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Adapting the Motors of Influenza Vaccination Acceptance Scale into the Motors of COVID-19 Vaccination Acceptance Scale: Psychometric evaluation among mainland Chinese university students

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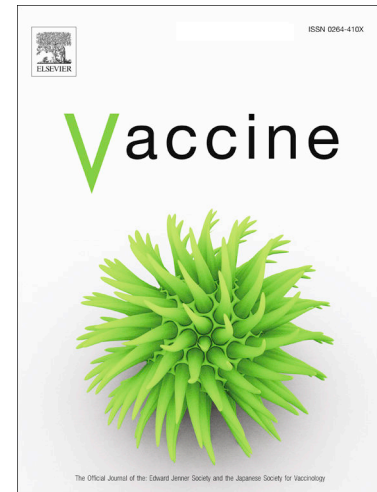
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Adapting the Motors of Influenza Vaccination Acceptance Scale into the Motors of COVID-19 Vaccination Acceptance Scale: Psychometric evaluation among mainland Chinese university students

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Abstract

Background: COVID-19 continues to ravage the world with economies and life significantly and negatively affected. Fortunately, there has been significant progress in the production of vaccines to stem the infection. However, with controversies and myths surrounding vaccinations, it is timely to examine individuals' willingness to vaccinate. The present study adapted the Motors of Influenza Vaccination Acceptance Scale (MoVac-Flu Scale) into the Motors of COVID-19 Vaccination Acceptance Scale (MoVac-COVID19S) for validation and assessed the acceptance of COVID-19 vaccination utilizing the cognitive model of empowerment (CME).

Methods: A total of 3145 university students (mean age=20.80 years; SD=2.09) were recruited for the present study between January 5 and 16, 2021. Two MoVac-COVID19S scales (9-item and 12-item) were adapted from the MoVac-Flu Scale, an instrument developed using CME. Psychometric tests were conducted to ascertain reliability and validity properties.

Results: The findings indicated that the MoVac-COVID19S had high internal consistency in both the 9-item version ($\omega=0.921$) and 12-item version ($\omega=0.898$). The factor structure of the MoVac-COVID19S (9-item and 12-item versions) corresponded well with CME theory. All the fit indices were satisfactory (comparative fit index=0.984, Tucker-Lewis index=0.971, root mean square error of approximation=0.088, standardized root mean square residual=0.058) but the 9-item MoVac-COVID had better fit indices than the 12-item MoVac-COVID due to the negative wording effects existing in the 12-item MoVac-COVID19S. The scale had satisfactory known-group validity in both 9-item and 12-item versions.

Conclusions: The MoVac-COVID19S has promising psychometric properties based on internal consistency, factor structure, and known-group validity.

Keywords: confirmatory factor analysis; COVID-19; psychometrics; vaccine; young adults

1. Introduction

The impacts of the coronavirus disease 2019 (COVID-19) on everyday human life have been substantial and have been remained for over 12 months (i.e., the entire year of 2020) [1]. For example, there has been much evidence of the impacts of COVID-19 on all aspects of human health, including physical, psychological, and social health [2-16]. Unfortunately, the impacts of COVID-19 have not been well controlled worldwide because several waves of outbreaks have been reported in many countries [4,7,17]. Therefore, healthcare providers and governments worldwide are expecting effective vaccinations to control and possibly end the large negative impact of COVID-19. However, the effectiveness of vaccination depends on the uptake rate of COVID-19 vaccination [18]. More specifically, a significant number of individuals need to get vaccinated in order for the transmission rate of COVID-19 to be kept

under control. Moreover, the development of COVID-19 vaccines worldwide has been accelerated, and more than 160 candidate vaccines have been tested and evaluated with some 20 or so candidates under clinical evaluation [19-21]. Therefore, it is important to understand individuals' attitudes and considerations regarding COVID-19 vaccination uptake.

In order to assess individuals' attitudes and considerations concerning COVID-19 vaccination uptake, the first step is to develop a valid instrument to obtain such information. Given that there has been a well-developed instrument on motors of influenza vaccination acceptance (i.e., Motors of Influenza Vaccination Acceptance Scale [MoVac-Flu Scale]), adapting items in the MoVac-Flu Scale to assess individuals' acceptance toward COVID-19 vaccination is more efficient than developing a new instrument to assess acceptance toward COVID-19 vaccination [22].

The MoVac-Flu Scale has a strong theoretical background. More specifically, the MoVac-Flu Scale was developed utilizing the cognitive model of empowerment (CME) [22,23]. The CME comprises four traits: values, impacts, knowledge, and autonomy. When using the four CME traits in the MoVac-Flu Scale, *values* indicate how much the respondent cares about the purpose of vaccination uptake; *impacts* indicate how much the respondent believes in the differences made by vaccination uptake to prevent infection transmission; *knowledge* indicates how much knowledge the respondent has about the vaccination uptake; and *autonomy* indicates how much confidence and control the respondent has in getting vaccinated if the respondent is willing to. Twelve items were then generated to capture the four CME traits with each trait comprising three items. Moreover, three items in the MoVac-Flu Scale are reverse-coded (one item in *knowledge* and two items in *autonomy*).

After psychometric testing, the final version of the MoVac-Flu Scale excluded three items and contains nine items embedded in a single construct (eigenvalue of 6.40 with 71% explained variance in the exploratory factor analysis) [22]. The three omitted items were the reverse-coded items. Given that prior evidence shows that wording effects have methodological impacts on the validity and reliability of an instrument (e.g., using a mixture of both positively and negatively worded items) [24-26], it is possible that the three omitted items are confounded by the wording effect. For example, the Kid-KINDL¹ (a generic quality of life instrument for children that contains both positively and negatively worded items) was found to have unsatisfactory fit indices when fitting the data with its original six-factor structure. However, its model fit substantially improved when considering the wording effects for its six-factor structure [26]. Therefore, the 12-item version of the MoVac-Flu Scale may have similar wording effects issue as found in the Kid-KINDL.

Therefore, the present study adapted the MoVac-Flu Scale to develop the Motors of COVID-19 Vaccination Acceptance Scale (MoVac-COVID19S) which was envisaged as an instrument to effectively assess the acceptance of COVID-19 vaccination. Moreover, the factor structure of the MoVac-COVID19S was examined using the confirmatory factor analysis (CFA) and several models in the CFA were tested. More specifically, taking reference from the MoVac-Flu Scale, the present study also developed two versions of the MoVac-COVID19S with different numbers of items (i.e., 9-item MoVac-COVID19S and 12-item MoVac-COVID19S). Different structures of the 9-item MoVac-COVID19S and 12-item MoVac-COVID19S were tested (Detailed information please see *2.4 Data analysis* section). In addition, the known-group validity of both 9-item and 12-item MoVac-COVID19S was

¹ The Kid-KINDL was developed by German scholars and they named this scale as Kid-KINDL based on words in the German language (quality of life in German is Lebensqualität; children in German is Kinder. Therefore, KINDL is the combination of KINDer and Lebensqualität).

assessed using a series of preventive COVID-19 infection behaviors.

2. Methods

2.1 *Participants and procedure*

The study protocol was approved by the Institutional Review Board of the Jianxi Psychological Consultant Association (IRB ref: JXSXL-2020-DE22) before data collection commenced. An online survey was distributed using a non-probability sampling strategy, with the period of data collection between January 5 and 16, 2021. During the data collection period, help was sought from the college counselors to launch the online survey to the students in their respective online social communities. In total, 3145 students (demographics information in Table 1) participated in the present study from 43 universities and across 30 provinces in mainland China. Participation was voluntary and anonymous, and all the participants were well informed about their rights in the study on the first page of the online survey. All participants provided informed consent to indicate their willingness to participate. The inclusion criteria for participants were (i) studying at a university (either undergraduate or postgraduate) in mainland China and (ii) being aged 18 years or above. Because the platform of online survey prompted participants to complete all items, the present study has no missing data.

(Insert Table 1 here)

2.2 *The MoVac-COVID19S*

After obtaining approval from the developer of the MoVac-Flu Scale (Professor Vallée-Tourangeau) and ensuring that there was no Chinese version of the MoVac-Flu Scale, the research team adapted the MoVac-Flu Scale into MoVac-COVID19S (see Table 2) utilizing the following steps. First, the word “flu” in the 12-item MoVac-Flu Scale was replaced by

“COVID-19”, and the English version of the MoVac-COVID19S was generated. Second, the authors followed the international guideline [27] to translate the English version of the MoVac-COVID19S into Chinese. More specifically, the standard forward-, backward-, and pretest-step methods were carried out during the translation procedure, which verified the linguistic validity of the MoVac-COVID19S. The four traits in the MoVac-COVID19S corresponded to the CME model: *values* (Items 3, 6, and 8), *impacts* (Items 1, 4, and 13), *knowledge* (Items 2, 5, and 10), and *autonomy* (Items 7, 9, and 11). Moreover, Items 7, 10, and 11 are negatively worded items. A 7-point Likert scale response format was used to assess the acceptance of the COVID-19 vaccination, where a lower score indicates a lower level of COVID-19 vaccine acceptance.

(Insert Table 2 here)

2.3 Other Measures: Risk perception and preventive COVID-19 infection behaviors

The preventive COVID-19 infection behaviors were modified from the Preventive COVID-19 Infection Behaviors Scale (PCIBS), a psychometrically robust instrument assessing COVID-19 preventive behaviors engaged in by individuals [12]. More specifically, the original 5-point Likert scale response format in the PCIBS was replaced with a dichotomous scale (yes vs. no). The 5-point Likert scale response in the PCIBS was converted into a dichotomous scale because dichotomous scales classify the participants into two categories (i.e., adhering to the behavior or not) for the following data analysis (i.e., independent *t*-tests for known-group validity; for detailed information please see the ‘*Data analysis*’ Section 2.4). Moreover, the specific behaviors assessed in the present study were “avoiding crowds as much as you can”, “keeping your house ventilated”, “sanitizing and cleaning your house”, “washing your hands as much as you can”, and “wearing a face mask as much as you can”.

2.4 Data analysis

The participants' characteristics were analyzed using descriptive statistics. Then, internal consistency was examined for the two versions of the MoVac-COVID19S (i.e., the 9-item and 12-item versions) using the McDonald's ω , where a value higher than 0.7 suggests the internal consistency is satisfactory.

Factor structures of the MoVac-COVID19S were evaluated using confirmatory factor analysis (CFA). More specifically, two versions of the MoVac-COVID19S were examined separately for their structures. For the 9-item MoVac-COVID19S, the collected data were fit with a one-factor structure and a four-factor structure (the four trait factors were value, impact, knowledge, and autonomy) corresponding to the CME traits. For the 12-item MoVac-COVID19S, the collected data were fit with a one-factor structure, a four-trait-factor structure (the same aforementioned four trait factors), a two-method-factor structure (the method factors were the positive wording and negative wording effects), and a four-trait-factor with two-minus-one-method-factor structure (the same aforementioned four trait factors together with the negative wording effect; i.e., the positive wording effect was not included in the structure). The study tested the four-trait-factor with two-minus-one-method-factor structure rather than the four-trait-factor with two-method-factor structure because the latter structure is more complicated and usually hard to fulfill the parsimony principle of a CFA model [26].

Commonly used fit indices, including comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), standardized root mean squared residual (SRMR), and Akaike information criterion (AIC) were used to evaluate whether the data fitted well with these proposed models. Moreover, the analysis was expected to have CFI and TLI > 0.9, RMSEA < 0.1, and SRMR < 0.08 to indicate a supported structure [28-31]. In

addition, χ^2 difference tests were carried out to understand which factor structure had a significantly better data-model fit [32]. All the CFAs were analyzed using the maximum likelihood estimator.

Finally, several independent *t*-tests were used together with the Cohen's *d* (i.e., the estimation of effect size: 0.2 is *small*, 0.5 is *moderate*, and 0.8 is *large* effect [33]) to examine the known-group validity of the MoVac-COVID19S. More specifically, the study examined whether the participants who adhered to preventive COVID-19 infection behaviors had a significantly higher MoVac-COVID19S score (in either the 9-item or the 12-item version) than those who did not adhere to preventive behaviors. Given that vaccine uptake is one type of preventive behavior, it was considered that those who adhered to other preventive COVID-19 infection behaviors assessed in the present study might have higher levels of vaccine acceptance than those who did not adhere to these preventive behaviors. All the analyses were performed using IBM SPSS 24.0 (IBM Corp., Armonk, NY), except for the CFA which was analyzed using LISREL 8.80 (Scientific Software International, Lincolnwood, IL, USA).

3. Results

There was an equal gender distribution among the 3145 Chinese university students (1578 females; 50.2%), and the participants were relatively young with a mean age of 20.80 years (SD=2.09). Most of the participants were undergraduate students (96.2%) and only a small proportion of the participants were majoring in health-related programs (7.7%). Their average score on the perceived risk was 3.26 (SD=0.97) and had high compliance in all the preventive COVID-19 infection behaviors (87.0% avoiding crowds; 95.2% keeping their house ventilated; 90.9% sanitizing their house; 97.2% washing hands; and 91.4% wearing a face mask) (Table 1). The MoVac-COVID19S demonstrated high internal consistency in both the

9-item version ($\omega=0.921$) and 12-item version ($\omega=0.898$).

Regarding the factor structure of the 9-item MoVac-COVID19S, the one-factor structure was significantly inferior to the four-factor structure ($\Delta\chi^2=12.195$, $\Delta df=5$, $p=.03$) although some of the fit indices in the one-factor structure were slightly better than those in the four-factor structure (Table 3). For the 12-item MoVac-COVID19S, the one-factor structure was significantly inferior to the four-trait-factor structure ($\Delta\chi^2=215.289$, $\Delta df=6$, $p<.001$), the two-method-factor structure ($\Delta\chi^2=2745.517$, $\Delta df=1$, $p<.001$), and the four-trait-factor with two-minus-one-method-factor structure ($\Delta\chi^2=3396.2583$, $\Delta df=15$, $p<.001$). Moreover, the four-trait-factor with two-minus-one-method-factor structure for the 12-item MoVac-COVID19S was significantly superior to the four-trait-factor structure ($\Delta\chi^2=3181.294$, $\Delta df=9$, $p<.001$) and the two-method-factor structure ($\Delta\chi^2=651.066$, $\Delta df=14$, $p<.001$). Table 3 summarizes the fit indices of all the tested factor structures for the MoVac-COVID19S, including both 9-item and 12-item versions.

(Insert Table 3 here)

Known-group validity of the MoVac-COVID19S was supported by all the preventive COVID-19 infection behaviors (Table 4). More specifically, the participants with high compliance in preventive COVID-19 behaviors consistently had significantly higher MoVac-COVID19S scores than did those with low compliance in COVID-19 preventive behaviors (t -values between 3.83 and 7.08; p -values $<.01$ in 9-item MoVac-COVID19S; t -values between 3.36 and 7.08; p -values $<.01$ in 12-item MoVac-COVID19S). Moreover, the effect sizes for the differences were from small to large effects (Cohen's $d = 0.23$ to 0.70 for 9-item MoVac-COVID19S; $= 0.24$ to 0.65 for 12-item MoVac-COVID19S).

(Insert Table 4 here)

4. Discussion

The present study adapted the MoVac-Flu Scale to assess the motors of COVID-19 vaccination acceptance (i.e., the MoVac-COVID19S). The MoVac-COVID19S was found to have promising psychometric properties in its internal consistency, factor structure, and known-group validity. The factor structure of the MoVac-COVID19S was examined across two versions (9-item and 12-item versions) and both versions corresponded well to the theoretical framework of CME [23]. Therefore, the MoVac-COVID19S is supported by the theory with empirical evidence from the present study. However, the 12-item MoVac-COVID, which contains both positively worded items and negatively worded items, demonstrated some poor fit indices when not taking account for the wording effects (RMSEA=0.169, SRMR=0.103). When considering the wording effects in the structure of the MoVac-COVID19S, all the fit indices were satisfactory (CFI=0.984, TLI=0.971, RMSEA=0.088, SRMR=0.058). This finding concurs with prior research on other instruments which have had similar issues (e.g., Kid-KIND) [24-26]. Therefore, future studies wanting to use the 12-item MoVac-COVID19S, should pay special attention to the potential threat of wording effects if they do not control for them. Nevertheless, the 9-item MoVac-COVID19S contained solely positively-worded items and is free from the threat of wording effects. Consequently, using the 9-item MoVac-COVID19S serves as an alternative way for future studies to examine the topic of acceptance of COVID-19 vaccination uptake.

Given that this is the first study to examine the psychometric properties of the MoVac-COVID19S, no prior studies can be used for direct comparisons. However, because the MoVac-COVID19S was adapted from the MoVac-Flu Scale [22], it is possible to compare the psychometric properties of both instruments (i.e., MoVac-Flu Scale vs. MoVac-COVID19S). Both instruments have excellent internal consistency: Cronbach's α in the

MoVac-flu, which only has been tested for its 9-item version, was 0.946 [22] and McDonald's ω in the MoVac-COVID19S was 0.921 (9-item version) and 0.898 (12-item version). The exploratory factor analysis together with parallel analysis showed that the 9 items in the MoVac-Flu Scale were embedded in a single construct [22]. The CFA findings in the present study also showed that the one-factor structure for the 9-item MoVac-COVID19S had acceptable fit indices. In other words, the present CFA findings agree with the exploratory factor analysis findings by Vallée-Tourangeau et al. [22]. However, the present CFA findings extend the prior one-factor structure findings because the data of 9-item MoVac-COVID19S fit better in the CME four-trait framework. More specifically, the 9-item MoVac-COVID19S had empirical evidence to support its underlying theoretical framework, which was not examined by Vallée-Tourangeau et al. [22]. Using the CFA model comparisons, the present study provided strong psychometric evidence to support the rigorous theoretical basis of the MoVac-COVID19S.

Aside from the supported factor structure, the present study found that the MoVac-COVID19S had satisfactory known-group validity in both 9-item and 12-item versions. More specifically, those who had higher compliance to preventive COVID-19 infection behaviors (including avoiding crowds, keeping their house ventilated, sanitizing their house, washing hands, and wearing a face mask) had higher acceptance of COVID-19 vaccination uptake. Individuals who adhered to any preventive COVID-19 infection behaviors were more likely than those who did not adhere to such behaviors to perform other types of COVID-19 preventive behaviors. Because vaccination uptake can be considered as a type of preventive COVID-19 infection behavior, individuals who adhered to other preventive behaviors (e.g., washing hands) may have higher acceptance of COVID-19 vaccination uptake. Consequently, known-group validity examined in the present study for the MoVac-

COVID19S was supported.

Based on the present study's findings, several implications can be made. First, the factor structure findings of the MoVac-COVID19S highlight the importance of considering cognitive empowerment, which can provide both healthcare providers and research personnel better understanding in vaccine hesitancy issues beyond the understanding of risk and benefits perceptions. Second, the 9-item MoVac-COVID-19 is a short tool with satisfactory psychometric properties, and therefore it can be combined with other vaccination-related instruments to form a useful toolkit to address vaccine hesitancy. For example, Kassianos et al. [34] used the MoVac-Flu Scale to explore and record how healthcare workers engaged and accepted flu vaccination across six European countries. Moreover, the MoVac-Flu Scale has been used to examine predictors of uptake of the influenza vaccine among older people in Greece [35]. Third, the MoVac-COVID19S can be used to explore and understand why a population reports lower levels of motivation to get vaccinated. Although many studies have reported the high willingness of COVID-19 vaccinating uptake [e.g., 21, 36-39], low acceptance can still be observed [40-43]. Therefore, with the use of MoVac-COVID19S (or named as Drivers of COVID-19 Vaccination Acceptance Scale [DrVac-COVID19S] in other research [44]), healthcare providers and researchers can obtain in-depth information regarding the underlying mechanism of individuals who are unwilling to get vaccinated. Subsequently, appropriate programs may be designed according to the information to tackle the issue of low acceptability of COVID-19 vaccination uptake. In other words, understanding the motors of vaccination via the MoVac-COVID19S could pave the way to target individuals' vaccine hesitancy by designing bespoke and potentially effective interventions. More specifically, the four CME traits (value, impact, knowledge, and autonomy) assessed by the MoVac-COVID19S can help identify the main driver(s) of

vaccine hesitancy. Additionally, communication campaigns or vaccine promotion strategies can be designed according to the information from the four CME traits.

There are some limitations to the present study. First, some important psychometric properties (e.g., test-retest reliability, responsiveness, and concurrent validity using adequate external criterion measures) were not examined in the present study. Therefore, the psychometric evidence of the study here was restricted and future studies are needed to increase the understanding of the MoVac-COVID19S's psychometric properties. Second, the present study adopted a cross-sectional design utilizing an online self-report survey.

Therefore, several featured limitations from such a design cannot be controlled. These limitations include the recall bias, the single-rater bias, the social desirability bias, and the weak evidence in a causal relationship. Third, only mainland Chinese university students were recruited for data analysis. Therefore, the representativeness of the present study cannot be made in relation to age (e.g., children and older individuals) or ethnicity populations (e.g., African-Americans, Europeans, etc.). Therefore, future studies should examine the MoVac-COVID19S in other populations using more representative samples.

4.1 Conclusion

The present study found that MoVac-COVID19S is a reliable and valid instrument for assessing individuals' acceptance of COVID-19 vaccination. The four traits in the CME were observed in both the 9-item and 12-item MoVac-COVID19S. However, the one-factor model also had acceptable fit indices in the CFA. The 12-item MoVac-COVID19S should consider its wording effects to reflect and clearly demonstrate the CME's four traits. Therefore, the 9-item MoVac-COVID19S can feasibly be used as a tool in a busy clinical setting to help healthcare providers obtain information about the acceptance of COVID-19 vaccination

uptake. The 12-item MoVac-COVID19S may be better used in the research context when researchers want to more thoroughly investigate the underlying mechanism and related factors to the acceptance of COVID-19 vaccination uptake.

Conflict of interests.

All the authors declare that there are no conflict of interests.

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Table 1. Characteristics of participants (N=3145)

| | n (%) ^a |
|-----------------|--------------------|
| Gender (female) | 1578 (50.2%) |

| | |
|---------------------------------|---------------------------|
| Age (year) | 20.80 (2.09) ^a |
| Education level (undergraduate) | 3026 (96.2%) |
| Professional (health-related) | 241 (7.7%) |
| Avoiding crowds (yes) | 2736 (87.0%) |
| Keeping house ventilated (yes) | 2993 (95.2%) |
| Sanitizing house (yes) | 2859 (90.9%) |
| Washing hands (yes) | 3057 (97.2%) |
| Wearing a face mask (yes) | 2876 (91.4%) |

^a Age is presented using mean and standard deviation instead of n (%)

Table 2. Item scores of the Motors of COVID-19 Vaccination Uptake Scale (MoVac-COVID19S) among 3145 university students

| Item number with descriptions | M (SD) | n (%) | | | | | | |
|--|-------------|-------------------|-----------|-------------------|----------------------------|----------------|-------------|----------------|
| | | Strongly disagree | Disagree | Slightly disagree | Neither disagree nor agree | Slightly agree | Agree | Strongly agree |
| 1. Vaccination is a very effective way to protect me against the COVID-19. | 5.76 (1.16) | 16 (0.5) | 16 (0.5) | 87 (2.8) | 331 (10.5) | 667 (21.2) | 1047 (33.3) | 981 (31.2) |
| 2. I know very well how vaccination protects me from the COVID-19. | 5.62 (1.24) | 22 (0.7) | 28 (0.9) | 113 (3.6) | 394 (12.5) | 768 (24.4) | 909 (28.9) | 911 (29.0) |
| 3. It is important that I get the COVID-19 jab. | 5.93 (1.14) | 12 (0.4) | 19 (0.6) | 53 (1.7) | 309 (9.8) | 537 (17.1) | 985 (31.3) | 1230 (39.1) |
| 4. Vaccination greatly reduces my risk of catching COVID-19. | 5.94 (1.08) | 10 (0.3) | 6 (0.2) | 61 (1.9) | 261 (8.3) | 573 (18.2) | 1082 (34.4) | 1152 (36.6) |
| 5. I understand how the flu jab helps my body fight the COVID-19 virus. | 5.62 (1.28) | 21 (0.7) | 52 (1.7) | 102 (3.2) | 432 (13.7) | 672 (21.4) | 921 (29.3) | 945 (30.0) |
| 6. The COVID-19 jab plays an important role in protecting my life and that of others. | 6.00 (1.06) | 11 (0.3) | 15 (0.5) | 35 (1.1) | 245 (7.8) | 503 (16.0) | 1117 (35.5) | 1219 (38.8) |
| 7. <u>I feel under pressure to get the COVID-19 jab.</u> | 4.85 (1.61) | 138 (4.4) | 146 (4.6) | 278 (8.8) | 664 (21.1) | 753 (23.9) | 585 (18.6) | 581 (18.5) |
| 8. The contribution of the COVID-19 jab to my health and well-being is very important. | 5.88 (1.14) | 21 (0.7) | 14 (0.4) | 45 (1.4) | 314 (10.0) | 566 (18.0) | 1066 (33.9) | 1119 (35.6) |
| 9. I can choose whether to get a COVID-19 jab or not. | 5.78 (1.24) | 32 (1.0) | 25 (0.8) | 66 (2.1) | 387 (12.3) | 564 (17.9) | 972 (30.9) | 1099 (34.9) |
| 10. <u>How the COVID-19 jab works to protect my health is a mystery to me.</u> | 4.78 (1.65) | 135 (4.3) | 210 (6.7) | 298 (9.5) | 616 (19.6) | 755 (24.0) | 570 (18.1) | 561 (17.8) |
| 11. <u>I get the COVID-19 jab only because I am required to do so.</u> | 4.43 (1.77) | 209 (6.6) | 296 (9.4) | 417 (13.3) | 691 (22.0) | 593 (18.9) | 428 (13.6) | 511 (16.2) |

| | | | | | | | | |
|---|-------------|----------|----------|-----------|------------|------------|------------|------------|
| 12. Getting the COVID-19 jab has a positive influence on my health. | 5.42 (1.39) | 55 (1.7) | 61 (1.9) | 118 (3.8) | 563 (17.9) | 667 (21.2) | 847 (26.9) | 834 (26.5) |
|---|-------------|----------|----------|-----------|------------|------------|------------|------------|

Note. Items underlined are reverse-coded items; Strongly disagree scores 1; Disagree scores 2; Slightly disagree scores 3; Neither disagree nor agree scores 4; Slightly agree scores 5; Agree scores 6; Strongly agree scores 7.

Table 3. Confirmatory factor analysis testing the structure of the Motors of COVID-19 Vaccination Uptake Scale (MoVac-COVID19S)

| Fit indices | 9 items | | 12 items | | | |
|---------------|-------------|--------------|---------------|---|--|---|
| | One factor | Four factors | One factor | Four trait factors: Correlated trait | Two method factors: Correlated method | Four trait factors and two minus one method factor: Correlated trait Correlated method minus 1 |
| χ^2 (df) | 448.359(24) | 436.164 (19) | 4309.436 (51) | 4094.147 (45) | 1563.919 (50) | 912.853 (36) |
| CFI | 0.992 | 0.992 | 0.930 | 0.936 | 0.973 | 0.984 |
| TLI | 0.988 | 0.985 | 0.910 | 0.906 | 0.965 | 0.971 |
| RMSEA | 0.075 | 0.084 | 0.163 | 0.169 | 0.098 | 0.088 |
| SRMR | 0.022 | 0.022 | 0.108 | 0.103 | 0.074 | 0.058 |
| AIC | 490.359 | 488.164 | 4363.436 | 4160.147 | 1619.919 | 996.853 |

Note ^a: Error terms of the following items were correlated: Items 1 and 2; Items 2 and 5; and Items 6 and 8.

CFI=comparative fit index; TLI=Tucker-Lewis index; RMSEA=root mean square error of approximation; SRMR=standardized root mean squared residual; AIC=Akaike information criterion

Table 4. Known-group validity of the Motors of COVID-19 Vaccination Uptake Scale (MoVac-COVID19S)

| | Mean (SD) | | <i>t</i> -value (<i>p</i> -value) | Cohen's <i>d</i> |
|---|-------------|-------------|------------------------------------|------------------|
| | Yes | No | | |
| MoVac-COVID19S (9-item version) | | | | |
| Avoiding crowds | 5.80 (0.89) | 5.58 (1.09) | 3.83 (<0.01) | 0.23 |
| Keeping house ventilated | 5.79 (0.90) | 5.34 (1.24) | 4.42 (<0.01) | 0.49 |
| Sanitizing house | 5.81 (0.89) | 5.36 (1.11) | 6.59 (<0.01) | 0.49 |
| Washing hands | 5.79 (0.90) | 5.15 (1.38) | 4.35 (<0.01) | 0.70 |
| Wearing a face mask | 5.81 (0.90) | 5.35 (1.04) | 7.08 (<0.01) | 0.50 |
| MoVac-COVID19S (12-item version) | | | | |
| Avoiding crowd | 5.52 (0.82) | 5.35 (0.98) | 3.36 (<0.01) | 0.24 |
| Keeping house ventilated | 5.52 (0.83) | 5.17 (1.09) | 3.99 (<0.01) | 0.43 |
| Sanitizing house | 5.53 (0.83) | 5.15 (0.95) | 6.52 (<0.01) | 0.45 |
| Washing hands | 5.52 (0.83) | 4.97 (1.23) | 4.13 (<0.01) | 0.65 |
| Wearing a face mask | 5.53 (0.83) | 5.13 (0.90) | 7.08 (<0.01) | 0.48 |

[45]

Abstract

Background: COVID-19 continues to ravage the world with economies and life significantly and negatively affected. Fortunately, there has been significant progress in the production of vaccines to stem the infection. However, with controversies and myths surrounding vaccinations, it is timely to examine individuals' willingness to vaccinate. The present study adapted the Motors of Influenza Vaccination Acceptance Scale (MoVac-Flu Scale) into the Motors of COVID-19 Vaccination Acceptance Scale (MoVac-COVID19S) for validation and assessed the acceptance of COVID-19 vaccination utilizing the cognitive model of empowerment (CME).

Methods: A total of 3145 university students (mean age=20.80 years; SD=2.09) were recruited for the present study between January 5 and 16, 2021. Two MoVac-COVID19S scales (9-item and 12-item) were adapted from the MoVac-Flu Scale, an instrument developed using CME. Psychometric tests were conducted to ascertain reliability and validity properties.

Results: The findings indicated that the MoVac-COVID19S had high internal consistency in both the 9-item version ($\omega=0.921$) and 12-item version ($\omega=0.898$). The factor structure of the MoVac-COVID19S (9-item and 12-item versions) corresponded well with CME theory. All the fit indices were satisfactory (comparative fit index=0.984, Tucker-Lewis index=0.971, root mean square error of approximation=0.088, standardized root mean square residual=0.058) but the 9-item MoVac-COVID had better fit indices than the 12-item MoVac-COVID due to the negative wording effects existing in the 12-item MoVac-COVID19S. The scale had satisfactory known-group validity in both 9-item and 12-item versions.

Conclusions: The MoVac-COVID19S has promising psychometric properties based on internal consistency, factor structure, and known-group validity.

Keywords: confirmatory factor analysis; COVID-19; psychometrics; vaccine; young adults

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

[47]

Adapting the Motors of Influenza Vaccination Acceptance Scale into the Motors of COVID-19 Vaccination Acceptance Scale: Psychometric evaluation among mainland Chinese university students

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[48]

Highlights

COVID-19 vaccine uptake is crucial in the attempt to inhibit the spread of COVID-19

The Motors of COVID-19 Vaccination acceptance Scale (MoVac-COVID19S) was developed

9-item and 12-item versions of the MoVac-COVID19S were psychometrically tested

MoVac-COVID19S can effectively assess the acceptance of COVID-19 vaccination

MoVac-COVID19S factor structure corresponds well with the cognitive model of empowerment

[49]

Journal Pre-proofs