

Personality traits as predictors of vaccine hesitancy and
preference for alternative medicine

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Abstract

The present study aims to investigate personality traits (Openness to experience, Agreeableness, Honesty-Humility) as predictors of vaccine hesitancy and preference for alternative medicine. The research question of the study is: How do personality traits relate to vaccine hesitancy and preference for alternative medicine? Participants ($N = 325$) from the Netherlands responded online to demographic questions, rated their indicators of vaccine hesitancy (5C Scale), alternative medicine use (I-CAM-Q questionnaire) and personality traits (60-HEXACO model). To test the hypotheses of the study multiple linear regression analysis was conducted. Openness was a positive predictor of alternative medicine use, but did not relate to vaccine hesitancy. Both alternative medicine use and vaccine hesitancy were not associated with Honesty-Humility and Agreeableness. Vaccine hesitancy and preference for alternative medicine were positively related, but this could not be attributed to personality traits. Individual differences have been largely unexplored in previous studies related to vaccine hesitancy and alternative medicine, so the present study contributes to a sparse literature concerning this topic.

Keywords: vaccine hesitance, complementary and alternative medicine, personality traits

Introduction

Vaccination is one of the most important inventions in the history of humanity, which has saved millions of lives and continues to be the most important guarantee of the health and well-being of people around the world (World Health Organization, 2019). Nevertheless, despite the proven high efficiency, there are people who refuse or delay vaccination, though vaccination services are available. This phenomenon is called vaccine hesitancy (MacDonald, 2015; McKee & Bohannon, 2016). In the Netherlands, the vaccination rate has decreased by about two-three percent over the last few years (van Lier et al., 2018). Since other countries also face a similar problem, the World Health Organization announced vaccine hesitancy among the top ten threats to global health in 2019 (World Health Organization, 2019). Understanding the reasons why people refuse or delay vaccination is important in order to develop effective strategies to increase vaccination coverage.

There have been a number of studies examining vaccine hesitancy and the mechanisms that are associated with it. The relation between vaccine hesitancy and preferences for complementary and alternative medicine (hereinafter referred to as alternative medicine) has repeatedly been confirmed (Browne, Thomson, Rockloff, & Pennycook, 2015; Jones, Sciamanna, & Lehman, 2010; Salmon et al., 2005). Alternative medicine covers a wide range of practices that go beyond the dominant evidence-based medical approach. Thus, “alternative medicine endorsement and vaccination skepticism are components of a common attitudinal stance, with some shared psychosocial determinants” (Browne et al., 2015, p. 11). According to the authors, Openness to experience explained the association between vaccine hesitancy and alternative medicine. It is the dimension of the Five-Factor Model of Personality (Piedmont, 2014). High scores on this dimension are conceptually related to the so-called “postmodern” culture associated with the movement against vaccination (Browne et al., 2015). According to the authors, Openness to experience includes a certain psychological

feature and a certain worldview, due to which a person: a) does not want to take into consideration scientific evidence; b) is unwilling to trust information from conventional authoritative sources; c) does not want to follow social norms.

It is important to note that other personality traits were not tested in the research by Browne and colleagues (2015), suggesting the possibilities for future investigation. According to the authors, the relationship of the personality factors and attitudes towards vaccination and alternative medicine is poorly studied. The problem of the present study is that there is not enough evidence why people who refuse or delay vaccination also have preferences for alternative medicine. Insight into that association could help in better understanding the underlying processes of vaccine hesitancy. Thus, the research question of the study can be formulated as following: How do personality traits relate to vaccine hesitancy and preferences for alternative medicine? In order to fill the existing knowledge gap, this study aims to investigate the relationship between vaccine hesitancy, alternative medicine and personality traits. The novelty of the present research lies in the attempt to explain the association between vaccine hesitancy and alternative medicine by personality traits.

Previous studies used the Big Five personality model, but there is another model - the HEXACO model of personality, which is an alternative to the Big Five and takes into account several personality variables that are poorly integrated into the Big Five (Ashton & Lee, 2007). The HEXACO model consists of six dimensions, which are consistent with the results of lexical cross-cultural studies of the personality structure: Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience. The HEXACO model involves the concept of reciprocal and kin altruism, while Big Five fails to explain these dimensions (Ashton & Lee, 2007). This is important for the present study since it deals with vaccination where the ideas of contributing to the common good and protecting other people are essential. Nevertheless, thorough search of the relevant literature yielded no

articles where personality traits of the HEXACO model were studied in relation to vaccine hesitancy and alternative medicine.

Openness to experience factor differs slightly between the HEXACO model and the Big Five Model. That is due to the exclusion of the Intellect aspect of the factor in the HEXACO model, which describes intelligence and mental capacities (Lee & Ashton, 2004). People high on Openness to Experience dimension of the HEXACO model are curious, express interest in unusual ideas and apply imagination in everyday life (Ashton & Lee, 2007). They are less confident in vaccine safety (Lee, Duck, & Sibley, 2017).

Some people, who have predisposition to be open to novel or unusual behaviors, are more likely to take a risk (Baiocco et al., 2017; Vries, Vries, & Feij, 2009; Weller & Tikir, 2010). In a health care context, they can manifest this tendency by refusing or delaying vaccination (Kalimeri et al., 2019; Ropeik, 2013). They may do so because they benefit from the protection provided by vaccinated people – behavior, which is called free-riding (Brewer, Chapman, Rothman, Leask, & Kempe, 2017).

There is an established association between Openness to Experience and alternative medicine (Browne et al., 2015; Smith et al., 2008; Toivonen, Tamagawa, Speca, Stephen, & Carlson, 2018). It is important to note that the last two studies used the Big Five model. Taken together, the present study is going to test the following hypotheses:

H1: Openness to experience positively relates to alternative medicine.

H2: Openness to experience positively relates to vaccine hesitancy.

Honesty-Humility, which is not captured by any of the Big Five domains, reflects a tendency to be prosocial and honest with other people, a tendency to cooperate, even if someone exploits them. Low levels of Honesty-Humility are associated with harmful impacts on society, fraud (Pletzer, Bentvelzen, Oostrom, & De Vries, 2019), taking health and safety risks, tendency to antisocial actions, social risk taking (Weller & Tikir, 2010). Taken together,

if to view vaccination refusal as free riding (exploiting others) and anti-social act, then people who are low in Honesty-Humility should be more prone to vaccine hesitancy. Some researchers see the main feature of this dimension in relation to the idea of exploiting others (Ashton & Lee, 2007), which is close to the idea of free riding in vaccination. According to it, it is profitable and rational for an individual to refuse vaccination and minimize expenses - time, money or unfavorable events (Betsch, Böhm, Korn, & Holtmann, 2017).

In addition, Honesty-Humility is negatively associated with sensation seeking and experience seeking (Vries, Vries, & Feij, 2009). Thus people who look for new diverse experience and are ready to take risks for such an experience can also have preference for alternative medicine. Also people who are low in Honesty-Humility do not adhere to normative rational thinking, thus making suboptimal choices in healthcare context (Weller, Ceschi, Hirsch, Sartori, & Costantini, 2018). It is plausible that alternative medicine and Honesty-Humility can be associated. Based on the theoretical review, the present study is going to test the following hypotheses:

H3: Honesty-Humility negatively relates to alternative medicine.

H4: Honesty-Humility negatively relates to vaccine hesitancy.

Agreeableness describes a tendency to cooperation, forgiveness, and tolerance towards others. People who are high on Agreeableness are more likely to behave prosocially, be good team workers, follow the descriptive norms and obey the requests (Lee & Ashton, 2009). That's why it is plausible that Agreeableness can be associated with alternative medicine and vaccination, as both of them are closely connected with social norms (it's socially approved to vaccinate and to use classic evidence-based medicine). There is a number of studies showing association between Agreeableness and attitudes towards vaccination. Low scores on Agreeableness relate to lower certainty about vaccine safety (Lee, Duck, & Sibley, 2017) and

higher vaccine hesitancy (Kalimeri et al., 2019). Taken together, the present study is going to test the following hypotheses:

H5: Agreeableness negatively relates to alternative medicine.

H6: Agreeableness negatively relates to vaccine hesitancy.

It is possible that personality traits are causal antecedents of vaccination hesitancy and preferences for alternative medicine. If this were a correct assumption, then variation in vaccination hesitancy would have similar causal antecedents to the variation in preferences for alternative medicine. Therefore, looking at the association between vaccine hesitancy and alternative medicine, and controlling for personality traits, this relationship will be reduced.

Taken together, this study is going to test the following hypotheses:

H7: When controlling for Openness to experience, association between vaccine hesitancy and alternative medicine will be diminished.

H8: When controlling for Honesty-Humility, association between vaccine hesitancy and alternative medicine will be diminished.

H9: When controlling for Agreeableness, association between vaccine hesitancy and alternative medicine will be diminished.

The present study investigates the three personality traits discussed above, and does not explore the other three – Emotionality, Extraversion, and Conscientiousness. This is because not enough evidence was found about their possible relationship with vaccine hesitancy and alternative medicine.

Method

Participants

Tilburg University SP Laboratory recruited participants among International and Dutch students of Tilburg University. Participants received an invitation from SP Laboratory to take part in the study and to fill out the online questionnaire. Three-hundred and twenty-

five participants took part in the research: 127 people (39%) completed the questionnaire in English and 198 (61%) people in Dutch.

Two responses were deleted after data screening for outliers. As a result, the sample size was 323 people (19.8% male and 79.9 % female, one person choose “Other/prefer not to say” option). Age of the respondents ranged from 18 to 41 years ($M = 20$, $Sd = 2.87$). Only 1.2% of the respondents had children. One person reported being a part of a religious and/or spiritual group that opposes vaccination and two people did not answer the question.

Power analysis in G*Power 3.1.9.4. was used to determine the required sample size. Assuming a population effect size of $r = .2$, and the significance level set at the conventional level of $p = .05$, a sample size of 193 gave power = .8 to observe a significant correlation (Browne et al., 2015; Cohen, 1992; Damnjanović et al., 2018). Therefore, the minimum sample size of the study was 193 participants.

Design and materials

The study was correlational because it looked for the associations between vaccine hesitancy, alternative medicine and personality traits. It had cross-sectional single-group design. Personality traits (Openness to Experience, Honesty-Humility and Agreeableness) were the independent variables of the study. They were measured using the 60-HEXACO questionnaire (Lee & Ashton, 2009). Openness to Experience, Honesty-Humility and Agreeableness scales scores were computed as means across items based on a 5-point response scale (1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, and 5 - strongly agree). Scale “Openness” (10 items, $\alpha = .809$) combined aesthetic appreciation and inquisitiveness facets. Scale “HonestyHumility” (10 items, $\alpha = .710$) combined sincerity, fairness, greed-avoidance and modesty facets. Scale “Agreeableness” (10 items, $\alpha = .756$) combined forgiveness, gentleness, flexibility and patience facets.

Vaccine hesitancy (15 items, $\alpha = .823$) was the dependent variable of the study. It was measured with the 5C scale (Betsch et al., 2018). It is a new validated tool for studying attitudes towards vaccination, developed for better understanding of vaccine hesitancy. The advantage of this scale is that it covers the concept of vaccination hesitancy more broadly and has strong theoretical basis. The scale score was computed as means across the items based on a 7-point response scale (strongly/moderately/slightly disagree, neutral, slightly/moderately/strongly agree). The higher the person had score on Vaccine hesitancy scale, the more doubts he had about vaccination. The scores were from min 1.00 up to max 4.87, range = 3.77. The 5C scale had the following sub-scales, which were used in the additional analysis: Confidence (3 items, $\alpha = .811$), Complacency (3 items, $\alpha = .548$), Constraints (3 items, $\alpha = .737$), Calculation (3 items, $\alpha = .780$), Collective responsibility (3 items, $\alpha = .556$). Confidence and Collective responsibility scales were reversed.

Preference for complementary and alternative medicine was the dependent variable of the study. It was measured with the international CAM questionnaire (I-CAM-Q), which was developed for conducting studies in different populations so the researchers could obtain the comparable data. It was validated in English speaking countries (Browne et al., 2015; Quandt, Ip, Saldana & Arcury, 2012; Quandt et al., 2009). Scale "CAM" consisted of 19 variables indicating the number of use of complementary and alternative medicine during the last 12 months (Appendix A). It had scores from 0 (no use) to 10 (a lot of use). 52% of the sample had score 0 or 1. Initially the scale consisted of 25 items indicating the number of use of complementary and alternative medicine during the last 12 months. After examining the Inter-Item Correlation Matrix and Item-Total Statistics (Cronbach's Alpha if Item Deleted) some items were deleted because the Cronbach's alpha was lower with them. As a result $\alpha = .624$.

The study had the following control variables: age, gender, kids, language. The dummy variables were coded as following: gender (0 - female, 1 - male), language (0 - Dutch,

1 - English), kids (0 – No, 1 – Yes). Age was centered for multiple regression analysis. Belonging to a religious organization was excluded from the analysis, as 99.1% of the participants did not belong to any.

Procedure

The method of the study was survey. Each participant responded to demographic questions, rated his / her indicators of vaccine hesitancy, alternative medicine and personality traits. The Ethics Review Board of the School of Social & Behavioral Sciences approved the study. The questionnaire was made in Qualtrics, in English and Dutch languages. Participants could chose the language in which it was more convenient for them to fill out the questionnaire. The approximate time for completing the questionnaire was 20 minutes. Informed consent was obtained before the data collection. Participants were given information about the aim of the study before filling in the questionnaire. They were informed that their participation was voluntary and they could withdraw at any time or refuse to participate entirely. The participants were given the contacts of the research supervisor, as well as the Ethics Review Board of Tilburg School of Social and Behavioral Sciences. In the end of the questionnaire the participants were thanked.

Results

Hypotheses testing

To test the hypotheses of the study multiple linear regression analysis in SPSS 23 (IBM Corp. Released, 2015) was conducted. In this study, three independent variables (Openness to Experience, Honesty-Humility and Agreeableness) were used to predict dependent variables (vaccine hesitancy and alternative medicine). The control variables of the study were age, gender, kids (whether the participants had children) and language of the participants (either English or Dutch). This analysis could be performed using multiple linear regression, since it assessed whether it was possible to predict dependent variable from a set

of independent variables (Tabachnick & Fidell, 2001). Multiple regression also allowed detecting the general fit of the model and the relative contribution of each of the predictors to the total explained variance, which helped in better understanding of the model.

Descriptive statistics of all the variables of the study are presented in Appendix B, Table B1. Results of data screening for missing values and outliers can be found in Appendix C. The correlations between the subscales of Vaccine hesitancy scale see in Appendix D, Table D2.

The first analysis tested the hypotheses 1, 3, 5. The model included control variables (age, gender, kids, language), personality traits (Openness, Honesty-Humility and Agreeableness) as the predictors and alternative medicine as the outcome variable (see Appendix E, Table E3). The model ($F(7, 314) = 12.84, p < .001$) explained 22% of the variance of alternative medicine score. In line with the hypothesis 1, Openness to experience was a positive predictor of preference for alternative medicine ($\beta = .31, p < .001$). Openness accounted for 8.3% of the variance in the alternative medicine score over and above the control variables. The hypotheses 3 and 5 were not supported: Honesty-Humility ($\beta = .01, p = .895$) and Agreeableness ($\beta = -.03, p = .607$) were not significant predictors of alternative medicine. Table 1 summarizes the analysis results.

Table 1

The main findings for the hypotheses 1, 2, 3, 4, 5, 6 (N = 323)

Predictor variable	Outcome variable			
	Use of alternative medicine		Vaccine hesitancy	
	<i>B (SE)</i>	<i>p</i>	<i>B (SE)</i>	<i>p</i>
Openness	0.83 (.15)	< .001	-0.04 (.11)	.729
Honesty-Humility	0.01 (.02)	.895	-0.14 (.13)	.274
Agreeableness	-0.01 (.02)	.607	0.16 (.12)	.184

The second analysis tested the hypotheses 2, 4, 6. The outcome variable was vaccine hesitancy, the predictors were personality traits (Openness, Honesty-Humility and Agreeableness) and control variables were the same as in the previous analysis (see Appendix E, Table E4). Using the enter method, the model was found to be non-significant, $F(7, 314) = .73$, $R^2 = .016$, $p = .648$. Openness, Honesty-Humility and Agreeableness were not significant predictors of vaccine hesitancy. This finding contradicts the hypotheses 2, 4 and 6. Table 1 summarizes the analysis results.

To test the hypotheses 7, 8, 9 and to explore the relation between vaccine hesitancy and alternative medicine while controlling for personality traits (Openness to Experience, Honesty-Humility and Agreeableness), four models were analyzed (see Appendix E, Tables E5 - E8). In Model 1, vaccine hesitancy was the dependent variable, alternative medicine was independent variable and age, gender, kids, language were the control variables. Models 2, 3 and 4 were the same, but had Openness, Honesty-Humility and Agreeableness as a predictor respectively. I checked whether the effect of alternative medicine in Models 2, 3, 4 was smaller than in Model 1. Table 2 summarizes the analysis results.

Model 1 with alternative medicine as the predictor produced $R^2 = .03$, $F(5, 316) = 2.25$, $p = .049$, indicating that it was a significant predictor of vaccine hesitancy. Alternative medicine contributed significantly to the model ($\beta = .18$, $p = .003$). Therefore, people who were more likely to use alternative medicine were also more hesitant about vaccination.

The results of the regression for Model 2 indicated that alternative medicine contributed significantly to the model ($\beta = .20$, $p = .001$), and Openness did not ($\beta = -.10$, $p = .140$). The effect for alternative medicine was not reduced. The hypothesis 7 was not confirmed: Openness did not explain the correlation between alternative medicine and vaccine hesitancy.

Table 2

The main findings for the hypotheses 7, 8, 9 (N = 323)

Outcome variable: Vaccine hesitancy								
	Model 1		Model 2		Model 3		Model 4	
Predictor variable	<i>B (SE)</i>	<i>p</i>	<i>B (SE)</i>	<i>p</i>	<i>B (SE)</i>	<i>p</i>	<i>B (SE)</i>	<i>p</i>
Alternative medicine	1.16 (.39)	.003	1.34 (.41)	.001	1.18 (.40)	.003	1.18 (.39)	.003
Openness			-.17 (.11)	.140				
Honesty-Humility					-.12 (.12)	.337		
Agreeableness							.13 (.11)	.255

According to the results of the regression for Model 3, the hypothesis 8 was not confirmed: Honesty-Humility ($\beta = -.06$, $p = .337$) did not explain the correlation between alternative medicine and vaccine hesitancy. The effect for alternative medicine was not reduced ($\beta = .18$, $p = .003$).

According to the results of the regression for Model 4, the hypothesis 9 was not confirmed: Agreeableness ($\beta = .06$, $p = .255$) did not explain the correlation between alternative medicine and vaccine hesitancy. The effect for alternative medicine was not reduced ($\beta = .18$, $p = .003$).

Additional findings

The analysis revealed several significant associations that were not expected. Being International or Dutch student was a predictor ($\beta = .25$, $p < .001$) of alternative medicine use

(see Appendix E, Table E3). International students who completed the questionnaire in English showed more favorable attitude towards alternative medicine.

Besides the hypotheses testing, multiple linear regression was performed to assess the ability of the personality traits to predict the sub-scales of 5C scale - Confidence, Constraints, Complacency, Calculation, Collective responsibility. Openness significantly predicted Calculation ($B = .36, SE = .14, \beta = .16, p = .011$) and Collective Responsibility ($B = .59, SE = .23, \beta = .16, p = .012$). Honesty-Humility significantly predicted Collective Responsibility ($B = .05, SE = .03, \beta = .12, p = .041$). For detailed results, please see Appendix E, Tables E9 and E10. All other results for the sub-scales were not significant.

Testing the assumptions

Relevant assumptions of multiple linear regression were checked for all the models. P-P Plot (Appendix F, Figures 1-6) showed that the residuals were normally distributed. Inspection of the scatterplots (Appendix F, Figures 7-12) showed that they were close to oval-shape and there was no clear pattern in the distribution, so the data did not violate linearity assumption and was homoscedastic (Tabachnick & Fidell, 2001). There was no pattern to the residuals: the residuals were not highly correlated and there were no long runs of positive or negative residuals (Appendix F, Figures 7-12). There was no multicollinearity in the data (correlation between all independent variables was lower than .42, $VIF < 1.29$).

Discussion

Major findings

Nine hypotheses were tested to answer the research question of the study: How do personality traits relate to vaccine hesitancy and preferences for alternative medicine? The present study examines vaccine hesitancy, use of alternative medicine and their associations with personality variables – Openness to experience, Honesty-Humility and Agreeableness.

One of the hypotheses was confirmed: Openness to experience was positively associated with preference to alternative medicine. There was not enough evidence to support the other hypotheses. Openness did not predict vaccine hesitancy. Honesty-Humility and Agreeableness were not significantly correlated with vaccine hesitancy and alternative medicine. While alternative medicine was found to be significant positive predictor of vaccine hesitancy, three personality traits failed to explain this relationship.

The finding that Openness is positively associated with alternative medicine goes in line with previous research (Browne et al., 2015; Smith et al., 2008; Toivonen et al., 2018). Thus, a person, who has predisposition towards Openness to experience, is inclined to neglect information that comes from generally recognized sources, does not believe in scientific evidence, and does not follow social norms. Such people are more curious, looking for variety, more willing to experiment and trying something new. Taking into account that alternative medicine is considered unconventional and can be seen as a way of variety seeking, the mechanism of the relation between Openness to experience and alternative medicine becomes clear.

One of the important findings of the study is that the association between Openness to experience and vaccine hesitancy was not confirmed. Literature offers contradictory findings: while some studies support the relation (Browne et al., 2015; Lee, Duck, & Sibley, 2017), there is a study, which does not find association between vaccine hesitancy and Openness. The authors explain their finding by small sample size (116 participants) which prevented them from obtaining the significant results (Kalimeri et al, 2019). The present study had larger sample size, but still there can be an issue with its demographic characteristics. Studies mentioned above sampled from Australian and New Zealand population, while the present study sampled from people in the Netherlands. In the study of Browne and colleagues (2015), the average age of the respondents was 55.2 years, and 35.4% of the participants had children.

Lee, Duck and Sibley (2017) had participants with average age of 47.5 years, and around 73.5% were parents. The average age of the participants in the present study was 20 years, and only 1.2% had children. Vaccination may be not an important and relevant issue for 20 years old people as they already have received most of the necessary vaccines and do not have children yet to think about their vaccination. While alternative medicine use is higher among younger population, vaccine hesitancy occurs more often among older individuals.

Krishnamoorthy and colleagues (2019) found that employed women 30 years old and above were about two times more vaccine hesitant than those younger than 30 years old and unemployed. Further research with a greater diversity of the participants is required to understand the nature of vaccine hesitancy in relation to personality traits.

The present study makes an attempt to contribute to understanding of the association between vaccine hesitancy and alternative medicine. According to the results of the present research, there was a weak positive association between vaccine hesitancy and preference for alternative medicine, but this could not be attributed to personality traits. It contradicts the results of Browne and colleagues (2015), who found that Openness to experience led to higher vaccine hesitancy and higher preference towards alternative medicine. One possible explanation for this inconsistent finding may lay in the limitations of the sample in the present study, which have been discussed above.

There can be other possible explanations, why vaccine hesitancy and preference for alternative medicine usually go hand in hand. Attwell, Ward, Meyer, Rokkas and Leask (2018) consider alternative medicine and vaccine hesitancy to be in “symbiotic relationship” where one does not cause the other or vice versa. There is a link between them, which the authors explain by people’s predisposition to “reifying the natural” and DIY-ethic (“do it yourself”) when people value autonomy, action and rely on themselves.

No support was found for any of the hypotheses concerning Honesty-Humility and Agreeableness. In the present study, Agreeableness predicted neither vaccine hesitancy nor preference for alternative medicine. This result contradicts findings of Kalimeri and colleagues (2019), as well as of Lee, Duck and Sibley (2017). Both of these studies used Big Five model, while the present study used the HEXACO model. Perhaps the difference in Agreeableness dimension between the two models could explain the inconsistencies in the results.

Agreeableness dimension in the Big Five model is more about interpersonal cooperation and is known to be a good predictor of antisocial versus prosocial behaviors (Ashton & Lee, 2007). The subscales help to catch the main point of this dimension: Trust, Morality, Altruism, Cooperation, Modesty, and Sympathy. Agreeableness dimension in the HEXACO model is about tolerance, forgiveness and calm temper (Lee & Ashton, 2006). The subscales are as follows: Forgiveness, Gentleness, Flexibility, Patience. Given these differences, as well as the fact that vaccination is a social behavior, inconsistencies in the results become more understandable.

As literature research has shown, Honesty-Humility has not been studied yet in relation to vaccine hesitancy and alternative medicine. Still, it is associated with taking health and safety risks, tendency to antisocial actions, social risk taking (Weller & Tikir, 2010), sensation and experience seeking (Vries, Vries, & Feij, 2009), irrational thinking (Weller et al., 2018). In the present study Honesty-Humility was a predictor of one of the 5C subscales (5C scale measures vaccine hesitancy). This finding will be discussed further on.

Additional findings

Personality traits were also tested for the associations with the subscales of the 5C scale, which measures vaccine hesitancy. While personality traits failed to predict vaccine hesitancy, Openness was a positive predictor of Calculation and Collective Responsibility subscales, and Honesty-Humility was positive predictor of Collective Responsibility. These

findings go in line with the research of Betsch and colleagues (2018). They found that the sub-scales measure vaccination behavior differently depending on the type of vaccine, target group and country. For example, Human papillomavirus vaccination was predicted solely by Confidence sub-scale, but not by the whole 5C scale. The authors explain this finding by the fact that vaccine hesitancy is a complex process, which can vary across place, time and type of vaccine. Therefore, personality traits may be associated with the certain sub-scales of vaccine hesitance scale, and not with a whole one.

Returning to the results of the study, Openness was a positive predictor of Calculation. Thus, people who are curious and open to new ideas, also prone to a more detailed and extensive search for information. They carefully weigh the risks associated with vaccination against the risks of possible disease. According to Betsch and colleagues (2018), the more people look for information about vaccination and weigh risks, the more vaccine hesitant they will become.

Collective responsibility sub-scale had two positive predictors: Openness and Honesty-Humility. Collective responsibility represents the desire to protect others by vaccinating oneself. Thus, individuals who are honest, prosocial, interested in other people, tend to act for the sake of the common good and to vaccinate themselves in order to protect others. On the other hand, people are ready to “free ride” when the necessary vaccination rate is obtained.

Interestingly, that English-speaking participants showed more favorable attitude towards alternative medicine. One of the possible explanations concerns cultural differences: International students come from different countries all over the world, so the tradition of alternative medicine use might differ from one in the Netherlands. However, in present research there is no data about the country of birth or the country, where the participants have been living for most of their life. Therefore, there is not enough evidence to speak about

cultural differences in alternative medicine use based on the present study. Nevertheless, according to the literature, alternative medicine use is associated with the cultural belief framework and lifestyle (Jones, 2001; Campesino & Koithan 2010; Chiu, Balneaves, Barroetavena, Doll, & Leis, 2006; Cuellar, Aycock, Cahill, & Ford, 2003). In addition, people with high income are more likely to use alternative medicine (Kate & Pat, 2004). May be it could be the case that International students have families with higher income and it is associated with the higher use of alternative medicine. However, the present sample does not provide information about the income of the participants' families.

Another possible explanation is the reliability and validity of the I-CAM-Q questionnaire in Dutch language. While English version is validated (Browne et al., 2015; Quandt, Ip, Saldana & Arcury, 2012; Quandt et al., 2009), Dutch version was translated without back-translation, pre-tests, reliability and validity analysis and used in the present study. Although the I-CAM-Q questionnaire is developed as international, according to the authors, further tests of validity and reliability of the questionnaire itself and its translations are necessary (Quandt et al., 2009). On the other hand, questionnaire in Dutch showed high internal reliability, no one of the participants reported difficulties in understanding or answering the questions. Therefore, the present study can contribute to the development and validation of the I-CAM-Q questionnaire in Dutch.

Limitations

This research is the subject to several limitations. Some of them have been discussed already: socio-demographic characteristics of the sample (young age, high education, no information on the income and the country where International students mostly lived) and validation of the I-CAM-Q questionnaire. It is important to remember that the present study is correlational and does not prove any causal relations.

One other limitation concerns measurement and recall bias when answering I-CAM-Q questionnaire. Participants were to recall how often they visited alternative medicine practitioners, used Herbal Medicine, Dietary Supplements and self-help practices during the last 12 months. While visiting a practitioner can be a significant event to remember, the amount of use of herbs, dietary supplements or self-help practices can be forgotten or mixed up by mistake. In addition, a person can have relatively high score of preference for alternative medicine because he practices yoga and takes vitamins. Nevertheless, for the treatment of the disease, he may have preferences for conventional medicine, rather than alternative one. To overcome this limitation in future research, it is possible to add questions that relate to people's preferences for alternative medicine. For example, Browne and colleagues (2015) added the following question: "If I was suffering from an illness or injury I would try an alternative therapy before seeking conventional medical treatment".

No exact information was found on how to compute the scales of the I-CAM-Q questionnaire. Respective authors of the survey were asked for details, but no response was received so far. Thus, the scale was computed to measure only the frequency of alternative medicine use. Meanwhile, the questionnaire also included questions about satisfaction with alternative medicine use and some open questions. Therefore, some data obtained from these questions was not used in the analysis. Based on the present study, suggestions for future research could be to compute the scales that would include all the data obtained from the I-CAM-Q questionnaire.

Conclusion

The present study sought to understand the relationship between preference for alternative medicine and vaccine hesitancy. Personality traits of the HEXACO model have been used for the first time (as the search for the relevant literature showed) in relation to vaccine hesitancy and alternative medicine. Openness to experience, Honesty-Humility and

Agreeableness did not explain the association between vaccine hesitancy and alternative medicine. According to the results, participants who were more open to new ideas showed higher preference for alternative medicine. None of the personality traits related to vaccine hesitancy. According to the results of the present study, people do not have predisposition to vaccine hesitancy because of their personality traits. However, given the limitations of the sample, replication of the study is needed in samples with a greater diversity of the participants – in age, parental and employment status. This will provide information whether the results of the present study can be generalized on the entire population of the Netherlands. Individual differences have been largely unexplored in previous studies related to vaccine hesitancy and alternative medicine (Toivonen et al., 2018), so the present study contributes to a sparse literature concerning this topic.

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Appendix A

Questions included in CAM (complementary and alternative medicine) scale

1. Have you seen any of the following providers in the last 12 months? Homeopath
2. Have you seen any of the following providers in the last 12 months? Acupuncturist
3. Have you seen any of the following providers in the last 12 months? Herbalist
4. Have you seen any of the following providers in the last 12 months? Spiritual healer
5. Some physicians provide complementary, as well as conventional treatments. Have you received any of the following complementary treatments from a physician in the last 12 months? Herbs
6. Some physicians provide complementary, as well as conventional treatments. Have you received any of the following complementary treatments from a physician in the last 12 months? Spiritual Healing
7. Some physicians provide complementary, as well as conventional treatments. Have you received any of the following complementary treatments from a physician in the last 12 months? Other
8. Please indicate below which categories of products you have used. Herbs/Herbal Medicine
9. Please indicate below which categories of products you have used. Vitamins/Minerals
10. Please indicate below which categories of products you have used. Homeopathic remedies
11. Have you used any of the following self-help practices in the last 12 months? Meditation
12. Have you used any of the following self-help practices in the last 12 months? Yoga
13. Have you used any of the following self-help practices in the last 12 months? Qingong
14. Have you used any of the following self-help practices in the last 12 months? Tai Chi
15. Have you used any of the following self-help practices in the last 12 months? Relaxation techniques

16. Have you used any of the following self-help practices in the last 12 months?

Visualization

17. Have you used any of the following self-help practices in the last 12 months? Attended a traditional healing ceremony

18. Have you used any of the following self-help practices in the last 12 months? Praying for own health

19. Have you used any of the following self-help practices in the last 12 months? Other

Appendix B

Table B1

Descriptive statistics for the independent and dependent variables of the study (N = 323)

Variable	<i>M</i>	<i>SD</i>
Openness	3.33	.68
Honesty-Humility	3.35	.56
Agreeableness	3.16	.58
Vaccine hesitancy	2.67	.79
Confidence Rv	2.35	1.12
Complacency	2.30	.95
Constraints	2.02	1.07
Calculation	4.30	1.54
Collective responsibility Rv	-.25	1.07
CAM	1.92	1.79

Note: CAM - complementary and alternative medicine, Rv - reversed

Appendix C

Missingness investigation and check for outliers

Missingness investigation for all the scales showed that there were no missing values.

Check for univariate outliers showed that scales “Openness” and “VaccinationHesitancy” didn’t have any observations with $z < -3$ or $z > 3$. Scale “Agreeableness” had observations with $z = -3.57$, scale “HonestyHumility” had observations with $z = -3.3$, scale “CAM” had 2 z-scores higher than 3 and 2 z-scores higher than 4.5. These last 2 cases were deleted as univariate outliers thus making the scale range of “CAM” from 0 to 10 (deleted answers had scores of 15 and 11). This made distribution of alternative medicine scale not so skewed. No substantive reason was found to remove other cases. Check for multivariate outliers based on Mahalanobis distances revealed no multivariate outliers.

Appendix D

Table D2

Inter-Item Correlation Matrix for the subscales of the 5C scale (N = 323)

	ConfidenceRv	Complacency	Constraints	Calculation	Collective ResponsibilityRv
ConfidenceRv	1.00				
Complacency	.52***	1.00			
Constraints	.32***	.35***	1.00		
Calculation	.31***	.30***	.22***	1.00	
Collective Responsibility Rv	.54***	.45***	.26***	.19***	1.00

Note: 5C scale - Vaccine hesitancy scale, Rv – reversed.

*** $p < .001$

Appendix E

Table E3

Multiple linear regression analysis for the Hypotheses 1, 3, 5 (N = 323)

Outcome variable: alternative medicine			
Predictor variable	<i>B</i>	<i>SE B</i>	β
Openness	0.83***	0.15	.31
Honesty-Humility	0.01	0.02	.01
Agreeableness	-0.01	0.02	-.03
Age	-0.02	0.03	-.04
Gender	-0.35	0.24	-.08
Kids	-0.68	0.82	-.04
User language	0.93***	0.21	.25
<i>R</i> ²		.22	
<i>F</i>		12.8***	

Note. *** $p < .001$

Table E4

Multiple linear regression analysis for the Hypotheses 2, 4, 6 (N = 323)

Outcome variable: vaccine hesitancy			
Predictor variable	<i>B</i>	<i>SE B</i>	β
Openness	-0.04	0.11	-.02
Honesty-Humility	-0.14	0.13	-.07
Agreeableness	0.16	0.12	.08
Age	0.27	0.25	.06
Gender	-2.68	1.80	-.10
Kids	-1.67	6.12	-.02
User language	-0.68	1.53	-.03
<i>R</i> ²		.02	
<i>F</i>		0.73	

Table E5

Multiple linear regression analysis for the Hypotheses 7, 8, and 9 (N = 323)

Outcome: vaccine hesitancy			
Predictor variable	<i>B</i>	<i>SE B</i>	β
CAM	1.16**	0.03	.18
Age	0.25	0.02	.06
Gender	-2.15	0.11	-.07
Kids	-2.34	0.40	-.02
User language	-2.47	0.10	-.10
<i>R</i> ²		.03	
<i>F</i>		2.25*	

Note. * $p < .05$; ** $p < .01$

Table E6

Multiple linear regression analysis for the Hypothesis 7 (N = 323)

Outcome: vaccine hesitancy			
Predictor variable	<i>B</i>	<i>SE B</i>	β
CAM	1.35***	0.41	.20
Openness	-0.17	0.11	-.10
Age	0.27	0.25	.07
Gender	-1.68	1.72	-.06
Kids	-1.92	5.99	-.02
User language	-1.18	1.54	-.07
<i>R</i> ²		.04	
<i>F</i>		2.25*	

Note. * $p < .05$; *** $p < .001$

Table E7

Multiple linear regression analysis for the Hypothesis 8 (N = 323)

Outcome: vaccine hesitancy			
Predictor variable	<i>B</i>	<i>SE B</i>	β
CAM	1.18**	0.40	.18
Honesty-humility	-0.12	0.12	-.06
Age	0.26	0.25	.06
Gender	-2.52	1.74	-.09
Kids	-1.98	6.01	-.02
User language	-2.56	1.48	-.11
<i>R</i> ²		.04	
<i>F</i>		2.03	

Note. ***p* < .01

Table E8

Multiple linear regression analysis for the Hypothesis 9 (N = 323)

Outcome: vaccine hesitancy			
Predictor variable	<i>B</i>	<i>SE B</i>	β
CAM	1.17**	0.39	.18
Agreeableness	0.13	0.11	.06
Age	0.27	0.25	.06
Gender	-2.17	1.69	-.07
Kids	-1.76	6.02	-.02
User language	-2.46	1.48	-.10
<i>R</i> ²		.04	
<i>F</i>		2.10	

Note. ***p* < .01

Table E9

Additional findings. Summary of regression analyses (N = 323)

Predictor variable	Calculation			Collective Responsibility		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
Openness	0.36*	0.14	.16	0.59	0.23	.16
Age	0.03	0.03	.05	-0.05	0.05	-.06
Gender	-0.56*	0.22	-.15	-0.54	0.37	-.08
Kids	0.15	0.78	.01	-0.81	1.29	-.04
User language	-0.25	0.19	-.08	0.51	0.32	.10
<i>R</i> ²		.04			.05	
<i>F</i>		2.31*			3.29**	

Note. * $p < .05$; ** $p < .01$.

Gender was coded as 0 – female, 1 – male

Table E10

Additional findings. Summary of regression analyses (N = 323)

Predictor variable	Collective Responsibility		
	<i>B</i>	<i>SE B</i>	β
Honesty-Humility	0.53*	0.26	.12
Age	-0.05	0.05	-.05
Gender	-0.21	0.37	-.03
Kids	-0.86	1.30	-.04
User language	0.87**	0.30	.17
<i>R</i> ²		.04	
<i>F</i>		2.85*	

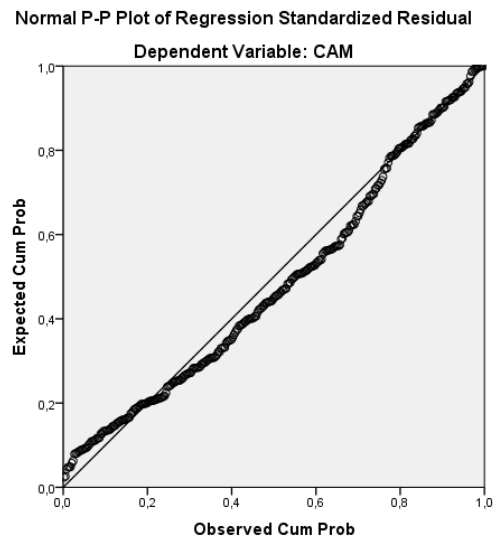
Note. * $p < .05$; ** $p < .01$

Appendix F

Assumptions of multiple linear regression

Figure 1

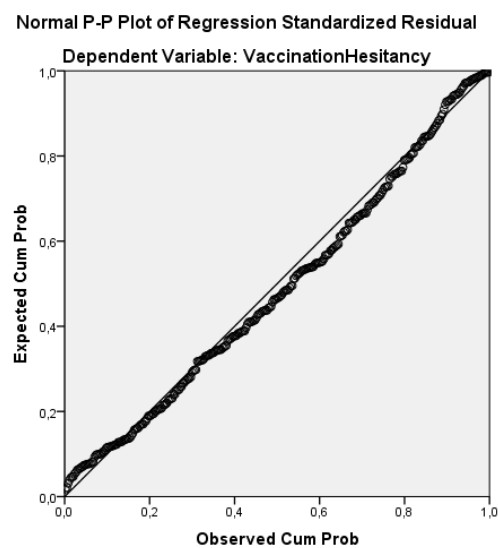
Checking residuals of the regression for normality. Model for the H 1, 3, 5 (N=323)



Note. Outcome: alternative medicine. Predictors: Openness, Honesty-Humility, Agreeableness.

Figure 2

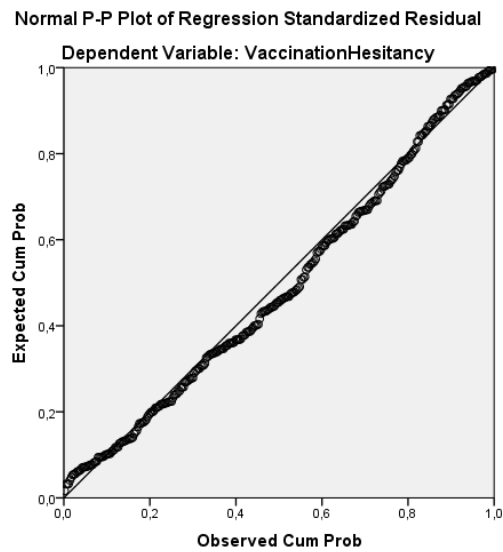
Checking residuals of the regression for normality. Model for the H 2, 4, 6 (N=323)



Note. Outcome: vaccine hesitancy. Predictors: Openness, Honesty-Humility, Agreeableness.

Figure 3

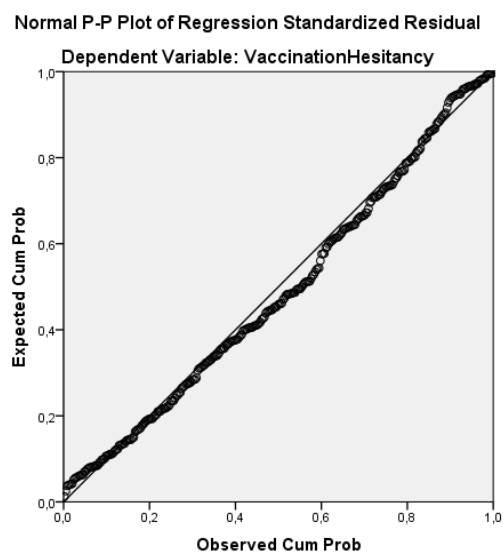
Checking residuals of the regression for normality. Model for the H 7, 8, 9 (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine.

Figure 4

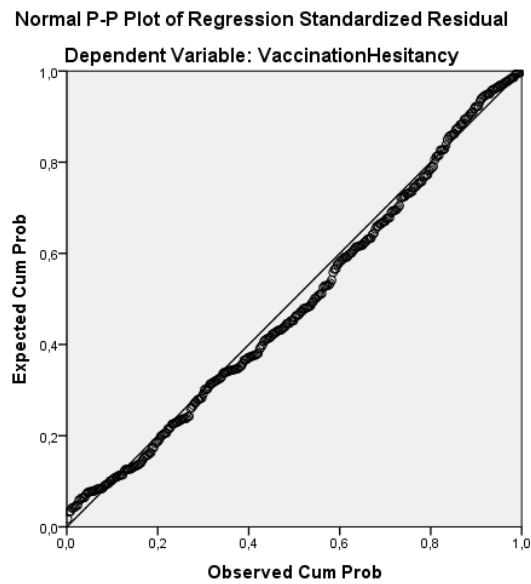
Checking residuals of the regression for normality. Model for the H 7 (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Openness.

Figure 5

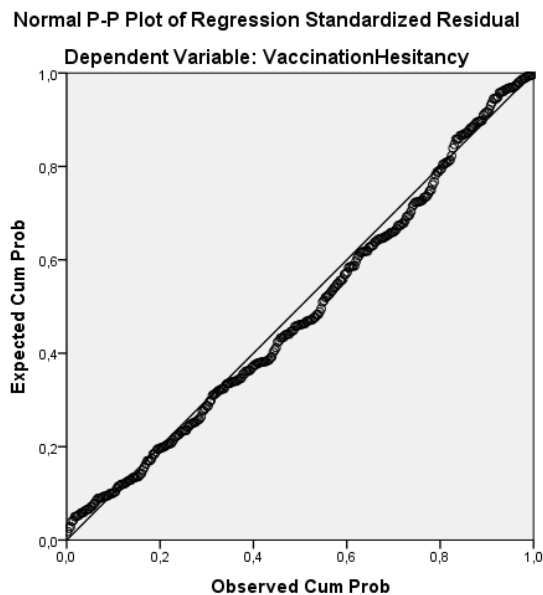
Checking residuals of the regression for normality. Model for the H 8 (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Honesty-Humility.

Figure 6

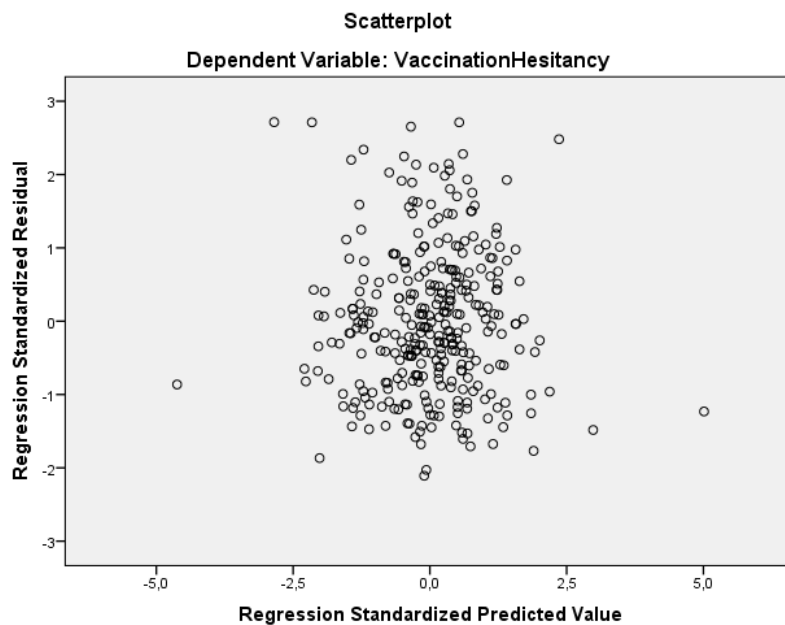
Checking residuals of the regression for normality. Model for the H 9 (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Agreeableness.

Figure 7

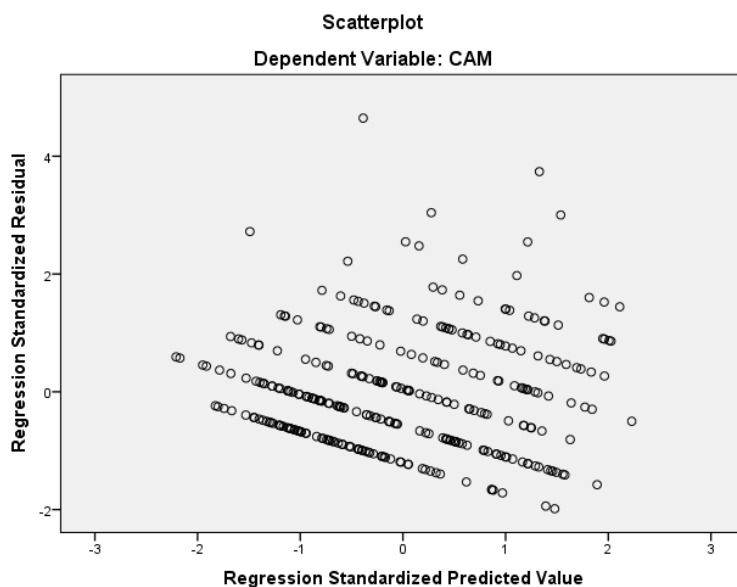
Scatterplot (N=323)



Note. Outcome: vaccine hesitancy. Predictors: Openness, Honesty-humility, Agreeableness.

Figure 8

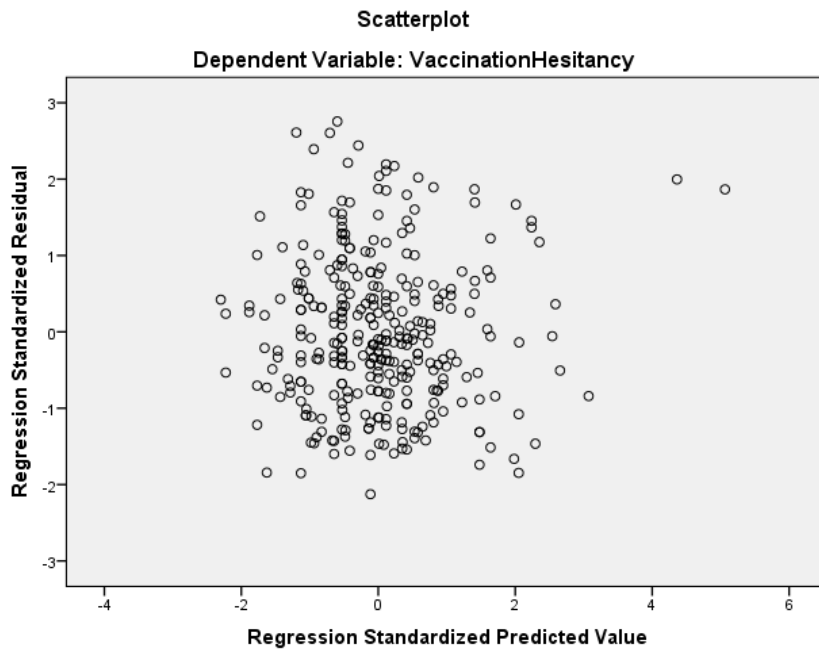
Scatterplot (N=323)



Note. Outcome: alternative medicine. Predictors: Openness, Honesty-humility, Agreeableness.

Figure 9

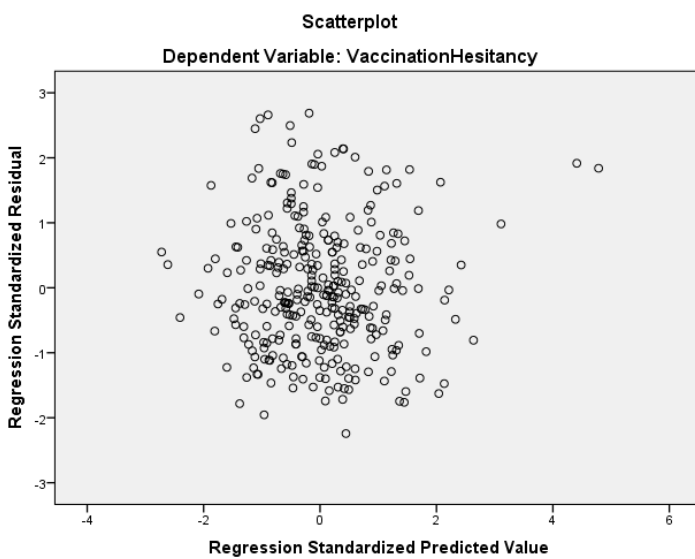
Scatterplot (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine.

Figure 10

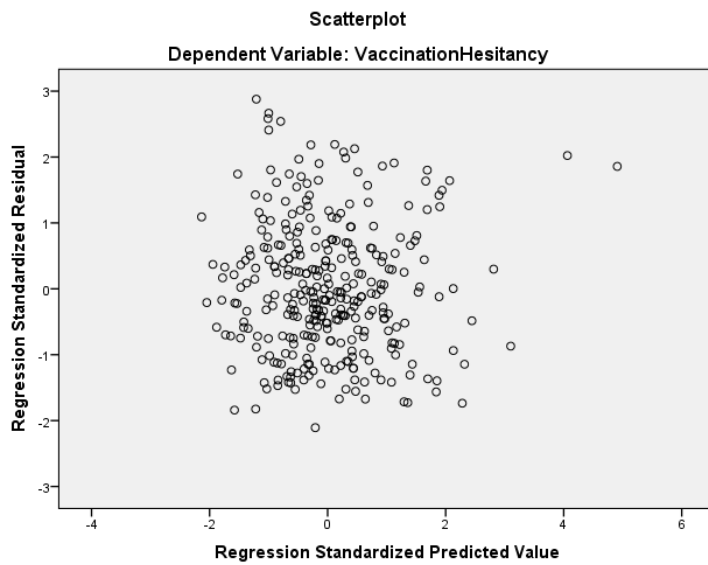
Scatterplot (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Openness.

Figure 11

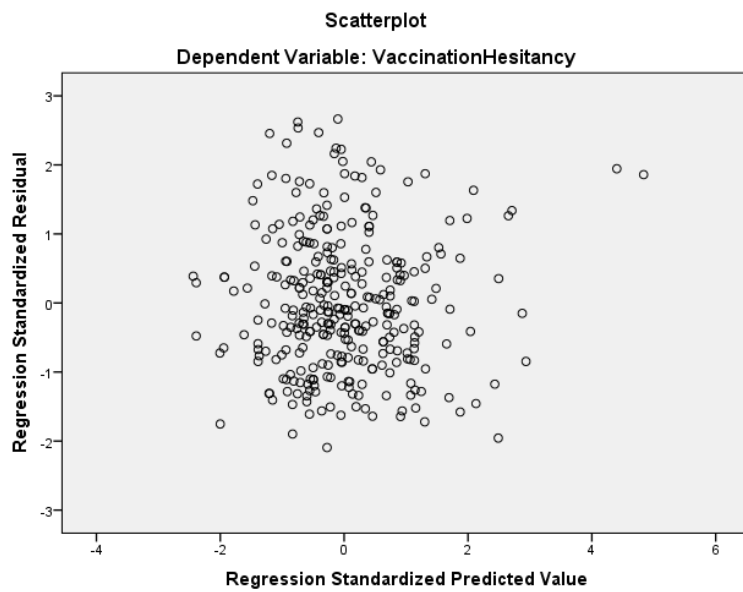
Scatterplot (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Honesty-humility.

Figure 12

Scatterplot (N=323)



Note. Outcome: vaccine hesitancy. Predictors: alternative medicine, Agreeableness.