 vaccines, higher educated people are more likely to diminish their doubts about the vaccine's safety.

In addition, education indirect effect on vaccine hesitancy was shown. Education could be considered as a buffer against conspiracy beliefs, as it has also been showed in previous studies (Georgiou, Delfabbro, & Balzan, 2019; Georgiou et al., 2020; van Prooijen, 2017). This is originated from the higher-educated people's level of knowledge, analytical thought, awareness of counterarguments and rebuttals . In other words, educated individuals are more likely to find flaws of evidence because of their skill in cognitive reasoning, analytical and critical thinking. These skills propel them toward more reliable and evidence-based arguments and consequently more trust in science, as well as less belief in conspiracy theories. Hence, those people who are more educated are less vaccine hesitant, due to their higher trust in scientific information and suspicion in conspiracy theories around COVID-19 vaccines.

Moreover, the more positive individuals are toward TCAM, the more hesitant they are toward COVID-19 vaccine. This is consistent with previous studies that show both trust in complementary alternative medicine and mistrust in conventional medicine predict the vaccine hesitancy (Bryden, Browne, Rockloff, & Unsworth, 2018; Cassell et al., 2006; Hornsey et al., 2020; Rozbroj, Lyons, & Lucke, 2019; Zuzak, Zuzak-Siegrist, Rist, Staubli, & Simões-Wüst, 2008). One possibility for this association could be the particular kind of socialization for complementary alternative medicine users. Most of them are propelled into a thinking style which indicates the unnecessary role of conventional medicine. Unlike Hornsey et al study, complementary alternative medicine is linked to mistrust in medicine which is in turn related to belief in anti-vaccine conspiracy theories, in line with Simione et al results . Thus, it appears that the influence of complementary alternative medicine on vaccine hesitancy occurs through diminishing the trust in medical science. This could lead to searching for information in unreliable sources and joining the communities that encourage conspiracy theories about the medical science, as well as the origin of COVID-19 virus and its vaccines. In other words, belief in complementary alternative medicine indirectly escalates the probability of becoming a COVID-19 vaccine hesitant, through its influence on mistrust in science and belief in conspiracy theories.

*Limitations and Suggestions for Future Research*

It is crucial to acknowledge that some factors should be taken into account when interpreting and generalizing the findings of this study. The results are based on a convenience sample who had access to the internet and online messengers. Therefore, the findings can only be generalized to the sort of people who undertake online panel surveys. It is also probable that vaccine hesitant people refused to take part when they became aware of the study purpose on the questionnaire instruction. Thus, the low rate of vaccine hesitancy could be due to the higher willingness of vaccine proponent people to participate in the study, rather than the actual rate of vaccine hesitancy in the society. Also, there was no theoretical background or empirical support for the mediation role of belief in conspiracy theory

in the relationship between underlying medical condition and vaccine hesitancy. Therefore, despite the significant role of underlying medical condition in predicting vaccine hesitancy, this variable was not included in the mediation models.

For future researchers, it is suggested to examine the predictive power of demographic factors using in-person instruments to have more generalizable results. Also, we recommend investigating the moderators in the relationship between demographic variables and vaccine hesitancy as well as the interaction between demographic factors in predicting vaccine hesitancy. In addition, more investigation into the relationship of underlying medical condition with vaccine hesitancy and the potential mediators is suggested to future researchers.

*Conclusion*

Overall, current study demonstrate that sociodemographic factors are not significant predictors of COVID-19 vaccine hesitancy, except for education, tendency toward TCAM and having the underlying medical condition. This research indicates the critical role that trust in science plays as the mediator between vaccine hesitancy and its predictors. Indeed, due to its association with belief in conspiracy theories, trust in science would play a key role in hindering the destructive consequences of vaccine hesitancy and should be considered in designing effective interventions. In addition, low-educated people and TCAM believers should be given special importance when developing interventions for tackling the COVID-19 vaccine hesitancy. Indeed, when working with low-educated people and those who believe in TCAM, policymakers should focus on fostering trust in science before developing measures for raising people's awareness. As mistrust in science acts as a buffer, information-based interventions might become futile among low-educated and TCAM believers without working on their trust levels.

Finally, in addition to providing a cultural and geographical comparison in COVID-19 vaccine hesitancy, this study shed light on the effect mechanism of demographic variables on COVID-19 vaccine hesitancy. The theoretical contribution of this study could be complemented by future research on moderators of these relationships and social interventions that are able to persuade people from different social classes. By knowing the determinants of vaccine hesitancy and their effect mechanisms, researchers would be more successful in designing preventive interventions in situations that need high acceptance and coverage rates. Therefore, the application of results is not restricted to the COVID-19 pandemic but could be applied to other necessary preventive behaviors in other serious health conditions.

**Ethical Approval**
The study was approved by the Research Ethical Committee of Isfahan University of Medical Sciences (IR.MUI.NUREMA.REC.1401.120).

**Data Availability Statement**
The authors confirm that the data supporting the findings of this study are available from the corresponding author.

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**Supplementary material**
Not applicable

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