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Recent enough to matter: Perceived temporal proximity, anxiety, and COVID-19 vaccine intent

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ABSTRACT

Background: Vaccine hesitancy undermines vaccination strategies and is shaped by non-modifiable contextual and individual/group factors, and potentially modifiable cognitive processes. The Health Belief Model (HBM) offers a framework for understanding health decision-making, including the role of threat perception, which is influenced by perceived proximity to a threat. Construal Level Theory (CLT) suggests that psychologically distant events are construed more abstractly, reducing perceived urgency. **While spatial and social proximity (physical closeness and effects on one's social network) have been widely studied, temporal proximity (nearness or distance in time) has been explored less**. Given research that the pandemic affected time perception, this study examined whether perceived temporal proximity predicts future COVID-19 vaccine intent, and whether this relationship is statistically mediated by COVID-19 anxiety.

Methods: A cross-sectional survey assessed whether temporal proximity was associated with future vaccine intent (less vs. more likely to vaccinate) using multivariable binary logistic regression. Mediation analysis tested whether COVID-19 anxiety explained this relationship. Covariates included age, gender, direct COVID impact/risk variables, and trust in government. In total, 696 individuals were included in analyses (345 women; mean age = 47.27 ± 15.53 years).

Results: Greater temporal proximity predicted greater intention to receive a future COVID-19 vaccine. There was also evidence of a significant indirect association via COVID-19 anxiety: greater perceived proximity was associated with higher anxiety, and higher anxiety was associated with greater vaccination intent. Significant covariates included perceived vulnerability to COVID-19, and trust in government.

Conclusions: Findings support evidence that proximity influences threat perception and behavioural intentions, demonstrating that temporal proximity functions similarly in a real-world preventative healthcare context. The observed indirect association via anxiety, considered alongside the HBM and CLT, is discussed as a possible mechanism underlying the proximity-intention link. Longitudinal research is needed to assess causality and inform communication strategies using temporal framing.

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1. Introduction

Vaccine hesitancy is the delay or refusal in vaccine uptake, regardless of availability [1]. This is a growing problem, highlighted by the World Health Organisation [2] as one of the top ten global health threats. This is concerning, as vaccines are a highly effective method of reducing global disease burden, and people who do not vaccinate, experience worse outcomes, including higher rates of infection, hospitalisation, intensive care admission, and mortality [3,4].

Vaccine uptake has faced resistance since the earliest efforts – such as in the United Kingdom, when the first mandatory smallpox vaccination program in 1853, was met with riots and widespread opposition [5]. Hesitancy has continued in various forms, rising and falling depending on context. Regarding COVID-19 vaccine uptake, a recent umbrella review found that during the pandemic, when vaccination was heavily promoted and prioritised by governments and healthcare systems worldwide, the pooled global prevalence of vaccination was 'unacceptably low' at 60.23% (95% CI: 58.27, 62.18) [6] though with substantial variation between countries and within populations. Uptake was worse in low-income countries (likely related to inequities in access alongside any other contributing factors; Dagovetz et al. [7]), and was predicted by a range of demographic, cognitive, and health related factors, including education, gender, COVID-19 knowledge, attitudes towards the vaccine, history of COVID-19 infection, and chronic health conditions. Crucially, COVID-19 vaccine coverage during the pandemic was strongly associated with rates of COVID-19 cases, hospitalisations [4], and mortality [3]. Furthermore, high rates of hesitancy have been expressed by frontline healthcare workers [8]. Beyond access and structural barriers, emerging evidence highlights the relevance of sociodemographic (e.g., age and education; Saffari et al. [9]), alongside psychological and belief-based factors (such as fear and conspiracy beliefs) in shaping COVID-19 vaccine hesitancy [10,11]. Clearly, even when vaccination is of utmost importance, hesitancy, driven by various factors, acts as a barrier to effective preventative healthcare.

Hesitancy across multiple vaccines has also increased globally since the COVID-19 pandemic [12], with COVID-19 vaccine attitudes appearing to influence other vaccine behaviours, such as uptake of influenza vaccine [9,13]. Recent qualitative work highlights that barriers to influenza vaccination are increasingly shaped by the legacy of COVID-19 [14], with people describing confusion around the difference between COVID-19 and other winter illnesses, vaccine fatigue (inaction regarding vaccines due to perceived burnout; Su et al. [15]), diminished trust in healthcare and government authorities exacerbated by perceptions of management of the pandemic, and the continued influence of misinformation. Greater understanding of the factors which exacerbate COVID-19 vaccine hesitancy is therefore critical to increasing vaccine acceptance and informing preparedness for future vaccination campaigns [11].

The decision to vaccinate is influenced by a range of factors. These factor types can be grouped in relation to their adaptability. Recent meta-analysis showed that fixed factors influencing COVID-19 vaccine acceptance included; living in an urban area, being male, married, or educated, having a history of influenza vaccination or comorbidities, or a higher level of income status [16]. While these findings are important, demographic and health-related factors are largely non-modifiable. In contrast, the accompanying systematic review component emphasised potentially modifiable influences, noting that trust in government and health authorities, fear of side effects, and misinformation were linked to hesitancy [16]. To inform effective public health interventions, it is crucial to explore cognitive and attitudinal variables that can be targeted and potentially modified to increase the likelihood of vaccine acceptance. Alongside similar contextual and individual/group factors highlighted by Baghani et al. [16], further systematic review work has evidenced modifiable determinants of COVID-19 vaccine hesitancy, including vaccine-specific concerns about safety/effectiveness; perceived barriers; poor vaccine knowledge, and disease-specific factors such as knowledge of COVID-19; perceived COVID-19 risk and severity [17].

These results align with well-established theoretical frameworks, such as the Health Belief Model (HBM), which explains health decision-making through key cognitive components [18,19], found to individually associate with COVID-19 vaccine hesitancy in review-level work [20]. The vaccine-specific concerns reflect the HBM constructs of perceived barriers and benefits, while poor vaccine knowledge relates to perceived benefits and self-efficacy. Of the disease-specific factors, knowledge of COVID-19 maps onto cues to action, while perceived risk and severity map directly onto the HBM constructs of 'perceived susceptibility and severity' – often combined into 'perceived threat', which is known to impact vaccination behaviour [21]. Critically however, threat perception is influenced by perceived proximity – e.g., the closer the threat, the higher the perceived risk [22,23]. Proximity is multifaceted, and is generally conceptualised across three main dimensions, namely: spatially (physical closeness of the threat), socially (whether members of one's own social network are affected), and temporally (how current or imminent a threat is – whether it is near or far in time) [24].

One theory based on perceived proximity which can be used in conjunction with the HBM to help understand threat perception [25] is Construal Level Theory (CLT; Trope and Liberman [26]). CLT proposes that events which feel psychologically distant, whether in space, social relevance, time, or likelihood, are processed more abstractly, whereas proximal events are processed more concretely and with greater emotional immediacy. Recent work applying CLT to vaccination decisions supports the relevance of perceived proximity in this context, finding that COVID-19 vaccines are often construed at a high, abstract level, particularly among unvaccinated individuals, suggesting that psychological distance may shape how people evaluate vaccination [25].

To date, research has largely focused on understanding the impact of spatial and social proximity on threat perception. A review by Balžekienė et al. [22] shows that individuals living spatially closer to threats (such as areas that had experienced natural hazards, terrorist attacks, or influenza epidemics), have consistently higher risk perceptions of these (except for nuclear threats). Similarly, Van Lent et al. [27] conducted an analysis of Dutch Tweets mentioning Ebola, and found that spatial proximity to affected regions predicted fear for self, while social proximity to socially/culturally close affected regions predicted fear for others. Another Tweet analysis by Atilla and Zwaan [28] found that the volume of COVID-19 Tweets, and the negativity of their sentiments, increased with spatial proximity. Furthermore, during COVID-19, greater social and spatial proximity were associated with greater COVID-19 related anxiety [23]. Interestingly, in the context of terrorist attacks in Norway, social proximity better explained fear and distress than spatial proximity [29]. Most of this work did not analyse the impact of proximity or the proximity-perception relationship on preventative behaviour or intentions.

However, in relation to COVID-19, Fuchs et al. [30] found that these proximal elements differentially impact cognitive and behavioural measures, as social proximity moderated the effect of personal risk on threat perception, while temporal and spatial proximity moderated the effect of threat perception on intention to travel during COVID-19. Similarly, Johnson [31] found that close physical proximity to Zika-related risks (such as potential mosquito habitat ranges, transmission sites, and regions with 100+ plus Zika cases) slightly increased personal risk and concern, as well as intention to adhere to protective behaviour guidelines such as mosquito control, avoiding travel to affected areas, and practicing safe sex. Conversely, Flamand et al. [32] found that closer spatial proximity to a chikungunya outbreak area was associated with increased knowledge about chikungunya transmission, but reduced concern and preventative behaviours, interpreted as potentially due to risk denial processes. Finally, Gao and Sun [33] found that the impact of psychological distance from COVID-19 (measured as a composite of all four CLT domains) on engagement in high-risk behaviours (e.g.,

attending crowded events) was mediated by COVID-19 threat perception and psychological insecurity, a generalised emotional state reflecting feelings of uncertainty and lack of safety.

Ultimately however, **the impact of temporal proximity specifically on threat perception, health behaviour, or intentions has received significantly less attention than spatial and social proximity.** Temporal proximity can refer to the past i.e. how recent or distant an event feels now in comparison to when it happened, or the future i.e. how long it feels until a future event is likely to occur.

Of work which has been conducted, this primarily focuses on climate change, finding that a perception of temporal proximity is linked to higher threat perception [34] and more pro-environmental behaviour such as trying to reduce personal carbon footprint [35]. While other work has been conducted within health/disease contexts, this has largely been experimental and therefore less ecologically valid than the literature described thus far. For example, a meta-analysis of experimental studies in broad health contexts found that temporally proximal message framing increases threat perception and behavioural intention, but not actual behaviour [36]. However, the impact of temporal proximity within a preventative healthcare context remains underexplored specifically in the context of vaccine intentions for ongoing health threats, despite its possible modulation of perceived threat, and subsequent potential impact on vaccine uptake intentions and actions.

The role of temporal proximity may be particularly critical in the decision to vaccinate for COVID-19 because of the impact of COVID-19 on representations of time. Research shows that there are significant individual differences in the perceived length of the pandemic, the amount of time that has passed since restrictions were lifted, and the extent to which people believe that the pandemic is over [37–39]. However, to date no research has examined how individual differences in temporal distance in relation to Covid-19 shape attitudes to vaccination.

The current study sought to fill this knowledge gap. Vaccine hesitancy remains a pressing concern, and may serve as an indicator of preparedness towards future epidemics and pandemics. While the rapid development and deployment of effective vaccines is crucial, their impact is inherently constrained if populations are unwilling to accept them. Examining COVID-19 vaccine hesitancy in the UK five years on - with 11th March 2025 marking five years since the pandemic was officially declared by the World Health Organisation (WHO [40]) – offers a timely opportunity to assess the population's preparedness for future outbreaks and vaccination efforts. The current study aimed to a) examine whether perceived temporal proximity of COVID-19 was associated with vaccine intent five years since the start of the pandemic, and b) test whether COVID-19 anxiety functions as a potential mediating mechanism underlying this relationship. It was hypothesised that 1) perceiving COVID-19 as temporally proximal would be associated with a greater likelihood of intending to receive a COVID-19 vaccine in the future, and 2) COVID-19 anxiety would statistically mediate this relationship.

2. Methods

2.1. Design and procedure

Data were collected as part of the *After the End* project, which investigates lived experiences in the aftermath of diseases, disasters, and other global health crises once they are officially declared to be 'over'. A cross-sectional, correlational design was used to assess factors associated with vaccine intent, which was analysed as a binary outcome: being less or more likely to have a COVID-19 vaccine in the future. The primary independent variable was perceived temporal proximity. Covariates included age, gender, direct COVID impact/risk variables (having long-COVID, having a health condition perceived as increasing vulnerability to COVID-19, or being a carer for someone vulnerable), and trust in government. Participants were adult UK residents recruited through Prolific.com, an online research platform where individuals opt in to take part in studies. Recruitment used Prolific's "Representative Sample" feature, which applies census-matched quota sampling to ensure that the sample reflects UK population distributions for age, gender, and ethnicity. Because Prolific distributes studies directly to eligible users, a conventional response rate was not calculated. The questionnaire was available for one day, on 8 March 2025, with no reminders issued. The study was approved by Liverpool John Moores University Research Ethics Committee (24/PSY/061) and was conducted in accordance with the Declaration of Helsinki.

2.2. Participants

Of the 1014 individuals who began the survey, 28 did not complete key sections and so had missing data on model variables. In addition, 7 participants identified as non-binary, and 3 preferred not to say. Because gender was included as a covariate and the number of nonbinary/non-identified participants was very small, inferential analyses were restricted to participants identifying as male or female.

After accounting for these exclusions, the binary recoding of vaccine intent and long-term vulnerable health conditions, and the exclusion of the first response option on the temporal proximity scale (all explained in the Materials section), 696 individuals identifying as male or female (68.6% of the original 1014) were included in inferential analyses. See Fig. 1 for a flow diagram of the analytical selection process. Descriptives for this analytic sample are provided below in Table 1.

2.3. Materials

2.3.1. Dependent variable: vaccine intent

Participants rated their vaccine intent by answering the following question: "Do you wish to receive COVID-19 vaccinations in the future?". This was scored on a 5-point Likert scale from definitely not (1) to definitely yes (5). A higher score on this measure signifies greater likelihood of getting the vaccine in future. For analysis, this was recoded into a binary positive or negative vaccine intent measure (with those who selected the middle option of "Might or might not", not included, $n = 161$, 16.8%), see Data analysis section for explanation.

2.3.2. Independent variables.

2.3.2.1. Demographics. Data were collected on age and gender

2.3.2.2. Direct COVID-19 impact and/or risk. Participants were asked to indicate whether they considered themselves to have long-COVID (yes/no), to have any long-term or chronic health conditions which make them vulnerable to COVID-19 (yes, no, or unsure – recoded to limit responses to yes/no for inferential analyses as a covariate and removing those who selected unsure; $n = 75$, 9.2%), and status as a carer for someone they would consider vulnerable to COVID-19 (yes/no).

2.3.2.3. Trust in government. Questions adapted from the OECD [41] survey on drivers of trust in public institutions, which was implemented in 30 countries and was previously fielded in 2021. Participants rated seven statements on a five-point scale from strongly disagree (1) to strongly agree (5): "I trust the Government", "If a corporation promoted a policy that benefited it but could be harmful to society as a whole, the government would not agree to the corporation's demands.", "In a large scale emergency, the government is ready to protect people's lives.", "When the government takes decisions it draws on the best available evidence, research and statistical data.", "The government clearly explains how its policy will affect me.", "The government treats people equally regardless of their income, gender identity, sexual orientation, ethnicity and country of origin.", "The government makes sure that new policies adequately balance the needs of different groups in society.". A

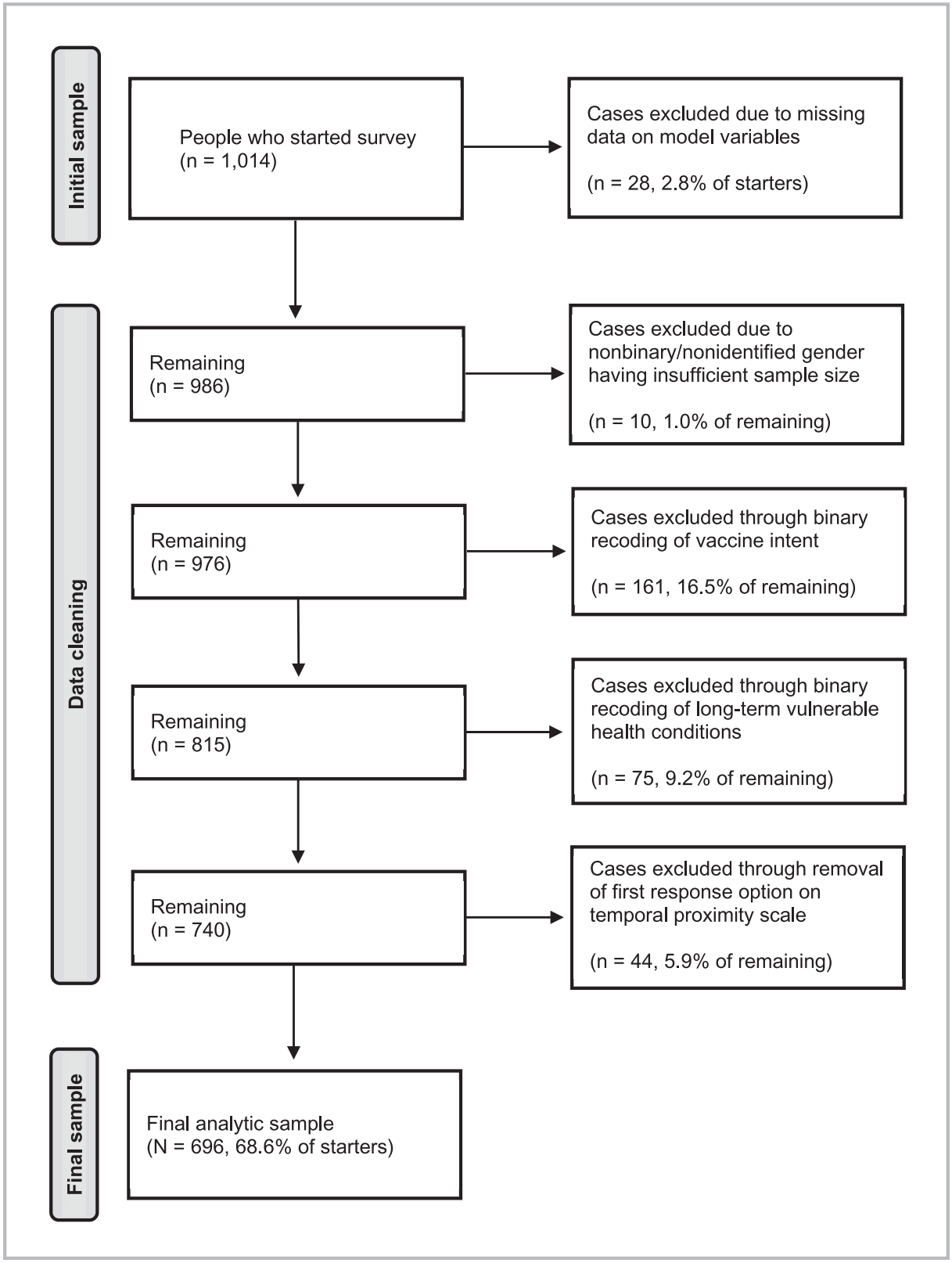

Fig. 1. Flowchart of analytic sample selection.

higher overall score indicates higher trust in UK government. In this study, Cronbach's α totalled 0.91, and ranged from 0.90 to 0.91 across the items.

2.3.2.4. Anxiety about COVID. Participants completed the validated Coronavirus Pandemic Anxiety Scale (CPAS-11; Bernardo et al. [42]) rating responses to items such as "Worried that I or someone in my family might get infected" from 0 (not at all) to 3 (nearly every day). Higher composite scores indicate that a person is more worried about COVID-19. In this study, Cronbach's α totalled 0.92, and ranged from

Table 1
Descriptive characteristics of the total analytic sample ($N = 696$) and by low ($n = 210$) versus high ($n = 486$) COVID-19 vaccine intention.

	Total	Low vaccine intent	High vaccine intent	Independent *t*-test		
	Min–Max (M ± SD)	Min–Max (M ± SD)	Min–Max (M ± SD)	*t*	*df*	*p*
Age	18–95 (47.27 ± 15.52)	18–83 (45.12 ± 13.91)	18–95 (48.34 ± 16.32)	−3.05	470.53	0.005
Trust in government	7–35 (19.76 ± 6.59)	7–32 (15.84 ± 6.48)	7–35 (20.88 ± 6.31)	−8.76	694	<0.001
Anxiety about COVID-19	11–54 (17.30 ± 8.01)	11–54 (15.94 ± 7.94)	11–53 (18.15 ± 8.14)	−2.06	686	0.040
Temporal distance*	2–6 (3.33 ± 0.98)	2–6 (3.23 ± 0.98)	2–6 (3.43 ± 1.02)	−2.01	694	0.045
	Total N (%)	**Low vaccine intent n (%)**	**High vaccine intent n (%)**	**Chi-square test**		
				X^2	*df*	*p*
Gender				5.28	1	0.022
Male	351 (50.4%)	92 (13.2%)	259 (37.2%)			
Female	345 (49.6%)	118 (17.0%)	227 (32.6%)			
Direct COVID-19 impact and/or risk:						
Long-COVID				0.02	1	0.887
No	651 (93.5%)	196 (28.2%)	455 (65.4%)			
Yes	45 (6.5%)	14 (2.0%)	31 (4.5%)			
Long-term vulnerable health condition				10.11	1	0.001
No	503 (72.3%)	169 (24.3%)	334 (48.0%)			
Yes	193 (27.7%)	41 (5.9%)	152 (21.8%)			
Carer for vulnerable person				0.61	1	0.436
No	588 (84.5%)	174 (25.0%)	414 (59.5%)			
Yes	108 (15.5%)	36 (5.2%)	72 (10.3%)			

* Note: The temporal proximity Likert item score ranges 2–6 because the first response option was excluded from analyses (see Materials for more information).

0.91 to 0.92 across the items.

2.3.3. Temporal proximity of COVID-19 pandemic

Perception of the temporal proximity of the end of the COVID-19 pandemic was assessed using a question designed to capture how long-ago participants felt that the pandemic meaningfully ended for them within their own timeline: "When do you feel the COVID-19 pandemic ended for you?". This was scored using a 6-point Likert item with the following options: 1 = I never felt COVID-19 was a threat to me, 2 = Between 4 and 5 years ago, 3 = Between 2 and 3 years ago, 4 = Between 1 and 2 years ago, 5 = Less than 1 year ago, 6 = The pandemic has not ended yet, or will never end. Whilst this was the initial scoring method, the first response option was later excluded from analyses due to concerns that it reflected threat perception rather than proximity ($n = 44$, 5.9%). While this exclusion did not affect the main results, the decision to exclude this data was supported by a robustness check using dummy-coded categories, in which this option showed a markedly different pattern from the remaining temporal-proximity responses. A higher score indicates the pandemic ending is perceived as more recent, or that the pandemic has not yet ended or will not end.

This approach to assessing temporal proximity is consistent with existing measures assessing temporality during day -to-day life in clinical and non-clinical groups [43–45] during and after global health emergencies [39,46–49].

2.4. Data analysis

Analyses were conducted using SPSS (version 30.0.0.0; IBM Corp [50]). Significance was accepted at $\alpha < 0.05$. To investigate factors associated with vaccine intent, a multivariable binary logistic regression was conducted to examine the impact of perceived temporal proximity of COVID-19 on binary vaccine intent (less vs more likely to have COVID-19 vaccine in future). This variable was added as continuous despite its ordinal scaling, as the underlying construct of time is inherently continuous, and would not be adequately represented if treated as nominal categories (as SPSS would otherwise do). Additionally, research using Monte Carlo simulations has shown that in parametric tests, individual Likert items with 5+ points maintain a type 1 error rate, and exhibit similar statistical power and correlation structures to true continuous variables [51]. Finally, a robustness check using dummy-coded categories showed a generally monotonic increase in effects across response options, supporting the treatment of the Likert predictor as approximately linear (see Supplementary Table 1).

The dependent variable of vaccine intent was recoded from categorical into binary because ordinal regression proved unsuitable. With multiple predictors, the cross-classification of predictor categories and dependent variable levels produced a large proportion of empty cells (approximately 79.5%), which compromised model stability. Recoding into a binary outcome reduced sparsity and enabled a more robust model fit. In the regression, age, gender, direct COVID impact/risk variables, and trust in government, were included as covariates.

Following the finding that perceived temporal proximity was a significant predictor, a mediation was conducted using the PROCESS macro [52] to examine whether the relationship between the predictor and vaccine intent was mediated by anxiety about COVID-19, controlling for age and gender and employing a 95% bias-corrected confidence interval based on 10,000 bootstrap samples to assess the indirect effect.

2.5. Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

3. Results

3.1. Multivariable binary logistic regression

The final model with all predictors was significant, $\chi^2(7) = 101.515$, $p < .001$, indicating that predictors reliably distinguished vaccine intent (see Table 2). The model explained 19.2% of the variance in vaccine intent (Nagelkerke $R^2 = 0.192$) and correctly classified 72.4% of cases. The Hosmer and Lemeshow Test indicated a good model fit, $\chi^2(8) = 4.66$, $p = .794$. Temporal proximity was a significant predictor, with people who perceived the pandemic as more proximal, being more likely

Table 2
Multivariable binary logistic regression examining perceived temporal proximity of COVID-19 on binary vaccine intent (less vs more likely to have COVID-19 vaccine in future).

Predictor	*β*	*SE*	*Wald*	*p*	*OR*	*95% CI*
Age	0.007	0.006	1.573	0.210	1.007	0.996–1.019
Gender (Female vs. Male)	−0.276	0.180	2.361	0.124	0.759	0.534–1.079
Long-COVID (Yes vs. No)	0.014	0.360	0.002	0.968	1.014	0.501–2.058
Long-term vulnerable health condition (Yes vs. No)	0.792	0.222	12.678	<0.001	2.208	1.428–3.414
Carer for vulnerable person (Yes vs. No)	−0.492	0.251	3.847	0.050	0.611	0.374–1.000
Trust in government	0.121	0.015	64.609	<0.001	1.129	1.096–1.163
Temporal proximity of COVID-19	0.241	0.098	6.080	<0.014	1.273	1.051–1.541
Constant	−2.567	0.518	24.578	<0.001	0.077	

Note: Vaccine intent coded as 0 = less likely, 1 = more likely. Categorical predictor reference categories: Male; No long-COVID; No vulnerable health condition; Not a carer.

to intend to vaccinate against COVID-19 in the future. Certain covariates were also significant predictors, such as having a condition that made participants vulnerable. Trust in government was also significant.

Of the significant predictors, having a long-term COVID-19 vulnerable health condition showed the strongest effect, more than doubling the odds of intended vaccine acceptance (OR = 2.21, a 121.0% increase in odds). Perceiving the pandemic as being temporally proximal was the next strongest predictor, increasing odds by about 27.0% (OR = 1.27). Finally, greater trust in government was associated with a modest increase in odds of around 13.0% (OR = 1.13).

3.2. Mediation

As shown in Fig. 2, the pattern of associations was consistent with an indirect relationship between perceived temporal proximity of COVID-19 and COVID-19 vaccine intent via COVID-19 anxiety.

Perceiving the pandemic as more temporally proximal was associated with greater anxiety about COVID-19 (a = 2.684, SE = 0.277, $p < .001$). Higher COVID-19 anxiety was, in turn, associated with greater odds of intended vaccine acceptance (b = 0.022, SE = 0.011, Z = 2.052, $p = .040$). The estimated indirect effect of perceived temporal proximity on vaccine intent through COVID-19 anxiety was significant (ab = 0.060, BootSE = 0.034, CI [0.003, 0.134]). The direct effect of perceived temporal proximity on vaccine intent was not significant (c' = 0.148, SE = 0.089, Z = 1.660, $p = .097$).

Taken together, these results are consistent with an indirect association, in which perceiving COVID-19 as more temporally proximal is associated with higher COVID-19 anxiety, which in turn was associated with greater intention to be vaccinated. The indirect pathway was significant when controlling for age and gender. However, when additional covariates (direct COVID-19 impact/risk variables, and trust in government) were added, the indirect effect was attenuated, suggesting conceptual overlap among these variables and COVID-19 anxiety.

4. Discussion

The current study aimed to a) examine whether perceived temporal proximity of COVID-19 was associated with vaccine intent five years since the WHO declared the start of the pandemic, and b) test whether COVID-19 anxiety functions as a potential mediating mechanism underlying this relationship. It was hypothesised that 1) perceiving COVID-19 as temporally proximal would be associated with a greater likelihood of intending to receive a COVID-19 vaccine in the future, and 2) COVID-19 anxiety would statistically mediate this relationship. Hypothesis one was supported, as temporal proximity was a significant predictor, in the expected direction. Additionally, greater likelihood of intended vaccine acceptance occurred when a person perceived their health as vulnerable to COVID-19, or when trust in government was higher. Hypothesis two was supported, in that the model indicated a significant indirect association via COVID-19 anxiety, although the direct association between

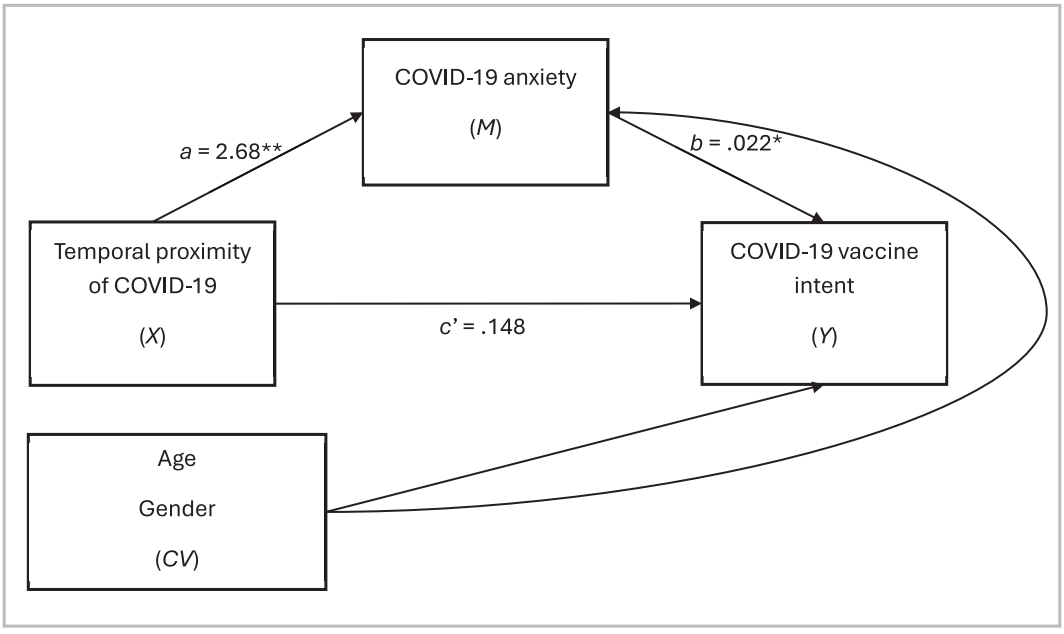

Fig. 2. Mediation model tested, illustrating the indirect pathway from perceived temporal proximity of COVID-19 to COVID-19 vaccine intent via COVID-19 anxiety, controlling for age and gender.

temporal proximity and vaccine intent was not statistically significant.

That participants who perceived COVID-19 as temporally proximal were more likely to intend to receive a future COVID-19 vaccine, is mostly in line with previous work, primarily on spatial and social proximity, which largely demonstrates that greater threat proximity increases threat perception [22,23,27–31,34,36], behavioural intention [30,31], and even behaviour [35]. Furthermore, this work builds upon experimental work by Huang and Xu [36] to show that temporal proximity still relates to preventative healthcare intentions even within real-world settings.

As outlined in the introduction, the HBM provides a useful framework for interpreting these findings, as perceived threat is a central determinant of health behaviour and is impacted by perceived proximity. When relating these findings to the HBM via the CLT framework of psychological distance, the results suggest that temporal proximity may relate to vaccine intention partly through its effect on how individuals mentally construe COVID-19 and its prevention. CLT proposes that greater temporal distance leads to more abstract, high-level construals, which can reduce the perceived urgency of action: distant risks feel less pressing, and distant benefits feel less certain. This aligns with the finding by Saxton et al. [25] that COVID-19 vaccines are often construed at a high, abstract level among unvaccinated individuals. Therefore, when COVID-19 feels temporally distant, individuals may discount the value of less certain future protection and instead prioritise immediate, concrete barriers, leading to lower intention to receive a future COVID-19 vaccine.

The additional predictors identified in the current study, perceived vulnerability to COVID-19, and trust in government suggest that psychological distance operates alongside established cognitive determinants rather than replacing them. Additionally, whilst not assessed directly, it is possible that greater trust in government reduces social proximity (i.e., decreasing the perceived gap between the individual and the institution providing vaccine information), while perceived health vulnerability may reduce distance in the CLT likelihood domain by making a negative health outcome feel more probable. That vaccination hesitancy was higher when trust in authority was lower, is also in line with previous work [16,17]. Similarly, that perceived personal vulnerability to COVID-19 was significant also fits well with the HBM, as this could be considered a proxy measure for perceived susceptibility, one of the HBM components [19].

Moreover, the finding of a significant indirect association via anxiety highlights an affective pathway through which psychological distance may relate to behaviour. When considered alongside the Gao and Sun [33] finding that psychological distance predicted higher-risk behaviours via threat perception and psychological insecurity, this suggests that psychological distance shapes health behaviour through intertwined cognitive and emotional processes, reinforcing the value of including temporal distance when examining factors associated with vaccine decision-making. However, that gender was not a significant predictor contradicts work highlighting men as less hesitant and more likely to accept COVID-19 vaccines [16,17]. This may reflect either a uniqueness of the current sample (less likely given the review-level nature of both prior works cited), or perhaps that gendered variation in vaccine intentions may be linked to perception of temporal proximity.

4.1. Implications for research and practice

The present findings suggest that the subjective sense of temporal proximity matters, and therefore public health communication must consider how to best convey the temporal relevance of infectious-disease risk. To support this, researchers should seek to understand whether messaging that reminds people of their own personal experiences with COVID-19, alongside informing about current risk, increases perceived temporal proximity and, in turn, engagement with preventative healthcare. However, it is also important to consider whether overemphasising or relying on constant crisis framing could potentially lead to fatigue, overwhelm, or mistrust, and therefore disengagement.

In designing public health communication, it may be useful to consider message framing in terms of construal level. Saxton et al. [25] suggest that when a health threat feels psychologically distant, people respond more to high-level, purpose-focused “why” messages, whereas proximal threats may be better supported by concrete, action-focused “how” messages. Their findings indicate that “why” focused messages were generally more persuasive for COVID-19 vaccination, although Milkman et al. [53] found that combining both “why” and “how” elements was most effective for annual flu vaccination. Applying this distinction to temporal proximity may help tailor communication strategies to how individuals are processing the threat.

Future research should examine how temporal cues can be incorporated into communication strategies, and whether doing so enhances engagement with preventative healthcare. It will also be valuable to explore how temporal proximity interacts with other psychological distance domains and how it relates to individual and contextual factors that shape vaccination decisions. Such work could help identify when and for whom particular communication approaches are most effective.

4.2. Strengths and limitations

There are various limitations of this work, namely that it utilises a cross-sectional, correlational design, and therefore cannot provide causal evidence for the relationships observed. Because temporal ordering and causality cannot be established, alternative explanations (including reverse associations or shared underlying factors) remain plausible. In addition, intentions do not necessarily translate into action, meaning this study cannot conclude that temporal proximity has an impact on vaccination behaviour. Longitudinal research would help to strengthen and extend the interpretation of these findings. Similarly, that temporal proximity was assessed using a single retrospective item may not fully capture the underlying psychological construct. Nevertheless, the measure of future COVID-19 vaccination intention used here offers valuable insight into individuals' current views and their potential responses in the event of a future outbreak, which is particularly relevant given that there is not currently an ongoing COVID-19 pandemic from which to observe real-world behaviour. This information can support advance public health planning and preparedness. The study also benefits from a large sample size that is broadly representative of the UK population in terms of age, gender, and ethnicity, which enhances the generalisability of the results. Unfortunately, while ethnicity information was used by Prolific to apply demographic quotas, it was not collected alongside study data and so could not be reported or analysed. Given evidence that ethnically minoritised groups may be less likely to engage in vaccination, contributing to health inequalities in disease outcomes [54,55], future research should examine whether temporal proximity relates to vaccination behaviour differently across groups.

5. Conclusion

In this cross-sectional, correlational study in the UK, conducted five-years on from when the pandemic was officially declared to have begun, greater perceived temporal proximity associated with a higher likelihood of intending to receive a COVID-19 vaccine in the future. There was also evidence of a significant indirect association via anxiety about COVID-19, with greater perceived proximity associated with higher anxiety, which in turn was associated with greater intention to be vaccinated. Additional predictors included perceived vulnerability to COVID-19, and trust in government. These findings are largely in-keeping with prior work, which highlights other forms of proximity as influencing threat perception and behavioural intentions. These findings also build on experimental work showing that temporal proximity relates to preventative healthcare behavioural intentions, by showing a similar relationship within a real-world context. Construal Level Theory

is used to enhance interpretation of the results, alongside the Health Belief Model. The observed indirect association via anxiety, considered alongside these two frameworks, is discussed as a potential affective pathway through which perceived temporal proximity may relate to COVID-19 vaccine intention. Future research should consider which factors influence perception of temporal proximity, the content and framing of public health strategies, how temporal proximity relates to and interacts with other types of proximity to influence vaccination behaviour, and examine further the potential emotional response mechanism underpinning the proximity – intention relationship. Finally, researchers should use longitudinal paradigms to investigate the potentially causal nature of these relationships.

CRediT authorship contribution statement

Anna Powell: Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation, Conceptualization. **Halina Suwalowska:** Writing – review & editing. **Osman Sankoh:** Writing – review & editing. **Chunlan Guo:** Writing – review & editing. **Emily Ying Yang Chan:** Writing – review & editing. **Sharifah Sekalala:** Writing – review & editing. **Laura Salisbury:** Writing – review & editing. **Patricia Kingori:** Writing – review & editing, Funding acquisition. **Cara Wilkins:** Supervision, Project administration. **Ruth Ogden:** Writing – review & editing, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Patricia Kingori reports financial support was provided by Wellcome Trust. Ruth Ogden reports financial support was provided by Wellcome Trust. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2026.128717.

Data availability

Data is available on the LJMU open access data repository [https://doi.org/10.24377/LJMU.d.00000275].

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