



Doctor recommendations and parents' HPV vaccination intentions in Kenya: A randomized survey

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ARTICLE INFO

Keywords:

HPV vaccines
Provider recommendation
Adolescent vaccines
Health communication
Kenya

ABSTRACT

The causal effect of a doctor's recommendation for Human Papillomavirus (HPV) vaccination on parents' decisions in low-resource settings is not well understood. This study investigates how doctors' endorsement of the HPV vaccine communicated through a public health poster affects parents' decisions to vaccinate their daughters in Kenya. In January and February 2021, 600 parents of daughters eligible for the HPV vaccine but not yet vaccinated were recruited and completed a randomized survey. Participants saw a poster from a national campaign about HPV vaccination and either nothing further (Control) or an additional poster containing an HPV vaccine recommendation from a female (FDR) or male doctor (MDR). Primary outcomes are intentions to vaccinate and perceived safety of the HPV vaccine. Both recommendation arms increased the likelihood that participants reported the highest levels of vaccine intentions compared to control (FDR: 33.7% $p = 0.01$; MDR: 30.5%, $p = 0.05$, compared to Control (22.4%)) and safety perceptions (FDR: 24.2%, $p = 0.09$; MDR: 28.0%, $p = 0.01$, compared to Control (17.1%)) but there was no statistically significant increase in the likelihood to report above moderate vaccine intentions (FDR: 72.6%, $p = 0.76$; MDR: 72.5%, $p = 0.77$, compared to Control (71.4%)) or safety perceptions (FDR: 68.9%, $p = 0.91$; MDR: 75.0%, $p = 0.17$, compared to Control (68.6%)). We find no differential treatment effect by the recommending doctor's gender. In conclusion, our results suggest that visual communication of a doctor's support for the HPV vaccine can strengthen above-moderate intentions and safety perceptions but may not be enough to persuade the vaccine hesitant to vaccinate.

1. Introduction

Cervical cancer rates in Sub-Saharan Africa are among the highest in the world (De Vuyst et al., 2013). In Kenya, cervical cancer is the leading cause of cancer deaths for women (Bruni et al., 2019). The Human Papillomavirus (HPV) vaccine, which targets the viral strains responsible for a majority of cervical cancers, represents a cost-effective approach to the prevention of cervical cancer in Sub-Saharan Africa (Ralaivov et al., 2018; Chido-Amajuoyi et al., 2019). The HPV vaccine also prevents against anal, oral, penile, and vulvovaginal cancers (Stratton and Culkin 2016; Dehlendorff et al., 2021; Zhang et al., 2021).

In 2019, the Kenyan government became the eleventh country in Sub-Saharan Africa to include the HPV vaccine in the national immunization package. The vaccine was made available for 10-year-old girls, free of charge at schools and health facilities (Tsu et al., 2021). So far, vaccination rates have fallen well below the target of 800,000 girls vaccinated in the first year, in part due to disruptions arising from the

COVID-19 pandemic. Studies in other Sub-Saharan African countries suggest other barriers may hinder complete vaccine coverage, including stigma, lack of knowledge, and misperceptions about side effects (Black and Richmond 2018).

Doctor recommendations have been found to be a strong predictor of HPV vaccination uptake and trust in the United States (Oh et al., 2021). However, in low resource settings, accessing doctors in local clinics may be logistically difficult or prohibitively costly. Further, ensuring that providers consistently offer HPV vaccine recommendations has proved challenging (Gilkey et al., 2015; Gilkey et al., 2016). A possible approach to obtain the benefits of a doctor's recommendation without the logistical and systemic demands of an in-person visit is through public health communications. We test the effect of this approach on HPV vaccine intentions and perceived safety among parents of adolescent girls in two urban counties in Kenya.

Materials for public health campaigns commonly include recommendations from doctors, but the causal effect of this low-touch

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<https://doi.org/10.1016/j.pmedr.2021.101659>

Received 8 June 2021; Received in revised form 30 November 2021; Accepted 7 December 2021

Available online 9 December 2021

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Table 1
Summary Stats and Balance Tests.

	Percentage or Mean (SE)				p-value from t-test			
	Full Sample	Control (N = 210)	Male Dr. Rec. (MDR) (N = 200)	Female Dr. Rec. (FDR) (N = 190)	Control vs. MDR	Control vs. FDR	MDR vs. FDR	N
Female (1/0)	64%	57%	69%	67%	0.01	0.03	0.73	600
Age	32.84 (0.29)	32.92 (0.50)	33.17 (0.47)	32.39 (0.52)	0.71	0.46	0.27	600
Completed Secondary (1/0)	26%	25%	27%	28%	0.61	0.43	0.78	595
Christian (1/0)	95%	93%	96%	95%	0.10	0.44	0.40	594
Above Median Income (1/0)	45%	47%	42%	44%	0.30	0.56	0.66	600
Resident of Nairobi City (1/0)	80%	81%	81%	77%	0.99	0.26	0.26	600
Likelihood daughter will contract HPV	2.76 (0.04)	2.71 (0.07)	2.74 (0.07)	2.84 (0.06)	0.71	0.15	0.28	595
Likelihood daughter will get cervical cancer	2.72 (0.04)	2.69 (0.07)	2.72 (0.07)	2.75 (0.07)	0.75	0.56	0.80	595
Perceived percent of men with HPV in community	21.72 (1.13)	21.43 (1.84)	21.67 (1.95)	22.11 (2.13)	0.93	0.81	0.88	595
Perceived percent of women with HPV in community	25.21 (1.18)	24.83 (1.94)	26.17 (2.08)	24.62 (2.10)	0.64	0.94	0.60	595
Nairobi County (1/0)	80%	81%	81%	77%	0.99	0.26	0.26	600

Notes: Percentages presented for binary variables and means with standard errors presented for continuous variables. Doctor abbreviated to Dr. and Recommendation abbreviated to Rec. in column headings.

Table 2
Logistic Regression of Treatment Effects.

	Vaccine Likelihood				Perceived Vaccine Safety			
	Very likely, Extremely likely = 1		Extremely likely = 1		Very safe, Extremely safe = 1		Extremely safe = 1	
	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)
Male Dr. Rec. (MDR)	72.5	1.07 (0.69:1.65)	30.5	1.57 (1.01:2.45)	75.0	1.36 (0.88:2.10)	28.0	1.85 (1.15:2.98)
Female Dr. Rec. (FDR)	72.6	1.07 (0.69:1.66)	33.7	1.82 (1.16:2.84)	68.9	1.03 (0.67:1.57)	24.2	1.54 (0.94:2.51)
Control (Reference)	71.4	–	22.4	–	68.6	–	17.1	–
N	600		600		600		600	
Postestimation tests:								
p-value: MDR vs. FDR	0.99		0.50		0.22		0.42	

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval, Dr., Doctor; Rec., Recommendation. Analyses adjusted for female (1/0) and Nairobi county (1/0).

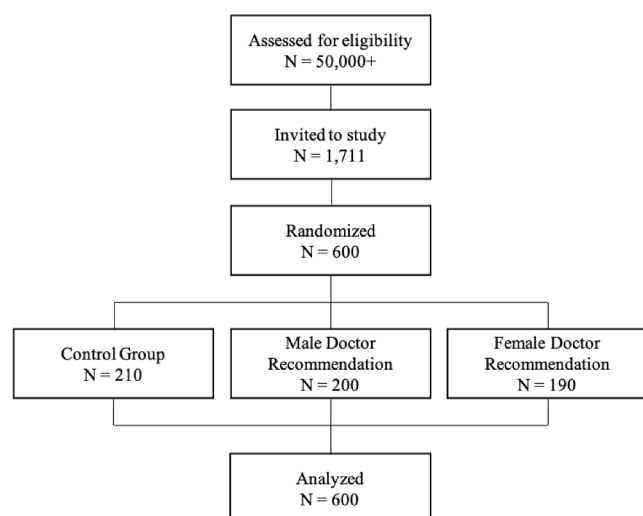


Fig. A1. Study Diagram.

surrogate recommendation has not yet been evaluated. There is causal evidence that in-person recommendations from doctors in the form of an announcement increase HPV vaccine rates in a clinical setting in the United States (Brewer et al., 2017). An in-person recommendation from a nurse practitioner has also been found to increase adult Hepatitis B vaccinations in a similar context (Kasting et al., 2019). These results,

related to work on ‘presumptive consent’ (Opel et al., 2013; Opel et al., 2015), suggest that the mere perception of a healthcare provider’s approval may increase vaccine uptake rates. However, a provider’s recommendation outside of an in-person visit may reduce the attention to or trust in the recommendation. As such, the merits of communicating doctor recommendations through public health messaging are *a priori* unclear.

We present results from a randomized survey run in two predominantly urban counties in Kenya – Nairobi and Nakuru – with parents of adolescent girls who have not yet received the HPV vaccine. We evaluate the impact of a doctor’s recommendation provided in the form of a public health poster against a control group and vary the gender of the doctor to assess if the treatment effect differs by the recommending doctor’s gender.

2. Methods

Eligibility criteria included being over 18 years old, having a daughter aged 8–11 years who has not received the HPV vaccination, owning a smartphone with WhatsApp, and having access to the internet. The study and recruitment took place in January to February 2021 during the COVID-19 pandemic. The smartphone and internet access criteria ensured that we could use remote surveying methods, described in more detail below. We focused on parents rather than adolescents as pre-study qualitative work indicated that parents are the relevant decision makers in this context.

Recruitment methods varied by county. In Nairobi, we recruited respondents from a pool of over 50,000 respondents managed by the

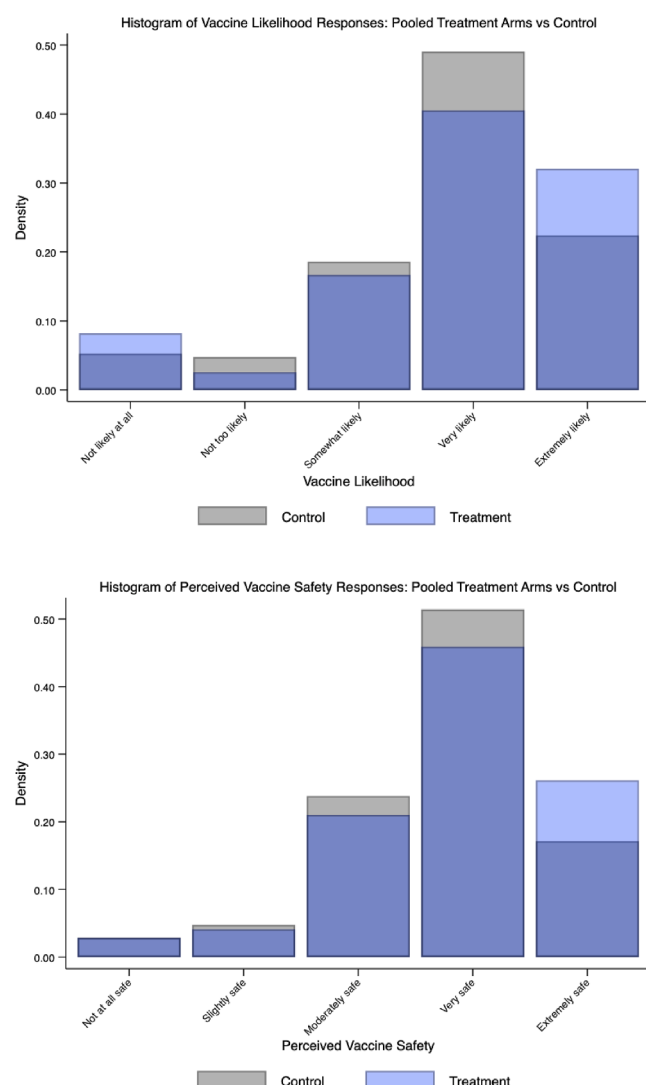


Fig. A2. Distribution of Responses for Vaccine Likelihood and Perceived Vaccine Safety.

Busara Center. The Busara Center is a research organization, headquartered in Nairobi, that provides research services to academics and has pioneered the running of laboratory-based social science experiments in low-income countries (Haushofer et al., 2012). The center manages a large participant pool in Kenya and has developed survey tools and a network of field officers to facilitate in-person and remote research. We randomly selected a sample of parents from the Busara Center's Nairobi participant pool and contacted them to administer a short screening survey over the phone to determine their eligibility.

In Nakuru, we recruited participants through convenience sampling using the Busara Center's network of field guides and determined eligibility through the same phone-based screening survey used for the Nairobi sample. Across both methods, we obtained contact information for 1,711 eligible participants. The study was approved by University of Nairobi and Kenyatta National Hospital IRB (#P160/03/2020) and Carnegie Mellon University IRB (# STUDY2020_00000386).

We sent the 1711 eligible participants a link to a Qualtrics survey via SMS that could be completed using a smartphone. Out of the 1711 eligible participants, 736 opened the Qualtrics link. We kept the link active until our target sample size of 600 was reached. After consenting to the study, participants responded to baseline questions about their demographics including gender, age, income, educational background, religion, income, county and village of residence. Participants also rated



Fig. A3. Control Poster Notes: Government campaign paper viewed by participants in all study arms. Swahili text with English translations as follows: Niko poa! Je, wewe? / "I'm cool! And you?"; "Komesha saratani ya mlango wa kizazi" / "End cervical cancer"; "Wasichana wote walio na umri wa miaka 10 wanahimizwa kwenda kwa chanjo ya HPV" / "All 10-year-old girls are encouraged to go for the HPV vaccine"; "Chanjo hii ni salama na njia dhambi ya kuzuia Saratani ya mlango wa kizazi" / "The vaccine is a safe and effective way to prevent cervical cancer"; "Kwa maelezo zaidi tembelea kituo cha afya kilicho karibu nawe au wasiliana nasi kupitia" / "For more information visit your nearest health facility or contact us via".

the perceived likelihood that their daughter would contract HPV/cervical cancer in the future without an HPV vaccine on a four-point scale including the response options: "Not likely at all", "Not too likely", "Somewhat likely", and "Very Likely" and the estimated percentage of men/women in their community with HPV. Estimated percentages were elicited with the following question "Out of 100 adult men[women] in your community, how many do you think have HPV infection at the moment?" with responses restricted to be between 0 and 100.

Out of 736 eligible participants who started taking the survey, 13 did not provide consent and 124 did not complete the baseline demographic questions resulting in 600 participants at the point of randomization. See the Appendix (Fig. A.1) for a study diagram.

We randomly assigned participants in equal proportions to one of three groups: (i) control, (ii) female doctor recommendation (FDR) or (iii) male doctor recommendation (MDR). We relied on Qualtrics' randomization feature for randomization. The groups varied only in the poster(s) they were shown: all participants were shown the poster used at the time of the survey as part of a national campaign for HPV vaccination. Additionally, the FDR (MDR) group were shown an additional poster with a photograph of a female (male) doctor and a brief quote noting that the doctor recommends the HPV vaccine. See the Appendix (Figs. A.3-5) for pictures of the posters.

We elected to provide all participants with the national campaign poster rather than just the control group to control for the display of a



Fig. A4. Female Doctor Recommendation Poster Notes: Government campaign paper viewed by participants in all study arms. Swahili text with English translations as follows: "Nilichukua kiapo cha kulinda watu dhidi ya ugonjwa na kifo. Ndio maana napeana Chanjo ya HPV kwa Wagonjwa wangu."/"I took an oath to protect people against sickness and death. That is why I give the HPV Vaccine to my Patients"; "Chanjo ya HPV inalinda dhidi ya saratani ya mlango wa kizazi."/"The HPV vaccine protects against cervical cancer."; "Ni salama na inatolewa bure kwa wasichana wote wa miaka 10 katika vituo vya afya vya umma kote nchini."/"It is safe and offered free of charge to all 10 year old girls in public health facilities nationwide."; "Picha sio za madaktari ambao majina yao imeandikwa"/"The photos are not of the doctors whose names are inscribed".

poster that encourages vaccine take-up. This also ensured that the treatment groups only differed from control in viewing the additional posters containing a doctor's recommendation. Participants were able to choose how long to view the poster and could stop viewing each poster and continue the survey at their discretion. We recorded the time each participant spent viewing the posters.

The primary outcomes for the study are self-reported likelihood to vaccinate and perceived vaccine safety. After viewing the poster(s), participants were asked "How likely is it that you will get your daughter the HPV vaccine?" with response options on a five-point scale including: "Not likely at all", "Not too likely", "Somewhat likely", "Very likely", and "Extremely likely". For perceived safety, we asked participants "How safe do you think the HPV vaccine is?" and provided response options on a five-point scale including: "Not at all safe", "Slightly safe", "Moderately safe", "Very safe", and "Extremely safe". For each outcome, we convert responses to each question to (i) a binary indicator taking the value 1 if participants provided responses in the top two categories (i.e., 'Very safe/likely' or 'Extremely likely/safe') and 0 otherwise, and (ii) a binary indicator taking the value 1 if participants provided responses in the top category (i.e., 'Extremely likely/safe') and 0 otherwise. We pre-registered that we would rely on (i) as our primary outcomes unless we

saw a ceiling effect in our outcome measure, defined as more than 90% of participants choosing the top two response options, in which case we would instead rely on (ii).

The sample size was determined by power analyses with an alpha of 0.05 and 80% desired power to detect a 10-percentage point difference between study arms. Given the immediacy of our outcome elicitation and the focus on intentions rather than actual behavior, we consider this difference to represent a small but nonetheless meaningful effect size in the study context. Our statistical analyses rely on logistic regressions to compare vaccine likelihood and perceived safety in the treatment groups to the control group. We use post-estimation Wald tests to test for differences in outcomes across the two treatment groups. All analyses are on an intent-to-treat basis and estimated with demographic controls. As participants were randomized to arms, the estimated treatment effects reflect the causal impact of the different posters on intentions and perceived safety. Analyses were conducted in 2021 with Stata version 15. This study was pre-registered with AsPredicted.org¹ (ID: 55625).

3. Results

In Table 1, we present summary statistics of our sample and balance tests. Our participants are 64% female, 95% Christian with 26% of the sample having completed secondary education and a mean age of 32.8 (SD = 7.0). Tests of differences across means reveal that the sample was balanced on all demographics except gender – the control group contains a statistically significant lower proportion (57%) of women compared to the two treatment groups (MDR: 69%, $p = 0.01$; FDR: 67%, $p = 0.03$). This difference is not due to attrition during the survey and appears to be an anomaly despite correctly implemented randomization. We control for gender in all our analyses.

Table 2 presents our main results. We find no statistically significant treatment effect for either treatment group when using our pre-registered version of the two primary outcome measures (Columns 1 and 3). That is, vaccine likelihood for the MDR and FDR arms is not identifiably different from control (MDR: aOR: 1.07, 95% CI: 0.69:1.65; FDR: aOR: 1.07, 95% CI: 0.69:1.66). The same is true for perceived vaccine safety (MDR: aOR: 1.36, 95% CI: 0.88:2.10; FDR: aOR: 0.98, CI: 0.67:1.57). There is also no difference in treatment effect by gender of the recommending doctor for vaccine likelihood ($p = 0.99$ for comparison between MDR and FDR arms) or vaccine safety ($p = 0.22$).

We looked at the distribution of responses by study arm for each measure using histograms (Appendix Fig. A.2). Although there is no ceiling effect in terms of the percentage of participants choosing the top two response options as pre-registered (a 90% threshold), the movement of the intervention occurred across the top two response options. Participants in the treatment groups are more likely to choose the highest response options—e.g., for vaccine likelihood, 31% and 34% in the MDR and FDR arms respectively—compared to 22% in the control arm - but these participants largely appear to be moving from the second highest response option. Thus, we also look at treatment effects on the likelihood to select the highest response option for each outcome variable. This analysis is presented in Table 2, Columns 2 and 4. On these measures, we see a statistically significant positive treatment effect on vaccine likelihood (MDR: aOR: 1.57, 95% CI: 1.00:2.45; FDR: aOR: 1.82, 95% CI: 1.16:2.84) and vaccine safety (MDR: aOR: 1.85, 95% CI: 1.15:2.98; FDR: aOR: 1.54, 95% CI: 0.94:2.51). There remains no difference in treatment effect by the recommending doctor's gender for vaccine likelihood ($p = 0.50$) or vaccine safety ($p = 0.42$).

We include a multinomial logit model of treatment effects on vaccine likelihood and perceived vaccine safety responses in Appendix Table A.1. In line with the interpretation of our results based on binary measures, we find that for vaccine likelihood, participants are less likely to choose 'Very likely' compared to 'Extremely likely' (MDR: aRRR: 0.61, 95% CI:

¹ Accessible at <https://aspredicted.org/blind.php?x=h6z8f2>

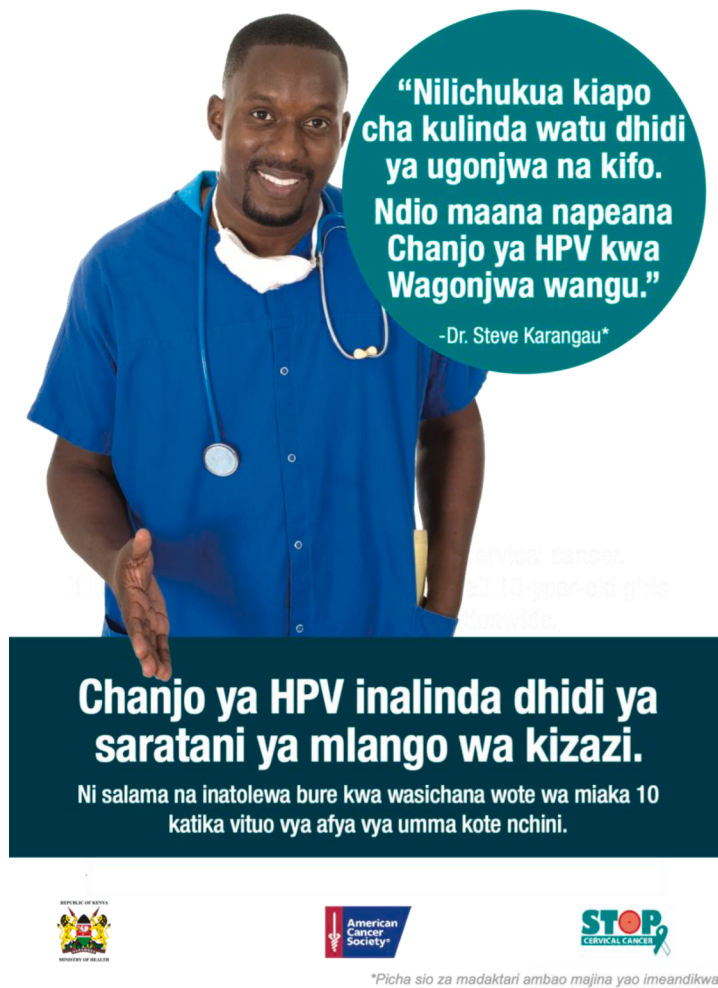


Fig. A5. Male Doctor Recommendation Poster Notes: Government campaign paper viewed by participants in all study arms. Swahili text with English translations as follows: “Nilichukua kiapo cha kulinda watu dhidi ya ugonjwa na kifo. Ndio maana napeana Chanjo ya HPV kwa Wagonjwa wangu.”/ “I took an oath to protect people against sickness and death. That is why I give the HPV Vaccine to my Patients”; “Chanjo ya HPV inalinda dhidi ya saratani ya mlango wa kizazi.”/“The HPV vaccine protects against cervical cancer.”; “Ni salama na inatolewa bure kwa wasichana wote wa miaka 10 katika vituo vya afya vya umma kote nchini.”/ “It is safe and offered free of charge to all 10 year old girls in public health facilities nationwide.”; “Picha sio za madaktari ambao majina yao imeandikwa”/ “The photos are not of the doctors whose names are inscribed”.

Table A1

Multinomial Logit Model of Treatment Effects on Vaccine Likelihood and Perceived Vaccine Safety Responses.

Panel A: Vaccine Likelihood Relative-Risk Ratios				
	Not likely at all vs. Extremely Likely aRRR (95% CI)	Not too likely vs. Extremely Likely aRRR (95% CI)	Somewhat likely vs. Extremely Likely aRRR (95% CI)	Very likely vs. Extremely Likely aRRR (95% CI)
Male Dr. Rec. (MDR)	1.19 (0.50:2.80)	0.44 (0.14:1.41)	0.61 (0.33:1.12)	0.61 (0.38:0.99)
Female Dr. Rec. (FDR)	0.98 (0.41:2.35)	0.39 (0.12:1.27)	0.57 (0.31:1.05)	0.51 (0.32:0.83)
Control (Reference)	–	–	–	–
Panel B: Vaccine Safety Relative-Risk Ratios				
	Not at all safe vs. Extremely Safe aRRR (95% CI)	Slightly safe vs. Extremely Safe aRRR (95% CI)	Moderately safe vs. Extremely Safe aRRR (95% CI)	Very safe vs. Extremely Safe aRRR (95% CI)
Male Dr. Rec. (MDR)	0.81 (0.25:2.65)	0.48 (0.17:1.39)	0.46 (0.25:0.84)	0.57 (0.34:0.93)
Female Dr. Rec. (FDR)	0.54 (0.14:2.08)	0.58 (0.21:1.62)	0.74 (0.41:1.35)	0.62 (0.37:1.05)
Control (Reference)	–	–	–	–

Abbreviations: aRRR, adjusted relative risk ratio; CI, confidence interval, Dr., Doctor; Rec., Recommendation. Analyses adjusted for female (1/0) and Nairobi county (1/0). Base response category for both outcomes is the maximum response option - ‘Extremely Likely’ for vaccine likelihood and ‘Extremely Safe’ for vaccine safety.

0.38:0.99; FDR: aRRR 0.51, 95% CI: 0.32: 0.83) and for perceived vaccine safety are less likely to choose ‘Very safe’ compared to ‘Extremely safe’, though this is not statistically significant for the FDR group (MDR: aRRR: 0.57, 95% CI: 0.34:0.93, FDR: aRRR: 0.62, 95% CI: 0.37:1.05). For the MDR group we also see a statistically significant decrease in the likelihood of selecting ‘Moderately safe’ versus ‘Extremely safe’ (aRRR

0.46, 95% CI: 0.25:0.84). At the request of reviewers, in Appendix Table A.2 we present results from a logistic regression of treatment effects where we pool the two treatment groups. As the two treatment groups are roughly similar sizes, the treatment effects are qualitatively similar to the results presented in Table 2.

Table A2
Logistic Regression of Pooled Treatment Effects.

	Vaccine Likelihood				Perceived Vaccine Safety			
	Very likely, Extremely likely = 1		Extremely likely = 1		Very safe, Extremely safe = 1		Extremely safe = 1	
	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)	%	aOR (95% CI)
Any Treatment	0.73	1.07 (0.73:1.56)	0.32	1.69 (1.14:2.50)	0.72	1.18 (0.82:1.71)	0.26	1.69 (1.11:2.60)
Control (Reference)	0.71	–	0.22	–	0.69	–	0.17	–
N	600		600		600		600	

4. Discussion

We evaluated a low-cost method of communicating a doctor's recommendation for the HPV vaccine among parents of adolescent girls in Kenya. The recommendation increased the likelihood that participants reported the highest intention to vaccinate and perceived vaccine safety. However, we found no effect of the recommendation on the likelihood to report above moderate vaccine intentions or perceptions of safety. We also find no differences in treatment effect by the recommending doctor's gender.

Our results suggest that visual communication of a doctor's support for the HPV vaccine can strengthen intentions and safety perceptions but may not be enough to persuade the vaccine hesitant to vaccinate. These results are consistent with previous studies showing a strong association between receiving a provider recommendation and vaccinate rates (Oh et al., 2021). Most closely related to our work is a study in which message content (gain versus loss framing versus control) and the strength of an in-person provider's recommendation (offered versus recommended) for adult hepatitis B vaccination are varied (Kasting et al., 2019). Similar to the present study, the authors find that a provider recommendation increases vaccination rates.

Notably, 10% of the sample report being unlikely to obtain the HPV vaccine for their daughters and 29% of the sample do not consider the vaccine to be very or extremely safe. These numbers add to the nascent literature on vaccine hesitancy in Sub-Saharan African (Cooper et al., 2018; Adamu et al., 2021) and suggest that an assessment of the predictors of HPV vaccine hesitancy may be a useful input into the development of other interventions.

We see two main directions for future work. First, the results raise the question of why the treatment posters led to an increase in participants reporting the highest levels of vaccine intentions and safety perceptions. We do not explore mechanisms in this paper as our study was designed to measure first order effects of the posters. One possibility is that participants impacted by the treatment engaged more with the treatment posters than the control poster. It is difficult to measure engagement accurately without technologies such as eye-tracking. However, we did measure time spent viewing each poster and find no statistically significant difference in time spent with each poster, suggesting that the treatment effect is more likely to be driven by changes in perceived safety or trust in the vaccine rather than differential engagement with the poster's message.

Second, public health campaigns are frequently multi-media, utilizing social, visual, video, and radio media. Our results speak only to the efficacy of a doctor's recommendation within a printed or online poster. Future research could compare the effect of doctor's recommendations when communicated in various media and identify the differential effect of each medium on vaccination uptake.

Our study has several limitations. First, we used a government public health campaign poster for the control group. This choice of control is conservative, in that we are controlling for the display of a poster that encourages vaccine take-up, and appropriate, in that it is equivalent to usual care. Also, as participants in the treatment groups saw the government poster, the only difference between treatment arms and the control is the additional poster containing the doctors' recommendations. However, other differences across the control and treatment

posters may be driving our results, such as repetition of the message across two different posters, the use of a photograph, or color scheme choice. We view these alternative explanations as unlikely, but they cannot be ruled out with this study design.

Second, we measure vaccine take-up intentions as our outcome measure rather than actual vaccination behavior. Vaccine intentions may differ from actual vaccination behavior due to social desirability bias or an intention to action gap. This choice was a result of budget constraints but also difficulties in obtaining reliable measures of vaccine take-up during the COVID-19 pandemic. Thus, although measuring vaccine intentions is a typical approach in the literature, we are unable to make claims about our intervention's effect on vaccine take-up. Relatedly, our outcome measure was elicited immediately after exposure to the poster and so likely represents an upper bound on the effect resulting from a public health campaign including similar messaging.

Third, as this study takes place with low-income individuals in two urban counties of Kenya and does not rely on representative sampling methods, it is unclear how well the results translate to different socioeconomic groups and rural populations within Kenya. It would be interesting to establish whether there is treatment effect heterogeneity with other more representative samples in Kenya and whether our results hold in alternative geographies.

5. Conclusion

We find that communicating a doctor's support of the HPV vaccine can increase intentions to obtain the HPV vaccine and perceptions of safety. This intervention may be particularly useful in low-resource settings where access to a doctor is logistically challenging or costly but accessing vaccine sites or mobile vaccine teams is less onerous. Thus, given the low-cost of this intervention, incorporating a doctor's recommendation into existing public health campaigns may be justified. However, the messaging should be evaluated against other potential message framings within the campaign's target population. For example, a recent study reports that providing individuals with a sense of ownership over a COVID-19 vaccination improved vaccination rates in the United States (Dai et al., 2021).

Funding

This study was funded by the American Cancer Foundation (Contract Number: 61049). The funders were not involved in the study.

CRediT authorship contribution statement

Samantha Horn: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Gretchen B. Chapman:** Conceptualization, Methodology, Writing – review & editing. **Kriti Chouhan:** Methodology, Investigation, Project administration, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

Appendix A

References

- Adamu, A., Essoh, T.-A., Adeyanju, G.C., Jalo, R.I., Saleh, Y., Aplogan, A., Wiysonge, C. S., 2021. Drivers of hesitancy towards recommended childhood vaccines in African settings: a scoping review of literature from Kenya, Malawi and Ethiopia. *Expert Rev. Vaccines* 20 (5), 611–621. <https://doi.org/10.1080/14760584.2021.1899819>.
- Black, E., Richmond, R., 2018. Prevention of cervical cancer in sub-Saharan Africa: the advantages and challenges of HPV vaccination. *Vaccines* 6 (3), 61. <https://doi.org/10.3390/vaccines6030061>.
- Brewer, N.T., Hall, M.E., Malo, T.L., Gilkey, M.B., Quinn, B., Lathren, C., 2017. Announcements versus conversations to improve HPV vaccination coverage: a randomized trial. *Pediatrics* 139 (1), e20161764. <https://doi.org/10.1542/peds.2016-1764>.
- Bruni, L., Albero, G., Serrano, B., Mena, M., Gómez, D., Muñoz, J., Bosch, F.X., Sanjosé, S., 2019. Human papillomavirus and related diseases in Kenya summary report 17 June 2019 [Date Accessed: 12th April 2021]. ICO Information Centre on HPV and Cancer (HPV Information Centre). www.hpvcentre.com.
- Chido-Amajuoyi, O.G., Domgue, J.F., Obi-Jeff, C., Schmeler, K., Shete, S., 2019. A call for the introduction of gender-neutral HPV vaccination to national immunisation programmes in Africa. *Lancet Global Health* 7 (1), e20–e21. [https://doi.org/10.1016/S2214-109X\(18\)30405-4](https://doi.org/10.1016/S2214-109X(18)30405-4).
- Cooper, S., Betsch, C., Sambala, E.Z., Mchiza, N., Wiysonge, C.S., 2018. Vaccine hesitancy—a potential threat to the achievements of vaccination programmes in Africa. *Hum. Vaccines Immunotherap.* 14 (10), 2355–2357. <https://doi.org/10.1080/21645515.2018.1460987>.
- Dai, Hengchen, Silvia Saccardo, Maria A Han, Lily Roh, Naveen Raja, Sitaram Vangala, Hardikkumar Modi, Shital Pandya, Michael Sloyan, Daniel M Croymans. 2021. Behavioural nudges increase COVID-19 vaccinations. 404, *Nature*, 597. <https://doi.org/10.1038/s41586-021-03843-2>.
- Dehlendorff, C., Baandrup, L., Kjaer, S.K., 2021. Real-world effectiveness of human papillomavirus vaccination against vulvovaginal high-grade precancerous lesions and cancers. *JNCI: J. Natl. Cancer Institute* 113 (7), 869–874. <https://doi.org/10.1093/JNCI/DJAA209>.
- Gilkey, M.B., Calo, W.A., Moss, J.L., Shah, P.D., Marciniak, M.W., Brewer, N.T., 2016. Provider communication and HPV vaccination: the impact of recommendation quality. *Vaccine* 34 (9), 1187–1192. <https://doi.org/10.1016/j.vaccine.2016.01.023>.
- Gilkey, M.B., Malo, T.L., Shah, P.D., Hall, M.E., Brewer, N.T., 2015. Quality of physician communication about human papillomavirus vaccine: findings from a national survey. *Cancer Epidemiol. Biomark. Prev.* 24 (11), 1673–1679. <https://doi.org/10.1158/1055-9965.EPI-15-0326>.
- Haushofer, J., Collins, M., de Giusti, G., Njoroge, J.M., Odero, A., Onyango, C., Vancel, J., Jang, C., Kuruvilla, M., Hughes, C., 2012. The Busara Center: a laboratory environment for developing countries. *SSRN Electronic J.* <https://doi.org/10.2139/ssrn.2155217>.
- Kasting, M.L., Head, K.J., Cox, D., Cox, A.D., Zimet, G.D., 2019. The effects of message framing and healthcare provider recommendation on adult hepatitis B vaccination: a randomized controlled trial. *Prev. Med.* 127 (October), 105798. <https://doi.org/10.1016/j.ypmed.2019.105798>.
- Oh, N.L., Biddell, C.B., Rhodes, B.E., Brewer, N.T., 2021. Provider communication and HPV vaccine uptake: a meta-analysis and systematic review. *Prev. Med.* 148 (July), 106554. <https://doi.org/10.1016/j.ypmed.2021.106554>.
- Opel, D.J., Heritage, J., Taylor, J.A., Mangione-Smith, R., Salas, H.S., DeVere, V., Zhou, C., Robinson, J.D., 2013. The architecture of provider-parent vaccine discussions at health supervision visits. *Pediatrics* 132 (6), 1037–1046. <https://doi.org/10.1542/peds.2013-2037>.
- Opel, D.J., Mangione-Smith, R., Robinson, J.D., Heritage, J., DeVere, V., Salas, H.S., Zhou, C., Taylor, J.A., 2015. The influence of provider communication behaviors on parental vaccine acceptance and visit experience. *Am. J. Public Health* 105 (10), 1998–2004. <https://doi.org/10.2105/AJPH.2014.302425>.
- Ralaivody, A.H., Gopalappa, C., Ilbawi, A., Pretorius, C., Lauer, J.A., 2018. Cost-effective interventions for breast cancer, cervical cancer, and colorectal cancer: new results from WHO-CHOICE 11 medical and health sciences 1117 public health and health services 11 medical and health sciences 1112 oncology and carcinogenesis. *Cost Effectiv. Resour. Allocat.* 16 (1), 1–14. <https://doi.org/10.1186/s12962-018-0157-0>.
- Stratton, K.L., Culklin, D.J., 2016. A contemporary review of HPV and penile cancer. *Oncology (Williston Park, N.Y.)* 30 (3), 245–249. <https://europepmc.org/article/med/26984219>.
- Tsu, V.D., Scott LaMontagne, D., Atuhebwe, P., Bloem, P.N., Ndiaye, C., 2021. National implementation of HPV vaccination programs in low-resource countries: lessons, challenges, and future prospects. *Prev. Med.* 144 (March), 106335. <https://doi.org/10.1016/j.ypmed.2020.106335>.
- De Vuyst, H., Alemany, L., Lacey, C., Chibwesha, C.J., Sahasrabudde, V., Banura, C., Denny, L., Parham, G.P., 2013. The burden of human papillomavirus infections and related diseases in Sub-Saharan Africa. *Vaccine* 31 (S5), F32–F46. <https://doi.org/10.1016/j.vaccine.2012.07.092>.
- Zhang, J., Qin, Z., Lou, C., Huang, J., Xiong, Y., 2021. The efficacy of vaccination to prevent human papilloma viruses infection at anal and oral: a systematic review and meta-analysis. *Public Health* 196 (July), 165–171. <https://doi.org/10.1016/j.puhe.2021.05.012>.