Health Psychology

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Online First Publication, September 8, 2022. http://dx.doi.org/10.1037/hea0001228

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ISSN: 0278-6133
https://doi.org/10.1037/hea0001228

How Do Vaccination Intentions Change Over Time? The Role of Motivational Growth

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Objective: Across nationwide rollout of COVID-19 vaccination, people in Belgium differed widely in their vaccination intention. In the present study, we examined (a) how people's vaccination intentions changed during the vaccination rollout and (b) whether changes in motivation (i.e., autonomous, controlled, and distrust-based (a)motivation) predicted changes in vaccination intention, thereby taking into account people's vaccination intention at baseline. ***Method:*** Using 4 subsamples of participants who were vaccinated at different time points (n_{total} = 10,799) between December 2020 and June 2021; we used latent change modeling and latent growth curve modeling to examine the associations among initial levels and changes in vaccination motivation and vaccination intention. ***Results:*** Across subsamples, changes in vaccination intention were found to be qualified by changes in motivation. An increase in autonomous motivation was related to a positive shift in vaccination intention, while an increase in both controlled motivation and distrust-based amotivation was related to a negative shift in vaccination intention. Moreover, autonomous motivation predicted especially an increase in vaccination intention among those initially low in vaccination intention, whereas an increase in either controlled motivation or distrust-based amotivation especially predicted a decrease in vaccination intention among those initially high in vaccination intention. ***Conclusions:*** Findings suggest that a growing sense of ownership and a reduction in distrust is critical for individuals to develop a stronger intention to get vaccinated, particularly when people had initially low vaccination intentions. We discuss conceptual, methodological, and practical implications.

Keywords: motivation, vaccine, vaccination hesitancy, COVID-19, pandemic

Supplemental materials: https://doi.org/10.1037/hea0001228.supp

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The Motivation Barometer is an initiative launched by the University of Ghent, and it eventually brought together researchers from the University of Leuven, the Université Catholique de Louvain, and the Université Libre de Bruxelles. The Motivation Barometer was continued throughout the COVID-19 pandemic thanks to funding provided by the University of Ghent and the Belgian Ministry of Public Health.

All deidentified data, analysis code, and research materials are available from Zenodo (https://doi.org/10.5281/zenodo.5796162).

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Since the worldwide outbreak of the COVID-19 virus, researchers have designed vaccines with an unprecedented speed, allowing policymakers to launch large-scale vaccination rollouts as a core strategy to handle the pandemic. However, it soon became apparent that vaccination rollouts would face a key psychological challenge, that is, to motivate people to take the vaccine. Although many people were immediately looking forward to receive their first injection, a sizable portion of the population adopted a wait-and-see, critical, or even rejecting attitude (e.g., Daly & Robinson, 2021). Clearly, understanding differences in vaccination intention and changes in these intentions is of paramount importance for a successful vaccination rollout (e.g., Hornsey et al., 2018). A particularly critical question is how stable individuals' initial vaccination intentions are. Are these initial intentions largely set in stone, or can motivational changes lead to an increase in acceptance of the vaccine across time? And can even people with low initial vaccination intentions develop greater acceptance of the vaccine through a motivational shift? Research addressing these questions is important from a policy perspective because motivational campaigns are only useful if changes in motivation are related meaningfully to changes in vaccination intentions. Conducted during the first 7 months of the Belgian vaccine rollout, the present longitudinal study aimed to provide, first, a fine-grained analysis of how vaccination intentions of individuals with different baseline attitudes (i.e., refusing, hesitant, accepting) evolved through time. Second, we examined which motivational factors facilitate and impede the transition toward acceptance of the COVID-19 vaccine.

Changes in Vaccination Hesitancy

As COVID-19 vaccines became available for the entire population and attracted media attention at the end of 2020, people's willingness to be vaccinated generally increased (e.g., Al-Amer et al., 2022). For instance, global data (coviddatahub.com) showed a growing willingness across time with the largest increase between November 2020 (55%) and February 2021 (77%, +22%). In parallel, the percentage of people hesitating or unwilling to get vaccinated decreased in most countries, with for instance a decrease from 19% of people hesitating in February 2021 to 8% in June 2021 in Spain.

These encouraging numbers notwithstanding, a substantial proportion of the population in many countries remained unwilling to be vaccinated at the end of 2020 (e.g., 16% in Spain and 35% in France). Sociodemographic factors like being a woman, being younger, and having a lower education level were associated with a more refusing attitude toward the vaccine (e.g., Butter et al., 2022). Also, higher levels of conspiracy beliefs, lower trust in politics (Van Oost et al., 2022), and the issues related to blood clots linked to the AstraZeneca vaccine decreased people's trust in the vaccine (Sabahelzain et al., 2021). Finally, the perceived risk of getting infected at a given moment in time played a role (Schmitz et al., 2022). To illustrate, a reduced willingness to be vaccinated was observed in the summer of 2020; a moment when many governments were loosening COVID-19 measures because of low infection numbers (e.g., Hyland et al., 2021).

The Role of Motivational Differences

Because voluntary vaccination undoubtedly stands as a motivationally driven behavior, it is critically important to identify the underlying motivational factors that potentially affect vaccination intention. Inspired by self-determination theory (SDT; Ryan & Deci, 2017; Vansteenkiste et al., 2006) and models of health behavior (e.g., social–cognitive models of pandemics; Hagger et al., 2020), we considered both qualitatively different types of motivation to be vaccinated (i.e., autonomous, controlled) as well as a lack of motivation (i.e., distrust-based amotivation) to predict time-related changes in vaccination intention. *Autonomous motivation* implies that individuals fully embrace vaccination because they perceive it as beneficial, meaningful, and in line with their personal values and goals (e.g., to protect themselves or their relatives, to overcome the crisis). Such a high level of ownership can be achieved when individuals generate important rationales themselves, or when the rationale for vaccination comes from external sources (e.g., governmental communication) and they concur with the provided arguments (Martela et al., 2021). In contrast, *controlled motivation* denotes a pressured and conflicted form of behavioral regulation. Individuals may feel obliged to take the vaccine because they seek contingently promised reward (e.g., social approval, economic returns) or because they want to avoid criticism or penalties (e.g., being denied access to social events, being discriminated). As such, autonomously motivated individuals experience the vaccination as something they want to do whereas those with controlled motivation see it as something they should do.

To be sure, vaccination could also be experienced as something that people do not want to do, resulting in a lack of motivation for getting vaccinated (i.e., amotivation). For example, citizens may fear serious side effects in the short or long run or may hold the belief that the development of the vaccine was too quick and therefore lacked appropriate testing (e.g., Milošević Đorđević et al., 2021). To the extent that such *distrust-based amotivation* stems from a wide array of sources, its evolution across time may be more difficult to predict because it may be more sensitive to sudden contextual changes. For instance, concerns about potential side effects of the AstraZeneca vaccine (i.e., blood clots) were extensively covered by the media, even though they were extremely rare (European Medicines Health, 2021).

Autonomous motivation is a positive predictor of health-related behaviors and intentions (including vaccination), whereas the effect of controlled motivation is typically weaker or even detrimental (e.g., Martela et al., 2021; Schmitz et al., 2022; Van Oost et al., 2022). For example, Schmitz et al. (2022) found that autonomous motivation to take the vaccine related positively to concurrent vaccination intentions, subscription to a waitlist to obtain a vaccine, and self-reported vaccine uptake over time. Controlled motivation did not demonstrate such a positive pattern, yielding only a small positive or nonsignficant association with vaccination intentions or self-reported uptake. Distrust-based amotivation was associated negatively with vaccination intentions. Moreover, it mediated, together with autonomous motivation, the positive effect of infection-related risk perception on vaccination intention and vaccination uptake, with risk perception having a negative effect on distrust-based amotivation and a positive effect on autonomous motivation (Schmitz et al., 2022).

As instructive as Schmitz et al. (2022) findings may be, these data remain silent about the evolution of people's vaccination intention during the vaccination rollout and whether a shift in motivational underpinnings may facilitate or impede a shift in vaccination intentions. In fact, we are not aware of data speaking to the important issue of how people's intention to get vaccinated changes over time and what may be the motivational determinants of such change. Of particular importance is the question whether motivation can still play a role among people with low initial vaccination intentions. Do these people, who are the least likely to take the vaccine, benefit from a motivational change thereby developing toward higher vaccination intentions as they grow in autonomous motivation?

The Present Study

The present longitudinal study, which was conducted between the beginning of December 2020 and the end of June 2021, had two key objectives. A first, rather descriptive, objective was to chart the evolution of individuals' vaccination intentions over time, thereby considering also their vaccination status (i.e., being vaccinated or not). Whereas previous research focused solely on intentions to get vaccinated at a single moment or compared cross-sectional samples across time (e.g., Hyland et al., 2021), we adopted a longitudinal design to gain a more detailed insight into the transition among the different subcategories of vaccination intentions and statuses across time within participants. We distinguished between five types of vaccination intentions, which we labeled as *totally refusing*, *refusing*, *hesitating*, *accepting*, and *totally accepting*. We expected that an overall positive change would be observed over time, with changing percentages of individuals indicating a gradual shift from (totally) refusing or hesitating to (totally) accepting or being vaccinated.

The second, and most important, objective was to examine whether changes in individuals' motivation (i.e., autonomous and controlled) and the lack thereof (i.e., distrust-based amotivation) would, respectively, facilitate or impede positive changes in vaccination intentions. Based on prior work and theorizing, we expected that an increase in autonomous motivation would predict an increase in vaccination intention, denoting a positive transition, whereas such a pattern would not be observed for controlled motivation. Increases in distrust-based amotivation were expected to relate to decreases in vaccination intention.

To investigate the generalizability of these motivational dynamics, we examined whether the effect of these motivational changes would depend on people's initial intention toward vaccination. We anticipated a number of possible interactions. For instance, it may be the case that changes in motivation more strongly affect a shift in vaccination intentions among those who initially hesitated, compared with those who (totally) refused to be vaccinated. Refusing individuals may be very resistant to change because they display severe psychological reactance against vaccination (e.g., Van Petegem et al., 2015). As such, even a motivational shift may not result in a change in vaccination intentions among these refusing individuals. Alternatively, because initial vaccination intentions among the (totally) refusing groups are low to begin with, there is more room for a shift in autonomous motivation to manifest in a positive change in vaccination intention. As such, a motivational shift could actually matter more for people initially low on vaccination intentions. Because the nature of a moderation effect by initial vaccination intention may go in different directions, we refrained from formulating specific a priori hypotheses and merely explored whether initial vaccination intention would alter the association between changes in motivation and changes in vaccination intentions across time.

Method

Procedure and Participants

We collected data in the context of the Motivation Barometer, a large-scale online research project that was designed to measure diverse psychological aspects regarding the COVID-19 crisis in the Belgian population (www.motivationbarometer.com). The project obtained ethical approval from the Ethics Committee of Ghent University. We conducted the current study in parallel with the national vaccination rollout, lasting from December 2020 till June 2021 (when most adults were invited for vaccination).

Participants were recruited for the baseline assessment via paid and unpaid social media advertisements and via different organizations and media (e.g., newspapers) who spread the link to the online survey. Herein, we assessed a set of background variables, including age and region of living to determine participants' eligibility (i.e., only people aged 18 or above and living in Belgium). The survey was available in Dutch and French. In the invitation for participation, we explained that the questionnaire assessed people's experiences during the COVID-19 period, including their psychological well-being, vaccination motivation and vaccination intention. At the end of the baseline assessment, participants had the opportunity to sign up for follow-up research by leaving their e-mail address. Participants learned that e-mail addresses were solely collected to link different waves and that their responses would be treated confidentially. During each consecutive wave, we emphasized to the respondents that their participation was voluntary and that there would be no consequences for nonparticipation. Also, no monetary reward was provided when completing the survey or participating at the follow-up survey. Participants could withdraw from the study at any time, thereby no longer receiving further invitations. When a participant did not participate at a particular wave but did not withdraw, we sent a new invitation during subsequent waves. At both the beginning and the end of the questionnaire, we provided practical contact information (e.g., information websites, mail address) in case of unclarities or in case the questionnaire had provoked negative thoughts and feelings to the participant. The median duration to complete the questionnaires was approximately 12 min.

In total, the data used in this contribution were collected during five different waves that took place between December 2020 and June 2021. In Wave 1 (December 4, 2020 through January 31, 2021), 54,195 participants (M_{age} = 49.5, ±14.37; 62.4% female; 82.2% Dutch-speaking; 78% living in Flanders, 16% living in Wallonia; 75.1% with a partner; 37% with a bachelor's level and 28.2% with a master's level) filled out an online questionnaire. From this sample, 20,919 participants (38.6%; 0.4% $\text{vaccinated}_{\text{sample}}$, 1.7% $\text{vaccinated}_{\text{population}}$) signed up to participate in follow-up research and were invited for the second wave (see Figure S1 in the online supplemental materials for an overview). In total, 4,129 people

(Response Rate with respect to baseline (RR) = 19.7%; 6.7% $\text{vaccinated}_{\text{sample}}$, 9.3% $\text{vaccinated}_{\text{population}}$) completed the first follow-up questionnaire (Wave 2), which was sent out between February 1, 2021 and March 31, 2021. The interval between these first two waves was longer compared with the other waves, as in this period, only particular subgroups of the population (e.g., people employed in the health sector) could receive a vaccine. The third wave, conducted between April 8 and 19, was completed by 6,529 participants (RR = 31.2%; 27.7% $\text{vaccinated}_{\text{sample}}$; 31.2% $\text{vaccinated}_{\text{population}}$). Between May 21 and 31, 6,390 participants completed the fourth data collection (Wave 4) (RR = 30.5%; 77.2% $\text{vaccinated}_{\text{sample}}$; 47.7% $\text{vaccinated}_{\text{population}}$), followed by the fifth and final collection (Wave 5), which was gathered between June 10 and 14 (n = 6,011; RR = 28.7%; 83.8% $\text{vaccinated}_{\text{sample}}$; 72.3% $\text{vaccinated}_{\text{population}}$). Sample characteristics at all waves were comparable in terms of sociodemographic composition. Also, the increasing vaccination rate observed in our data was comparable to the official rate observed in the general Belgian population, with the fourth wave in May being an exception. During this month, there was a higher proportion of vaccinated participants in our sample compared with the proportion in the general population. This difference might be due to the mean age of participants in the present study being somewhat higher than the mean age of the population and to the fact that older participants had already been invited for vaccination by that time. At the end, Belgium was positioned as one of the top countries in terms of vaccination coverage compared with other countries (ourworldindata .org).

Measures

Before presenting the items regarding vaccination, we assessed several sociodemographic variables in each wave, including age (on a bar from 0–100), gender (1 = male, 2 = female), education level (1 = no secondary, 2 = bachelor's level, 3 = master's level), region of living (1 = Flanders, 2 = Wallonia, 3 = Brussels), and relationship status (1= no partner, 2 = partner). As living region overlapped strongly with language, we excluded this variable as a covariate in the analyses.

Vaccination Intention

In each wave, we assessed the following vaccination-related measures. First, we asked participants whether they already received a vaccine (at least one dose). When they were still unvaccinated, they had to rate the following item: "If you had the opportunity to be vaccinated against COVID-19 next week, what would you decide?" on a 5-point Likert scale, where 1 = *I would refuse without any hesitation*, 2 = *I probably would refuse*, 3 = *I would hesitate*, 4 = *I probably would accept*, and 5 = *I would accept without any hesitation*.

(Lack of) Motivation to Become Vaccinated

At each wave, participants had to indicate the extent to which different reasons for accepting or refusing vaccination applied to them, in the case they were not already vaccinated (Schmitz et al., 2022). Three items tapped into autonomous reasons to become vaccinated (e.g., "Getting vaccinated aligns with my personal values": $\alpha_{\text{wave 1–5}}$ = .89–.96 across subsamples) and three items tapped into controlled reasons to get vaccinated (e.g., "I feel pressured to get vaccinated": $\alpha_{\text{wave 1–5}}$ = .70–.75 across subsamples). Further, three items measured people's distrust-based amotivation (e.g., "I do not trust the vaccine": $\alpha_{\text{wave 1–5}}$ = .79–.87 across subsamples). Participants answered all items on a 5-point Likert-type scale ranging from 1 (*totally disagree*) to 5 (*totally agree*).

Analysis Plan

Before conducting the main analyses, we performed a set of three preparatory analyses to examine patterns of missingness in the data (see Figure S1). Here, we describe these analyses briefly, with more details and a visual overview in the online supplemental materials.

First, we examined the role of missingness due to overall nonparticipation after the baseline assessment. We found that participants who filled out at least one follow-up survey (n = 11,764) were older and had higher scores for vaccination intention and autonomous motivation, as well as lower scores for controlled motivation and distrust-based amotivation at baseline compared with those who only completed the baseline survey (n = 9,155).

Second, we made a deliberate choice to distinguish among four subsamples in the follow-up group based on two criteria. The first criterion refers to structural missingness, involving the moment when a participant reported to be vaccinated. As soon as a participant was vaccinated in a given wave, the participant's data from this wave (and subsequent waves) could no longer be included in the analyses estimating this participant's trajectory of vaccination intentions. Indeed, it is not useful to predict a person's intentions after being vaccinated. This deliberate choice to no longer use individuals' data after they were vaccinated resulted in structural missingness (see the online supplemental materials for a more detailed description). For instance, when a participant reported to be vaccinated at Wave 4, this participant was assigned to Subsample 2, in which we used only the available measurements from Wave 1 to Wave 3 to estimate the models. The second criterion involves that people were included in the analyses only if they participated at least twice in the follow-up assessments (i.e., to yield reliable estimations of their trajectories). This approach resulted in five subsamples ($n_{Subsample\_1}$ = 1508; $n_{Subsample\_2}$ = 2463; $n_{Subsample\_3}$ = 1307; $n_{Subsample\_4}$ = 5521). A comparison of these subsamples showed that those in Subsample 1 had the highest scores on vaccination intention and autonomous motivation and that participants in Subsample 4 had the highest scores on controlled motivation and distrust-based amotivation.

Third, within each subsample, there were still some missing values because some participants did not fill out all items. Within each of the subsamples, Little's missing completely at random (MCAR) tests confirmed that these values were MCAR. Therefore, in the analyses using the subsamples (Objective 2), we used the full information maximum likelihood (FIML) estimator, which produces unbiased parameter estimates and standard errors given the satisfaction of MCAR assumption (Von Hippel, 2016).

To address Objective 1, we used a Sankey diagram, which provides a descriptive overview of the transitions in vaccination intentions across waves. This was done using the complete (imputed) dataset of participants in all subsamples (i.e., Subsample 1 to 4, N = 10,799). In this plot, categories are connected by colored lines from which the color represents the most recent category, and the

width represents the number of participants shifting from one category to another over time. Detailed information is provided by a colored contingency table including percentages of participants going from one level at Wave T to the levels at Wave T + 1 (see Table 1S in the online supplemental materials). As Sankey diagrams can only be generated using complete cases, we could not rely on FIML for these analyses. Instead, missing data were imputed through the linear interpolation algorithm using the *imputeTS* R package (Moritz & Bartz-Beielstein, 2017).

To address Objective 2, which involves assessing relationships among people's initial levels (i.e., latent intercepts) and time-related changes (i.e., latent slopes) of the study variables, we used latent change modeling (LCM) in Subsample 1 and latent growth curve modeling (LGCM) in Subsamples 2 to 4. Whereas LCM allows for an estimation of latent change across two time points (i.e., the number of waves included in Subsample 1), LGCM allows for an estimation of latent trajectories across three time points or more (as is the case in Subsamples 2 through 4). Both models shed light on the mean-level change in the variables across time and test whether there is interindividual variation in these parameters.

All analyses were done separately within each subsample and separately for each of the three different motivational variables (i.e., autonomous motivation, controlled motivation, and distrust-based amotivation), resulting in a total of 12 series of analyses (i.e., 4 subsamples by 3 motivation types). By repeating this set of analyses in each subsample, we performed an internal replication of the proposed hypotheses while also shedding light on the variability in effects as a function of longer time frames. Each model consisted of two latent variables representing the overall levels of the study variables and two latent variables representing the slopes of these variables (i.e., the degree of intraindividual change in these variables across time). In addition, the models includes three sets of latent two-way interactions (i.e., $\text{Level}_{\text{vaccination}} \times \text{Level}_{\text{motivation}}$; $\text{Level}_{\text{vaccination}} \times \text{Change}_{\text{motivation}}$; and $\text{Level}_{\text{motivation}} \times \text{Change}_{\text{motivation}}$). The interaction between individuals' initial level of vaccination intention and their change in motivation (in the prediction of change in vaccination intention) was of particular interest, because this interaction allowed us to examine whether a motivational change matters among people initially low on vaccination intention. We evaluated the goodness of fit by the root mean square error of approximation (RMSEA), the standardized root square residual (SRMR), and comparative fit index (CFI), where a combination of an RMSEA below .06, an SRMR value below .09, and a CFI of at least .90 suggests a good model fit (Kline, 2015).

Results

Preliminary Analyses

Data were analyzed using R (R Core Team, 2020). Table 1 shows descriptive statistics as well as between-participants (i.e., changes between participants) and within-participant (i.e., changes across time within participants) Pearson correlations between all variables. As age represents a between-participants difference, no within-person correlations are presented. The mean score for autonomous motivation is the highest, whereas distrust-based amotivation yielded the lowest mean (all ps $< .001$ of paired-sample t-tests). Age is associated negatively with controlled motivation and distrust-based amotivation. At both levels of analysis, autonomous motivation is related to both less controlled motivation and distrust-based amotivation which are positively interrelated. Vaccination intention is positively correlated with autonomous motivation and negatively with controlled motivation and distrust-based amotivation.

Furthermore, multivariate analyses of covariance displayed no differences in the study variables in terms of gender (Wilks' $\lambda = .981$), $F(4, 4225) = 1.89$, $p = .15$, relationship status (Wilks' $\lambda = .990$), $F(4, 2024) = .66$, $p = .62$), education level (Wilks' $\lambda = .921$), $F(8, 3892) = 2.54$, $p = .07$, and language (Wilks' $\lambda = .978$), $F(5, 436) = 1.65$, $p = .14$).

Objective 1: Transitions in Vaccination Intention Over Time

Figure S2 in the online supplemental materials shows a Sankey diagram including the transitions of individuals' vaccination intentions, in relation to their vaccination status. Table S1 in the online supplemental materials also provides more detailed information by presenting the percentage of participants moving out of a specific category of vaccination intention from one wave to the next. A number of findings are worth noting. First, the extreme vaccination intention categories (i.e., totally refusing and totally accepting) show a higher level of stability as compared with the other categories. Especially those refusing and hesitating show the largest degree of change toward other levels of vaccination intentions. Second, there is a clear trend toward greater vaccination intentions and self-reported vaccination across time. A greater proportion of individuals in the hesitant category moves toward the (totally) accepting category instead of toward the (totally) refusing category. This positive change can especially be observed from Wave 2 to Wave 3 (i.e., February/March 2021 to April 2021). Third, as more

Table 1
Between-Participants and Within-Participants Correlations Among Assessed Variables

Variable	*M*	*SD*	1	2	3	4	5
1. Age	53.82	14.37					
2. Vaccination intention	4.86	1.29	.22***		.28***	−.10***	−.06***
3. Autonomous motivation	4.23	1.11	.08***	.79***		−.09***	−.05***
4. Controlled motivation	2.45	1.03	−.24***	−.38***	−.44***		.03***
5. Distrust-based amotivation	2.29	1.07	−.08***	−.58***	−.67***	.32***	

Note. Data are based on all subsamples ($N = 10{,}799$). Correlations below the diagonal refer to between-participant correlations; correlations above diagonal refer to within-participant correlations (i.e., within participants across time).
*** $p < .001$.

vaccines became available across time, there was a greater overall change in intention toward vaccination, especially when vaccinations were rolled out at a high pace (i.e., April to May 2021).

Objective 2: The Role of Motivational Changes in Vaccination Intentions

Main Effects of Motivational Changes

Figures 1, 2, and 3 present the output of the LCMs and LGCMs for each type of motivation. In each figure, the output is displayed separately for each subsample. The pattern of findings was fairly stable across subsamples, indicating that the moment of vaccination did not have a noticeable effect on the structural relations. All fit indices in the figures show moderate to acceptable values.

Figure 1 displays the model including autonomous motivation. First, initial levels of autonomous motivation and initial vaccination intention are strongly positively related. Moreover, changes in autonomous motivation and vaccination intentions were also positively related across all four sets of analyses, implying that an increase in autonomous motivation across time is positively related to an increase in vaccination intentions. Next, baseline levels of autonomous motivation were negatively related to change in vaccination intention in three of the four analyses. These findings indicate that vaccination intentions of already highly autonomously motivated individuals did not change very much. Also, levels of initial vaccination intention related negatively to change in autonomous motivation. In other words, individuals high in initial vaccination intention grew less in autonomous motivation, presumably because they were already highly autonomously motivated at baseline.

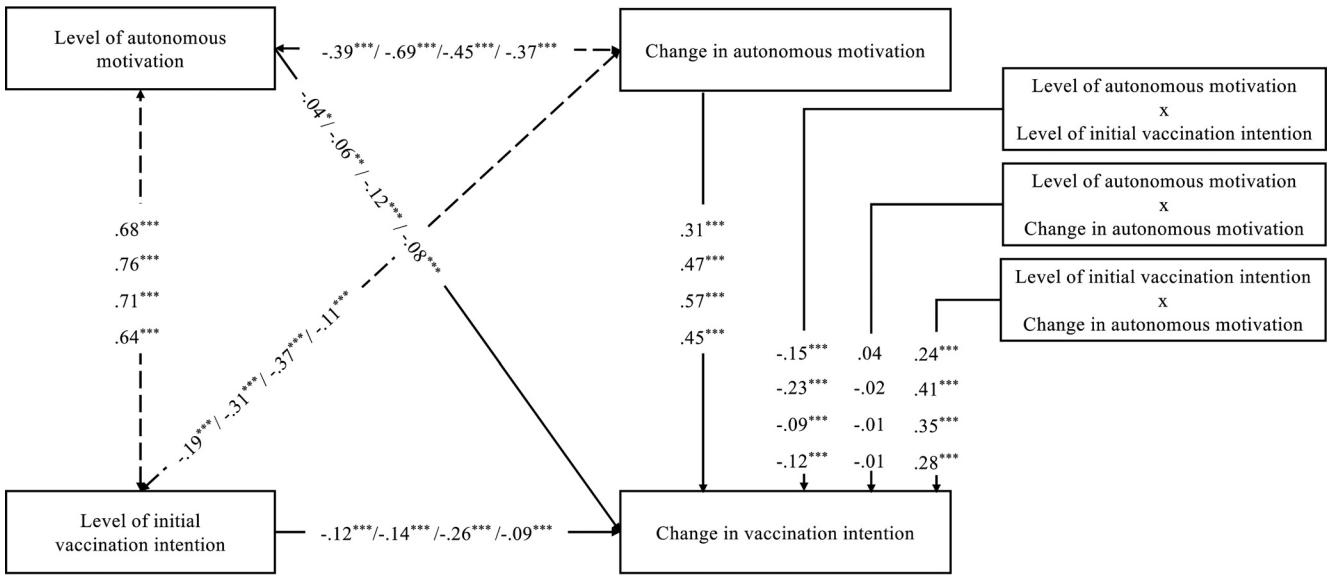
Figure 2 displays the results for controlled motivation. In contrast with the results obtained for autonomous motivation, initial levels of controlled motivation and initial vaccination intention were associated negatively, suggesting that people scoring high on controlled motivation have a lower initial vaccination intention. After controlling for the association between level and change in the assessed constructs, the change in controlled motivation related negatively to a change in vaccination intention, suggesting that participants becoming increasingly controlled motivated across time show a decrease in vaccination intention across time. Further, controlled motivation at baseline did not predict change in vaccination intention or vice versa. The findings for distrust-based amotivation in Figure 3 are analogous to those observed for controlled motivation: distrust-based amotivation and vaccination intentions were negatively related both in terms of initial levels and in terms of change across time.

Interactions Among Initial Levels and Rates of Change

The coefficients of the interaction effects in Figure 1 indicate that initial vaccination intention was a significant moderator of the effects of level and change in autonomous motivation in all four sets of analyses. First, as is shown in Figure 4a, a change in autonomous motivation contributed more strongly to a change in vaccination intention among individuals having a low vaccination

Figure 1

Output of Latent Change Model and Latent Growth Curve Analyses for Autonomous Motivation Across Subsamples

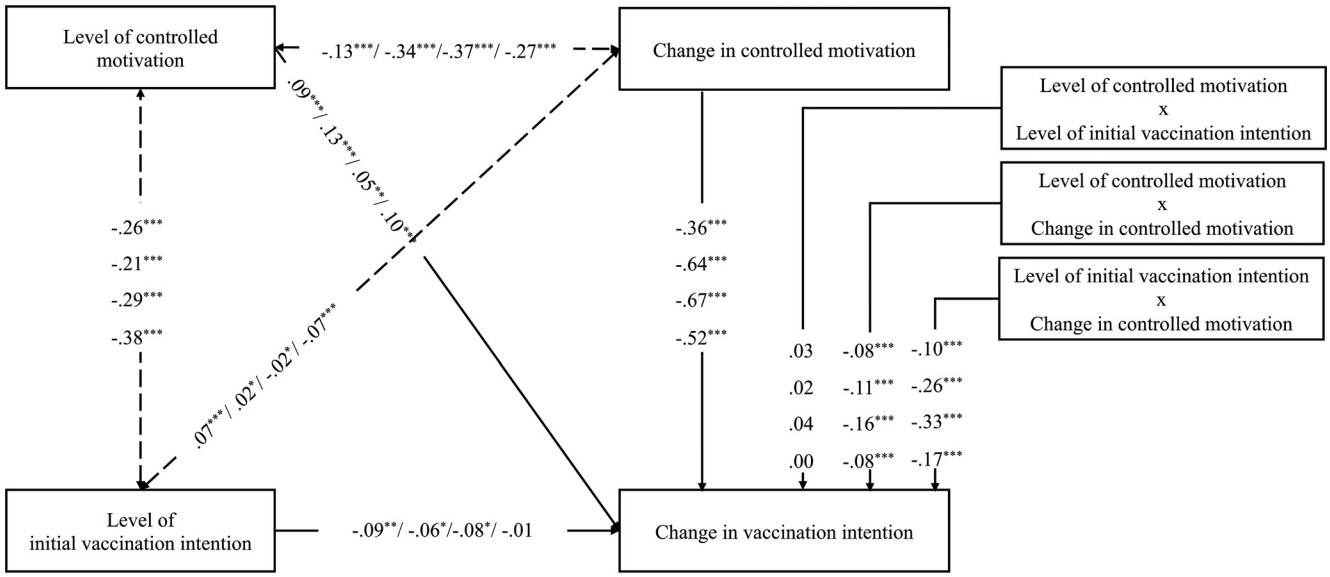


Time$_{1\text{-}2}$: $\chi^2(15) = 165.84$, $p < .001$; CFI = .99; RMSEA = .08; SRMR = .05
Time$_{1\text{-}3}$: $\chi^2(7) = 107.02$, $p < .001$; CFI = .98; RMSEA = .05; SRMR = .04
Time$_{1\text{-}4}$: $\chi^2(18) = 113.54$, $p < .001$; CFI = .98; RMSEA = .04; SRMR = .04
Time$_{1\text{-}5}$: $\chi^2(41) = 315.29$, $p < .001$; CFI = .98; RMSEA = .06; SRMR = .05

Note. Coefficients are standardized and fit indices are added. The four coefficients are presented in order of the subsamples with the first coefficients referring to Subsample 1, the second to Subsample 2, the third to Subsample 3, and the fourth to Subsample 4.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 2

Output of Latent Change Model and Latent Growth Curve Analyses for Controlled Motivation Across Subsamples



Time$_{1\text{-}2}$: $\chi^2(15) = 429.39$, $p < .001$; CFI = .86; RMSEA = .11; SRMR = .07
Time$_{1\text{-}3}$: $\chi^2(7) = 91.23$, $p < .001$; CFI = .96; RMSEA = .05; SRMR = .04
Time$_{1\text{-}4}$: $\chi^2(22) = 59.33$, $p < .001$; CFI = .98; RMSEA = .03; SRMR = .04
Time$_{1\text{-}5}$: $\chi^2(41) = 157.24$, $p < .001$; CFI = .98; RMSEA = .04; SRMR = .06

Note. Coefficients are standardized and fit indices are added. The four coefficients are presented in order of the subsamples with the first coefficients referring to Subsample 1, the second to Subsample 2, the third to Subsample 3, and the fourth to Subsample 4.
* $p < .05$. ** $p < .01$. *** $p < .001$.

intention at baseline. Presumably, individuals low in initial vaccination intention had the most room for the benefits of autonomous motivation to manifest. Second, Figure 4b indicates that the negative association between one's initial level of autonomous motivation and one's change in vaccination intention was particularly strong among those who report a higher initial vaccination intention.

A number of interaction effects also emerged in the analyses involving controlled motivation. As is shown in Figure 2, the negative associations between changes in controlled motivation and changes in vaccination intention across time were moderated by (a) initial vaccination intention and (b) participants' initial levels of controlled motivation. An increase in controlled motivation yielded especially a decrease in vaccination intention among individuals high in initial vaccination intentions, whereas those low in initial vaccination intentions at baseline were less strongly negatively affected by controlled motivation (Figure 5a). Further, a change in controlled motivation yielded a somewhat less pronounced negative effect on individuals' change in vaccination intention among those were more highly controlled motivated to begin with (Figure 5b).

The observed interaction pattern for distrust-based amotivation was similar to the one observed for controlled motivation. An increase in distrust-based amotivation was more strongly associated with a decrease in vaccination intention among those having a high vaccination intention at baseline (Figure S3a) and those initially scoring low on distrust-based amotivation (Figure S3b).

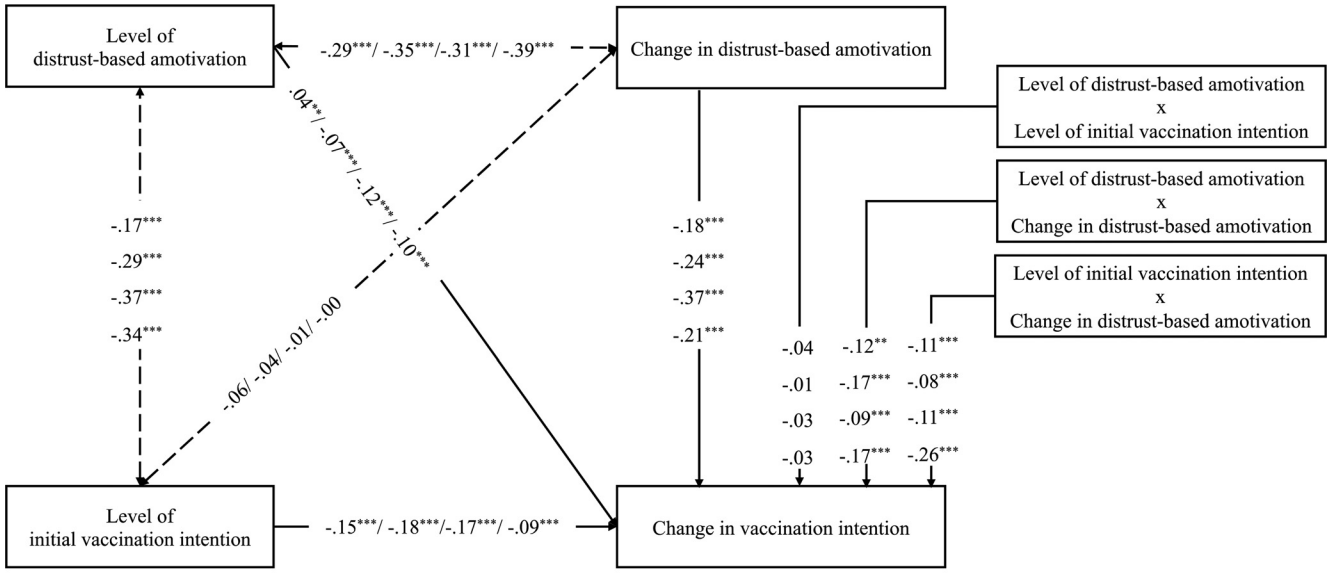
General Discussion

Although vaccines against COVID-19 have been developed with an unprecedented speed, large-scale vaccination rollouts worldwide not only faced practical obstacles but also the psychological challenge to increase vaccine acceptance as much as possible. Previous research (e.g., Schmitz et al., 2022) has shown that the type of motivation is related to both individuals' intention and effective vaccine uptake, with autonomous motivation relating positively to these outcomes and with both controlled motivation and distrust-based amotivation yielding a negative relation. Yet, what is missing from previous work in this area, is a more fine-grained, dynamic, and longitudinal perspective on the relation between motivation and vaccination intention. Using five waves of data collected across 7 months of the vaccination rollout in Belgium, the present study allowed us to provide unique insight in the changes in vaccination intention over time and to examine whether people's change in vaccination intention can be predicted by changes in vaccination motivation.

At a descriptive level, we observed a generally positive trend in vaccination intention and uptake across time, with most of the participants shifting toward (total) acceptance or vaccination uptake across time. The steep increase in vaccination uptake from Wave 3 (April 2021) to Wave 4 (May 2021) can in part be explained by the fact that the vaccine became more widely available by that time. Whereas most of the hesitating participants evolved toward more positive intentions across time, those totally refusing the vaccine remained relatively more stable across time. Apparently,

Figure 3

Output of Latent Change Model and Latent Growth Curve Analyses for Distrust-Based Amotivation Across Subsamples



Time$_{1\text{-}2}$: $\chi^2(15) = 96.13$, $p < .001$; CFI = .91; RMSEA = .09; SRMR = .06
Time$_{1\text{-}3}$: $\chi^2(7) = 170.56$, $p < .001$; CFI = .93; RMSEA = .07; SRMR = .05
Time$_{1\text{-}4}$: $\chi^2(22) = 172.08$, $p < .001$; CFI = .94; RMSEA = .05; SRMR = .07
Time$_{1\text{-}5}$: $\chi^2(41) = 241.87$, $p < .001$; CFI = .98; RMSEA = .05; SRMR = .05

Note. Coefficients are standardized and fit indices are added. The four coefficients are presented in order of the subsamples with the first coefficients referring to Subsample 1, the second to Subsample 2, the third to Subsample 3, and the fourth to Subsample 4.
** $p < .01$. *** $p < .001$.

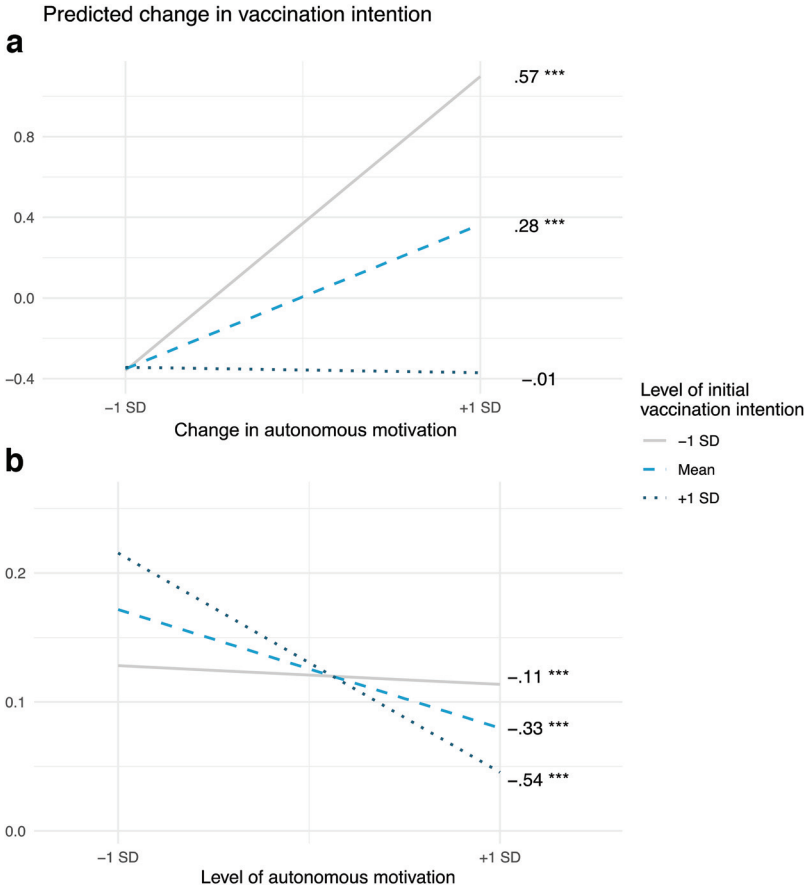
people with an initially more extreme (negative) attitude toward the vaccine seem to be more resistant to change, an effect that could possibly be explained through processes of psychological reactance and the rigidity accompanying such reactance (Van Petegem et al., 2015). Similar findings have been obtained in research on individuals' political (e.g., Fridman et al., 2021) and religious (e.g., Sarnoto & Hayatina, 2021) attitudes toward vaccination. Importantly, even among people with an initially very low intention for vaccination, there was room for change. This observation raised the question whether a motivational shift relates to a change in vaccination intentions, even among people with initially low intentions.

To examine the role of motivational changes in the development of vaccination intentions, a series of structural models was estimated through LCM and LGCM analyses. As expected, we found that when participants displayed an increase in autonomous motivation over time, they manifested a positive change in vaccination intention across time. In contrast, increases in controlled motivation and distrust-based amotivation were related to decreases in vaccination intentions. Consistent with SDT, people become more inclined to accept the vaccine if they increasingly see the personal relevance of the vaccine (e.g., for their own health) and perhaps even conceive vaccination as being in harmony with broader prosocial values (e.g., the protection of others, i.e., autonomous motivation). In contrast, people who feel increasingly pressured to take the vaccine or who develop a sense of distrust toward the vaccine display substantial reductions in vaccination intentions.

Although the main effect of change in autonomous motivation was positive, an important question is whether the benefits of autonomous motivation apply also to people with initially low vaccination intentions. Interestingly, the moderation analyses revealed that the facilitating role of increasing autonomous motivation was even more pronounced for those expressing lower vaccination intentions at baseline. Apparently then, people with initially low vaccination intentions are not "lost causes". In fact, they have most room for change, and a positive motivational shift seems to make a stronger difference for them compared with people with initially more favorable attitudes toward the vaccine. Conversely, the detrimental effects of changes in controlled motivation and distrust-based amotivation were most pronounced among those having already an initial more favorable attitude toward vaccination. Presumably, the ownership to take a well-informed decision is more easily threatened by increasing controlled motivation among individuals who initially lean toward vaccination. That is, the encountered pressure may interfere with their rhythm to come to a self-endorsed decision and may even elicit reactance as it the additional push is perceived as unneeded or even intrusive. This nuanced pattern of interaction findings indicates that different types of motivation play a somewhat more prominent role for some groups of individuals than for others. These findings underscore our decision to treat these motivational subtypes separately instead of creating a composite score, which involves weighting the subtypes according to their position on the self-determination continuum (e.g., the relative autonomy index).

Figure 4

Significant Interaction Effects Among Level of Initial Vaccination Intention and Change in Autonomous Motivation and Level of Autonomous Motivation in the Prediction of Change in Vaccination Intention



*** $p < .001$.

Practical Implications

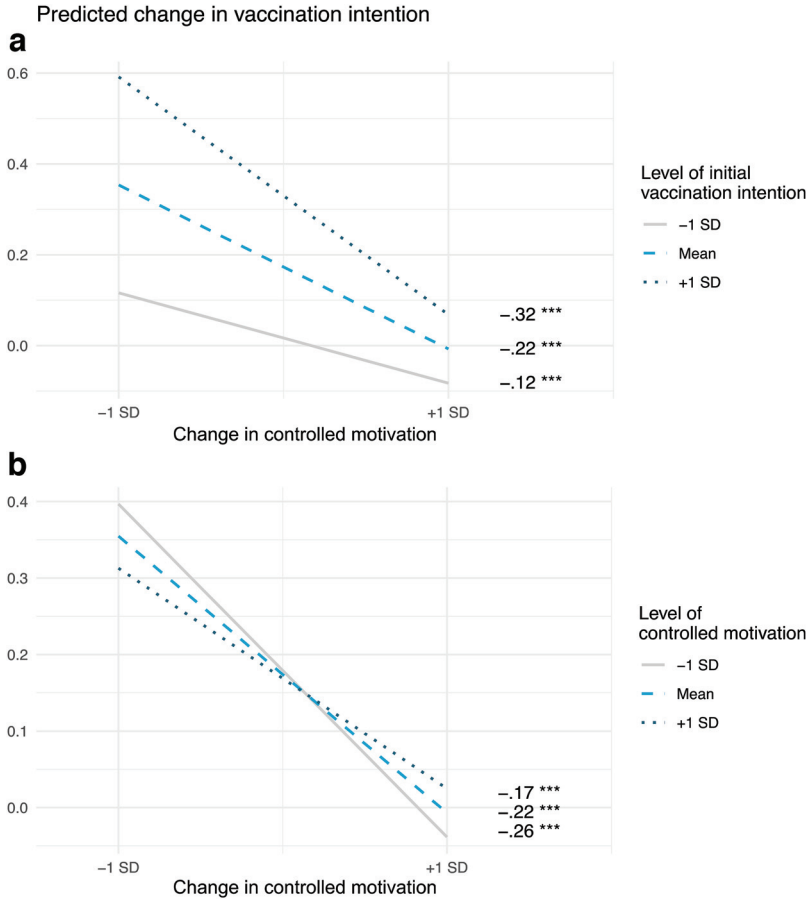
Although the present findings are correlational and do not allow us to draw causal conclusions about the direction of effects, they are important in two major ways. First, they show that policymakers do well to support citizens' autonomous motivation. To the extent that citizens develop greater autonomous motivation, they report a parallel positive change in vaccination intention, a finding that was even observed for those who initially totally refused the vaccine. Second, to the extent that citizens feel increasingly more seduced or manipulated into vaccination, they report a negative shift in vaccination intention over time, especially if they expressed already initial positive intentions. Yet, in many countries worldwide, a variety of rather controlling strategies have been used (e.g., using vouchers, shaming, guilt-induction; Holt, 2021). The current findings support the importance of use of an autonomy-supportive approach, where policymakers have a good insight into the multiple obstacles for vaccination, acknowledge the resistance of unvaccinated individuals and follow the rhythm of unvaccinated persons to form their own opinion and decision (e.g., Vansteenkiste & Sheldon, 2006). Also, health care professionals could be trained to provide targeted information to people's questions and concerns about the vaccine in an autonomy-supportive way (Gagneur et al., 2018; Martela et al., 2021). Rather than offering information and help in a mechanical and standardized way, a tailored approach is suggested to promote an autonomous or self-endorsed decision to get vaccinated.

Limitations

One limitation is that our sample is self-selected and not representative of the Belgian population. The current sample comprised a large proportion of female, older, and higher educated participants. The longitudinal sample was even more self-selective, as participants with higher initial vaccination intentions had a greater likelihood of continuing their participation. Such self-selection raises questions about the generalizability of our findings. A second limitation is that we did not address all potential factors that may predict people's vaccination intention. For instance, at the beginning of the data collection period, vaccines were only available to a limited part of the population (e.g., health sector, elderly people). Further, regional differences in the vaccination rollout or

Figure 5

Significant Interaction Effects Among Change in Controlled Motivation and Level of Initial Vaccination Intention and Level of Controlled Motivation in the Prediction of Changes in Vaccination Intention



*** $p < .001$.

medical reasons of individuals may also have impacted the probability of vaccination. To demonstrate the unique role of motivation, it would have been advisable to control for factors like people's political orientation (e.g., Fridman et al., 2021), professional health care status (e.g., Al-Amer et al., 2022) or religion (e.g., Sarnoto & Hayatina, 2021). Third, as noted, the correlational nature of the study prevents us from drawing causal conclusions. Possibly, alternative analyses, like the random-intercept cross-lagged panel model, would have shed light on the direction of effects. Finally, as getting vaccinated does not involve a single decision, but a sequence of decisions (e.g., a booster dose) it would have been advisable to follow participants over longer periods of time to examine whether motivational differences do matter beyond the initial decision to accept a vaccine.

Conclusion

With a nationwide vaccination rollout as an important way to control the pandemic, many countries faced the psychological challenge of motivating people to get the vaccine. Based on a unique longitudinal dataset collected during the vaccination rollout in Belgium, our findings showed an increase in the willingness toward vaccination across time. Most importantly, we showed that an increase in autonomous motivation to become vaccinated is a strong and positive predictor of greater acceptance of the vaccine across time specifically among people with low initial vaccination intentions. From a societal point of view, the current findings emphasize the need for strategies enhancing people's autonomous motivation rather than using coercive methods, even and perhaps especially for those initially hesitating or refusing the vaccine.

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Received December 23, 2021
Revision received June 22, 2022
Accepted June 28, 2022 ■