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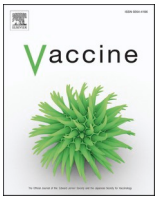

Intervention-amenable factors associated with lack of HPV vaccination in Kenya: Results from a large national phone survey

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ABSTRACT

Background: Coverage of human papillomavirus (HPV) vaccination remains suboptimal in many countries, but the determinants are not well-understood particularly in low- and middle-income countries. We undertook a random digit dialed phone survey across Kenya between July–October 2022, with parents/caregivers of pre-adolescent girls, to identify intervention-amenable factors associated with respondents' daughter's HPV vaccination status.

Methods: Informed by the World Health Organization Behavioral and Social Drivers of Vaccination framework, we collected information about respondents' knowledge about and hesitancy toward HPV vaccine, perceived risk of cervical cancer, social norms around HPV vaccination, trust in institutions, and access to HPV vaccination services.

Results: 1416 parents/caregivers completed the survey (97.4 % of those eligible), of whom 38.2 % said that age-eligible girl(s) in their household had received any doses of the HPV vaccine. Knowledge/perceptions: In multivariable models adjusted for sociodemographic characteristics, respondents with less HPV vaccine hesitancy and fewer concerns about safety were more likely to have vaccinated daughter(s), as were those with greater knowledge about HPV vaccine and knowing someone who had died from cervical cancer. Social norms: Having spoken with others about HPV vaccination, although reported by less than half of respondents, and believing that other parents have vaccinated their daughters were associated with having vaccinated daughter(s). Respondents with more trust in information about HPV vaccination from health systems, and with higher trust in institutions, had greater odds of having vaccinated daughter(s). Access: One-fifth of respondents had experienced, or anticipated experiencing, challenges accessing HPV vaccination services, and these respondents had approximately half the odds of having a vaccinated daughter compared to their counterparts.

Conclusions: Promising areas for intervention include: targeted messaging about safety of the HPV vaccine, increasing parents'/caregivers' knowledge about the vaccine, and leveraging trusted messengers including health workers, faith leaders, and peer parents/caregivers.

1. Introduction

The vaccine to prevent human papillomavirus (HPV) is essential for the elimination of cervical cancer. [1,2] In countries where the burden of cervical cancer is high, and where health systems struggle to provide secondary prevention through screening and cancer treatment, HPV vaccination is urgently needed. [2–4] Although many low- and middle-income countries (LMICs) have introduced national programs for HPV vaccination, uptake remains low. [5–7] Previous studies have identified some factors that may be associated with HPV vaccination in LMICs, including knowledge and attitudes about HPV and the HPV vaccine, social norms, and availability of vaccination services. [8–12] Many of these studies were qualitative, from small samples or local regions; the literature lacks a large-sample, national-level, theory-informed

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quantitative evaluation of factors associated with uptake of the HPV vaccine in a LMIC context.

Kenya is one of the largest countries in Africa, and experiences a high burden of cervical cancer – an estimated age-standardized 31.3 cases and 20.6 deaths per 100,000 women each year are attributable to cervical cancer; this can be compared to the incidence and mortality rates in the United States of 6.2 cases and 2.1 deaths per 100,000 women respectively. [13] Kenya introduced a national HPV vaccination program in 2019, and targets girls aged 10–14 for vaccination (boys are not recommended for vaccination). In 2022, it was estimated that only 26 % of age-eligible girls had received a first dose of the HPV vaccine. [7] However, the correlates of HPV vaccine uptake in Kenya are not well-characterized, which limits our ability to design effective programs for increasing vaccination. For example, it is unclear to what extent vaccine attitudes (confidence or hesitancy), or knowledge, or access barriers contribute to vaccination.

The goal of this study was to identify potentially modifiable factors associated with HPV vaccination in Kenya, using a recently-disseminated WHO theory-based framework of vaccination determinants. We investigated factors hypothesized to be associated with HPV vaccination of one's daughter among 1400 Kenyan adult parents or caregivers of age-eligible girls, selected through random digit dialing. Parents and caregivers are important decision-makers for vaccination decisions of preadolescent girls, [14–16] and so constituted the focus of this study.

2. Methods

2.1. Study design and sampling frame

We conducted a cross-sectional phone survey, aiming for a sample of 1400 respondents. We obtained a list of 25,000 phone numbers from Sample Solutions, a company that provides lists of randomly sampled phone numbers in many countries globally. The random list for this study included phone numbers for each mobile service provider proportionate to its market share in Kenya. Next, we used a computer algorithm to randomly select numbers to be contacted. As the purpose of this study was to explore associations between respondent characteristics and HPV vaccine uptake – not to generate population-level generalizable estimates of vaccine uptake – we did not use any special sampling procedures. Eligible respondents were those who identified as parents or caregivers of a girl aged 10–16 years; this age range was selected to capture girls who were currently or recently age-eligible for HPV vaccination in Kenya.

2.2. Conceptual model and survey instrument

This study was informed by the World Health Organization Behavioral and Social Drivers of Vaccination framework (BeSD). [17,18] The BeSD framework was developed based on prior work to identify factors that might shape vaccination behavior, [19] and posits that vaccine uptake follows from motivation to vaccinate plus practical issues, and that motivation is shaped by intrapersonal and social factors. The conceptual model for this study is shown in Fig. 1; based on our prior formative work, [20,21] we added "knowledge" as a construct within the "thinking and feeling" domain, and "trust" as a construct within the "social processes" domain.

We designed a survey instrument with questions to capture each construct in Fig. 1. We incorporated previously implemented survey questions and modules (see below), for greater comparability to other findings in the literature.

- HPV vaccine hesitancy was measured based on the Vaccine Hesitancy Scale (VHS)-HPV; [22] our survey used one of the VHS-HPV questions about importance, one about efficacy, one about risk as a new vaccine, three about side effects (mild/moderate short-term, severe short-term, and long-term), and one about following recommendation from health care provider(s). Some of the original VHS-HPV items were excluded because they were difficult to translate for the Kenyan context; and we added questions to differentiate between severity and duration of side effects, based on our formative work on this topic. [21] We created a hesitancy score per Helmkamp et al. [22]: the seven included questions were asked using a Likert response scale (strongly agree, agree, disagree, strongly disagree) to which we assigned points of 1, 2, 4, and 5; we aligned valence of all questions so that higher points indicated more hesitancy, and we created a summed score. We also asked the same questions about hesitancy toward routine childhood vaccines and scored it the same way.
- We used a subset of questions about knowledge of HPV and the HPV vaccine from previous studies; [23,24] the survey included seven items that our binational team felt could be well-translated and -understood in the Kenyan context, which was confirmed during the piloting exercise. Each was scored as answered correctly, or not; and we generated a knowledge score that summed how many of the seven questions were answered correctly (versus incorrect or "do not know").
- Perceptions about cervical cancer risk were captured by asking whether the respondent knew someone who had cervical cancer (used previously by our team). [25]
- HPV vaccination social norms were explored using questions from the "influence" and "communication" domains of the Human Papillomavirus Attitudes and Beliefs Scale [26]: comfort discussing HPV vaccine, perceptions of whether other parents/caregivers in the community vaccinate their daughters against HPV, and who the respondent had spoken with about the HPV vaccine—including health worker recommendation.

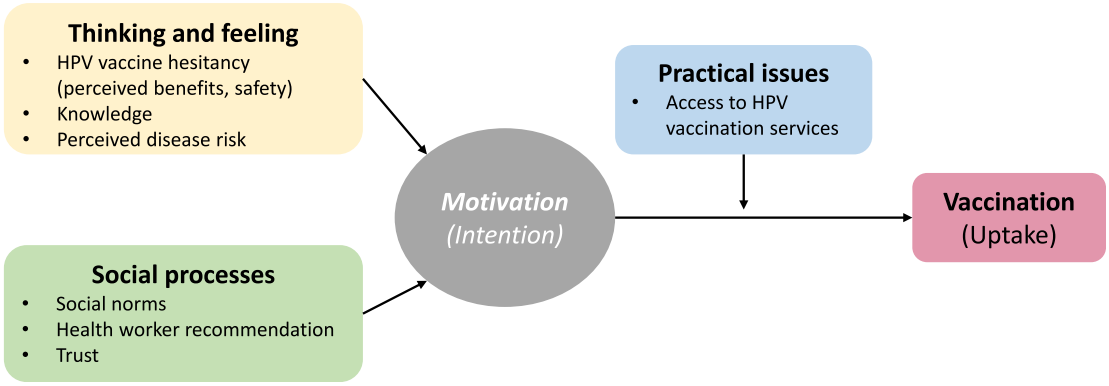

Fig. 1. Study conceptual model.

- Trust in institutions used a shortened version of this module from the Wellcome Global Monitor; [27] for each institution, respondents were asked if they trusted it not at all, a little, some, or a lot. We measured trust in each institution and also calculated a trust score that summed these together. We also used the Wellcome Global Monitor survey questions about trusted information sources (adapted to be specifically about the HPV vaccine). [27]
- We asked about difficulty of access to the HPV vaccine (barriers actually experienced, if the respondent's daughter was vaccinated, or anticipated barriers if she respondent's daughter was not vaccinated). We also asked about experiences with specific access barriers, namely getting permission (from a spouse or other family member), affording the vaccination visit, distance to the vaccination location, and too busy to go get the vaccine.

To measure the outcome variable – whether any HPV vaccine doses have been received by the respondent's daughter(s) – we asked whether the respondent's age-eligible daughter's HPV vaccine card was available. If available, we asked for information from this card: dates and places when HPV vaccine doses were received. If the card was not available, we asked the respondent to report this information to the best of their recollection: when and where their daughter had received doses of the HPV vaccine. There is no national registry for HPV vaccination in Kenya, so surveys are the only way to collect this information; we triangulated these two data sources (vaccine card and self-report) to best ascertain receipt of the vaccine. In addition, the Kenyan vaccination schedule includes no other vaccines for this age group, [28] so any recalled vaccine at these ages is likely to be for HPV. Parents/caregivers reported on all age-eligible daughters; for analysis, we summarized across daughters so the variable compared whether any daughter had received any doses, versus all daughters had received zero doses.

The survey instrument was developed in English and translated to Swahili (the national language in Kenya) by the experienced field management team in Kenya. The instrument was back-translated to English to ensure the validity of the questions. The recruitment and data collection tools were pilot tested: we received an initial list of 1000 randomly selected Kenyan phone numbers from Sample Solutions, and over a two-day period, contacted 458 phones and completed test surveys with 28 respondents. These data were reviewed for completeness and archived as pilot data. The main goal of the pilot exercise was to estimate a likely completion rate for the survey from the random sample, and to test the research tools so any necessary refinements could be made before data collection began.

2.3. Data collection

Prior to data collection, all enumerators were trained for a one-week period; this included comprehensive conceptual orientation to study tools and data collection techniques, as well as consenting procedures. During the data collection period, these enumerators would dial a randomly generated phone number from the sampling frame and would assess eligibility and interest of anyone who answered the call. For eligible and interested respondents, after obtaining oral informed consent, the enumerator would begin the survey. Enumerators asked each survey question aloud and recorded the response on a tablet or laptop computer using SurveyCTO software. Those who completed the survey were given approximately US$ 1. To ensure high-quality data collection, we conducted random back-checks of the data and audio audits for approximately 10 % of the sample who completed the phone surveys; this confirmed very high data quality across all the enumerators. The data were collected between July–October 2022.

2.4. Data analysis

We classified each respondent as having a daughter who had received none or any doses of the HPV vaccine, to reflect updated global guidance moving toward a single-dose vaccine series. [29] We assessed what proportion of respondents reported having a vaccinated daughter. We summarized all independent variables per the BeSD framework by daughter's vaccination status. We then assessed whether the odds of vaccination (any versus no doses) differed using multivariable models which included the following parent/caregiver-level covariates based on known or suspected association with HPV vaccination: age (as a continuous value), respondent gender (female or male), current employment status (employed or unemployed), highest level of educational attainment (primary level or less, some or all of secondary level, or beyond secondary level), current marital status (married or unmarried), location of residence (urban, or town, or rural), religion (no religion, Catholic, Anglican, Seventh Day Adventist, Other Christian, Muslim, or other), and household income sufficiency over the past 12 months (more than sufficient to meet expenses, just enough to meet expenses, not sufficient to meet expenses).

Chi-square tests, two-sample *t*-tests and ANOVA F-tests were used to access the bivariate relationships between two variables. Unadjusted odds ratios (OR) and adjusted odds ratios (aOR) with 95 % confidence intervals (95 % CI) were obtained using logistic regression. We also conducted analyses stratified by respondent (parent/caregiver) gender. Lastly, we conducted sensitivity analyses that repeated all main analyses with the outcome as zero doses, one dose, or more than one dose of the HPV vaccine using multinomial logistic regression. *P*-values less than 0.05 were considered statistically significant. Statistical analyses were conducted in Stata v18.

2.5. Ethical review

This study was reviewed and approved by the University of California Los Angeles (#22–000005) and by the Kenya Medical Research Institute Scientific and Ethics Review Unit (#SERU4456), and was granted a research permit by the Kenya National Commission for Science, Technology and Innovation (#821192).

3. Results

A total of 19,688 phones were dialed, and 10,096 caregivers screened for eligibility (51.2 % of phones dialed). There were 1454 eligible respondents (14.4 % of all caregivers screened), of whom 1416 agreed to participate (97.4 % of those eligible) and 1400 completed the survey. Among these 1400 survey respondents, 1347 provided information about HPV vaccine doses for daughters/girls in the household, constituting the sample for this analysis. Characteristics of respondents are shown in Table 1. Just over half of respondents were women (54.8 %, $n = 738$) and 45.2 % were men ($n = 609$). The average age was 39 (median 38, IQR 33–45). Most respondents (81.4 %, $n = 1092$) were currently employed, and most were married (76.8 %, $n = 1030$). The sample included 41.1 % of people who had college/university education or higher, 30.3 % who completed secondary school, and 28.6 % who had primary-level education or less. Approximately half reported having insufficient household income to meet expenses over the past year (54.0 %, $n = 721$). 22.6 % of respondents lived in urban areas ($n = 304$), 33.0 % in towns/trading centers ($n = 445$), and 44.4 % ($n = 598$) in rural areas. Nearly all (98.4 %, $n = 1321$) identified as religious, primarily Christian denominations. Appendix A compares the sample characteristics to the general Kenyan population per the 2022 Demographic and Health Survey (a nationally-representative household survey); [30] this sample included more employed respondents, those with higher educational attainment, and a lower share of urban respondents than the overall Kenyan population.

Overall, 38.2 % of daughters/girls in the household had received any doses of the HPV vaccine ($n = 514$). Uptake of the HPV vaccine was reported more often by female parents/caregivers, those who were married, and those living in rural areas ($p < 0.05$ for all) (Table 1). Educational attainment and income were not associated with reported

Table 1
Characteristics of the sample, stratified by daughter's HPV vaccination status.

	Full sample	Zero HPV vaccine doses	Any HPV vaccine doses	p-value for zero vs. any HPV vaccine doses
	n = 1347	*n* = 833	n = 514	
Gender: Female	738 (54.8 %)	406 (48.7 %)	332 (64.6 %)	< 0.0001
Male	609 (45.2 %)	427 (51.3 %)	182 (35.4 %)	
Employed: Yes	1092 (81.4 %)	680 (81.9 %)	412 (80.6 %)	0.55
No	249 (18.6 %)	150 (18.1 %)	99 (19.4 %)	
Married: Yes	1030 (76.8 %)	628 (75.7 %)	402 (78.5 %)	0.02
Single	221 (16.5 %)	145 (17.5 %)	76 (14.8 %)	
Widowed	41 (3.1 %)	19 (2.3 %)	22 (4.3 %)	
Divorced/ separated	50 (3.7 %)	38 (4.6 %)	12 (2.3 %)	
Educational attainment: Primary or less	385 (28.6 %)	238 (28.6 %)	147 (28.6 %)	0.98
Secondary	408 (30.3 %)	254 (30.5 %)	154 (30.0 %)	
Beyond secondary	554 (41.1 %)	341 (40.9 %)	213 (41.4 %)	
Income sufficient: Yes	143 (10.7 %)	89 (10.8 %)	54 (10.6 %)	0.991
Just enough	471 (35.3 %)	291 (35.3 %)	180 (35.3 %)	
Not sufficient	721 (54.0 %)	445 (53.9 %)	276 (54.1 %)	
Residence: Urban	304 (22.6 %)	223 (26.8 %)	81 (15.8 %)	< 0.0001
Town	445 (33.0 %)	288 (34.6 %)	157 (30.5 %)	
Rural	598 (44.4 %)	322 (38.7 %)	276 (53.7 %)	
Religion: Not religious	21 (1.6 %)	12 (1.5 %)	9 (1.8 %)	0.70
Catholic	324 (24.2 %)	199 (24.0 %)	125 (24.5 %)	
Anglican	134 (10.0 %)	77 (9.3 %)	57 (11.2 %)	
Seventh Day Adventist	96 (7.2 %)	62 (7.5 %)	34 (6.7 %)	
Other Christian	668 (49.9 %)	415 (50.0 %)	253 (49.6 %)	
Muslim	84 (6.3 %)	58 (7.0 %)	26 (5.1 %)	
Other	13 (1.0 %)	7 (0.8 %)	6 (1.2 %)	
Age, mean (median; IQR)	39.0 (38; 33–45)	38.9 (38; 32–45)	39.3 (38.5; 33–45)	0.45

vaccination. Among those with any doses of the vaccine (n = 514), 42.21 % had reportedly received only 1 dose (*n* = 217) and 57.78 % had received 2 doses (*n* = 297) (Appendix B).

3.1. Thinking and feeling

Vaccine hesitancy and perceptions: Approximately 95 % of respondents expressed positive attitudes about the importance and effectiveness of the HPV vaccine (Table 2). Nearly all respondents (96.6 %) also said they would do what a health care provider recommends about HPV vaccination. Approximately 44 % of respondents said they would do what their religious leader recommends about the HPV vaccine, and 23 % said they would do what their traditional leader recommends.

Nearly half of parents/caregivers said they were concerned about effects from the HPV vaccine: 49.3 % were concerned about mild to moderate short-term effects and 45.7 % were concerned about serious short-term effects, while 48.3 % were concerned about any long-term effects. Urban respondents and those with greater educational attainment more commonly expressed concerns about HPV vaccine safety, and overall had greater hesitancy, than rural respondents and those with less educational attainment (Appendix C).

Table 2
HPV vaccine hesitancy ("thinking and feeling" correlates of HPV vaccine uptake).

	n (%) agree[1]	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose (s) (95 % CI)[4]
The HPV vaccine is important for my daughter's health	1242 (95.3 %)	2.47** (1.33, 4.61)	2.83** (1.43, 5.63)
Getting the HPV vaccine is a good way to protect my daughter from disease	1251 (95.8 %)	2.12* (1.13, 3.99)	2.17* (1.11, 4.26)
The HPV vaccine carries more risks than older vaccines[2]	297 (27.6 %)	0.61*** (0.46, 0.81)	0.60** (0.44, 0.80)
I am concerned about mild to moderate short-term effects of HPV vaccine[2]	626 (49.3 %)	0.59*** (0.47, 0.75)	0.59*** (0.47, 0.75)
I am concerned about serious short-term effects of HPV vaccine[2]	578 (45.7 %)	0.60*** (0.48, 0.76)	0.61*** (0.48, 0.77)
I am concerned about long-term mild, moderate or severe effects of HPV vaccine[2]	610 (48.3 %)	0.60*** (0.48, 0.76)	0.62*** (0.49, 0.79)
I do what the health care provider recommends about HPV vaccine[3]	1290 (96.6 %)	5.31*** (2.08, 13.53)	5.00** (1.92, 12.97)
	Mean (SD)	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose (s) (95 % CI)[3]
HPV vaccine hesitancy score (can range 7–35, higher score indicates more hesitancy)	14.02 (6.17)	0.94*** (0.92, 0.96)	0.94*** (0.92, 0.96)

1: Strongly agree or Somewhat agree, versus Strongly disagree or Somewhat disagree (Don't know and missing for each question are excluded).
2: Indicates this variable was reverse-coded to calculate the attitudes score.
3: Excludes people without a health care provider.
4: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).
* p < 0.05, **p < 0.01, ***p < 0.001.

Parents/caregivers with positive attitudes about HPV vaccine importance and efficacy had significantly higher odds of having a daughter with any doses of the vaccine than parents/caregivers who did not feel the vaccine was important or efficacious (Table 2). In adjusted models, respondents who were concerned about side effects had approximately 40 % lower odds of having a vaccinated daughter than parents/caregivers who were not concerned about side effects, whether short- or long-term. Those who said they would listen to a health care provider's advice about the HPV vaccine had much higher odds of having a vaccinated daughter than respondents who said they would not listen to a health care provider's HPV vaccination advice (aOR 5.00, 95 % CI 1.92, 12.97). In gender-stratified models, the overall relationship between positive attitudes and daughter's vaccination persisted (Appendix D), although the associations between positive attitudes about importance and effectiveness were significantly associated with daughter's vaccination only among male respondents, whereas concern about long-term side effects and willingness to follow a health worker's HPV vaccination were associated with daughter's vaccination status only among female respondents.

We assessed whether a similar hesitancy score about routine childhood vaccines was associated with uptake of the HPV vaccine. Although the routine vaccine hesitancy score was correlated with the HPV vaccine

hesitancy score (Pearson correlation coefficient 0.53, $p < 0.0001$), it was not associated with uptake of the HPV vaccine in either unadjusted (OR 0.98, 95 % CI 0.96, 1.00) or adjusted models (aOR 0.99, 95 % CI 0.97, 1.01).

Knowledge about HPV vaccine: Parents/caregivers mostly understood that the HPV vaccine offers protection against cervical cancer (92.3 % answered this correctly) and that someone could have HPV for many years without knowing it (85.6 % answered this correctly) (Table 3). Only 55.6 % of respondents knew that HPV was sexually transmitted, and only 40.7 % knew that men can get HPV. Overall, women had higher knowledge about HPV and HPV vaccine than men, and knowledge was lowest among urban respondents compared to those living in urban areas or towns (Appendix E). There was a small inverse association between respondent educational attainment and most specific knowledge items, with those with primary or less education more often responding correctly (knowledge score of 4.9, on a 0–7 scale) than those with secondary education or higher (knowledge scores of 4.6 and 4.8, respectively) (Appendix E).

Those with greater overall knowledge (more correct answers) had significantly higher odds of having vaccinated daughters (Table 3); the three specific items that were significantly correlated with daughter's HPV vaccination status were: knowing that the HPV vaccine offers protection against cervical cancer (aOR 2.51 for having a vaccinated daughter), knowing that screening is still needed even after HPV vaccination (aOR 1.61), and knowing that HPV vaccine is most effective when given before sexual debut (aOR 1.31) (Table 3). In models that stratified by respondent gender, these associations between knowledge and daughter's vaccination status were generally stronger and more commonly significantly significant among male respondents compared to females (Appendix F).

Perceived risk of cervical cancer: Almost 40 % of respondents knew someone who had died due to cervical cancer; and daughters of these respondents had approximately 30 % higher odds of being vaccinated against HPV than girls whose parents/caregivers did not know someone who had cervical cancer (Table 4). There were very few demographic characteristics associated with experience with cervical cancer, although female respondents had significantly higher odds of knowing someone who has died due to cervical cancer than male respondents (Appendix G). In models stratified by respondent gender, the association between knowing someone who had, or died from, cervical cancer followed a similar pattern (Appendix H).

3.2. Social factors

Social norms: Fewer than half of respondents said they had ever spoken with their daughter, other parents/caregivers, or with a health care worker, about the HPV vaccine – although the odds of having a vaccinated daughter was much higher among those who had, versus had not, discussed it (Table 5). Women more commonly than men said they had these conversations, as did respondents with more educational attainment (Appendix I). These associations were similar in gender-stratified models (Appendix J) although the association between speaking with one's daughter, and with a health worker, about HPV vaccine was more strongly associated with daughter's vaccination status among male respondents than females.

Nearly all respondents said they would be comfortable talking with their daughter about the HPV vaccine (although only one-third reported having actually done so) (Table 5). Although respondents perceived pro-vaccination social norms about routine childhood vaccines (over 93 % said that other parents in their community were vaccinating their children), over 40 % did not think that other parents were vaccinating their daughters against HPV (Table 5). Those who perceived that HPV vaccine was more common in their social network had over three times the odds of having vaccinated daughters than those who did not perceive this (Table 5). These relationships with similar in gender-stratified models (Appendix J).

Trust in institutions: Most respondents (approximately 80 %) said they would trust information about HPV vaccine from the Ministry of Health or from doctors and nurses a lot; these respondents also had approximately twice the odds of having a vaccinated daughter, in

Table 3
Knowledge of HPV and of HPV vaccine ("thinking and feeling" correlates of HPV vaccine uptake).

	n (%) who responded correctly[1]	OR any vaccine dose(s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[2]
HPV can cause cervical cancer, true (vs. false or don't know)	869 (64.8 %)	1.12 (0.89, 1.42)	1.11 (0.87, 1.41)
HPV can be passed on during sexual intercourse, true (vs. false or don't know)	746 (55.6 %)	1.27* (1.02, 1.59)	1.19 (0.94, 1.50)
Men can get HPV, true (vs. false or don't know)	546 (40.7 %)	0.91 (0.72, 1.14)	0.83 (0.65, 1.05)
A person could have HPV for many years without knowing it, true (vs. false or don't know)	1150 (85.6 %)	1.10 (0.80, 1.51)	0.96 (0.69, 1.34)
The HPV vaccine is most effective if given to girls who have never had sex, true (vs. false or don't know)	978 (73.1 %)	1.49** (1.16, 1.93)	1.31 (0.99, 1.72)
The HPV vaccine offers protection against cervical cancer, true (vs. false or don't know)	1238 (92.3 %)	2.77*** (1.68, 4.57)	2.51*** (1.48, 4.25)
Girls who have had the HPV vaccine do not need cervical cancer screening/test when they are older, false (vs. true or don't know)	853 (63.6 %)	1.55*** (1.23, 1.96)	1.61*** (1.26, 2.06)
	Mean (SD)	OR any vaccine dose(s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[3]
HPV knowledge score (can range 0–7, higher score indicates greater knowledge)	4.76 (1.64)	1.13** (1.05, 1.21)	1.09* (1.01, 1.17)

1: Correct answer, versus *incorrect answer or don't know (missing for each question is excluded).*

2: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).

** $p < 0.05$, **$p < 0.01$, ***$p < 0.001$.*

Table 4
Perceived risk of cervical cancer ("thinking and feeling" correlates of HPV vaccine uptake).

	n (%) Yes	OR any vaccine dose(s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[1]
Do you know anyone who has had cervical cancer? No	675 (50.3 %)	(ref)	(ref)
... Yes, they are still alive	134 (10.0 %)	1.11 (0.76, 1.64)	1.12 (0.75, 1.67)
... Yes, they died	534 (39.8 %)	1.38** (1.10, 1.75)	1.30* (1.01, 1.66)

1: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).

2: Yes (anyone) versus no one.

* $p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 5
Social norms about HPV vaccine ("social factor" correlates of HPV vaccine uptake).

	n (%) Yes	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[1]
Have you ever talked about cervical cancer or HPV vaccine with your daughter?	449 (33.4 %)	4.50*** (3.53, 5.73)	4.28*** (3.33, 5.50)
Have you ever talked about cervical cancer or HPV vaccine with other parents?	650 (48.4 %)	2.45*** (1.96, 3.07)	2.21*** (1.75, 2.81)
Have you ever talked about cervical cancer or HPV vaccine with a health care worker?	610 (45.4 %)	2.78*** (2.21, 3.48)	2.57*** (2.02, 3.26)
	n (%) Comfortable[2]	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[1]
How comfortable do you feel talking about cervical cancer or HPV vaccine with your daughter?	1247 (92.8 %)	1.57 (1.00, 2.47)	1.60 (0.99, 2.55)
How comfortable do you feel talking about cervical cancer or HPV vaccine with other parents?	1280 (95.2 %)	1.61 (0.92, 2.81)	1.53 (0.86, 2.73)
	n (%) Agree[3]	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose(s) (95 % CI)[1]
I feel that other parents in my community are vaccinating their daughters against HPV	791 (58.7 %)	3.29*** (2.58, 4.19)	3.33*** (2.58, 4.31)
I feel that other parents in my community are vaccinating their children with routine childhood vaccines	1254 (93.1 %)	1.48 (0.93, 2.35)	1.47 (0.91, 2.38)

1: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).
2: Very comfortable or Somewhat comfortable, versus Not comfortable or Don't know.
3: Strongly agree or Somewhat agree or Don't know, versus Strongly disagree or Somewhat disagree.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

adjusted models (Table 6). In gender-stratified models, this association was stronger and only statistically significant among female respondents (Appendix K). Likewise, the most-trusted entities were health workers: 74.2 % of respondents said they trusted doctors and nurses a lot, and 57.9 % said they trusted community health volunteers a lot (Table 6) – and these people also had significantly greater odds of having daughters who had received any doses of the HPV vaccine. Trust in other institutions was much lower, and not associated with HPV vaccine uptake in adjusted models. Respondents with lower educational attainment reported significantly higher trust than respondents with more educational attainment, as did those in rural areas compared to those in urban areas (Appendix K). Overall, people who reported higher levels of trust had higher odds of having daughters with any doses of the HPV vaccine (aOR 1.06) (Table 6) and these associations were overall similar in the gender-stratified models (Appendix L).

3.3. Practical issues

Overall, 20.9 % of respondents said they anticipated or experienced challenges accessing the HPV vaccine (Table 7): 15.0 % of those whose daughters had received any doses and 24.6 % of those whose daughters had not yet received any doses (data not shown). Among those with vaccinated daughters who reported experiencing an access challenge ($n = 77$), 83.1 % said it was a little or somewhat difficult to access at least one of the doses, and 16.9 % said it was very difficult (data not shown).

Table 6
Trust in institutions ("social factor" correlates of HPV vaccine uptake).

	n (%) a lot[1]	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose (s) (95 % CI)[2]
How much do you trust HPV vaccine information from the Ministry of Health	1037 (77.3 %)	2.24*** (1.68, 2.99)	2.30*** (1.70, 3.10)
How much do you trust HPV vaccine information from doctors and nurses	1081 (80.6 %)	1.89*** (1.40, 2.55)	1.90*** (1.40, 2.60)
How much do you trust...			
.. the people in your community	368 (27.4 %)	1.03 (0.80, 1.32)	1.01 (0.78, 1.32)
... the national government	565 (42.2 %)	1.27* (1.02, 1.59)	1.25 (0.98, 1.58)
... the county government	478 (35.6 %)	1.23 (0.98, 1.55)	1.19 (0.94, 1.52)
... doctors and nurses	996 (74.2 %)	1.30* (1.00, 1.68)	1.29 (0.99, 1.69)
... community health workers/ volunteers	773 (57.9 %)	1.52*** (1.21, 1.91)	1.53*** (1.21, 1.94)
... people who work at non-governmental organizations/ civil society	520 (39.1 %)	1.14 (0.91, 1.43)	1.17 (0.93, 1.49)
	Mean (SD)	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose (s) (95 % CI)[3]
Trust score (can range 0–18, higher score indicates greater trust)	13.30 (3.24)	1.06** (1.02, 1.10)	1.06** (1.02, 1.10)

1: A lot, versus some, a little, or not at all.
2: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 7
Accessing the HPV vaccine ("practical issues" correlates of HPV vaccine uptake).

	n (%) Yes	OR any vaccine dose (s) (95 % CI)	aOR any vaccine dose (s) (95 % CI)[1]
Accessing the HPV vaccine is/ would be difficult (vs. not difficult)	279 (20.9 %)	0.54*** (0.40, 0.72)	0.52*** (0.39, 0.71)
Accessing the HPV vaccine is/ would be...			
... not at all difficult	1054 (79.1 %)	(ref)	(ref)
... a little or somewhat difficult	203 (15.2 %)	0.65** (0.47, 0.90)	0.64** (0.46, 0.90)
... very difficult	76 (5.7 %)	0.29*** (0.16, 0.54)	0.26*** (0.14, 0.49)

1: Adjusted odds ratios were adjusted for: age (continuous), gender (female/male), employment status (employed/unemployed), marital status (married/unmarried), educational attainment (primary/secondary/beyond), income sufficiency (sufficient/just enough/insufficient), location of residence (urban/town/rural), religion (none/Catholic/Anglican/SDA/Other Christian/Muslim/Other).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Among those with unvaccinated daughters who anticipated an access challenge ($n = 202$), 68.8 % said they thought it would be a little or somewhat difficult, and 31.2 % said they thought it would be very difficult (data not shown). There were no significant differences in access by respondent characteristic, including urbanicity of residence (Appendix M). In adjusted models, experiencing or anticipating access difficulties, and feeling that these were very difficult, was significantly associated with having received any doses of the HPV vaccine (Table 7); the gender-stratified models looked very similar, although the lower adjusted odds for those who reported "a little or somewhat difficult" versus "not at all difficult" was significant only among female respondents (Appendix N).

3.4. Sensitivity analysis with "number of doses" outcome

We repeated the main analyses but using an outcome that represented number of HPV vaccine doses reportedly received: none (reference group) versus 1 dose versus 2 doses. The main results as shown in the above tables remain unchanged: vaccine hesitancy was significantly associated with number of doses, as were social norms, trust in institutions, and access to vaccination services (Appendix O).

Lastly, we found that the main independent variables were significantly correlated with each another, but the correlation coefficients were small, suggesting that the factors are relatively independent of one another (Appendix P).

4. Discussion

We sought to identify intervention-amenable factors associated with HPV vaccination in Kenya. Through this nation-wide, random digit dialed phone survey, we captured a large and diverse respondent population; and observed strong relationships between all hypothesized determinants and girls' reported HPV vaccination status: hesitancy toward the HPV vaccine, knowledge about HPV and HPV vaccine, knowing someone who had died due to cervical cancer, social norms about HPV vaccination, trust in HPV vaccine information and in institutions, and access to HPV vaccination services.

In this sample, approximately 38 % of respondents said their age-eligible daughter(s) had received any doses of the HPV vaccine. This is somewhat higher than the official Kenyan government estimate from 2021 that 29 % of age-eligible girls had received the first HPV vaccine dose. This may be because respondents to this survey were not fully representative of the general Kenyan population; [30] this survey had a very high response rate, so we do not believe there was differential survey response, but rather, phone ownership may be distributed in a non-representative manner. Other surveys from low- and middle-income countries have found that mobile phone respondents differ from the general population, [31–33] which may be due to underlying disparities in mobile phone ownership as well as different patterns in who completes surveys (versus attrition or nonresponse). [34,35] We did not aspire to generate nationally representative estimates, so did not use special sampling or data weighting techniques for this sample, but do want to highlight that the results may not generalize to the full population. Additionally, access to the vaccine was reportedly quite good in this population; only approximately 20 % said they had, or anticipated having, any access difficulties; and the most common barriers experienced were around ability to attend the visit, affordability, and geographic accessibility. These results should therefore also be interpreted in the context of a group reporting few experienced or anticipated HPV vaccine access challenges.

Our findings point to potentially modifiable factors related to uptake, especially at the intra- and inter-personal levels. We feel that the study's results should be considered both in terms of frequency (how many parents/caregivers reported these factors) and magnitude (how strongly are the factors associated with HPV vaccination), so address both aspects here. Many respondents acknowledged the importance of the HPV vaccine and felt it was effective, but approximately half expressed concerns about side effects from the vaccine (both short- and long-term). Overall greater hesitancy toward the HPV vaccine was associated with lower likelihood of having a vaccinated daughter. Other studies from Africa have similarly found that knowledge and attitudes about the HPV vaccine are associated with intention to vaccinate, [8,11,36,37] or vaccination itself. [38] Importantly, we did not see any association between hesitancy in routine childhood vaccines and one's daughter's HPV vaccination status – suggesting there may be uniquely relevant hesitancy factors around HPV vaccine. Messaging and outreach strategies that specifically addresses attitudes toward the HPV vaccine, and specifically safety concerns, are urgently needed.

We also found that knowledge about HPV and HPV vaccine was mediocre; for example, only 64.8 % of respondents knew that HPV could cause cervical cancer, and only 55.6 % knew that HPV was sexually transmitted. Other studies from Kenya [11] and other African countries [36,39,40] have also found generally poor knowledge about HPV and HPV vaccine. We found higher knowledge among women than among men, and a similar gendered effect on knowledge has also been identified previously. [11,40] Despite mediocre levels of knowledge, our survey found that knowledge was associated with vaccine uptake. Thus, improving knowledge is another important area for intervention, and our results suggest that educating parents/caregivers about the importance of early HPV vaccination may be particularly impactful.

In addition, these results underscore the importance of engaging health workers in communicating about the HPV vaccine with parents/caregivers. Almost all respondents (97 %) said they would do what a health care provider recommends about HPV vaccination and the majority (81 %) said they would trust HPV vaccine information from health workers a lot – but fewer than half (45 %) said they had ever spoken with a health care provider about the vaccine. Trust in health care workers, and previous positive vaccination experiences, have been found to be associated with HPV vaccination intention and uptake in previous studies. [8,39] There are many ways to engage health workers in promoting HPV vaccine. One high-yield approach might be to raise awareness among women who come for cervical cancer screening; parents' experience with screening was identified as a correlate of HPV vaccination in Zambia as well. [37] Health worker interventions could also target multiple cadres, not only clinicians but also community health workers, pharmacists, and others. Nearly half of respondents in this study also said they would heed a religious leader's advice, so this may be another high priority group to engage.

Despite somewhat limited knowledge about HPV and HPV vaccine, cervical cancer is highly salient in this population: approximately half of respondents knew someone who had cervical cancer, and most of these affected women had died – and respondents who knew someone affected by cervical cancer had higher odds of having daughters vaccinated against HPV. A study from Zambia similarly found that first-hand experience with cervical cancer was associated with parental consent to vaccinate one's daughter. [37] This suggests that an intervention leveraging trusted messengers who are themselves cervical cancer survivors may be an effective approach to promote HPV vaccination.

Social norms and perceptions of peers' vaccination behaviors also emerged as an important correlate of HPV vaccination. Although nearly all respondents said they would feel comfortable talking about HPV vaccine, only half had done so. In order to advance pro-vaccination social interactions, future interventions might seek to foster community dialogue and facilitated engagement about HPV vaccine. Programs could also seek to equip parents/caregivers with tools, language, and factual information in order to initiate facts-based, open HPV vaccine discussions with other parents/caregivers and within their household.

We found urban-rural differences in both our dependent and independent variables, which deserves further study. In this sample, significantly more respondents in rural areas said their daughters had received HPV vaccine versus those in urban areas – and also expressed less HPV vaccine hesitancy, higher knowledge about HPV and HPV

vaccine, fewer pro-vaccination social norms, and lower trust in institutions. A similar pattern was seen for respondents with greater educational attainment, which has also been found in other studies of HPV vaccination in Kenya and elsewhere in Africa. [11,39] Further studies will be needed to improve our understanding of the unique attitudes and experiences of people in urban areas and in higher socioeconomic strata; for example, are sources and spread of information (and misinformation) different in urban environments, or if there are different prevalent social norms.

This study has numerous strengths including its large sample size, its use of random-digit dialing for respondent selection, the measurement of HPV vaccination as an outcome (rather than intention or motivation), and the inclusion of multiple well-used tools to measure theoretically-motivated determinants of HPV vaccine uptake. However, several limitations should be noted. First, as this was a phone survey designed to assess associations between HPV vaccine uptake and parent/caregiver thinking/feeling, social norms, and access, the sample was not designed to be representative of the Kenyan population and the results should not be inferred as such. Second, we obtained a high response rate (97.4 % of those who completed the screening and were eligible to participate) but this response rate cannot be well-contextualized and the potential for selection bias cannot be eliminated. Third, although we assessed vaccination cards and attempted to determine vaccine receipt using all available data, we used parent/caregiver report of HPV vaccination as our outcome, and it is possible that parents/caregivers do not perfectly report their daughters' vaccination status.

5. Conclusions

We identified a number of intervention-amenable factors associated with girls' HPV vaccination status in Kenya. Promising areas for intervention include: messaging about the HPV vaccine's safety, improving parents'/caregivers' knowledge about HPV and the HPV vaccine, addressing misinformation, activating peer messengers (whether parents/caregivers of preadolescent girls or women who have experienced cervical cancer), encouraging pro-vaccination social norms, and leveraging trusted messengers like religious leaders and health workers. As HPV vaccine uptake remains very low in Kenya – as in many low- and middle-income countries – interventions are urgently needed, and large, theory-informed, individual-level surveys like this one can offer valuable insights for policymakers, practitioners, researchers, and the global cancer control and vaccination communities.

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CRediT authorship contribution statement

Corrina Moucheraud: Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Eric Ochieng:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation. **Vitalis Ogutu:** Writing – review & editing, Software, Project administration, Data curation. **L. Cindy Chang:** Writing – review & editing, Formal analysis. **Ginger Golub:** Writing – review & editing, Supervision, Conceptualization. **Catherine M. Crespi:** Writing – review & editing, Supervision, Methodology, Funding acquisition. **Peter G. Szilagyi:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

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Data availability

The authors do not have permission to share data.

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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.2024.126410.

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