



Short Communication

Public misperceptions of COVID-19 vaccine effectiveness and waning: experimental evidence from Ireland

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ABSTRACT

Objectives: The study set out to measure public understanding of COVID-19 vaccine effectiveness (VE) and how effectiveness wanes with time since vaccination. Because perceived VE is a strong predictor of vaccine uptake, measuring perceptions can inform public health policy and communications.

Study design: Online randomised experiment.

Methods: The study was undertaken in Ireland, which has high vaccination rates. A nationally representative sample ($n = 2000$) responded to a scenario designed to measure perceptions of COVID-19 VE against mortality. The length of time since vaccination in the scenario was randomly varied across four treatment arms (2 weeks, 3 months, 6 months, and 9 months).

Results: The public underestimates VE, with substantial variation in perceptions. A majority (57%) gave responses implying perceived VE against mortality of 0–85%, i.e., below scientific estimates. Among this group, mean perceived VE was just 49%. Over a quarter (26%) gave responses implying perceived VE greater than 95%, i.e., above scientific estimates. Comparing the four treatment groups, responses took no account of vaccine waning. Perceived VE was actually higher 9 months after vaccination than 2 weeks after vaccination.

Conclusion: Despite high vaccination rates, most of the public in Ireland underestimates VE. Furthermore, the general public has not absorbed the concept of vaccine waning in the months following vaccination. Both misperceptions may reduce vaccine uptake, unless public health authorities act to correct them through improved communication.

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Introduction

High vaccine effectiveness (VE) has been a vital component of humankind's response to the COVID-19 pandemic. In addition to ensuring good protection from disease, high VE increases the incentive for individuals to take vaccines. However, the strength of this incentive is likely to depend on public perceptions of VE.

Although multiple factors contribute to willingness to take COVID-19 vaccines, there is good evidence that perceived effectiveness is a strong determinant. In surveys undertaken across multiple countries before the licensing of COVID-19 vaccines, intention to take the vaccine depended on prospective VE.¹ Initial

vaccine hesitancy is associated with low knowledge about VE.² The proportion of hesitant individuals has been systematically linked with information provided about VE.^{3,4} Experimental manipulation of VE in public health messaging has a positive influence on stated intentions to get vaccinated.^{5,6} Changes in perceptions of VE have been associated with higher likelihood of intention to take the vaccine and self-reported vaccination behaviour in longitudinal data.⁷ Given this accumulation of evidence, the starting point of the present study is that perceptions of VE are likely to be a factor in people's ongoing decisions to take COVID-19 vaccines and, therefore, that public perceptions of VE are likely, at least in part, to determine the success of continuing COVID-19 vaccination campaigns.

Among people who have already been vaccinated, willingness to take additional doses is also likely to vary with perceptions of how protection wanes. We know of no study that has measured public

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perceptions of vaccine waning, or its relationship with vaccine intentions or behaviour.

Given the above, we set out to measure perceptions of VE and how VE wanes over time via a randomised experiment with a large, nationally representative sample.

Methods

The randomised experiment was conducted in Ireland, with a sample of 2000 adults who participated in an online survey between May 31st and June 21st, 2022. Ireland has one of the higher rates of COVID-19 vaccination in Europe, according to the European Centre for Disease Prevention and Control.⁸ Participants were recruited from existing panels of online survey respondents held by two national market research companies (RED-C Research, www.redcresearch.ie; Behaviour & Attitudes, www.banda.ie). The study was inserted into two waves of an existing survey, Ireland's Social Activity Measure (SAM). SAM was a fortnightly study of 1000 adults, which ran from January 2021 until June 2022 and measured levels of social activity and perceptions of the pandemic.⁹ Sampling was by quota to match the adult population (aged 18 years and older) of Ireland by sex, region, age and social grade. Table A1 in the appendix presents detail on the sociodemographic characteristics of the sample. Socio-economic indicators were educational attainment, employment status and 'social grade', which is a classification system based on the occupation of the chief income earner of the participant's household.¹⁰ We aimed to match quotas based on the proportion of households in higher, intermediate and junior managerial/professional roles (ABC1) and those in manual or causal work or unemployed (C2DE). The sample closely matches the most recent Irish Census of Population, with a slight (c. 5 %-point) under-representation of adults aged 18–39 years relative to adults aged 40–59 years.

Given time pressures for gathering data during the pandemic, online panels have clear advantages but could, in principle, be more prone to selection biases than probability samples. Empirically, following improvements in internet penetration and online panel construction, close correspondence across survey modes has been recorded.^{11,12} Any selection bias in our sample would be more relevant to the absolute measures of VE than to the relative measures across experimental conditions. More generally, despite large changes to online activity and behaviour, direct evidence supports the validity of online survey experiments conducted during the pandemic.¹³

The primary methodological challenge was to design a survey question that both minimised ambiguity and could be understood without specialist medical or statistical expertise. We know of no established method for measuring perceived VE in the general population. We therefore designed a question to measure an individual's perception of VE for COVID-19 vaccines based on a combination of established literature in judgment and decision-making and an informal pilot intended to identify any ambiguity.

For simplicity, we focused on VE against death following exposure to COVID-19. Prior evidence has established that the concepts of sampling, conditional probability and relative risk are challenging for many people.¹⁴ The question was therefore expressed in the form of a simplified numeric counterfactual. Given pressures of time, the question was then piloted informally online, using a convenience sample of approximately 25 professional contacts, friends and family members, who were asked to respond to the question and highlight any ambiguity or difficulty understanding the meaning or intention of the question. This process led us to pose the question in the form of a narrative, avoiding the expressions 'fully vaccinated' and 'booster', because there was confusion over whether these referred to second, third or fourth doses. Since

the total number of doses an individual required to be fully vaccinated also varied according to the original vaccine taken, we did not specify the type of vaccine in the narrative.

The final question was as follows:

Please imagine the following story. There were 100 people who were exposed to COVID-19 within the past two months. They became infected and unfortunately did not survive. None of the 100 had taken a COVID-19 vaccine.

Now suppose instead that exactly the same 100 people had all taken an approved vaccine [two weeks/three months/six months/nine months] before they were exposed to the virus.

How many of the 100 who died do you think would instead have survived?

The software randomised participants into four conditions, with all aspects identical except the 'treatment', which was the time since vaccination (in bold).

We chose not to give detail about who the 100 individuals were, since to do so would raise concepts of sampling that some respondents would find difficult. Piloting suggested that participants would understand this scenario as a simple comparison, in general, of the likelihood of death between unvaccinated individuals and individuals who had taken whichever course of vaccinations had been recommended to them. The response box required an entry but was left open, allowing people to write comments or qualifiers as well as numbers. This provided indications of whether some respondents felt that the question was ambiguous, confusing or otherwise unreasonable. Due to the randomised design, alternative interpretations were equivalent across conditions.

For comparison with the public responses, scientific estimates of VE are, of course, imprecise and depend on the relevant SARS-CoV-2 variant. Large sample cohort studies that estimate VE against severe COVID-19, hospitalisation or mortality from two weeks after vaccination have typically ranged from 85 to 95%, even for those at high risk.^{15–17} Estimates of VE waning over time fall in the range 8–25 percentage points over 4–8 months.^{15,16,18,19} At the time of data collection, the Omicron variant had become dominant in Ireland. While somewhat lower estimates of VE against infection have been recorded in relation to the Omicron variant, VE against severe disease and death appears similar.²⁰ While these figures are estimates and may change with further research, they reflect contemporaneous scientific understanding and provide benchmarks for comparison of public perceptions.

Results

Of the 2000 participants, 1821 (91%) provided a number between 0 and 100. The 9% non-response rate was consistent across treatments. Most non-responses consisted of 'don't know' or similar. Just 20 responses (1%) complained about the question wording (6 responses) or that the answer depended on information not provided (14 responses, mostly mentioning the ages of the 100 people). Non-responses were excluded.

Of usable responses, the majority (57%) provided responses of 0–85, below the benchmark described above. There was high variability, with 29% of responses at 50 or below and just over a quarter of responses (26%) above 95. The mean response was 69. Overall, therefore, VE was underestimated relative to the scientific benchmark, with substantial variability.

Fig. 1 indicates how responses varied by treatment group. Mean responses (1a) indicate no tendency to account for waning VE. The somewhat higher mean for longer compared to shorter durations since vaccination is short of statistical significance (Kruskal–Wallis,

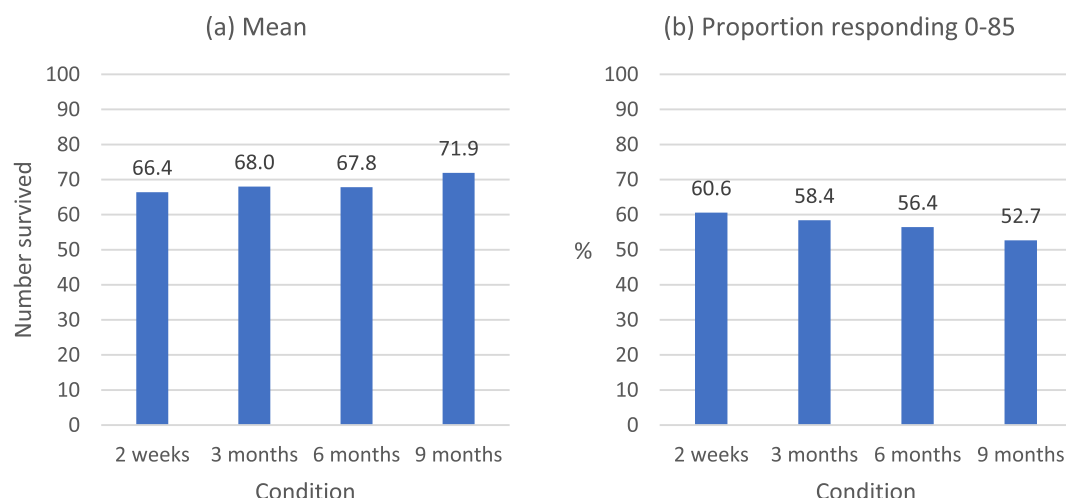


Fig. 1. (a) Mean response by condition; (b) proportion of respondents in each condition who gave a response of 0–85, i.e., below the scientific benchmark.

$P = 0.144$). The proportion providing a response in the range 0–85 (1b) was lower for longer compared to shorter durations since vaccination. Logistic regression of whether participants gave a response in the range 0–85 on treatment group, controlling for sex, age, educational attainment (5 categories) and vaccination status, suggests that low responses were significantly more likely in the shortest duration (2 weeks) condition than in the longest duration (9 months) condition compared to the ($P = 0.015$). In other words, if anything, participants perceived the opposite of VE waning.

We tested for differences in response by various sociodemographic characteristics, including sex, age, educational attainment and rural versus urban residential location. The only background characteristic to display a statistically significant relationship with the response was age. Fig. 2 shows this effect, with responses pooled across treatment conditions. Mean responses (2a) show that people aged 60 years and over believed, on average, that the vaccine would save 6 more lives out of 100 than people aged 18–39 years – a significant difference (Kruskal–Wallis, $P = 0.015$). However, with a mean estimate of 72, this more vulnerable group's perception of VE was still well below scientific estimates. The proportion providing a response in the range 0–85 (2b) was also lower for the oldest group (logistic regression, $P = 0.05$), although the majority remained below the scientific benchmark.

Furthermore, responses to the different treatment conditions among older people suggested that, in common with the rest of the sample, they perceived no VE waning up to 9 months.

Discussion

These data suggest that in a country with a high vaccination rate by international standards, the majority of the general public underestimate VE. While around one-quarter overestimate VE, underestimation is more common. Importantly, public perceptions of VE do not account for waning protection over a 9-month period. Although the latter finding might be taken to imply that many people overestimate VE over longer durations, the important point to note is that both misperceptions could reduce the inclination for people who have already been vaccinated to take additional doses. This is, firstly, because they (on average) underestimate VE and, secondly, because they believe they have higher immunity from their previous dose. As outlined in the Introduction, although there is existing evidence to support a link between perceived VE and willingness to take a COVID-19 vaccine, we are not aware of previous evidence in relation to perceptions of how protection wanes or how these influence willingness to take the vaccine.

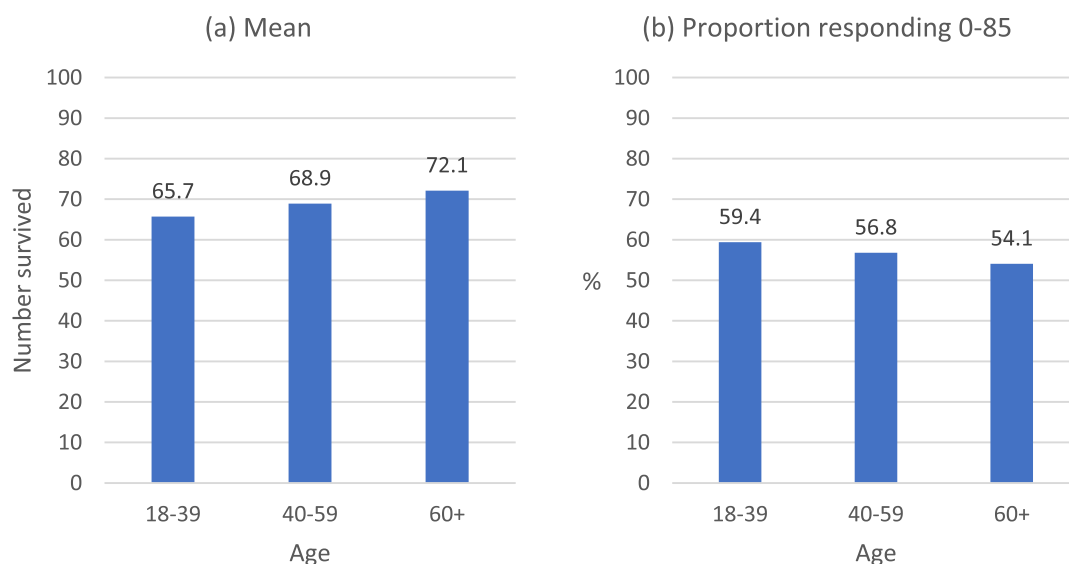


Fig. 2. (a) Mean response by age; (b) proportion of respondents by age who gave a response of 0–85, i.e., below the scientific benchmark.

Given the additional vulnerability of older people to COVID-19, some comfort can be taken from the fact that those older than 60 years had somewhat more accurate perceptions of VE than younger adults. However, even this older group still underestimated VE by a substantial amount. It is also notable that there were no significant differences in responses by educational attainment, given the inherent complexity of the numeric counterfactual scenario that respondents were asked to contend with.

Experiments and surveys that aim to measure public perceptions of quantitative scientific phenomena must inevitably present simplified questions and scenarios. While the research team put much effort into the question wording used here, it remains possible that participants in this study misinterpreted the question in some systematic way, although entries in the open text response box provide some comfort that the large majority intuitively understood what they were being asked. Future research might seek to compare this question with alternative methods for measuring public perceptions of VE.

Perceptions of VE continue to be important in combatting COVID-19. The current findings have relevance for ongoing efforts by public health authorities and governments to increase vaccination rates and to ensure that people take booster doses. Failure to understand VE waning may also have behavioural implications if people, especially vulnerable people, underestimate how their exposure to risk from social activity changes over time. Continued communication of the high rate of VE against severe illness and death, together with the time-course over which it wanes, appears warranted.

Author statements

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Ethical approval

Ethical approval for this study was obtained in accordance with the ethics policy of the Economic and Social Research Institute (ESRI). Informed consent was obtained from participants online, before participation.

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Competing interests

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.11.002>.

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