Empirical research

Development of Health Beliefs Model (HBM) Scale to Study Attitudes towards COVID-19 Vaccine

Salome Dumbadze[1]
Georgian Institute of Public Affairs (GIPA
Alexandre Avaliani
Georgian Institute of Public Affairs (GIPA),
Irine Akhobadze
Georgian Institute of Public Affairs (GIPA),

Abstract

Research of population's vaccination related attitudes and beliefs has become increasingly important due to the COVID-19 pandemic.

People hold different attitudes towards vaccination. The same is true for Georgian population, where opinions differ regarding vaccination and open skepticism is also observed. Despite urgent need, there is no quality psychometric instrument in Georgian which would measure attitudes to the virus and the vaccines.

The current study aimed to develop an HBM model based Georgian instrument to study attitudes towards vaccination against COVID-19. The study was conducted nationwide in online format and via social networks. During the development of the instrument 86 people were interviewed in the first pilot study and 103 in the second. 2,056 people participated in

[1] **Corresponding Author**:
Salome Dumbadze, Georgian Institute of Public Affairs (GIPA), E-mail: salome.dumbadze@gipa.ge

the final study out of which the data collected from 1,996 people was subjected to processing. In the course of questionnaire development, an expert team of five people was involved in the process to ensure the instrument's content validity. The HBM model based COVID-19 vaccine questionnaire measured five constructs: perceived susceptibility, perceived severity, perceived barriers, perceived benefits and cue to action. Each factor showed high internal consistency. Furthermore, the instrument demonstrated a good predictive validity and predicted vaccination status with 93% accuracy. The final version of the questionnaire consists of 17 items and measures five different factors: 'perceived susceptibility' to COVID-19 (2 items, α=.948), 'perceived severity' of disease which is person's beliefs about seriousness of disease in case of contracting infection (2 items, α=95), 'perceived benefit' of vaccination against COVID-19 (5 items, α=.972), 'perceived barriers' related to vaccination against COVID–19 (7 items., α=.895). To conclude, because of the instruments satisfactory psychometric properties, the instrument can be used to study attitudes towards COVID-19 and COVID vaccine. However, due to study limitations it is advisable to test the instrument's psychometric properties in the population beyond Facebook users.
Key words: HBM(Health Belief Model), COVID-19, vaccine, vaccination.

Introduction

World Health Organization declared on January 30, 2020, that the spread of a new Coronavirus (SARS-CoV-2), the first cases of which were recorded in China in December 2019, to be a global threat for the world population. In March, 2020, the COVID-19 epidemic was officially qualified as a pandemic (WHO, 2020).

The fast spread of Coronavirus and a high mortality rate resulted in an urgent need of developing a vaccine against COVID-19 (Li et al., 2020). Consequently, different vaccines against COVID-19 were developed within a short period, which made it possible to provide them for free to global population in one year's time after the spared of COVID-19.

Already on January 30, 2021, 100 million doses of authorized vaccines against COVID-19 were distributed to population. On April 24 of the same year the distribution rate increased up to a billion doses (Bollyky et al., 2021). However, the development of a vaccine does not at all mean that it will be readily accepted by a large part of population, which is a globally observed phenomenon. It is mainly related to the ratio between perceived risks and benefits, religious beliefs and lack of knowledge about vaccines (Sallam, 2021). Consequently, success of an immunization programs mostly depends on the population's readiness for vaccination (Savoia et al., 2021).

Success of an immunization program also largely depends on targeted and effective communication of the health sector and PR specialists with the population (Malik et al., 2020) with consideration of the barriers which prevent people from vaccination (Sallam, 2021).

A study conducted in Finland before the development of the COVID–19 vaccine showed that the COVID-19 vaccine evoked as much fear in respondents as the virus itself. Therefore, the belief about the safety of vaccine is a much stronger predictor of immunization than the experience of virus related threat (Karlsson et al., 2021).

In spite of the fact that from March 21, 2021, free vaccines became available in Georgia, attitudes to vaccination prevalent in that year were quite diverse and skeptical, as demonstrated by Georgian Red Cross study (IFRC & Georgian Red Cross, 2021). Even though the Government planned to vaccinate 60 % of Georgian population by the end of the year, at the end of the autumn only 36.5% was vaccinated. The Red Cross started a survey in September 2021 and interviewed a random sample of 7,926 respondents. Out of the unvaccinated respondents only 36% was planning to get vaccinated, whereas 32% was hesitant and another 32% did not show any intention to take COVID-19 vaccine. Respondents' decision was mainly determined by their perceptions related to little experience with COVID vaccine, its safety and lack of trust.

For an in-depth analysis of the issue it is important to realize which personal attitudes reduce vaccination probability.

HBM model

The Health Belief Model, also known as HBM model, was developed in the 1950s by social psychologists Hochbaum, Rosenstock, and their colleagues. The model attempts to explain the basis of preventive health behavior (Hochbaum, 1958; Rosenstock, 1960, 1974 as cited in Champion & Skinner, 2008). This theoretical framework is widely used for preventive behaviors related to various diseases, including COVID-19. The model considers the following factors: perceived susceptibility to disease, perceived severity of disease, perceived benefits, perceived barriers and cue to action (Ban & Kim, 2020). The definitions of each component of the model given by Champion and Skinner (Champion & Skinner, 2008) can be found below:

Perceived susceptibility: Beliefs about the probability of contracting a disease. The individual's beliefs regarding the probability of contracting a specific disease before considering a preventive behavior.

Perceived severity: Beliefs about the seriousness of disease if this disease is contracted by individual. Seriousness refers to clinical outcomes (e.g., death, limitation of capacities, pain, etc.), as well as social outcomes (negative impact on work, family, social relationships). The combination of the above two constructs is known as perceived risks.

Perceived benefits: Effect of perceived risks on behavioral changes. If an individual does not believe in benefits of specific preventive measures, she/he will not undertake behavior. Behavioral changes will only take place if the individual believes that the given behavior could reduce the perceived threat.

Perceived barriers: Negative aspects of a specific preventive behavior. At this stage, the individual unconsciously evaluates the costs related to the behavior and its potential rewards.

A specific preventive behavior may be beneficial in a certain respect, but it may later bring some harm.

Thus, susceptibility and severity create a need for action and provide the individual with the energy necessary for such an action, whereas benefits (differently from barriers) evoke behavior (Rosenstock, 1974, as citied in Champion & Skinner, 2008).

Cues to action: HBM model implies the existence of cues which trigger people's behavior. It is believed that the readiness for action caused by perceived susceptibility and perceived benefits requires an impact of certain factors such as the processes taking place within the body or the environment (Hochbaum, 1958; Rosenstock, 1960, 1974, as cited in Champion & Skinner, 2008). It should be noted, however, that the researcher who put forward this idea, had not empirically studied the given variable. In general, there are very few studies focusing on the construct in question.

HBM model and vaccination against COVID-19

The last two years saw an increased number of studies using HBM model in the context of vaccination against COVIOD-19. The study conducted by Limbu and colleagues aimed to carry out a systematic analysis of the research using the theoretical framework of HBM model and examine the utility of its constructs in the context of vaccination against COVID-19 (Limbu et al., 2022). The study analyzed 16 articles which resulted in the data on a total of 30,242 participants. The research shows that out of the HBM constructs perceived barriers and perceived benefits are most closely related to vaccination reluctance. As expected, perceived benefits and perceived risks negatively related to behavior, whereas perceived barriers positively correlated with negative attitude towards vaccination against COVID-19. The authors conclude that HBM model provides a useful framework for examining behaviors related to vaccination against COVID-19.

The current study

The primary task was the translation of the existing instruments into the Georgian language. In that period (summer 2021), only two instruments were available for the measurement of COVID-19: The instrument developed in Greek (Zampetakis & Melas, 2021) and an English language instrument (Wong et al., 2021). After receiving a special permission, the Greek instrument was translated into Georgian. It should be noted that scenarios in the questionnaire were related to the context when vaccines were not yet available. Also, the author of the research advised us to enter changes into the instrument and emphasized that since each construct was measured by single item, the validity and reliability of the instrument were questionable. As for the questionnaire developed by Wong (2021), it mainly focused on the barriers related to vaccination difficulties in Hong Kong clinics rather than specific attitudes and beliefs, which was irrelevant for our study and did not correspond to the attitudes towards preventive behavior.

Stemming from the above, it became necessary to develop a new instrument based on HBM model which would be relevant for the current context and would measure the attitudes and beliefs held by the Georgian and global population in relation to already available COVID-19 vaccines. The current study mainly focuses on the attitudes towards COVID-19 and vaccination against COVID-19.

Methods

Study design overview

Preparation for the final study

Initially, we reviewed several questionnaires based on the HBM model. Later, we wrote down a preliminary list of items, which, in our opinion, was suitable for the measurement of target constructs and would capture the attitudes and trends observed in the social media in relation to COVID-19 vaccine. At the third stage, the number of statements was reduced following a joint multiple review which mainly included the evaluation of content validity, spelling, ease of perception, adequate level of abstraction and other similar aspects. Throughout these stages, a number of items was changed, replaced and added.

Based on these 54 items, the first pilot study was conducted with the aim to: 1) understand the psychometric properties of the questionnaire only at a superficial level, allowing quick and effective prevention of strikingly illogical deviations, and also detect different patterns as indicators of potential errors (for example, a high correlation between some items became a further issue for review and correction); 2) determine technical standards for the questionnaire concerning the software, linguistic aspect, ease of perception, adequacy, etc.

Based on these data, we conducted:

1) Exploratory factor analysis (EFA). Similarly, for other basic statistical analysis we used the IBM SPSS 25 computer program, namely the method of Principal Axis Factoring;

2) Reliability analysis (to determine internal consistency based on Cronbach's alpha).

3) At this stage, we also determined relationship of independent variables (at the level of items) with dependent variables[2], in order to understand which of them was a better predictor of vaccination intention and behavior (vaccination status). Vaccination intention

[2] Correlations and T-test with effect size.
Vaccination behaviour and intention as dependent variables were examined within the framework of a larger research project that aimed to identify predictors of vaccination against Covid-19. The study also used the VAX (General Vaccine Attitudes Survey) questionnaire and examined demographic and other variables.

and behavior were chosen as dependent variables. To measure vaccination intention, respondents were asked questions about the strength of their intention to vaccinate. As for the measurement of behavior, respondents were asked whether they were vaccinated or not. It should be noted that dependent variables were measured using the questionnaire which measured attitudes towards vaccination. Therefore, vaccination behavior variable was measured retrospectively.

4) Inter-item correlation was determined to obtain a quantitative indicator of overlap between the items. In addition, semantic evaluations were also used.

Based on the results of the first pilot study, the modified[3] questionnaire was evaluated by experts. The main criterion for expert selection was professional knowledge in the fields of psychology and healthcare. The final selection of experts included psychologists from three different fields, a language specialist and a doctor. First, they were given a brief description of the instrument used in the study and information about the measurement purposes of each construct. At the next stage, they evaluated representativeness of the items, their meaning and clarity on a 4-point scale. They also provided open feedback on other aspects of the questionnaire (e.g. sequence, size, design, etc.) as they had the opportunity to express personal opinion or ask a clarifying question in the additional comment section of the evaluation form.

The version of the questionnaire derived from expert feedback was tested in the second pilot study with similar, though different, objectives and with the use of the relevant methods and analysis.

Methods used in the final study

At the final stage of the research, the tool (in which the experience of the second pilot study and, therefore, all the previous stages were taken into account) was tested using an internet survey, which started on October 9, 2021 and ended on the 28th of the same month. In this case, parallel validity was added to the analysis conducted within the pilot studies, which was calculated by correlating the corresponding constructs (barriers and benefits) with the Georgian version of the VAX questionnaire which measures general attitudes towards vaccination. It was expected that there would be a relationship (although not very intense) between general attitude towards vaccination and attitudes towards a particular vaccine (in this case, the coronavirus vaccine).

R program (specifically Lavaan) was used for confirmatory factor analysis (CFA). The rest of statistical analysis was performed with the use of IBM SPSS 25.

[3] At this stage, as well as at the third and other subsequent stages, modification involved not only deletion of items, but also their replacement, correction and addition. The questionnaire design and structure were also changed.

Participants and their selection criteria

The first pilot study was conducted using the convenience sampling method[4], with participation of 86 people.

Convenience sampling was used also for the second pilot study (103 participants). Respondents in the final study were randomly selected through Facebook ads. A total of 2,056 people participated in the final version of the questionnaire, but only 1,996 were eligible for analysis. Reasons for exclusion from the analysis included refusal to complete the questionnaire, extremely influential and/or radical score on the scales (outliers), and the doctor's recommendation not to take the COVID vaccine.

1,114 (55.9%) of the eligible respondents were women and 882 (44.1%) were men. Their average age was 48 years. 605 participants (30%) had a master's degree, 420 (21%) had a bachelor's degree, 318 people (16%) had completed professional education, 239 (12%) respondents indicated 'Other', 143 (7.2%) had a secondary education, 145 (7.3%) had a doctor's degree; 58 (2.9%) were bachelor program students, 33 (1.6%) – master program students, 33 (1.7%) – doctoral program students, and 5 (0.3%) had incomplete secondary education.

Materials and Procedures

All network field studies (pilot and final) were conducted using an internet version of the questionnaire (in particular, Google Forms)[5].

All constructs in the studies were measured on a 5-point scale. Out of them, Barriers, Benefits and Cues to action were measured on a Likert scale, where point 1 corresponded to "I do not agree with the statement at all", and 5 - "I completely agree with the statement". Points 2, 3, and 4 between these two extremes were untitled. Potential responses to the constructs of Susceptibility and Severity were "very low", "low", "medium", "high" and "very high".

It is worth noting that some questions intended for vaccinated and unvaccinated respondents had identical, but differently formulated content. These questions were related to perceived risks (perception of current susceptibility/severity for the unvaccinated, perception of susceptibility/severity for the vaccinated) and cues to action. As for perceived barriers and benefits, both types of respondents answered the same items regardless of vaccination status.

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[4] Such a selection method was used for the following reason: 1) As already said, we were interested in the regularities and psychometric properties only at a superficial level; 2) We wanted to obtain a maximum number of reciprocal, live feedbacks, which would be better achieved using the people we were familiar with.

[5] It should be noted that the development and validation studies of the HBM instrument were conducted within the framework of a larger research project aimed at determining predictors of vaccination against Covid-19.

Results

First pilot study results

As a result of the exploratory factor analysis (EFA), the Kaiser-Meyer-Olkin measure and Bartlett's sphericity test confirmed the adequacy of the sample for analysis. The factor structure matched our hypothesized, HBM based model, quite well. Despite this, some changes were still introduced due to obtained results. The most important change concerned Cues to Action which was specified as a formative rather than a reflective construct.

According to the reliability analysis (Cronbach's alpha) conducted within the first pilot study, all constructs revealed a high level of internal consistency (at least .871).

It is noteworthy that predictive validity contributed to the solution of issues concerning improvement of the questionnaire. Also, due to the item content overlap, several items were revised and/or removed from the questionnaire.

As for the experts' feedback regarding the evaluation of the Health Beliefs Model based scale, they mostly discussed the need to add an extra point to the rating scale in order to increase the differentiator. It was recommended to use a 5-point evaluation scale. Also, depending on the content of the items, it was suggested to assign a different verbal meaning to each of the points. In addition, according to one of the experts, it would be better to formulate certain items in a simplified way for the purpose of clarity. The same expert suggested other possible versions of wording for several items.

Second pilot study results

The analysis of internal consistency (Cronbach's alpha) conducted within the framework of the second pilot study yielded high overall reliability indicators. An exception was the past version of the Cues to Action construct, which was found to have low reliability. This, once again, proved our logical assumption that the given construct is formative rather than reflective. For these reasons, we decided to convert its items into the responses that could be selected through a checkbox[6] instead of a Likert scale, which would also save the time required for the completion of the questionnaire. Also, the Perceived Susceptibility scale index fell slightly below (by 0.001) the desired threshold of .7, which resulted in the replacement of one item.

The criterion of predictive validity contributed to the resolution of issues concerning modification and removal of items. We changed and/or removed items due to content overlap.

[6] When using a Checkbox, participants simply report a dichotomous response as to whether the given reason drives their intention and/or behavior to vaccinate.

Final Study Results

Factor Analysis

Similar to the pilot studies, the factor structure of the HBM questionnaire was almost confirmed by the final study. To investigate the factor structure of the questionnaire, 17 items were subjected to exploratory factor analysis. The Kaiser-Meyer-Olkin measure (KMO=.936) and the statistically significant Bartlett's sphericity test- $\chi 2(33762.554) = 1680.17$, $p<.001$ - confirmed the adequacy of the sample for analysis. After several rotations and variations of other methods, we arrived at the final model. In this solution we used oblique rotation. A maximum likelihood factor analysis with a cutoff point of .40 with 4 factor extraction criteria yielded a four-factor model accounting for 71.66% of the variance. The results of the factor analysis are shown in the table below (Table 1). The item related to religious beliefs, as one of the possible barriers, was removed from the questionnaire due to its low factor loading (-.46).

Table 1

Exploratory Factor Analysis Results

HBM items	Factor Loadings			
	1	2	3	4
Factor 1: Perceived Barriers				
1.Barrier1	**-.458**			
2. Barrier2	**-.690**			
3. Barrier3	**-.626**			
4. Barrier4	**-.669**			

5. Barrier5	**-.655**			
6. Barrier6	**-.653**			
7.Barrier7	**-.624**			
8.Barrier8	**-.623**			
Factor 2: Perceived Benefits				
9.Benefit1		**.822**		
10.Benefit2		**.928**		
11. Benefit3		**.928**		
12.Benefit4		**.901**		
13.Benefit5		**.874**		
Factor 3: Perceived Susceptibility				
14.Susceptibility1			**.948**	
15.Susceptibility2			**.950**	
Factor 4: Perceived Severity				
16.Severity1				**-.946**
17. Severity2				**-.954**

Reliability

Internal consistency analysis (Cronbach's alpha) conducted within the final study showed a high level of reliability for all constructs. Perceived Susceptibility scale consisted of 2 items. It should be noted that after considering the results of the second pilot study, the reliability index of Perceived Susceptibility substantially increased, resulting in high internal consistency (α = .948). As for the rest of the factors, similar to Perceived Susceptibility each of them was characterized by high internal consistency: Perceived Severity scale (α = .950), Perceived Benefits (α = .972) and Perceived Barriers (α = .895).

Item content overlap

Internal consistency analysis (Cronbach's alpha) performed for the final study showed a strong correlation between several items. All of these pairs were part of the same construct. In particular, a strong correlation was revealed between two items of Perceived Severity scale (r = .9), two items of Perceived Susceptibility scale (r = .9); between the second item and the 3rd (r = .92), 4th (r = .89), and 5th (r = .9) items of the Perceived Benefits scale. Correlations higher than .8 were also common among other statements (mostly paired with the first statement) of the Benefits construct. However, we did not consider it necessary to make changes for several reasons: 1) high correlations were observed only between the statements of the same factor; 2) although a single-item constructs are considered undesirable, Perceived Severity and Perceived Susceptibility constructs were so narrow that it was difficult to find an acceptable alternative; 3) logical comparison of content similarities between the items did not reveal clearly excessive overlaps.[7]

Concurrent Validity

Both variables were found to highly correlate with VAX scores (namely, barriers r = .814, and benefits r = -.813), which supports the validity of the HBM based questionnaire.

Predictive Validity

According to binomial logistic regression analysis Perceived Barriers scale is a good predictor of vaccination intention r_s (677) = .466, p < .001 and behavior t(1139.528) = -46.555, p < 0.001.; Perceived Benefits scale is even a better predictor of vaccination intention r_s (677)) = .609, p < .001 and behavior t(1146.135) = 57.943, p < 0.001. Statistically significant, but weaker relationship with the same dependent variables was shown by Perceived

[7] For example, a high correlation (.9) was found between the following statements: '2. In my opinion, the anti-COVID vaccine protects against further health complications and keeps people alive' and '5. I think that the vaccine against COVID will help to end the pandemic', although obviously they are quite different in content.

Susceptibility (r_s (711) = .323, p < .001; t (1438.712) = 21.615, p < 0.001) and Perceived Severity (r_s (711) = .312, p < .001; t (1344.375) = 22.531, p < 0.001). Binomial logistic regression analysis showed that all constructs predict vaccination behavior (in particular, whether a person has already been vaccinated or not) with approximately 93% accuracy.

Discussion

The model gives quite a good description of the factor structure obtained by factor analysis. However, it is necessary to take into consideration that one of the five constructs of HBM model – Cues to action, is a formative rather than reflective construct.

Similar to the systematic analysis conducted by Limbus and colleagues (2022), in the current study Perceived Barriers and Perceived Benefits are the best predictors of respondents' vaccination intention. Relatively less significant (though still important) was the role of Perceived Susceptibility and Perceived Severity. Our results replicate the results of another systematic study which reviewed 32 articles to determine predictive validity of HBM model and revealed the same regularities (Zewdie et al., 2022). The developed instruments measure just these important components and, differently from other available questionnaires, considers the local context, the corresponding time period and a more detailed and wider list of perceived barriers and benefits than presented in other available questionnaires (see, for example, Zampetakis & Melas, 2021; Wong et al., 2021; Jones & Wallis, 2022). It should be noted that similar to the studies described in the analysis, the developed instrument can predict from the individual's attitudes, with a high level of accuracy, whether the individual intends to take the vaccine and whether she/he has already performed or has not performed yet the corresponding preventive behavior.

According to the theory of reasoned action of Fishbein & Ajzen and Ajzen's theory of planned behavior, intention is an important precondition of behavior. Consequently, in the case of strong intentions, there is a higher probability that intentions will translate into behavior (Ajzen, 1991). However, intention does not always transform into behavior and is not its only precondition (Sutton, 2001). In addition to supporting Fishbein and Ajzen's theoretical framework (Ajzen, 1991), the finding of the current study also supports the research concerning COVID-19 vaccination related beliefs (Seddig et al., 2022) where attitudes towards COVID-19 and preventive vaccination can better predict vaccination intention and a high probability of the corresponding behavior than normative and control beliefs. The instrument developed within the framework of the current study measures just those attitudes that are related to COVID-19 (perceived susceptibility and severity) and vaccination, which, in turn, are strong predictors of vaccination intention and status.

It is important to consider the above factors in combination and not regard them as isolated entities. For example, a low level of subjective risk will not evoke sufficient motivation to vaccinate even if the trust in vaccination increases. At the same time, if an individual expects that she/he will have a severe form of disease, then they might decide that the side effects of vaccination are less important compared to the risk of contracting the virus and make a decision in favor of vaccination. It is the principle of the HBM model since it emphasizes that it is important to consider the factors involved in the model within a single context rather than study them separately.

Study results and raw material (along with the corresponding data) can be searched free at the following web address: https://osf.io/su5er/, which will help interested persons to replicate the study or use it for their research purposes.

Study limitations

Although participants were selected through probability sampling via Facebook ads, it could be the algorithm, per se, that gave a priority to a specific group of users. The findings can be more or less generalized to the population of registered users in Georgia. However, the questionnaire has not been completed by those individuals who are not the users of social network. Another study limitation is that vaccinated and unvaccinated individuals answered the questions about perceived risks (susceptibility and severity) and cues to action in relation to different time periods. In particular, vaccinated respondents had to recall susceptibility and severity as perceived by them before vaccination, whereas unvaccinated individuals had to answer the questions regarding their current perceptions. It should be noted, however, that the items were identical in terms of their content.

Conclusion

An instrument based on HBM model was created within the framework of the study to examine the attitudes towards vaccination against COVID-19. As a result, a 17-item questionnaire was developed to measure the following dimensions of HBM model: Perceived Susceptibility, Perceived Severity, Perceived Benefits, Perceived Barriers and Cues to Action. The instrument showed satisfactory psychometric properties: expected factorial structure, high internal consistency between the constructs, ability to differentiate the vaccinated from the unvaccinated with 93% accuracy. However, given research limitations, it would be advisable to test the questionnaire using a larger sample beyond Facebook users. It should be noted that the instrument can be also tested and used in international studies. In addition, the questionnaire will enable researchers to study attitudes towards any specific vaccination and the obtained scores can be used for identification of those groups which are more or less

inclined to accept COVID-19 vaccinations. Apart from COVID-19, slightly modified versions of the questionnaire could be used for the examination of attitudes towards any new vaccines developed for other diseases.

Financial support of the study

The study has been supported by the Research Department of the Georgian Institute of Public Affairs (GIPA) and conducted within the framework of small grant project (No.8.10.2021.5).

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