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# Do Optimism and Moralization Predict Vaccination? A 5-Wave Longitudinal Study

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This study is part of a larger longitudinal project. The questionnaires for waves 1-3 are on Open Science Framework: https://osf.io/2eb65/; https://osf.io/967vm/; https://osf.io/tqngd/ (After the initial waves, no changes were made to the materials). The data and syntaxes are during the review procedure accessible at https://osf.io/cgmnd/?view_only=e25ddae24da24f32a5638951df35205ehttps://osf.io/cgmnd/?view_only=e25ddae24da24f32a5638951df35205e, but will after acceptance be made public through the repository of KU Leuven. The research in this paper was supported by FWO-Grant G0G6620N, awarded to the last four authors and Eliane Deschrijver (UGent & UNSW). We have no known conflicts of interest to disclose. We warmly thank Roel Vercammen, Gunther Ackermans, and Lander Van den Eynde for their help in the organization of the data collection.

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**Abstract**

**Objective:** To examine if personal and comparative optimism, perceived effectiveness, and moralization of vaccination predicts people's decision to get vaccinated.

**Methods:** We measured self-reported vaccination decisions in a 5-wave longitudinal study (N ≈ 5000/wave) in Belgium over a six months period (December 2020-May 2021) during the COVID-19 pandemic. Among the predictors were demographic factors, personal and comparative optimism for three aspects of COVID-19 (infection, severe disease, good outcome), perceived effectiveness of vaccination, and the extent to which vaccination is being viewed upon in prosocial terms (altruism, civic spirit) versus as instrumental in one's self-interest (common sense, concern about one's health).

**Results:** The actual availability of vaccines changed people's outlook on vaccination. Marked differences emerged in vaccination decision between linguistic-cultural regions (Flemish Region, Walloon Region, Brussels Capital Region). Personal and comparative optimism predicted vaccination decisions to different extents depending on participants' age and on whether the optimism was for infection, severe disease, or a good outcome. In older participants, vaccination decision was mostly predicted by personal optimism; in younger participants it was mostly predicted by comparative optimism. Moralizing vaccination predicted a *lower* likelihood of a positive vaccination decision, that is, higher vaccine hesitancy or refusal, particularly in older participants.

**Conclusions:** Assessments of risk perception serving to inform vaccination campaigns should differentiate between expectations concerning the risk of infection and expectations concerning the outcome of an infection. Public health messages should address comparative optimism, particularly when targeting younger populations. Contrary to popular belief, moralizing vaccination may reduce the willingness to get vaccinated.

*Keywords*: Vaccination Attitudes; Optimism; Moralization; Social Perception; Age Differences

**Do Optimism and Moralization Predict Vaccination? A 5-Wave Longitudinal Study**

During the global outbreak of COVID-19, behavioral precautions (travel restrictions, social distancing) have entailed great economic and social costs. Vaccination has thus become the main strategy to reduce the number of infections and mitigate their consequences. As of mid-October 2022, over 12.8 billion vaccine doses had been administered worldwide (ourworldindata.org/covid-vaccinations).

However, even in countries where vaccines are widely available, reaching the vaccination level needed to achieve herd immunity has proven a challenge (e.g., Giurgea & Morens, 2022). Vaccination hesitancy and refusal markedly differ between demographic groups (Murphy et al., 2021) and are due, among other variables, to mistrust of benefits, worries about side-effects, and belief in conspiracy theories (Truong et al., 2022). We here use the term 'vaccination intention' to denote the continuum from vaccination eagerness to straight vaccination refusal.

Common-sense and theories of health behavior state that people's intention to get vaccinated against a disease depends on the perceived risk of the disease and the protection that vaccination is believed to provide (An et al., 2021). Higher expectations concerning the extent to which vaccination mitigates symptoms of COVID-19 as well as the extent to which they curb the virus transmission are associated with greater vaccination readiness (Korn et al., 2021). However, public health communication often rests upon the assumption that more people will intend to get vaccinated if they think of vaccination in terms of prosocial morality as well as in terms of self-interest.

We therefore examined to what extent risk perception and moralization vs. perceived effectiveness of vaccination predicted vaccination intention. More specifically, we examined the role of optimism concerning the risk of COVID-19, as a factor likely to reduce vaccination intention, and of moralization, as a factor about whose influence mixed evidence exists. To better understand any moralization effect that we might find we also examined the perceived effectiveness of vaccination to curb the transmission of the disease. We did so in longitudinal study that allowed us to examine how these variables predict vaccination intention, and how *changes* in them predict (change in)

vaccination intention. Our study was based on a large, nationally representative sample, which allowed us to examine how demographics interacted with psychological variables.

**Personal and Comparative Optimism**

Perceptions of the likelihood of getting a disease and of its severity are critical determinants of vaccination intention (e.g., Brewer et al., 2007). This is also true for vaccination against COVID-19 (e.g., Caserotti et al., 2021). Thus, informing citizens on the risks of COVID-19 contamination may seem sufficient to persuade most people to get vaccinated.

However, people do not always feel that public health information is personally relevant to them (e.g., Kreuter & Wray, 2003). One reason for this is comparative optimism, the belief that positive events are more likely and that negative events are less likely *to happen to oneself than to others* (e.g., Shepperd et al., 2013). It is distinct from personal optimism, the belief that positive events are likely or that negative events are unlikely. If most members of a group believe that their future will be better than average, some members must be mistaken (unless in very skewed distributions). Thus, the general occurrence of comparative optimism is labelled 'unrealistic optimism'. Unrealistic optimism occurs for many health-related issues (e.g., Weinstein, 1983), including COVID-19, but more so for the likelihood of getting infected and infecting others than of getting severely ill (e.g., Asimakopoulou et al., 2020; Kuper-Smith et al., 2021). The reason is that unrealistic optimism is greater for events that seem under one's control; people perceive more control over infection with COVID-19 than over its severity (e.g., Asimakopoulou et al., 2020; Hoorens et al., 2022).

Comparative optimism has implications for public health communication. Messages that target a social group (or society as a whole), seem relevant for other group members, rather than for the self. For diseases other than COVID-19, comparative optimism predicts lower interest in public health information (e.g., Taber et al., 2015) and lower vaccination intention (Brewer et al., 2007).

**Vaccination as a moral act**

Authorities have advocated vaccination by emphasizing its value for protecting more vulnerable citizens (e.g., Maeckelberghe, 2021). This strategy hinges on the assumption that prosocial moral

values are potent motivators (Pfattheicher et al., 2022). Examining the validity of this assumption is important for two reasons.

First, moral appeals come with downsides. They enhance the persuasiveness of messages among individuals who view an issue in moral terms (Luttrell & Petty, 2021), but reduce it among those who do not (Luttrell et al., 2019). They even backfire when they make members of low-risk groups acutely aware of the asymmetric distribution of risks and benefits of vaccination (Wells et al., 2020). Finally, reports about the societal costs of vaccination refusal may induce guilt, and thus create psychological threat for people who are still hesitant to get vaccinated. Threat entails avoidance, and may thus eradicate whatever vaccination readiness was left (e.g., Graton & Mailliez, 2019).

Second, of all the moral motives that people may have, prosocial motives are the most cross-culturally general (e.g., AlSheddi et al., 2020). Yet, the evidence for their role in vaccination decisions is mixed (e.g., Böhm & Betsch, 2022). Motives related to the values of purity and liberty have consistently been shown to be associated with greater vaccination hesitancy (Amin et al., 2017). In contrast, prosocial motives have in some studies positively predicted vaccination intention (e.g., Li et al., 2016) but were in other studies outweighed by self-interest (Wells et al., 2020). We believe that this inconsistency is partly due to methodological limitations. Most studies have directly asked people about their motives, but self-reports of prosocial motives are vulnerable to social desirability (Hornsey et al., 2018; Murphy et al., 2021). We therefore decided to examine the role of prosocial morality while minimizing potential distortions due to social desirability.

**Socio-demographic and cultural-regional factors**

Authorities have sometimes used a ‘one size fits all’ approach to promote vaccination (e.g., Raz et al., 2021). However, a differentiated approach is needed if determinants of vaccination intention differ between groups. Age and gender are the most obvious sociodemographic predictors. Because COVID-19 symptoms are generally worse in older people and in men, one might expect that self-protection is more important for them. However, comparative optimism concerning the likelihood of infection seems greater in men than in women (Dolinski et al., 2020; Smith et al., 2021) and in older

than in younger people (Druică et al., 2020; Smith et al., 2021). Thus, it is important to examine how age and gender interact with the psychological variables of interest.

Moreover, the absence of cultural and regional differences in people's outlook on COVID-19 should not be taken for granted. Our research took place in Belgium, a densely populated small country (11.5 million on under 31 square kilometers) with three linguistic communities: a Dutch speaking one in the North (Flemish Region; 'Flanders' for short), a French speaking one in the South (Walloon Region; 'Wallonia'), and a German speaking one in the East (geographically in Wallonia). Besides the Flemish and Walloon Regions, there is the Brussels Capital Region ('Brussels' for short) The country is highly segregated, e.g., inhabitants rarely consume media of other linguistic groups. Its three regions differ in political, cultural, and social respects, and in health policies and behaviors – including concerning vaccination. In 2018, for example, HPV-vaccination reached a coverage of 91% via the Dutch-speaking school system and 36% via the French-speaking school system despite vaccination being free everywhere (Tjalma et al., 2018). The Belgian situation thus offers a unique opportunity to study intergroup differences in predictors of vaccination intention.

### The present research

We tested the hypothesis that comparative and personal optimism concerning COVID-19 predict lower vaccination intention. Earlier findings and theoretical considerations regarding the effects of moralization point in opposite directions; thus, we did not a priori have hypotheses about it. Finally, we examined age, gender, and regional differences in optimism and moralization and their interaction with comparative optimism and moralization.

## Method

### Transparency and Openness

The research was part of a longitudinal study on COVID-19-related beliefs, vaccination readiness, and behavioral precautions. We here describe the variables that were included in the present study. All measures in the questionnaire, including those not included here, are on OSF (see Author Note), as are the data and syntaxes. We report how we determined our sample size and all data exclusions.

**Participants**

Participants were adult members (18+) of the Belgian online panel of a European market research and polling agency (iVox). They were invited to participate through a link in their account, to achieve a stratified sample ($N \geq 5000$) that was representative for Belgium on age, gender, region, and education. To be included in a wave, invited participants had to give informed consent and give likelihood estimates for at least one infection-related and one outcome-related event, plus ratings of their general adherence to behavioral precautions and the impact of these precautions and of at least one COVID-19-related event. From Wave 2 on, they were invited one month after having given informed consent for a previous wave. To compensate for attrition, new participants were invited until at least 5000 had given informed consent.

Table 1 shows key demographical characteristics (see also Table S1 in Supplemental Materials). As compared to the general population (% between brackets from statbel.fgov.be), our sample was highly educated (32.9%). We categorized participants into 6 age groups, consistent with those in earlier research (e.g., Murphy et al., 2021). Some age groups were overrepresented (45-54: 17.4%) or underrepresented (65+: 24.6%) by more than 1-2%. The sample was generally representative on gender (50.9% women) and region (Flanders 57.7%; Wallonia 31.6%; Brussels 10.5%).

----------Table 1 here----------

**Material**

Participants filled out an online questionnaire, developed by us in Dutch and professionally translated into French, through the online platform Qualtrics (in a single session per wave). To minimize the burden on them we used the demographical information that they had given to subscribe to the panel (i.e., we did not repeatedly ask all demographics during the various waves).

***Vaccination status and intention***

While the study was being prepared, it was unclear when exactly vaccines would become available in Belgium and what the vaccination strategy would be, including the order in which various groups would get the opportunity to get vaccinated and to what extent citizens would be given a

choice to advance or delay their vaccination. To maximally capture various outlooks on vaccination, we asked about participants' intention (for when vaccines became available) by requesting them to pick one of four responses: "Try to get the vaccine as soon as possible", "Get vaccinated, but without any haste", "Wait until there is a lot of experience with it before possibly getting vaccinated", or "Certainly not get vaccinated". The first two options were considered to reflect degrees of a positive vaccination intention, whereas the last two options reflected degrees of a negative intention as these involved at least an active attempt to postpone vaccination.

Vaccines became available in Belgium towards the end of Wave 1. From Wave 2 on, we asked if participants had been vaccinated: "No, I haven't been offered that yet", "No, I was offered that, but I have not made use of it", or "Yes." Only those who did not pick "yes" saw the question about vaccination intention (slightly reworded as vaccination was no longer hypothetical). While vaccination was voluntary, the vaccination campaign involved strictly implemented priority rules based on age, health status, and profession. Because there was no legal leeway to speed one's vaccination up, the distinction between getting vaccinated 'as soon as possible' and 'without any haste' became irrelevant. It was unclear if citizens who had initially refused would get another vaccination opportunity during the ongoing outbreak. The distinction between "Wait until there is a lot of experience with it before possibly getting vaccinated", or "Certainly not get vaccinated" thus also lost relevance. However, we decided to keep the four answer options to ensure comparability across waves and to anticipate on potential policy changes (see Table S2 in Supplemental Materials).Finally, the increasing proportion of vaccinated participants created a dilemma for the data analysis. One option, considering non-vaccinated participants only, would have made the samples in the waves incomparable due to a decreasing proportion of participants from priority groups and an increasing proportion of vaccine refusers among the remaining participants from these groups. We thus chose the other option of including all participants. That required an index for vaccination readiness, which would be applicable to the whole sample. We therefore created a binary variable, which we called *Vaccination decision*. Its value was positive if a participant was *or*

would get vaccinated as soon as possible or without any haste and negative if a participant was not vaccinated *and* intended to delay or refuse vaccination. Combining actual and intended vaccination was warranted because, in the case of COVID-19, vaccination intention is an excellent predictor of vaccine uptake (Griffin et al., 2022; Wang et al., 2022).

***Comparative and Personal Optimism***

Participants estimated the likelihood that six events would in the next three months happen to them and to the average person of their age and gender, by moving a slider from 0% (will certainly not happen) to 100% (will certainly happen). First, infection-related events (getting infected or re-infected, infecting others) appeared in random order. Next came items about severe disease (being admitted to hospital, and to an intensive care unit), and good outcomes (having few symptoms, fully recovering), all in random order. Self-estimates for all events were given before other-estimates (i.e., estimates for the average other).

We calculated *comparative optimism scores* per event, with positive scores denoting comparative optimism. For infection and severe disease, we took other-minus-self; for good outcome self-minus-other. By averaging scores over type of event, we calculated three scores per participant per wave: for infection (Cronbach's $\alpha$ = .72), severe disease (Cronbach's $\alpha$ = .79), and good outcome (Cronbach's $\alpha$=0.37). We also calculated *personal optimism scores* for the three types of events (infection, severe disease, good outcome), with higher scores denoting more optimism. For good outcome, they were average self-ratings. For infection and severe disease, they were 100 - average self-rating. Personal optimism was thus the complement of perceived risk, but we use the optimism framing to facilitate the comparison between comparative and personal optimism.

***Vaccination Moralization and Effectiveness***

From Wave 2 on, we asked to what extent getting vaccinated against COVID-19 was indicative of two prosocial moral motives (altruism, civic spirit) and two instrumental ones (common sense, care for one's own health). Participants answered on a 4-point scale from 0 (*Not at all*) to 3 (*To a large extent*). We created a *moralization index* by subtracting the average rating for instrumental motives

from the average rating for the prosocial motives; thus, positive scores denoted greater moralization.

We also asked participants how effectively vaccination helped to contain the spread of the coronavirus. They answered by moving a slider on a scale from 0 (*Not at all*) to 4 (*To a very large extent*). We asked about effectiveness for curbing the spread of infections rather than for mitigating symptoms because any moral motive to get vaccinated would involve protecting others by containing the spread of the virus rather than mitigating one's own symptoms.

**Procedure**

We informed prospective participants about the five waves. For ethical reasons, we stressed that responses were useful regardless of participation in earlier waves and that participation did not imply any obligation to participate in later ones. Those individuals who actively gave informed consent got access to the survey. The informed consent procedure and the debriefing informed readers about available support lines and the necessity to call a physician should they experience symptoms. The research was ethically and legally approved by the Social and Societal Ethical Committee (SMEC) and the Privacy / Data Protection Officer of KU Leuven (application G-2020-2626/2626R4).

**Statistical Analysis**

We analyzed the data in SAS Version 9.4. Missing values were imputed 10 times, assuming missingness at random (Rubin, 1976); estimates were computed using Rubin's rules (Rubin, 1978).

To explore vaccination decision we built generalized linear models of vaccination decision per region (see below). More specifically, we modelled the evolution of vaccination decision with generalized estimating equations (GEE) for clustering due to repeated measurements on the same participants (Molenberghs & Verbeke, 2005). We calculated Type III tests of fixed effects obtained from GEE after multiple imputation via the method of Li et al. (1991). The initial models included wave, gender, age, educational level, household size, and urbanisation, the interactions of age with gender and wave with the other predictors, plus the interaction of wave, age, and gender. In the fixed-effects structure, wave was a categorical predictor. The variable 'age' always refers to the six age groups. We performed stepwise variable reduction based on type III tests of fixed effects.

We also built mixed models to identify the demographic variables that predicted comparative and personal optimism, perceived effectiveness, and moralization of vaccination. The initial models were identical to those for vaccination decision, except that the interactions of all effects with region were included. Hence, this comprehensive model allowed each (interaction) effect to differ across regions. We again performed stepwise variable reduction based on type III tests of the fixed effects on the pooled data of the three regions. We then fitted the final model on each region separately. Note that mixed models are a special case of structural equation models (SEM); the random effects in the mixed model correspond to the latent variables in the SEM approach.

We built joint mixed models (Molenberghs & Verbeke, 2005) to examine how comparative and personal optimism were related to vaccination decision. Having repeatedly measured the variables within participants (in all waves), we included random effects at the individual level. The variance and correlation structures of the optimism scores were not constant; we thus included random slopes in addition to random intercepts. In this class of models, random effects in the model of an outcome variable (here: vaccination decision) are allowed to be correlated to random effects in the model of a given predictor variable, to allow both processes to be associated. Because the association between vaccination decision and the predictor variables was likely to depend on participant age, the correlation between the random effects was also allowed to vary with age. More specifically, we assumed the Fisher Z transformation of the correlation to be the linear function $\alpha+\beta*age$. We used *F*-tests to test overall associations between optimism and vaccination decision. We also used *F*-tests to examine if changes in optimism relative to the predicted evolution based on solely the wave were associated with vaccination decision.

The joint model that tested associations between perceived effectiveness and moralization of vaccination as predictor variables (measured from Wave 2 on) and vaccination decision as the outcome variable was like the joint model of optimism and vaccination decision, except that we did not test associations between *changes* in perceived effectiveness and moralization on the one hand and vaccination decision on the other hand. For effectiveness, this was because of a ceiling effect.

For moralization, it was because of the ratings' stability. We used *F*-tests to test associations.

The reported analyses are on all participants; for a sensitivity analysis on only those participants who were in the study from Wave 1 on, please see Appendix 6 (Supplemental Materials).

## Results

The means and tests for moralization and perceived effectiveness (Table S3) and unrealistic optimism (Table S4) appear in the Supplemental Materials. We found unrealistic optimism for infection and severe disease, but not for a good outcome. Participants generally viewed vaccination as highly effective and as instrumental for one's self-interest rather than something moral.

Of the tested models we here describe general trends. For the variable 'age', we zoom in on the age groups where changes occurred (for parameter estimates and other statistical information concerning tests of the effects, see Supplemental Materials, Appendix 1: vaccination decision, Appendix 2: optimism, Appendix 3: effectiveness and moralization, Appendix 4: joint model).

### Vaccination decision

In the Figures showing vaccination decision, variables not involved in the depicted effect were set to the values of the largest group, that is, 'female', 'no higher education, '45-54 years', and 'small municipality' (statistics in Appendix 4). Figure 1 shows vaccination intentions per region after multiple imputation. In Wave 1, the estimated probability of a positive vaccination decision was higher in Brussels and Wallonia than in Flanders. Between Waves 1 and 2, it increased in Flanders. In Brussels, it increased in men of all age groups and women of 45 years up only. In Wallonia, it increased in men and women of 45 years up, did not change in men under 45, and decreased in women under 45. Given these dissimilar patterns, we conducted further analyses per region.

----------Figure 1 here----------

In all regions, wave, age, and interactions of wave with age and wave with gender predicted vaccination decision. In Wallonia and Flanders, gender, education, and the interaction of wave with education also predicted vaccination decision. In Wave 1, the probability of a positive vaccination decision was higher in women than in men, but from Wave 2 on it was higher in men (Figure 2).

----------Figure 2 here----------

In Wave 1, the probability of a positive vaccination decision was higher in the age groups under 55, but from Wave 2 on it was higher in people of 55 years up (Figure 3).

----------Figure 3 here----------

In Wallonia and Flanders, the evolution of vaccination decision also depended on educational level (Appendix 1). In Wave 1, having a higher education predicted a lower probability of a positive vaccination decision, but from Wave 2 on it predicted a higher probability.

**Optimism**

Table 2 shows *p*-values of type III tests of significant fixed effects in the models of optimism (see also Appendix 2). Personal optimism increased over Waves 1-3 but dropped in Wave 4 and increased again in Wave 5. Men in all regions were more comparatively optimistic than women concerning a good outcome, and men in Flanders and Wallonia were also more personally optimistic about it. In Flanders alone, men were also more comparatively and personally optimistic concerning infection.

Participants in older age groups tended to be more personally optimistic for infection than participants in younger age groups. Participants in younger age groups were more personally optimistic for severe disease and a good outcome than those in older age groups, but participants in the oldest age groups were more comparatively for these aspects of COVID-19. Finally, highly educated participants were more personally optimistic for severe disease and good outcome. In Flanders, they were also more personally optimistic for infection and more comparatively optimistic for a good outcome.

----------Table 2 here----------

**Perceived effectiveness and moralization of vaccination**

The *p*-values of the type III tests of fixed effects are in Table 2 (see also Appendix 3). Participants generally perceived vaccination as effective. Perceived effectiveness increased over waves. Participants in older age groups and highly educated participants found vaccination more effective. Over the waves, and peaking in wave 4, participants increasingly saw vaccination as an act in one's

self-interest rather than as a moral act. Participants in younger age groups generally saw vaccination more in moral terms. In Flanders, women and participants without a higher education also saw vaccination somewhat more in moral terms.

**Association between optimism and vaccination decision**

Table 3 shows the results of the joint mixed models. By way of examples, we present estimated correlations at the arbitrarily chosen ages 30 and 60 years. In older age groups, more personal optimism for infection was associated with a higher probability of a positive vaccination decision, whereas more personal optimism for severe disease and a good outcome with a lower probability. In younger age groups, more comparative optimism for severe disease was associated with a lower probability, but more comparative optimism for a good outcome with a higher probability of a positive vaccination decision. Changes in optimism were also associated with vaccination decision. In younger age groups, increasing personal optimism for infection or severe disease was associated with a lower probability, but increasing personal optimism for a good outcome and increasing comparative optimism for infection or severe disease were associated with a higher probability of a positive vaccination decision. In older age groups, only increasing personal optimism for infection was associated with a lower probability of a positive vaccination decision.

----------Table 3 here----------

**Association between perceived effectiveness, moralization, and vaccination decision**

The results of the *F*-tests for the associations between perceived effectiveness and moralization of vaccination and vaccination decision appear in Table 3. The higher the perceived effectiveness of vaccination, the higher the probability of a positive vaccination decision was. Perceived effectiveness particularly predicted vaccination decision in the older age groups.

The more participants saw vaccination as something instrumental in one's self-interest rather than as something moral in the prosocial sense of the word, the more likely they were to get vaccinated; again, this was particularly true in older age groups. The older participants were, the more perceived effectiveness was associated with a positive vaccination decision.

## Discussion

In a five-wave longitudinal survey, we examined if psychological variables along with socio-demographic variables predicted vaccination intention against COVID-19. Two external events affected the study. One was the introduction of vaccines towards the end of Wave 1. The second involved rumors in French-speaking social media, just before Wave 2, about a presumed detrimental effect of vaccination on women's fertility and their unborn children. During Wave 3, authorities contradicted the rumors and emphasized the importance for pregnant women of getting vaccinated. As these events arguably had implications for our research, we discuss them first.

### Evolution of vaccination decisions as a function of socio-demographic and cultural variables

The increase (between Wave 1 and Wave 2) in the proportion of a positive vaccination decision in most groups of participants cannot be due to a different meaning of a positive decision in Wave 2 than in Wave 1. In the case of COVID-19, intended and actual vaccination are functionally equivalent (Griffin et al., 2022; Wang et al., 2022). Very few participants were vaccinated by wave 2. Thus, the most plausible explanation is that the availability of vaccines changed vaccination from a hypothetical possibility into a real prospect. The elimination of hypotheticality greatly reduces the psychological distance of an event, thus altering people's decisions (Trope & Liberman, 2010) to such an extent that preference reversals occur depending on choices being between hypothetical versus real option (Kühberger et al., 2002).

A remarkable exception to the increasing proportion of a positive vaccination decision from Wave 1 to Wave 2 involved the groups of women in the fertile age groups in Wallonia and Brussels. Deviating from the general pattern, they showed a decrease from Wave 1 to Wave 2 and later never fully caught up with the other groups. We suggest that the fake news about the effect of vaccination on female fertility in French-speaking media turned our study into a natural quasi-experiment on effects of rumors about vaccination side-effects. This fake news reached the French-speaking members of its target group (i.e. women of fertile age, living in Wallonia or Brussels) but not the Dutch-speaking ones (i.e. women of fertile age, living in Flanders). Thus, the rumors may have

discouraged the members of this subgroup to decide to get vaccinated. This interpretation is consistent with earlier findings on the role of rumors about side-effects in vaccination hesitancy (e.g., Pertwee et al., 2022) and with the observation that the effect of the fake news generalized somewhat to groups that shared characteristics with women in the younger age groups in Brussels and Wallonia: in these regions, men in the younger age groups showed either a small decrease in vaccination willingness, or they showed a smaller increase than men in the older age groups in their own region or men in the younger age groups in Flanders.

**Optimism, perceived effectiveness, and moralization**

The progress of the vaccination campaign, broadcasted daily, may have contributed to increasing personal optimism over the waves. The temporary drop in Wave 4 may be due to media coverage of the threat associated with the Delta variant and insecurity about the vaccines' efficacy against it.

The age differences in personal optimism seem to reflect general awareness of two highly publicized observations: that COVID-19 is generally more severe in older patients, and that the young people's lifestyles entail a relatively high risk of infection. However, these differences were offset by higher comparative optimism for infection in young people, and for outcomes of infection in older people. Another widely covered finding, that the illness is generally more severe in men, seems not to have come across. If anything, men were more optimistic than women. We thus extended earlier findings on gender differences (e.g, Dolinski et al., 2020; Smith et al., 2021) and age differences (e.g., Druică et al., 2020; Hoorens et al., 2022; Smith et al., 2021) in comparative optimism for COVID-19. We suggest that comparative optimism might to some extent be a psychological defense mechanism. Generally, the lower the personal optimism of participants of a given age concerning a given aspect of COVID-19, the more comparatively optimistic they were for that aspect. This interpretation is consistent with earlier evidence that increasing risk perception may go hand in hand with increasing comparative optimism (McColl et al., 2021).

Optimism predicted vaccination decision. Among participants in older age groups, it was personal optimism that best predicted vaccination decision; among participants in younger age groups, it was

comparative optimism. Particularly among participants in younger age groups, changes in optimism were also associated with vaccination decision. However, the direction in which optimism predicted vaccination decision was highly variable, even in age groups, and it depended on the aspect of COVID-19 on which the optimism bore. Thus, findings on comparative optimism and vaccination against more familiar diseases (cf. Brewer et al., 2007) may not readily be transferrable to COVID-19.

**Perceived Effectiveness and Moralization of Vaccination**

The finding that participants in older age groups perceived vaccination as more effective than participants in younger age groups was surprising. We did not ask how well vaccination protected the individual (where older people have more to gain) but how well it helped curbing the spread of the virus. Thus, older people seem more aware of the role of vaccination in virus containment.

The older participants were, the more they saw vaccination in terms of self-interest rather than prosocial morality. The more they saw vaccination in moral terms, the less they were willing to get vaccinated. This finding is important because health authorities have often assumed that framing the vaccination decision morally ("Do it for others") enhances vaccination readiness.

**Strengths**

Our longitudinal design allowed us to identify the direction of relationships rather than merely assessing associations between variables, like many cross-sectional surveys. We reached a large sample that was more representative for the general population in terms of critical demographic variables than studies using convenience samples or snowballing recruitment techniques could ever be. Moreover, our study began just before vaccines became available. We thus covered the critical time when vaccination shifted from a hypothetical option to a real prospect.

The validity of self-reports has been disputed. In the case of motives, asking why people act in certain manners may tap into social desirability or self-justification instead (Hornsey et al., 2018; Murphy et al., 2021). Our approach limited that by asking to what extent *several* valuable qualities could be inferred from the decision to get vaccinated. Thus, people could deny that vaccination had a moral motive without presenting themselves unfavorably or without feeling that they failed to justify

their behavior. Moreover, our measure tapped into the *relative* importance of morality, and thus provided a purer measure of moralization than measures based on ratings of moral motives only.

**Limitations**

We singled the factors that we studied out because methodologically strong research about them was called for, but acknowledge that vaccination behavior depends on other variables as well (e.g., Truong et al., 2022). Comorbidity is likely to be among them. We did not include it in our models because it was strongly associated with personal and comparative optimism (but see Appendix 5 in the Supplemental Materials). In addition, our sample was relatively highly educated. That does not compromise our conclusions, as we compared groups and evolutions over time. Still, our overall findings should not be interpreted as offering a representative impression of how Belgians feel about vaccination. Moreover, most effects were small for traditional standards in psychological research. However, small effects are consequential, especially if outcomes accumulate over time (Funder & Ozer, 2019). Finally, we did not aim at a comprehensive view of people's views of the effectiveness of vaccination. We only wished to understand the relationship between vaccination intentions and viewing vaccination as an action towards a prosocial goal (protecting others). Thus, our findings should not be construed as giving a full view of the role of perceived effectiveness of vaccination.

**Implications**

Risk perception clearly plays a role in vaccination readiness (An et al., 2021; Korn et al., 2021), but having the mass media cover who is more at risk than others does not suffice to encourage high-risk groups to get vaccinated. For example, they may be informed of the particular aspects of a disease (e.g., infection vs. outcome) for which their group is at risk, but that information may be set off by enhanced comparative optimism for that particular aspect.

The increase in most groups of the willingness to get vaccinated once that became a real prospect shows that findings on vaccination readiness, hesitance and refusal may markedly differ as a function of whether vaccination was possible at the time of the data collection. Thus, policy decisions based on extrapolations from findings obtained before vaccines were available should happen with caution.

A similar word of caution holds for measures of risk perception as predictors of vaccination uptake. The complexity of the relationship between optimism and vaccination decision shows that there is no such thing as 'general' optimism, and not even general comparative optimism. To get a full view of risk perception, researchers need to assess not only how likely people feel they are to get infected, but also how bad it would get for them should they get infected.

Above all, the almost routine use of moral arguments in appeals to get vaccinated (e.g., Maeckelberghe, 2021), based on the assumption that prosocial moral values are potent motivators (Pfattheicher et al., 2022), may need reconsideration. Our participants did not generally see vaccination in predominantly moral terms. Combined with earlier findings on the unwanted effects of moral arguments on individuals who view the involved issue in non-moral terms (e.g., Luttrell et al., 2019; Luttrell & Petty, 2021), our findings calls for caution in the use of such appeals. We do not claim that moral appeals always fall on hard ground. Nor do we claim that appeals to altruism can always be avoided. Vaccination decisions based on pure self-interest are sometimes insufficient to entail herd immunity (Wells et al., 2020). We do claim, however, that 'fertile moral ground' should not be taken for granted, and that conflicting earlier findings on the effects of moral appeals may be due to varying levels of moralization in the populations under study.

## Conclusion

Both comparative and personal optimism predict vaccination readiness, but to varying extents. Younger people's comparative (vs. personal) optimism seems to predict their vaccination readiness better, whereas older people's personal (vs. comparative) optimism seems to predict it better. Stated differently, personal risk perception predicts vaccination readiness among older people, but relative risk perception does so among young people. The older people are, the better perceived effectiveness seems to predict vaccination readiness. In contrast to what is often assumed, however, the more people see vaccination in moral terms, the lower their willingness to get vaccinated.

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Table 1

*Key demographic characteristics of the samples per wave*

| **Wave** | **1** | | **2** | | **3** | | **4** | | **5** | |
|---|---|---|---|---|---|---|---|---|---|---|
| Start date | 13 Dec 2020 | | 12 Jan 2021 | | 13 Feb 2021 | | 17 Mar 2021 | | 17 Apr 2021 | |
| End date | 29 Dec 2020 | | 2 Feb 2021 | | 3 Mar 2021 | | 12 Apr 2021 | | 16 May 2021 | |
| N Informed consent | 5669 | | 5286 | | 5071 | | 5083 | | 5373 | |
| N Actual participants* | 5417 | | 5116 | | 4946 | | 4968 | | 5234 | |
| From wave 1 | 5417 | | 3175 | | 3430 | | 3200 | | 2646 | |
| From wave 2 | - | | 1941 | | 1386 | | 1069 | | 823 | |
| From wave 3 | - | | - | | 130 | | 70 | | 58 | |
| From wave 4 | - | | - | | - | | 629 | | 138 | |
| From wave 5 | - | | - | | - | | - | | 1569 | |
| | N | % | N | % | N | % | N | % | N | % |
| Gender | | | | | | | | | | |
| Men | 2643 | 48.8 | 2402 | 47.0 | 2392 | 48.4 | 2377 | 47.8 | 2470 | 47.2 |
| Women | 2767 | 51.1 | 2708 | 52.9 | 2540 | 51.4 | 2540 | 51.1 | 2742 | 52.4 |
| Neither/Other/Missing | 7 | 0.1 | 6 | 0.1 | 14 | 0.3 | 51 | 1.0 | 22 | 0.4 |
| Age | | | | | | | | | | |
| 18-24 | 469 | 8.7 | 367 | 7.2 | 270 | 5.5 | 358 | 7.2 | 285 | 5.4 |
| 25-34 | 1025 | 18.9 | 863 | 16.9 | 719 | 14.5 | 774 | 15.6 | 750 | 14.3 |
| 35-44 | 815 | 15.0 | 777 | 15.2 | 715 | 14.5 | 768 | 15.5 | 822 | 15.7 |
| 45-54 | 1251 | 23.1 | 1160 | 22.7 | 1158 | 23.4 | 1140 | 22.9 | 1247 | 23.8 |
| 55-64 | 829 | 15.3 | 847 | 16.6 | 869 | 17.6 | 832 | 16.7 | 885 | 16.9 |
| 65+ | 1028 | 19.0 | 1102 | 21.5 | 1215 | 24.6 | 1096 | 22.1 | 1245 | 23.8 |
| Education | | | | | | | | | | |
| Secondary school | 2756 | 50.9 | 2650 | 51.8 | 2609 | 52.7 | 2589 | 52.1 | 2471 | 47.2 |
| Higher education | 2661 | 49.1 | 2466 | 48.2 | 2337 | 47.3 | 2379 | 47.9 | 2763 | 52.8 |
| Region | | | | | | | | | | |
| Brussels Capital Region | 533 | 9.8 | 476 | 9.3 | 464 | 9.4 | 574 | 11.6 | 475 | 9.1 |
| Flanders | 3233 | 59.6 | 3058 | 59.8 | 3027 | 61.2 | 2903 | 58.4 | 3308 | 63.2 |
| Wallonia | 1651 | 30.6 | 1582 | 30.9 | 1455 | 29.4 | 1491 | 30.0 | 1451 | 27.7 |

* Individuals who gave informed consent and answered key questions (see ‘Participants’ section)

Table 2

*P-values for significant predictors of perceived effectiveness, moralization and optimism for infection, severe disease, and a good outcome.*

| Predictor | Personal optimism | | | Comparative optimism | | | Effectiveness | Moralization |
|---|---|---|---|---|---|---|---|---|
| | Infection | Severe | Good | Infection | Severe | Good | | |
| **Brussels Capital Region** | | | | | | | | |
| Wave (W) | .029 | .005 | .005 | .172 | .219 | .048 | .002 | <.001 |
| Age | <.001 | <.001 | <.001 | .856 | .241 | .069 | <.001 | .016 |
| Gender | .004 | - | .363 | .656 | .392 | .034 | .771 | .071 |
| Household | <.001 | .003 | .148 | .025 | .273 | - | .541 | .014 |
| Education | .271 | .028 | .009 | .395 | - | 221 | .001 | .022 |
| W*Age | .092 | .089 | .636 | .283 | .935 | .608 | .904 | - |
| W*Gender | - | - | - | - | - | - | .494 | - |
| Gender*Age | .602 | - | - | .688 | .313 | - | .304 | .657 |
| W*Age*Gender | - | - | - | - | - | - | .070 | - |
| **Walloon Region** | | | | | | | | |
| Wave (W) | <.001 | <.001 | .002 | .001 | .168 | .525 | <.001 | <.001 |
| Age | <.001 | <.001 | <.001 | <.001 | <.001 | .520 | <.001 | <.001 |
| Gender | .111 | - | .038 | .037 | .789 | .008 | .078 | .004 |
| Household | <.001 | .053 | .519 | .802 | .674 | - | <.001 | .224 |
| Education | .542 | .001 | <.001 | .020 | - | .417 | <.001 | .062 |
| W*Age | .369 | <.001 | .612 | .402 | .046 | .751 | .814 | - |
| W*Gender | - | - | - | - | - | - | .018 | - |
| Gender*Age | .914 | - | - | .483 | .180 | - | .003 | .208 |
| W*Age*Gender | - | - | - | - | - | - | .602 | - |
| Urbanisation | - | .021 | .109 | - | .514 | - | .165 | - |
| **Flemish Region** | | | | | | | | |
| Wave (W) | <.001 | <.001 | <.001 | .019 | .408 | .010 | <.001 | <.001 |
| Age | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| Gender | <.001 | - | <.001 | .024 | .200 | <.001 | .438 | .001 |
| Household | .020 | .023 | .005 | .001 | .794 | - | <.001 | .886 |
| Education | .002 | <.001 | <.001 | .328 | - | .004 | <.001 | <.001 |
| W*Age | .088 | <.001 | .037 | <.001 | .008 | .140 | .001 | - |
| W*Gender | - | - | - | - | - | - | .263 | - |
| Gender*Age | <.001 | - | - | .073 | .020 | - | .201 | .041 |
| W*Age*Gender | - | - | - | - | | - | .036 | - |
| W*Household | - | - | .099 | .002 | - | - | - | - |
| Urbanisation | - | .621 | .293 | - | .251 | - | .042 | - |

Table 3.

*Association between optimism, perceived effectiveness, and moralization, and vaccination decision.*

| Predictor | Participants | *p*-value overall association with vaccination | Fisher Z transformed correlation random intercepts predictor - vaccination (*p*-value) | Fisher Z transformed correlation random slope predictor - random intercept vaccination (*p*-value) |
|---|---|---|---|---|
| Optimism infection | | | | |
| Personal | All | <.001 | -.090+.003***age* (.001) | -.094-.002***age* (<.001) |
| | 30 years* | | .007 | -.143 |
| | 60 years* | | .104 | -.190 |
| Comparative | All | .006 | -.154+.003***age* (.080) | .370-.007***age* (.016) |
| | 30 years* | | -.050 | .172 |
| | 60 years* | | .054 | -.023 |
| Optimism severe disease | | | | |
| Personal | All | <.001 | .239-.008***age* (<.001) | -.373+.006***age* (.009) |
| | 30 years* | | .010 | -0.192 |
| | 60 years* | | -0.216 | -0.016 |
| Comparative | All | <.001 | -.461+.007***age* (<.001) | .456-.007***age* (.003) |
| | 30 years* | | -.236 | .237 |
| | 60 years* | | -.019 | .029 |
| Optimism good outcome | | | | |
| Personal | All | <.001 | .178-.006***age* (<.001) | .327-.005***age* (.049) |
| | 30 years* | | .002 | .181 |
| | 60 years* | | -.172 | .039 |
| Comparative | All | .010 | .276-.005***age* (.049) | -.288+0.004***age* (.186) |
| | 30 years* | | .114 | -.171 |
| | 60 years* | | -.047 | -.058 |
| Effectiveness vaccination | | | | |
| | All | <.001 | .279+.015***age* (<.001) | - |
| | 30 years* | | .616 | - |
| | 60 years* | | .820 | - |
| Moralization vaccination | | | | |
| | All | <.001 | .059-.005***age* (<.001) | - |
| | 30 years* | | -.077 | - |
| | 60 years* | | -.211 | - |

* 30 and 60 years were arbitrarily chosen to illustrate the outcome of the formula at different ages.

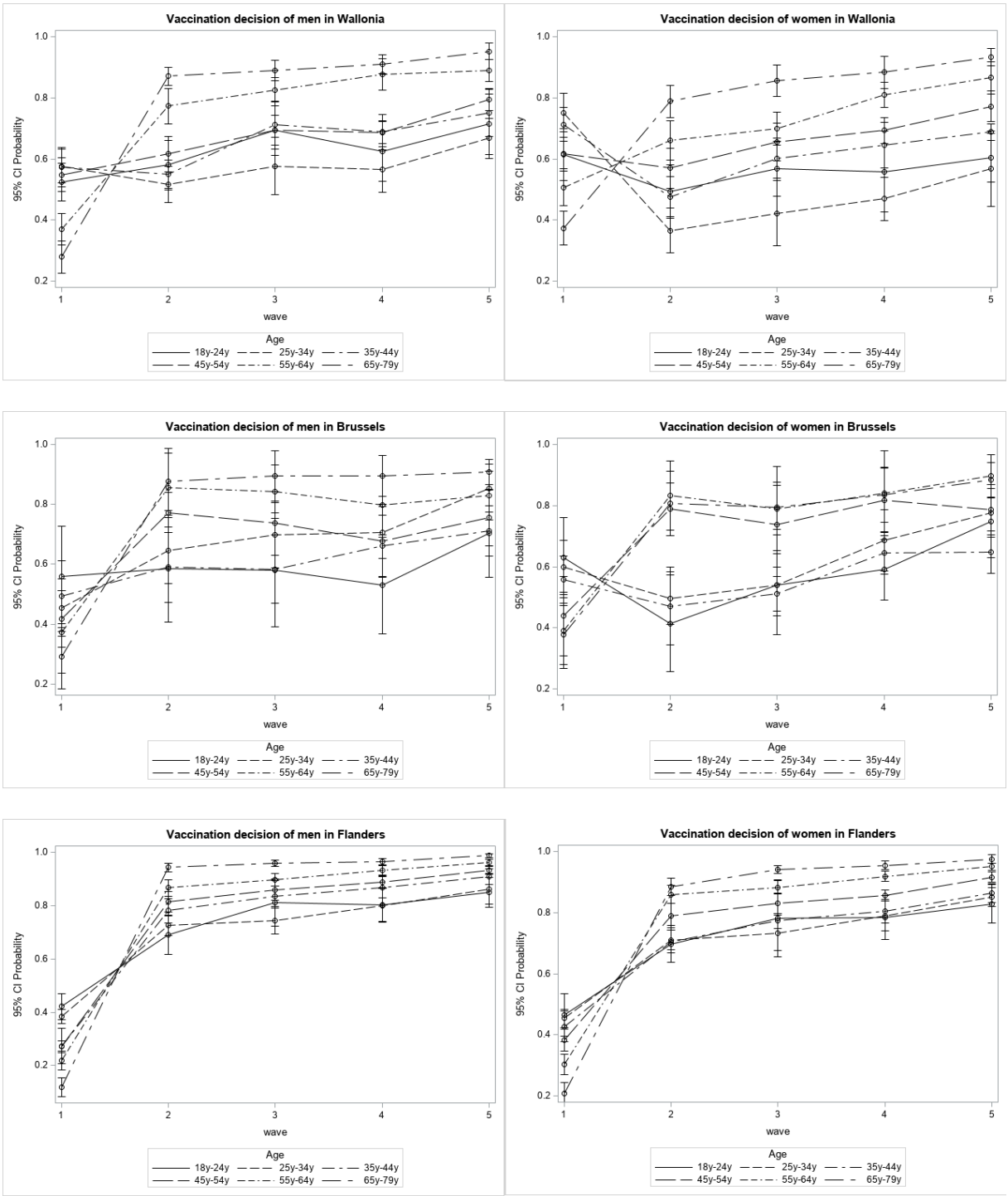


Figure 1. Probability of a positive vaccination decision in Wallonia (top), Brussels Capital Region (middle) and Flanders (bottom) per gender and age group.

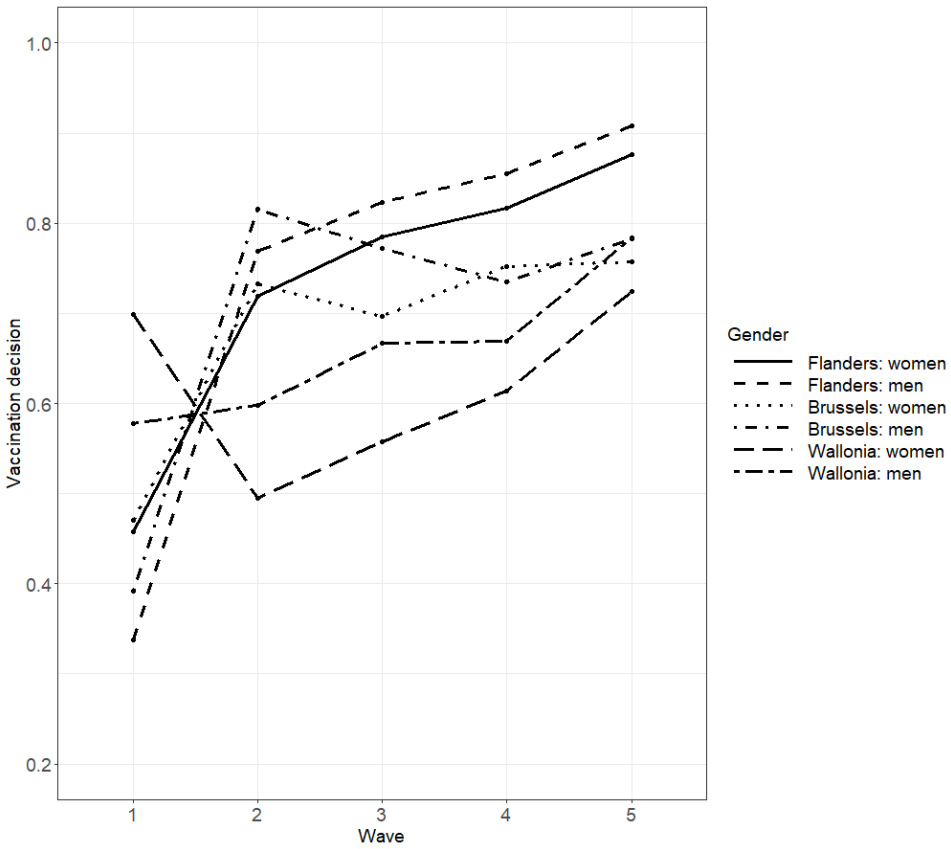


Figure 2. Estimated probability of a positive vaccination decision per region and gender.

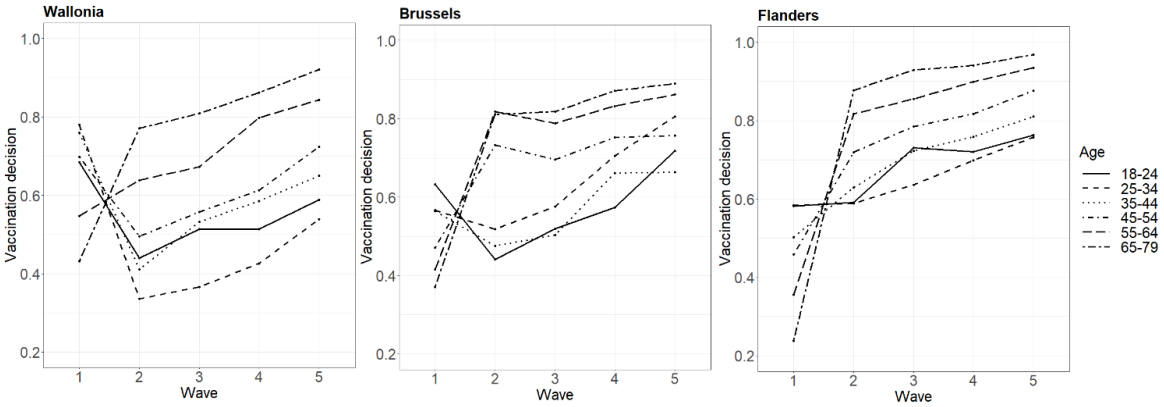


Figure 3. Estimated probability of a positive vaccination decision as a function of region (Wallonia = Walloon Region; Brussels = Brussels Capital Region; Flanders = Flemish Region) and age group.