

Teacher vaccinations enhance student achievement in Pakistan: The role of role models and theory of mind

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We provide experimental evidence that role models can galvanize prosocial actions amid global crises, exemplified by the COVID-19 pandemic. In a randomized control trial comparing role models, cash incentives, and celebrity endorsements, only role models successfully mitigated vaccine reluctance and ameliorated pandemic-induced educational setbacks. Monthly tracking of vaccination status was achieved via QR-code-verified certificates. Theory-of-mind behavioral data on the mentalizing of others shed light on the mechanism underlying the role model effect. This research, from Pakistan, suggests how role models and theory of mind have the potential to play a role in tackling global challenges.

COVID-19 vaccination | role models | celebrity | theory of mind

Influence and authority exerted by role models can have profound implications for global challenges. Public skepticism can pose a substantial hurdle to resolving such crises, with a significant number of individuals choosing to disregard advice or expert guidelines, despite their efficacy (1). This problem escalates when public figures and celebrities, seen as role models, abstain from endorsing these recommendations or even actively discourage prosocial actions with positive externalities (2, 3).

Despite advancements in global vaccination efforts, vaccine hesitancy remains a critical challenge, not just for COVID-19 but for various other vaccines as well. This paper provides experimental evidence that role models can be effectively leveraged to enhance vaccine uptake and mitigate hesitancy. Our study, conducted in the context of the COVID-19 pandemic, offers broader insights applicable to vaccine campaigns worldwide. We examine how role models, cash incentives, and celebrity endorsements impact vaccination behaviors, providing valuable lessons for public health strategies beyond the pandemic era.

In this paper, we provide experimental evidence that role models may be leveraged to reduce vaccine hesitancy and mitigate COVID-19-related learning losses. We implement a randomized control trial among teachers in Pakistan to test the efficacy of conditional cash transfers (4–6), role models (7–10), and celebrity appeals (11) to spur COVID-19 vaccinations. In our intervention, the three treatment arms involve varying intensities of monetary incentives amounting up to 30% increases in monthly wages of teachers. Two treatment arms involve a role model and celebrity delivering a targeted message to get the COVID-19 vaccine. Each of these treatment arms had strong ex ante reasons to work, in light of the large body evidence on conditional cash transfers, role models, and celebrity appeals. A final treatment arm involves the role model delivering a placebo lecture unrelated to vaccination. To ensure comprehensibility and reinforce the message of the treatment, each treatment is accompanied by an individual one-on-one structured discussion with our enumerator, building on recent studies advocating discussions as an effective medium of persuasion (see, e.g., ref. 12).

In our study, we employ a unique blend of behavioral and administrative data, specifically QR-validated COVID-19 vaccination certificates, alongside the Reading the Mind in the Eyes Test (RMET), to decipher the underlying mechanisms of our treatment effects. This approach builds on the work of Weidmann and Deming (13), who validated the RMET as a measure of social intelligence. The RMET, developed by Baron-Cohen et al. (14), involves showing participants photographs of eyes, focusing exclusively on the eye region. Participants are then tasked with identifying one of four emotions that best corresponds to the expression in each image. This test not only assesses the participant's ability to recognize emotions in others but also evaluates their capacity to infer others' mental states. The RMET is particularly valuable due to its definitive right or wrong answers, its high test–retest reliability, and its efficiency and reliability in administration, as highlighted by Pinkham et al. (15).

Significance

Despite advancements in global vaccination efforts, vaccine hesitancy remains a major obstacle, impacting not only COVID-19 vaccination campaigns but also the acceptance of other vaccines. This paper investigates how to increase teacher vaccination rates in a developing country, highlighting the effectiveness of role models while noting the ineffectiveness of cash incentives. Our experimental findings show that the role model treatment significantly boosted vaccination rates, mediated by teachers' empathy as measured by the Reading the Mind in the Eyes Test (RMET). This led to reduced teacher absenteeism and improved student performance. Our research offers insights into leveraging social influence and empathy to enhance vaccine acceptance, with broad implications for vaccination strategies in the Global South.

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The authors declare no competing interest.

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Our results indicate a substantial impact of role models on teachers' vaccination status as verified by their COVID-19 certificates. A year after the treatment, the teachers assigned to the role model delivering a targeted message about getting vaccinated were 18% more likely to get vaccinated. These effects are qualitatively significant and indicate a persuasion rate of about 20% (16). To put this magnitude into perspective, the effect sizes are roughly equivalent to exposure to Fox News on Republican vote share in Presidential elections (17) or the impact of get-out-to-vote phone calls on voter turnout in the United States (5). The role model-treated teachers are also 0.5 sigma less likely to be absent in the following academic year, and their students see a rise in test scores across all subjects in national assessments: a 0.11 sigma increase in mathematics, 0.15 sigma increase in English Language, 0.13 sigma increase in General Knowledge, and a 0.14 sigma increase in Urdu Language test scores. In contrast, cash incentives and celebrity treatments have no statistically discernible impact on teacher's vaccinations or students' test scores. The ineffectiveness of cash incentives on actual vaccinations contrast with a recent study documenting their effectiveness in a developed country (7) and is more in line with recent meta-analysis on the impact of financial rewards on intention to vaccinate (18, 19). Our findings are more consistent with the hypotheses that cash incentives can fail or even backfire by crowding out prosocial behavior (20, 21). The results are robust to multiple hypothesis testing, providing evidence that our findings are not driven by false positives, strengthening the reliability of our findings. Our study shows, therefore, that one way to ameliorate learning losses due to global disruptions such as the COVID-19 pandemic may be an effective teacher vaccination campaign.

We next leverage the information on the timing of vaccination through the certificates, detailed teachers' absenteeism data, and student mathematics test scores available for up to 18 mo posttreatment to trace the dynamic impact of the treatment on monthly outcomes. The dynamics clarifies the mechanism explaining the rise in test scores. In the months after the treatment, we see the impact of role model gradually increasing the vaccination rates and student test scores, while it lowers teacher absenteeism. The dynamic pattern of teacher absenteeism being impacted after vaccination spikes is consistent with a recent study finding a lag of about 2 mo between getting vaccinated and developing immunity for COVID-19 (22). Significantly, the effects on teacher absenteeism are exclusively seen in cases of lengthy absences (that is, consecutive absences lasting over 7 d), as opposed to shorter ones. This suggests that it is likely the contracting of COVID-19, which typically results in a more prolonged sickness, that is responsible for these findings. As vaccination becomes widespread, the effect of role model messaging diminishes for vaccination and absenteeism, but the impacts on student achievement persist, consistent with lasting impacts of teacher absenteeism on student learning.

To explore whether the ability to empathize with the gender identity of the role model enhanced the role model effect, we examined the RMET by gender of eyes. Previous research has documented that female role models play an especially important factor in explaining education outcomes and economic decisions (8–10, 23). We hypothesized that teachers who are better able to empathize with the female role model will be disproportionately impacted by the role model treatment. We contribute to the prior literature on role models by unpacking the mechanism. We show that the role model effect is mediated through the mentalizing of others (13). The teachers who better identify the mental states in female eyes are more impacted by the role model treatment. In contrast, teachers' better identification of emotions in male eyes does not appear to mediate the impact of the role model treatment. In summary, the gathered evidence underscores the significance of mentalizing or understanding others' perspectives, which fosters attentive engagement with the information and actions of group members. This level of attention proves advantageous in group settings, thereby fostering collective benefits.

Our experiment randomly assigned the treatments among 607 teachers across 52 schools in Pakistan. The randomization at the teacher level provided advantages such as the ability to match an individual teacher to the class and to collect rich granular data such as COVID-19 Vaccination Certificates and data on RMET. Because treatment and control group teachers may interact within a school, we leverage the design to measure spillover effects with some of the control teachers becoming partially treated. We use the random variation in treated teachers across schools to find that the treatment effect on vaccinations essentially identical as more teachers get treated within a school. Restricting to the sample of control teachers, the fraction of treated teachers in a school also does not yield significant estimated spillover effects. These patterns suggest that, information spillovers are a key part of the success of the treatment (see, e.g., ref. 12).

Considering the nature of the setting, time frame, and choice task, we examined natural measures such as actual vaccinations. In terms of scaling our intervention in other settings, the intervention was cheap to deliver. It may also be scaled to other decision-makers such as teachers in South Asia. The selection mechanisms and training are similar to many other developing countries, especially India and Bangladesh, which, like Pakistan, have similar public school teachers based on a hiring system that was inherited from the British during Colonial rule. Pakistan, India, and Bangladesh alone consist of more than a quarter of the world's population, making this study particularly relevant for a large number of people. However, we view these results as a WAVE1 insight, in the nomenclature of ref. 24, and replications need to be completed in future research to assess external validity of this research.

Our research contributes to four key literatures. First, it contributes to the literature on vaccine hesitancy that has emerged as a global phenomenon amid COVID-19 (1). Recent scholarship is mixed on optimal ways to reduce vaccine hesitancy. Dai et al. (25) found that timely nudges to get vaccinated increase vaccine uptake, while Rabb et al. (26) document that these very same messages do not stimulate vaccine demand and argued that the earlier result merely accelerated vaccination among those who were already intending to get vaccinated. In contrast, Brewer et al. (27) find that monetary incentives increase vaccine uptake, though Jacobson et al. (18) and Jilke et al. (20) in a randomized control trial of 42,000 individuals conclude that they do not.[†] Jilke et al. (20), like Bénabou and Tirole (21), hypothesize that incentives can fail or even backfire by crowding out prosocial behavior. These studies are important but their lessons may be more relevant to countries in the Global North. In addition, different from past studies, our study focuses on primary school teachers who may act as role models for the students that they teach and are known to have a substantial impact on student learning and future labor market outcomes (28). We further are able to measure and observe student learning outcomes and link teachers to students at the classroom level. Our results suggest that targeted messaging by role models may be an effective tool for overcoming vaccine

^{*}RMET scores participants on their ability to recognize mental states of others as expressed by human eyes. Initially, overall RMET, i.e. without split by gender of eyes, was preregistered within the AEA RCT Registry ID AEARCTR-0008084, and we decided to investigate whether the effect if heterogeneous in gender in the process of collecting data and in light of the result on female role model we found. This deviation from this pre-registration is further discussed in the of *SI Appendix*, Appendix S3.

[†]Interestingly, (20) note that policymakers believed that incentives would increase vaccination rates by 15%.



Fig. 1. Impact on full vaccinations. *Note*: The figure above presents the fraction of teachers who got two doses of COVID-19 vaccination as ascertained by their COVID-19 certificate, by their treatment status, 12 mo posttreatment. Lottery is the average for the group of teachers given Lottery treatment, i.e., opportunity to win a "lucky draw" of 10 times her monthly salary; Cash 15% stands a cash award equivalent to 15% of teachers' monthly salary, while the Cash 30% stands for the randomly assigned group of teachers has given cash equivalent to about 30% of their monthly salary. Celebrity treatment requests for vaccination by a prominent celebrity. Role Model emphasizes the same message but via the medium of a female role model. Further details on the treatment can be found in *Sl Appendix*, Fig. S2. 95% CI are also presented.

hesitancy in the Global South. This approach is particularly effective among teachers, who, as "motivated agents" (29), are driven more by internal factors like beliefs, values, and duty, rather than external incentives. Teachers, influenced by respected role models, might internalize vaccination as a facet of their professional identity and commitment to student welfare. This internalization contrasts with monetary incentives, which could be perceived as undermining their intrinsic motivation. Moreover, our study demonstrates the type of message a role model could deliver to successfully reduce vaccine hesitancy. First, the role model encourages teachers to get vaccinated, motivating this decision by emphasizing that vaccination is important for the safety of both teachers and their students, for which teachers supposedly should be concerned: "Right now, I am addressing all the teachers of Progressive Education Network. I request you all to please, please get Covid-19 Vaccination as this is really important for your safety as well as for all your students." To further persuade the teachers about the safety of the vaccine, the role model mentions that she and all of her family members are fully vaccinated: "I myself am fully vaccinated along with all my family members." Finally, the role model explicitly assures teachers that the vaccine is not harmful and advises them not to trust sources that claim otherwise: "please do not fall for any misinformation or rumor, this vaccination is completely safe and is for our own protection."[‡] In conclusion, our study provides evidence from a randomized trial conducted in the Global South using administrative data on vaccination certificates to examine vaccine uptake-addressing a gap in existing literature, such as ref. 11, which faced limitations in tracking actual vaccinations. This methodological advancement allows for more precise observations and interpretations, particularly regarding the role of educators as pivotal agents in vaccine advocacy.

Second, we contribute to the important literature on teacher absenteeism, a widespread phenomenon in developing countries where nationwide surveys have documented up to 25% of teachers being found absent from classes during regular school hours (30, 31). Randomizing teacher absences for estimating causal effects is challenging. In our experiment, we are able to ascertain the causal effects of teacher absenteeism on student achievement. Instrumental variables estimate would suggest that one SD increase in teacher absenteeism reduces student achievement by 0.6 SD. Put differently, we found that role model messaging reduced teacher absenteeism by 20% and raised student test scores by 0.15 SD. Our reduced form results are larger than the effect of the only other randomized trial we are aware of ref. 32 where 50% reduction in teacher absenteeism achieved with monitoring technology and financial incentives led to student achievement increasing by 0.17 SD. These estimates should be interpreted with caution as the role model treatment may have direct effects through teacher behavior or COVID-related student behaviors.

Third, we build on a burgeoning literature on trust in healthcare (33). Recent research has indicated that disparities in healthcare outcomes may be attributed to identity of the health-care deliverer with ref. 34 documenting that racial identity of care-giver is a crucial determinant that explains the gap in mortality between black and white males. It is pertinent to note that the selection of the female role model was predicated on the anticipated perception of her as a role model by teachers rather than her celebrity status, the message was the same, and we are limited by the number of messaging treatments and the fact that ex ante, the treatments we used were at equipoise as to their potential effectiveness. Our findings suggest that in low trust societies, the perceived legitimacy of an information source can alter behavior when large cash transfers that may even exceed 30% of wages do not.

Finally, our study also builds on the rich literature of social influence, particularly focusing on the seminal work of Kelman (35), who identified three processes of social influence: compliance, identification, and internalization. Compliance refers to the change in behavior due to direct social pressure, identification involves adopting behaviors to establish or maintain a relationship with a person or group, and internalization is when an individual accepts the influence because it is congruent with their own values and beliefs. In our intervention, the video featuring the role model leverages compliance through direct appeals and identification by presenting a relatable figure whom teachers aspire to emulate. Recent studies, such as ref. 36, further explore these concepts within prosocial behavior settings. Their research highlights the importance of social frameworks in shaping behaviors, providing empirical evidence on how social influence mechanisms can effectively promote prosocial actions. Additionally, ref. 37 demonstrates that messages from health professionals, who serve as role models, can reduce COVID-19 travel and infections, emphasizing the critical role of credible sources in health behavior interventions. Azevedo et al. (38) found that messages from plausible role models, such as well-respected academics, improved various health behaviors, further supporting the relevance of role models in public health campaigns. There is also a vast literature on the effectiveness of nudges in shifting vaccination behavior and intentions. Ref. 27 provides a comprehensive review of this literature, highlighting which interventions are effective in increasing vaccine uptake. Much of this literature focuses on intentions to vaccinate rather than actual behavior. Our study contributes to this body of work by providing evidence on the impact of different interventions on actual vaccination behavior, verified through QR-validated COVID-19 vaccination certificates.[§] Taken together, these insights are directly relevant to our study, as we investigate the

⁺The picture, transcript, and video recording of the role model treatment can be found in *SI Appendix*, Fig. S2's panel *B*.

⁶Several studies, including (39–41), have relied on self-reported vaccination data rather than vaccination certificates. While this approach serves as a useful initial step, the interpretation of the resulting evidence remains uncertain due to potential discrepancies between reported and actual vaccination statuses.

Table 1. Impact on vaccinations in levels

	Fully vaccinated				
	(1)	(2)	(3)	(4)	(5)
Lottery	-0.066	-0.070	-0.062	-0.070	-0.061
2	(0.066)	(0.065)	(0.067)	(0.065)	(0.066)
Cash 15%	-0.037	-0.028	-0.037	-0.025	-0.033
	(0.065)	(0.065)	(0.065)	(0.066)	(0.065)
Cash 30%	0.026	0.029	0.029	0.030	0.033
	(0.066)	(0.065)	(0.066)	(0.065)	(0.065)
Celebrity	-0.002	-0.0002	-0.001	-0.001	0.0002
	(0.065)	(0.065)	(0.065)	(0.066)	(0.065)
Role model	0.177**	0.094	0.187***	0.101	0.155**
	(0.071)	(0.070)	(0.072)	(0.070)	(0.069)
Role model X Female RMET		0.105**		0.098*	
		(0.048)		(0.052)	
Role model X Male RMET			0.008	0.057	
			(0.052)	(0.050)	
Role model X Overall RMET					0.138**
					(0.056)
Female RMET		0.061***		0.070**	
		(0.022)		(0.028)	
Male RMET			0.022	-0.015	
			(0.021)	(0.027)	
Overall RMET					0.042**
					(0.020)
Individual teacher controls	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	607	607	607	607	607
R-squared	0.160	0.195	0.162	0.197	0.184
Mean dependent var	0.314	0.314	0.314	0.314	0.314

Note: Robust SE appear in brackets (clustered at the teacher level). The dependent variable switches on if the teacher has taken two doses of COVID-19 vaccination as ascertained by their COV-ID-19 certificate, measured 12 mo after the treatment. Lottery is a dummy variable that switches on when the teacher has given Lottery treatment, i.e., opportunity to win a "lucky draw" equivalent to about 10 times teachers' monthly salary. Cash 15% stands a cash saward equivalent to 15% of teachers' monthly salary, while the Cash 30% stands for dummy switches on when the teacher has given cash equivalent to about 30% of her monthly salary. Celebrity treatment requests for vaccination by a prominent celebrity. Role Model delivers the same message but via the medium of a female role model. RMET reports the total number of correct answers to a total of 20 questions, each of which asks "What emotion are the eyes showing?" on different pictures of male and female eyes. This is also standardized to mean zero and 50 one. The teacher-level controls include all teacher characteristics reported in Table 2. A triple asterisk signifies a *P*-value of less than 0.05, and a single asterisk marks a *P*-value of less than 0.10. ***P < 0.01, **P < 0.05, *P < 0.1.

impact of a female role model in encouraging COVID-19 vaccinations among teachers in Pakistan.

The rest of this paper is organized as follows. In Section 1, we discuss the background, ethics, and design of the experiment. Section 2 report the results of impact on vaccinations of teachers and learning outcomes of students, while Section 3 reports evidence for the mechanism and dynamics of the treatment effects. Section 4 provides some concluding remarks. Section 5 provides materials and methods used in the study. Additionally, *SI Appendix*, Appendices U and V describe the data and report a series of robustness checks, respectively.

1. Background, Ethics, and Experiment Design

1.1. Background. We collaborate with the Progressive Education Network (PEN), a network of schools, that aims to improve the quality of education via a public–private partnership similar to charter schools in the United States (42). These schools are privately managed using public funds, in a public–private partnership. We implement a randomized evaluation in all

of PEN's charter schools in the State of Punjab, the largest province of Pakistan, where the network "adopts" 52 schools, employs 607 teachers, and has roughly 15,000 students. All treatments were rolled out in August 2021, with the baseline data collected 6 mo before treatment (February 2021), midline 12 mo (September 2022) posttreatment, and endline 18 mo posttreatment (March 2023), respectively. The students' test scores are from standardized exams held 12 mo following the treatment. For mathematics, we have test scores for 6, 12, and 18 mo after the treatment, and vaccinations and absenteeism data are available at the monthly level up to 18 mo posttreatment. The evolution of vaccinations is ascertained by the dates on the vaccination certificates. A typical official COVID-19 certificate is presented as *SI Appendix*, Fig. S1. This allows us to trace the dynamic effect of the treatments.

1.2. Deviation from Preregistration. Preregistration for the main experiment was registered with the American Economic Association's registry for randomized controlled trials (AEARCTR-0008084). *SI Appendix*, Appendix S3 reports and discusses the deviations from the preregistration.



Fig. 2. Impact on student test scores—standardized. *Note*: The figure reports coefficient estimates corresponding to the Role Model Treatment based on specification (43) with all controls reported. The dependent variables are standardized to mean zero and SD for test scores in Math, English, General Knowledge, and Urdu scores from regular examinations held 12 mo following the treatment. Controls include all individual characteristics. 95% confidence bands are also reported. Table-form representation of this figure with coefficient estimates on all other treatments is reported in *SI Appendix*, Table S7.

1.3. Research Ethics Approvals. Our study protocols were reviewed and approved by Institutional Review Boards. Earlier, we had also received separate administrative approvals from the PEN administration, and teacher representatives and consent from individual teachers and caregivers of students.⁹

1.4. Study Design. Using a random number generator, we randomly assigned 607 teachers to one of the following treatment arms: i) Cash 15% treatment (101 teachers); ii) Cash 30% treatment (101 teachers); iii) Cash Lottery treatment (101 teachers) iv) Celebrity treatment (101 teachers), v) Role Model treatment (101 teachers), and vi) the control or placebo treatment on macroeconomics of equal length to celebrity and role model treatment and was delivered by the same person delivering the role model treatment (102 teachers).

1.5. Treatment Logistics. The treatments were delivered to the teachers according to their treatment status via prerecorded videos live on Zoom. PEN administration organized classrooms for the teachers in their district, where they could access Zoom. Our team of field assistants shared their screen to show the recorded video to each individual teacher according to her treatment status. Specifically, according to each teacher's treatment status, first, a video recording was shown live by a field assistant to the individual teacher on Zoom by sharing their screens. These videos are hyperlinked in SI Appendix, Figs. S1 and S2. The video treatment was followed by a 20-min individual structured discussion between the teacher and the field assistant. Particularly, each video was followed by the field assistant asking the following questions: Q1. What do you think was the main message of the video? Q2. Did you find the video useful? Q3. How can you apply the video lessons in your life? The recording of the video on Zoom was also disabled and we gave explicit instructions not to communicate the contents with fellow teachers. We also gave explicit instructions for teachers to be alone in the room during the intervention and our team of field assistants was able to interact with teachers one-on-one on Zoom and finish the treatment roll out within two days.

[¶]The consent statement that we administered can be found in *SI Appendix*, Appendix S2.1.

1.6. Cash 15%, Cash 30%, and Lottery Treatments. In the first two treatment arms, the teachers are randomly assigned to receive a cash incentive equivalent to 15% and 30% of their monthly salary if they got the COVID-19 vaccine. In the first treatment arm, it was announced: "We offer a one-time cash award of 15% of teachers" monthly salary (US\$7.5) for those teachers getting the COVID-19 vaccine. For teachers getting vaccinated after this announcement, please present proof of your vaccination via the official COVID-19 *certificate to the PEN administration.*" In the second treatment arm, we offer a one-time cash award of 30% of teachers' monthly salary (US\$15) for those teachers getting the COVID-19 vaccine, we announce "For teachers getting vaccinated after this announcement, please present proof of your vaccination via the official COVID-19 certificate to the PEN administration." In the lottery treatment arm, the teachers are randomly assigned with an opportunity to win a cash award through a "lucky draw." Those who get vaccinated after our treatment are eligible for the lottery. In this treatment arm, it is announced: "those getting vaccinated after this date, please share your certificates with us and become part of this lottery and get the opportunity of winning a 500 USD Cash prize." Each teacher in this treatment arm had an equal probability of winning the lottery, hence the expected winnings are approximately US\$5. SI Appendix, Figs. S1.1 and S1.2 provide the complete video announcements made in this treatment arm with subtitles in English, while in SI Appendix, Appendix S2.2, we provide a transcript of structured discussion questions that followed the video announcements of the treatments.

1.7. Celebrity Treatment. In this treatment arm, a prominent Pakistani newscaster and journalist, Mr Iqrar-ul-Hassan makes a personalized appeal to the PEN teachers to get the COVID-19 vaccine. The message urged the teachers that the COVID-19 vaccine is safe and effective, that the celebrity himself, his siblings, and parents are all vaccinated against COVID-19. The video message ends by Mr Iqrar making an appeal to all PEN teachers to get vaccinated as soon as possible. The picture, transcript, and video recording of the celebrity treatment can be found in *SI Appendix*, Fig. S2's panel *A* and its corresponding note in the *SI Appendix*, Appendix S1.[#]

1.8. Role Model Treatment. In the role model treatment group, the exact message of the celebrity is repeated but it is now delivered by a female role model. Specifically, the role model is someone the teachers look up to, a young professor at an elite private university in Lahore, Pakistan. This role model was chosen following three 30-min auditions of three role models (2 females and one male) with a random sample of 17 PEN teachers where we assessed who the teachers are most likely to look up to. Specifically, we ask the 17 teachers to choose one of the three auditioners after a 15-min presentation by each of them. The specific question was Who among the three presenters would you be most likely to consider as a role model? We selected the auditioner that received the most votes." Our chosen role model holds a Ph.D. in Economics from Rotterdam Erasmus University and has enjoyed a highly successful career in academia. She served as a researcher at Oxford University. Importantly, the chosen role model was particularly fit to our study's target demographic-teachers. Many of these educators aspire to pursue higher studies, making our role model particularly apt and relatable to the sample under study. Her academic journey

 $^{^{\#}}$ To get an idea about the celebrity's popularity, he, for instance, has 6.4 million Twitter followers, see e.g., his Twitter (hyperlinked).

^IThe chosen role model received 16 out of 17 votes, making her a clear winner.

Table 2. Balance over teacher characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	Pretreatment COVID vaccination	Av. teaching hours	Av. class size	Teaching experience	Years of education	Educational specialization
Lottery	-0.038	-0.265	0.187	-0.055	-1.394	-0.583*
2	(0.034)	(0.398)	(0.222)	(0.066)	(2.783)	(0.354)
Cash 15%	-0.020	-0.381	-0.001	0.022	-1.801	-0.450
	(0.034)	(0.427)	(0.221)	(0.067)	(2.898)	(0.275)
Cash 30%	-0.001	-0.549	0.212	-0.017	-0.495	-0.286
	(0.036)	(0.384)	(0.208)	(0.064)	(2.949)	(0.369)
Celebrity	-0.053	0.116	0.157	-0.049	1.503	0.132
5	(0.035)	(0.417)	(0.213)	(0.064)	(2.950)	(0.425)
Role model	-0.027	-0.234	0.338*	0.007	-1.124	-0.314
	(0.041)	(0.433)	(0.195)	(0.066)	(2.938)	(0.440)
Individual controls and school FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	607	607	607	607	607	607
R-squared	0.094	0.155	0.128	0.101	0.122	0.083
F-statistics	0.675 [0.643]	0.732 [0.600]	0.892 [0.486]	0.461 [0.805]	0.301 [0.912]	1.185 [0.315]
Mean of dependent var	0.088	4.706	12.549	0.255	25.275	30.490

Note: Robust SE appear in brackets (clustered at the teacher level). The dependent variables in Panel A are pretreatment vaccination status dummy, teaching experience which is the years of teachers' education, Educational Specialization, which is a dummy variable that switches on when a teacher has obtained pedagogical specialization. Av. Class Size is the average number of students a teacher teaches in each class and Av. Teaching Hours is the total number of teaching hours per week. Lottery is a dummy variable that switches on when the teacher has given Lottery treatment, i.e., opportunity to win a "lucky draw" equivalent to about 10 times teachers' monthly salary; Cash 15% stands a cash award equivalent to 15% of teachers' monthly salary, while the Cash 30% stands for dummy switches on when the teacher has given cash equivalent to about 20% of her monthly salary. Celebrity treatment requests for vaccination by a prominent celebrity. Role Model delivers the same message but via the medium of a female role model. A placebo group is assigned an equal length message unrelated to COVID-19 vaccination via the same female role model. The *P*-value for testing the joint significance of all treatments is reported in square brackets next to the value of the F-statistic. **P < 0.01, **P < 0.05, *P < 0.1.

and accomplishments appeared to resonate with teachers in our interviews who aspire to advance their education and careers. The role model urged the teachers that the COVID-19 vaccine is safe and effective, that she, her siblings, and parents all got the vaccine. Identical to the celebrity message, this treatment arm also ends by making an appeal to all PEN teachers to get vaccinated as soon as possible. The transcript and links to the video recording of actual role model treatment can be found in *SI Appendix*, Fig. S2 of panel *B*.

1.9. Placebo. The placebo group gets a lecture of equal length as the role model and celebrity treatment, on macroeconomics. The message is delivered by the *same female role model* but this time with no mention of COVID-19 vaccination. Specifically, the lecture provides brief explanations of macroeconomic concepts such as GDP, GNP, unemployment, savings, and investments.

2. Main Results

2.1. Impact on Vaccinations. Our results indicate that the role model treatment had a qualitatively and statistically significant impact on vaccinations as verified by the teachers' COVID-19 certificates. From Fig. 1, we observe that one year after the treatment, about 50% of the teachers are fully vaccinated in the group assigned the role model treatment, relative to about 30% in the placebo group. This is particularly interesting since the same person delivered the role model and placebo treatment. Column (1) of Table 1 reports these results in regression form with the addition of individual-level controls. The coefficient estimate implies that role model—treated teachers are 18% more likely to

get vaccinated. These results are also summarized in *SI Appendix*, Fig. S4. In our discussion of mechanisms, we will delve into the dynamic effect of the treatment, specifically examining its impact on a month-to-month basis. *SI Appendix*, Table S1 displays the means across treatment conditions. The fraction of individuals who received the first dose is comparable across all treatment conditions. This can be attributed to the random assignment of teachers within schools and the centralized organization of transportation for the first dose. Therefore, teachers had little discretion in the decision to receive the first dose. The effects observed in the study pertain to the decision of becoming fully vaccinated.

2.2. Heterogeneity by Gender of Eyes. The effect of role models on vaccinations is more pronounced on teachers who better identify with the gender of the role model. We hypothesized that since all PEN teachers are female, the teachers who are better able to empathize with the gender identity of the female role model as opposed to the male celebrity treatment would be disproportionately impacted by the role model treatment. We, therefore, preregister outcome on the RMET. Estimates from Table 1 suggest that the results are largely driven by only those teachers who scored high in ascertaining mental states in female eyes in the RMET. Table 1's Column 2 shows that a teacher who scored 1 SD higher in Female RMET is about 10% more likely to be vaccinated due to the role model treatment. Column 3

^{**}Using the formula for persuasion rate, in (16), we obtain persuasion rate (f) = 21.7%. We used data from 5/ Appendix, Table S1 and the pretreatment vaccinations from Table 1 to make this computation. The formula for persuasion rate is as follows: $f = 100 * (Y_T - Y_C)/(e_T - e_C) * 1/(1 - Y_O)$. Specifically, Y_T (successful vaccinations in the Treatment group) = 52, Y_C (successful vaccinations in the Control group) = 32, e_T (size of role model treatment group) = 101, e_C (size of control group who got the treatment = 0, $(1 - Y_O)$ (the fraction of population left to be convinced, i.e., 1 - fraction of people already vaccinated at baseline = (1 - 0.088). This gives Persuasion rate (f) = 100*((52 - 32)/(101))(1/0.912) = 21.7%.

	Teachers' absenteeism			
	(1)	(2)	(3)	(4)
Lottery	-0.180	-0.172	-0.187	-0.173
	(0.136)	(0.135)	(0.136)	(0.136)
Cash 15%	-0.122	-0.139	-0.119	-0.138
	(0.134)	(0.135)	(0.134)	(0.136)
Cash 30%	-0.128	-0.135	-0.132	-0.135
	(0.139)	(0.138)	(0.140)	(0.138)
Celebrity	-0.170	-0.175	-0.173	-0.175
	(0.135)	(0.135)	(0.135)	(0.135)
Role model	-0.487***	-0.284**	-0.487***	-0.286**
	(0.140)	(0.130)	(0.141)	(0.132)
Role model X Female RMET		-0.294***		-0.298***
		(0.102)		(0.109)
Role model X Male RMET			0.088	0.001
			(0.108)	(0.110)
Female RMET		-0.113*		-0.110
		(0.060)		(0.070)
Male RMET			-0.065	-0.006
			(0.053)	(0.061)
Individual teacher controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes
Observations	607	607	607	607
R-squared	0.116	0.157	0.119	0.158

Note: Robust SE appear in brackets (clustered at the teacher level). The dependent variable is the total number of absences recorded after 12 mo posttreatment which is standardized to mean zero and SD one and measured 12 mo following the treatment. Lottery is a dummy variable that switches on when the teacher was assigned the Lottery treatment, i.e., opportunity to vin a "lucky draw" equivalent to 10 times her monthly salary; Cash 15% stands a cash award upon getting vaccinated equivalent to 15% of teachers' monthly salary, while the Cash 30% stands for dummy switches on when the teacher has been given cash equivalent to about 30% of her monthly salary. Celebrity treatment requests for vaccination by a prominent celebrity. Role Model delivers the same message but via the medium of a female role model. A placebo group is assigned an equal length message unrelated to COVID-19 vaccination delivered via the same female role model. RMET reports the total number of correct answers to a total of 20 questions, each of which asks "What emotion are the eyes showing?" on different pictures of male eyes. This is also standardized to mean zero and SD one. The teacher-level controls include all teacher characteristics reported in Table 2. ***P < 0.01, **P < 0.05, and *P < 0.1.

of Table 1 documents that the Male RMET score does not mediate the effect of the role model treatment on vaccination. In contrast, Column 4 suggests that Female and Male RMET capture different soft skills.^{††} Teachers who better evaluate the emotion associated with men's eyes are no more likely to get vaccinated, while those who better evaluate female eyes are more likely to get vaccinated. This suggests a mechanism of these female teachers successfully mentalizing and empathizing more with the female role model –who matches with their gender identity– compounds the effect of the role model treatment on getting the COVID-19 vaccine.^{‡‡}

2.3. Impact on Student Test Scores. We also observe that our treatment spilled over to students and raised their test scores. Fig. 2 and *SI Appendix*, Table S7 in Appendix present these results with our full set of student test scores measured at month 12 posttreatment. The role model–treated teachers have students whose test scores are 0.10 to 0.15 SD higher than the placebo-treated group. To put this in

^{##}*SI Appendix*, Table S6 in Appendix S2 reports the results corresponding to Table 2 in SD.

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perspective, the role model treatment moves a typical B+ student to A-. The teachers in the role model-treated group have students who show improvements in test scores across the board: in Mathematics, English Language, General Knowledge, and Urdu Language standardized tests. The increase in test scores across all available subject domains is suggestive of a global improvement in academic achievement. Since the central aim of our study is to discern which interventions effectively enhance vaccination uptake and impact student test scores, we have adopted an instrumental variable (IV) specification. This approach uses the role model treatment as an instrument for vaccination status, confirmed by a first stage indicated by an F-Statistic of 13.076 which is above the threshold of 10. In the second stage, we examine the impact of teacher vaccination on student test scores. Across the full spectrum of student test scores, our analysis reveals a positive correlation between teacher vaccination and student performance. The findings, as detailed in *SI Appendix*, Table S4, indicate that vaccination is associated with an increase in student test scores by more than half a SD. In the next section, we will analyze the dynamics of the treatment effect for mathematics, for which we have more fine-grained data.

3. Mechanism and Dynamics of Treatment Effects

3.1. Impact on Teacher Absenteeism. We find support for a mechanism explaining this rise in student test scores: teacher absenteeism. The evidence suggests that the role model-treated teachers are about 0.5 SD less likely to be absent relative to the

¹¹When the interaction of Female RMET with each treatment is included in the regression, the RMET score alone does not significantly affect vaccination uptake. This suggests there is no baseline relationship between Female RMET and vaccination status. These results are presented in *SI Appendix*, Table S12 in Appendix S2. However, we do see Female RMET has a significant impact on vaccination for teachers treated with the Lottery and some of the cash treatments. The same role model delivered both the primary intervention and the lottery messages allowing for a clearer attribution of the observed interaction to the role model and the theory of mind mechanism. The observed difference in outcomes between the lottery and some of the direct cash incentives arms could be partly attributed to a crowding-out effect where monetary incentives may diminish intrinsic motivation. Broadly speaking the results reinforce the mechanism that a role model and empathy towards the gender of the role model is what can heighten compliance with norm change.



Fig. 3. Treatment effect on teachers' absenteeism and vaccinations—Levels. *Note:* The figure reports coefficient estimates corresponding to the Role Model Treatment based on specification (43) but at the month level. The dependent variables in panels A and B are teachers' full vaccinations and absences, respectively, recorded monthly. 95% Cl are also reported. Tables 1 and 3 illustrate results at month t + 12 of this figure for all treatments. Both panels present results in levels.

placebo group, 12 mo posttreatment (Column 1 of Table 3). These effects are particularly pronounced in those teachers who scored high in the RMET for female eyes (Column 2 of Table 3). In contrast, teachers who score high for male eyes in the RMET are no more likely to reduce their school absenteeism. This is precisely what we had found for the role model treatment impacting teacher COVID-19 vaccinations. The role model treatment teachers who score high in female RMET scores are more likely to be vaccinated and less likely to miss school. This further supports the idea that teachers who got vaccinated were less likely to miss school and hence had students who performed better academically.^{§§}

3.2. Dynamic Impact on Vaccinations, Absenteeism, and Student Test Scores. We next leverage the exact timings of vaccinations using the dates on vaccine certificates and teacher "attendance registers" that PEN network records to ascertain evolution of absences. This allows us to explore the mechanism underlying increase in student test scores and assess the overtime impact of the role model treatment on teacher vaccinations and absenteeism up to 18 mo posttreatment. Fig. 3 reports the evolution of coefficient estimates of the role model treatment on vaccinations (Panel A) and absenteeism (Panel B). We find that vaccination among teachers gradually rises following the role model message to get vaccinated and peaks at about 6 mo posttreatment. Around the same time, we observe absenteeism falls with the minimum point at month 8, posttreatment. This is consistent with recent evidence that vaccine immunity peaks around 1 to 2 mo postvaccination (22). We interpret these results as vaccinated teachers building immunity against COVID-19 and who are then less likely to be absent. A similar pattern is observed for mathematics test scores for which we have data for 4 exams, 1 exam pretreatment and 3 posttreatment, with each exam held about 6 mo apart. Fig. 4 reports the impact of role model treatment on math test scores. We find that the treatment effects on math scores gradually increase following the treatment." However, unlike the results for vaccinations and absenteeism, the impact on student test

scores appears persistent. This is consistent with recent concerns on the learning losses due to COVID-19 may lead to permanent disparities in learning that may not be easy to reverse with a single policy action (38).

3.3. Additional Evidence for the Mechanism. The results on the dynamics of the treatment effects strongly suggest that the rise in student test scores may be explained by the rise of vaccinations and a fall in teacher absenteeism. Additional evidence supports this interpretation. First, we leverage administrative data on "attendance registers" of teachers at PEN that record teacher absences by reason of absence. We do this to investigate whether the role model treatment impacts teacher absences due to all reasons or only those sought due to catching COVID-19. Table 4 reports these results where we estimate the specification in Column 4 of Table 1 but where we distinguish absences by the reason of absence. We find that only when COVID-19 is explicitly stated as the reason for absence in PEN attendance registers, do we find an effect of the role model treatment. The absences due to other reasons for leaves appear to be unaffected by the role model treatment. These results are further reinforced when we assess the treatment effect by lumpy (more than a week) or short absences (less than a week). These results presented in SI Appendix, Table S8 indicate that the role model treatment effect is almost exclusively driven by lumpy absences, what one would expect for the teacher catching COVID-19 and not being able to attend class. Shorter than a week absences are unaffected by the role model treatment.

3.4. Alternative Mechanism. The rise of test scores following the role model treatment may also be explained by the role model, who is a female, influencing gender norms. For instance, just a message by a role model fosters progressive gender attitudes among teachers, which facilitates learning among boys and girls. The fact that the macroeconomics placebo video message was also delivered by the same role model undermines this hypothesis. Moreover, we draw on data collected on gender attitudes from our recent work (44) and test whether the treatment impacts gender norms. *SI Appendix*, Table S9 reports these results. We



Fig. 4. Impact on students' mathematics scores—standardized. *Note:* The figure reports coefficient estimates corresponding to the Role Model Treatment based on specification (43). The dependent variable is students' Math score every 6 mo, standardized to mean zero and SD one. The record of Mathematics scores is available from six months prior to the treatment, i.e., for (t – 6) till (t + 18), for every semester, roughly lasting 6 mo. Estimates in regression tables are for 12 mo following the treatment. Controls include all individual characteristics. 95% CI are also reported.

⁵⁵SI Appendix, Table S8 reports corresponding results on absenteeism in levels i.e., in terms of days missed.

^{¶¶}To ease comparisons, figures report the results in levels, however, results in SD are reported in *SI Appendix*, Figs. S6 and S7.

	COVID is reason for absence		All other for abs	All other reasons for absence	
	(1)	(2)	(3)	(4)	
Lottery	-0.185	-0.182	0.018	0.015	
	(0.137)	(0.138)	(0.149)	(0.149)	
Cash 15%	-0.159	-0.153	0.069	0.042	
	(0.136)	(0.137)	(0.155)	(0.155)	
Cash 30%	-0.142	-0.138	-0.006	-0.006	
	(0.136)	(0.137)	(0.151)	(0.150)	
Celebrity	-0.184	-0.183	-0.012	0.009	
	(0.133)	(0.134)	(0.150)	(0.149)	
Role model	-0.325**	-0.324**	0.115	0.118	
	(0.133)	(0.134)	(0.161)	(0.159)	
Role model X Female RMET	-0.331*** (0.109)	-0.328*** (0.111)	0.093 (0.108)	0.087 (0.108)	
Role model X Male RMET	-0.012 (0.108)	–0.016 (0.109)	0.066 (0.105)	0.067 (0.103)	
Female RMET	-0.104	-0.105	-0.033	-0.033	
	(0.070)	(0.071)	(0.060)	(0.060)	
Male RMET	-0.003	-0.003	-0.018	0.011	
	(0.059)	(0.060)	(0.056)	(0.056)	
Individual teacher controls	No	Yes	No	Yes	
School fixed effects	Yes	Yes	Yes	Yes	
Observations	607	607	607	607	
R-squared	0.166	0.168	0.061	0.083	

Table 4. Mechanism—impact on teacher's reason for absence—standardized

Note: Robust SE appear in brackets (clustered at the teacher level). The dependent variable in columns (1) and (2) is the total number of absences due to COVID illness and measured 12 mo following the treatment. The dependent variable in columns (3) and (4) is the total number of absences due to other reasons (i.e., marriage, funeral) recorded after 12 mo posttreatment. The dependent variables are standardized to mean zero and SD one. *Lattery* is a dummy variable that switches on when the teacher was assigned the Lottery treatment, i.e., opportunity to win a "lucky draw" equivalent to 10 times her monthly salary; *Cash 15%* stands a cash award upon getting vaccinated equivalent to 15% of teachers monthly salary, while the *Cash 30%* stands for dummy switches on when the teacher was assigned an equal length message unrelated to COVID-19 vaccination delivered via the same female role model. RMET reports the total number of correct answers to a total of 20 questions, each of which asks "What emotion are the eyes showing?" on different pictures of male and female eyes. This is also standardized to mean zero and SD one. *Leter-level* controls include all teacher characteristics reported in Table 2. ****P* < 0.01, ***P* < 0.05, and **P* < 0.1.

find that the role model does not impact our overall composite index of gender attitudes (Column 1), nor do we find statistically significant impact of the role model treatment on the indices' subcomponents: Women's economic, political, and social rights indices are unaffected by the role model treatment.^{##}

4. Conclusions

This paper investigates how to increase vaccinations of teachers in a developing country in a setting that allows us to observe actual vaccination choice, measure important downstream outcomes from getting vaccinated, and explore underlying mechanisms of potential treatment effects. We deploy five treatments in our study: high and low conditional cash transfers, role models, celebrity endorsements,

and lotteries. However, only the role model treatment significantly influenced vaccination behavior. Higher vaccination rates in the role model treatment led to substantial downstream consequences, such as reduced teacher absenteeism and improved student test scores across subjects including mathematics, English, and general knowledge. These results highlight the broader educational and social benefits of increased vaccination rates, which extend beyond mere health outcomes. The effectiveness of the role model treatment appears to be mediated by teachers' ability to empathize with the role model, as measured by the RMET. This test evaluates social intelligence and empathy, which are crucial for understanding and internalizing the messages delivered by the role model. Our findings suggest that empathy and social intelligence play a key role in the influence of role models, providing insights into the psychological mechanisms that underpin persuasion and behavior change in public health contexts.

5. Materials and Methods

5.1. Data Accessibility. The datasets, as well as the associated code, protocols, and materials used during the current study are available via https://doi.org/10.3886/E209533V1.

5.2. Empirical Specification. The impact of our five treatments can be evaluated by comparing outcomes across groups in a simple regression framework. For each outcome, the estimation equation is

$$Y_{i} = \alpha + \beta \operatorname{Cash} 15\%_{i} + \gamma \operatorname{Cash} 30\%_{i} + \delta \operatorname{Lottery}_{i} + \omega \operatorname{Celebrity}_{i} + \theta \operatorname{Role} \operatorname{Model}_{i} + X_{i} \mu + \epsilon_{i}$$
[1]

where Y_i is the outcome for a teacher or student *i*; *Cash* 15%_{*i*} is a dummy variable equal to one if the teacher is assigned to the monetary incentive of 15% of monthly salary as a cash award treatment; *Cash* 30%_{*i*} is a dummy variable equal to one if the teacher is assigned the monetary incentive of 30% of monthly pay cash award treatment; *Lottery*_{*i*} is a dummy variable equal to one if the teacher is assigned the monetary incentive of 30% of monthly pay cash award treatment; *Lottery*_{*i*} is a dummy variable equal to one if the teacher is in the group given the opportunity to participate in the lottery monetary incentive treatment; *Celebrity*_{*i*} and *Role Model*_{*i*} switch on if the teacher is assigned celebrity and role model treatments, respectively; and X_i is a vector of individual-level controls. We cluster SE at the teacher level since that is our level of randomization. In Eq. **1**, β measures the effect of the 15% cash treatment; α the effect of the 30% cash treatment; δ the effect of the lottery treatment; and ω measures the effect of the celebrity treatment.

Data, Materials, and Software Availability. All data needed to evaluate the conclusions of this study are deposited in the public repository openICSPR and accessible at https://doi.org/10.3886/E209533V1 (45). All other data are included in the article and/or *SI Appendix*.

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^{##}For details on the construction of indices, including the survey instrument used *SI Appendix*, Appendices S2.3 and S2.4.

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