

Factors Associated with Human Papillomavirus Vaccine Uptake Among Secondary School Girls in Ubungo, Dar es Salaam: An Analytical Cross-Sectional Study

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ABSTRACT

Background: Human papillomavirus (HPV) vaccination is a key primary prevention strategy for cervical cancer, yet vaccine completion remains uneven in many low- and middle-income settings. In Tanzania, HPV vaccination has been delivered through school-based, health-facility-based, and community outreach platforms. Local evidence is needed to understand uptake and barriers among in-school adolescents in urban settings.

Methods: An analytical cross-sectional study was conducted among 500 secondary school girls aged 14 to 16 years in Ubungo Municipal Council, Dar es Salaam, Tanzania. Participants were selected using a two-stage sampling procedure from government and private secondary schools. Data were collected using a structured self-administered questionnaire. Full HPV vaccination was defined as self-reported receipt of two HPV vaccine doses. Frequencies and percentages were used to describe vaccination status and reported barriers. Logistic regression was used to identify factors associated with full vaccination.

Results: Overall, 121 girls (24.2%) had received two HPV vaccine doses, 98 (19.6%) had received one dose, and 281 (56.2%) had never received the HPV vaccine. Full vaccination increased with age and class level. In multivariable analysis, full vaccination was independently associated with age 16 years (aOR 3.73, 95% CI 1.77 to 8.26), Form 4 class level (aOR 4.88, 95% CI 1.65 to 12.77), basic HPV vaccine knowledge (aOR 5.38, 95% CI 2.32 to 12.46), health-facility visit in the previous six months (aOR 2.06, 95% CI 1.21 to 3.51), and healthcare-provider encouragement (aOR 2.79, 95% CI 1.59 to 4.87). Among 110 never-vaccinated girls who were unwilling to receive HPV vaccine, the most common barriers were wanting more information (80.0%), parental or guardian refusal (58.2%), fear of side effects (56.4%), fluctuating vaccine availability (46.4%), and not knowing where to obtain the vaccine (43.6%).

Conclusion: Full HPV vaccination coverage among secondary school girls in Ubungo Municipal Council was low. Uptake was influenced by age, class level, HPV vaccine knowledge, recent contact with health services, and encouragement from healthcare providers. Among unvaccinated girls who were unwilling to receive the vaccine, the main barriers were informational gaps, parental influence, safety concerns, and difficulties navigating vaccination services. Improving HPV vaccination in similar urban settings in Tanzania will require practical adolescent-focused education, targeted communication with parents, strong and consistent recommendations from trusted healthcare providers, and better coordination of vaccination services across both government and private schools.

BACKGROUND

Human papillomavirus (HPV) is a common sexually transmitted infection, and persistent infection with high-risk HPV types is the necessary causal pathway for most cervical cancers. Most HPV infections clear spontaneously, but persistent oncogenic infection may progress to precancerous cervical lesions and invasive cervical cancer over many years.¹ Cervical cancer is therefore largely preventable through HPV vaccination, screening, and timely treatment of precancerous lesions; when invasive disease occurs, management may include

surgery, radiotherapy, chemotherapy, palliative care, or combinations of these depending on stage and service capacity.¹

Cervical cancer remains a major public health problem globally, with an estimated 660,000 new cases and 350,000 deaths in 2022.¹ The burden is disproportionately borne by low- and middle-income countries, where access to vaccination, screening services, timely diagnosis and treatment, and comprehensive cancer care continues to be uneven. The World Health Organization's global strategy for

cervical cancer elimination sets a 2030 target of 90% of girls fully vaccinated with the HPV vaccine by age 15 years, 70% of women screened with a high-performance test by ages 35 and 45 years, and 90% of women with precancerous lesions or invasive cancer treated or managed.²

Tanzania introduced HPV vaccination nationally in April 2018, using a two-dose schedule for adolescent girls after earlier demonstration experience in Kilimanjaro Region.³ Delivery was implemented through routine immunisation structures, including school-based, health-facility-based, and community outreach platforms.³ However, programme experience in Tanzania and other East African settings indicates that vaccine availability alone does not ensure uptake or completion. Knowledge, parental permission, school mobilisation, healthcare-provider recommendation, perceived safety, and the reliability of delivery platforms all influence whether eligible girls receive the vaccine.³⁻⁷

Evidence from Tanzania has documented persistent gaps in HPV vaccine uptake. In Ilala Municipality, Dar es Salaam, only about one in five adolescent girls had received the second HPV vaccine dose, with uptake associated with age, attitude, and awareness of the second dose.⁴ Earlier Tanzanian research also identified limited knowledge, fear of side effects, fertility concerns, absence on vaccination days, and parental refusal as reasons for non-vaccination.⁷ These findings show that local evidence remains important because HPV vaccine uptake may vary by municipality, school setting, delivery pathway, and social context within the same national programme.^{4,7}

Ubungu Municipal Council provides a relevant urban setting for examining HPV vaccine uptake because it includes government and private secondary schools across multiple wards and operates within a mixed vaccination-delivery environment involving schools, health facilities, and community outreach. In such a setting, low uptake cannot be explained by distance alone. This pattern may reflect the way information access, parental decision-making, school organisation, provider communication, and service follow-up interact in practice.

This study assessed HPV vaccine uptake and factors associated with full vaccination among secondary school girls aged 14 to 16 years in Ubungu Municipal Council, Dar es Salaam. The study examined child-level, household-level, school-level, and health-service factors associated with receipt of two HPV vaccine doses and described reported barriers among never-vaccinated girls who were unwilling to receive the vaccine if it were made available.

METHODS

Study Design

This was an analytical cross-sectional study conducted among secondary school girls in Ubungu Municipal Council, Dar es Salaam, Tanzania. The design was used to estimate the prevalence of full HPV vaccination and examine factors associated with vaccination status at one point in time. Reporting was guided by relevant items from the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.⁸

Study Setting

The study was conducted in Ubungu Municipal Council, an urban municipality in Dar es Salaam, Tanzania. At the time of the study, the municipality had 14 wards and 64 secondary schools, including 29 government schools and 35 private schools. Eleven wards had both government and private secondary schools, while three wards had government secondary schools only. HPV vaccination services were delivered through school-based, health-facility-based, and community outreach platforms. This setting allowed assessment of HPV vaccine uptake among adolescents attending both government and private schools within an urban Tanzanian vaccination-delivery context.

Study Population

The study population comprised ordinary-level secondary school girls aged 14-16 years enrolled in government and private secondary schools in Ubungu Municipal Council. Participants were drawn from Forms 1-4. This age range was selected because girls in this group were expected to have had an opportunity to receive HPV vaccination during or after Tanzania's national HPV vaccine roll-out period.

Inclusion and Exclusion Criteria

Girls were eligible if they were aged 14 to 16 years, enrolled in a selected secondary school, present during data collection, and assented to participate. Girls were excluded if they were absent during data collection or if their questionnaire lacked information required to determine HPV vaccination status.

Sample Size Estimation

The sample size was estimated using the single population proportion formula for health studies:⁹

$$n = \frac{Z^2 p(1 - p)}{d^2}$$

where n denotes the required sample size, Z represents the standard normal deviation corresponding to a 95% confidence level, p is the anticipated prevalence of HPV vaccine uptake in the study population, and d is the desired margin of error. The expected prevalence was set at 15.7%, calculated from two Ugandan studies that reported HPV vaccine uptake of 13.8% in Mbale District and 17.6% in Lira District.^{10,11} A 5% margin of error and 95% confidence level were used.

The initial sample size was approximately 204. Because multistage sampling was used, a design effect of 2 was applied, giving 408 participants. After allowing for 10% non-response, the minimum required sample size was 453. The final sample was increased to 500 to allow selection of 20 eligible girls from each of the 25 selected schools.

Sampling Procedure

A two-stage sampling procedure was used. In the first stage, schools were stratified by ownership as government or private. One government school and one private school were randomly selected from each ward where both

school types were available. In the three wards without private secondary schools, the available government school was included. This yielded 25 selected schools. In the second stage, class registers were used to identify eligible girls aged 14-16 years in each selected school. Twenty eligible girls were selected from each school using simple random sampling. This multistage approach was appropriate because the study population was naturally organised within administrative wards, schools, and individual students.¹²

Data Collection Tool and Procedure

Data were collected between March and April 2021 using a structured self-administered questionnaire. The tool was adapted from previous HPV vaccine uptake studies in East Africa and modified for the Tanzanian secondary school context.^{10,11} The questionnaire collected information on socio-demographic characteristics, HPV vaccination status, HPV vaccine knowledge, attitudes towards HPV vaccination, household factors, health-service factors, and reasons for non-vaccination.

The questionnaire was prepared in English and translated into Kiswahili. It was pre-tested before the main study, and minor revisions were made to improve clarity, sequencing, and comprehension. Trained research assistants administered the questionnaire during school hours. Students completed the questionnaire privately in classrooms and returned it to the research team.

The respondents were adolescent girls. Parents or guardians were not included as respondents; instead, household and parental variables were reported by the students. Administrative permission was obtained from the relevant municipal and school authorities, and written assent was obtained from the students in accordance with the approved protocol.

Study Variables

The primary outcome was full HPV vaccination, defined as self-reported receipt of two HPV vaccine doses. Girls who had received one dose or no dose were classified as not fully vaccinated for the primary regression analysis. For descriptive analysis, HPV vaccination status was also presented in three categories: never vaccinated, received one dose, and received two doses.

Independent variables were grouped into child-level, school-level, household-level, and health-service factors. Child-level factors included age, class level, religion, residence, health insurance status, recent health-facility visit, sexual practice, HPV vaccine knowledge, and attitude towards HPV vaccination. School-level factors included school ownership, categorised as government or private. Household-level factors included living arrangement, mother's presence in the household, household size, parent or guardian attentiveness, parental or guardian education, and household media ownership. Health-service factors included healthcare-provider encouragement, perceived HPV vaccine availability and accessibility, perceived vaccine shortage, place of vaccination, availability of health workers at the vaccination site, and receipt of information before vaccination.

Household media ownership was treated as a simple

indicator of media exposure rather than a direct measure of household economic status, because detailed household wealth information may be difficult for adolescent respondents to report accurately.

Measurement of HPV Vaccine Knowledge and Attitude

HPV vaccine knowledge was assessed using six practical knowledge domains: awareness of HPV vaccine, knowledge of vaccine benefits, knowledge of the recommended number of doses, knowledge of the recommended dose interval, knowledge of the target age group for HPV vaccination in Tanzania, and knowledge of where the HPV vaccine could be accessed. These domains reflect the type of information needed for adolescents to recognise the vaccine, understand its purpose, and identify potential vaccination access points. Similar knowledge and service-access domains have been used in the HPV vaccine uptake studies among adolescent girls in East Africa.^{10,11} Knowledge was categorised as no/limited knowledge or basic knowledge according to the study analysis coding.

Attitude towards HPV vaccination was measured using five three-point items assessing beliefs about HPV as a cause of cervical cancer, seriousness of cervical cancer, importance of HPV vaccination for girls, perceived vaccine efficacy, and perceived vaccine side effects. These items correspond to common health-behaviour constructs related to perceived seriousness, perceived benefit, and perceived barriers to preventive action.^{13,14} Attitude was categorised as negative, positive, or neither positive nor negative.

Barrier Assessment

Reasons for non-vaccination were assessed among girls who had never received the HPV vaccine and who reported that they would not accept vaccination if it were offered. Barrier items were structured as multiple-response yes/no questions; therefore, barriers were analyzed based on the frequency of endorsement. However, participants were not asked to rank the relative importance of the barriers.

Data Management and Statistical Analysis

Data were cleaned and analysed using SPSS version 26. Frequencies and percentages were used to summarise categorical variables. HPV vaccination status was described overall and by age category, class level, and school type. For inferential analysis, full HPV vaccination was coded as 1 for girls who had received two doses and 0 for girls who had received one dose or no dose. Bivariate logistic regression was used to estimate crude odds ratios and 95% confidence intervals for associations between independent variables and full vaccination. Logistic regression was selected because the primary outcome was binary.¹⁵

Variables with $P \leq .10$ in bivariate analysis were considered for multivariable logistic regression. These included age, religion, class level, HPV vaccine knowledge, attitude towards HPV vaccination, recent health-facility visit, healthcare-provider encouragement, perceived vaccine availability and accessibility, and mother's presence in the household. Adjusted odds ratios, 95% confidence intervals, and P -values were reported. Statistical

significance was considered at $P < .05$.

School type was examined descriptively and in bivariate analysis because the sampling design included both government and private schools. Age and class level were both retained in the multivariable model because age may reflect eligibility and time since vaccination opportunity, while class level may reflect cumulative exposure to school-based health information and vaccination activities.

Bias Control and Data Quality Assurance

Random selection of schools and students was used to reduce selection bias. Private questionnaire completion was used to reduce social desirability bias, especially for sensitive questions. The self-administered format reduced interviewer influence. Recall bias was possible because vaccination cards were not reviewed; however, direct questions on receipt of the HPV vaccine and number of doses were used to reduce outcome misclassification. Research assistants were trained before data collection. The questionnaire was pre-tested, completed questionnaires were reviewed for completeness, and data cleaning included range and consistency checks.

Ethical Considerations

Ethical approval was obtained from an institutional review board. Permission to conduct the study was obtained from Ubungo Municipal Council and selected school authorities. Participation was voluntary. Students provided written assent before completing the questionnaire and were informed that they could decline or withdraw without penalty. No names were recorded in the analysis dataset, and all data were handled confidentially.

RESULTS

Participant Characteristics

The analysis included 500 secondary school girls aged 14–16 years. Of these, 280 (56.0%) were from government schools and 220 (44.0%) were from private schools. Overall, 212 girls (42.4%) were aged 14 years, 152 (30.4%) were aged 15 years, and 136 (27.2%) were aged 16 years. Most participants lived in urban areas, 476 (95.2%). By religion, 222 (44.4%) were Muslim, 273 (54.6%) were Christian, and 5 (1.0%) reported another religion or no religion.

By class level, 130 girls (26.0%) were in Form 1, 161 (32.2%) in Form 2, 152 (30.4%) in Form 3, and 57 (11.4%) in Form 4. Most participants lived with both parents, 334 (66.8%), while 78 (15.6%) lived with their mother only, 21 (4.2%) with their father only, and 67 (13.4%) with a guardian, step-parent, or other household arrangement (Table 1).

HPV Vaccination Status

Overall, 121 girls (24.2%) had received two doses of HPV vaccine and were classified as fully vaccinated. Ninety-eight girls (19.6%) had received one dose only, while 281 (56.2%) had never received the HPV vaccine. Full vaccination increased with age. Among girls aged 14 years, 21 (9.9%) were fully vaccinated, compared with 43 (28.3%) among girls aged 15 years and 57 (41.9%) among girls aged 16 years. Full vaccination also increased

by class level, from 12 (9.2%) among Form 1 students to 26 (45.6%) among Form 4 students.

By school type, 63 government school students (22.5%) and 58 private school students (26.4%) were fully vaccinated. School type was not significantly associated with full vaccination in bivariate analysis, but vaccination status is presented by school type because both government and private schools were included in the sampling design (Table 2).

Child-level Factors Associated with full HPV Vaccination

In bivariate analysis, age, class level, HPV vaccine knowledge, attitude towards HPV vaccination, and recent health-facility visit were associated with full HPV vaccination. Girls aged 15 and 16 years had higher odds of full vaccination than girls aged 14 years. Similarly, girls in Forms 2, 3, and 4 had higher odds of full vaccination than girls in Form 1.

A total of 325 girls (65.0%) were classified as having basic HPV vaccine knowledge, while 175 (35.0%) had no or limited knowledge. Girls with basic HPV vaccine knowledge had higher odds of full vaccination than those with no or limited knowledge. Attitude towards HPV vaccination was associated with full vaccination in bivariate analysis but did not remain independently associated after adjustment.

Household and Health-service Factors Associated with Full HPV Vaccination

Mother's presence in the household showed a weak association with full vaccination in bivariate analysis but did not remain statistically significant after adjustment. Other household factors, including household size, parent or guardian attentiveness, and parental or guardian education, did not show independent association with full vaccination.

Health-service factors showed stronger associations. Girls who had visited a health facility in the previous six months had higher odds of full vaccination than those who had not. Girls who had been encouraged by a healthcare provider to receive the HPV vaccine also had higher odds of full vaccination. Perceived vaccine availability and accessibility were associated with full vaccination in bivariate analysis but did not remain statistically significant after adjustment.

Independent Factors Associated with full HPV Vaccination

In the multivariable logistic regression model, five factors remained independently associated with full HPV vaccination: age, class level, HPV vaccine knowledge, recent health-facility visit, and healthcare-provider encouragement.

Age remained associated with full vaccination after adjustment. Compared with girls aged 14 years, girls aged 16 years had higher adjusted odds of full vaccination (aOR 3.73, 95% CI 1.77 to 8.26; overall $P = .003$). Class level was also independently associated with full vaccination. Compared with Form 1 students, Form 4 students had higher adjusted odds of full vaccination (aOR 4.88, 95% CI 1.65 to 12.77; overall $P = .020$).

Girls with basic HPV vaccine knowledge had higher adjusted odds of full vaccination than those with no or

TABLE 1: Characteristics of secondary school girls by school type in Ubungo Municipal Council, Dar es Salaam, Tanzania (N=500)

Characteristic	Total (N=500) n (%)	Government (n=280) n (%)	Private (n=220) n (%)
Age			
14 years	212 (42.4)	131 (46.8)	81 (36.8)
15 years	152 (30.4)	69 (24.6)	83 (37.7)
16 years	136 (27.2)	80 (28.6)	56 (25.5)
Class level			
Form 1	130 (26.0)	95 (33.9)	35 (15.9)
Form 2	161 (32.2)	86 (30.7)	75 (34.1)
Form 3	152 (30.4)	69 (24.6)	83 (37.7)
Form 4	57 (11.4)	30 (10.7)	27 (12.3)
Religion			
Muslim	222 (44.4)	146 (52.1)	76 (34.5)
Christian	273 (54.6)	134 (47.9)	139 (63.2)
Other/none	5 (1.0)	0 (0.0)	5 (2.3)
Residence			
Urban	476 (95.2)	265 (94.6)	211 (95.9)
Rural	24 (4.8)	15 (5.4)	9 (4.1)
Living arrangement			
Both parents	334 (66.8)	182 (65.0)	152 (69.1)
Mother only	78 (15.6)	46 (16.4)	32 (14.5)
Father only	21 (4.2)	10 (3.6)	11 (5.0)
Step-parent/guardian/other	67 (13.4)	42 (15.0)	25 (11.4)
Health-service exposure			
Visited health facility in past six months	196 (39.2)	106 (37.9)	90 (40.9)
Encouraged by healthcare provider	221 (44.2)	134 (47.9)	87 (39.5)
Perceived HPV vaccine as available	259 (51.8)	160 (57.1)	99 (45.0)
Did not perceive vaccine as available	240 (48.0)	120 (42.9)	120 (54.5)

TABLE 2: HPV vaccination status by age, class level, and school type among secondary school girls in Ubungo Municipal Council, Dar es Salaam, Tanzania (N=500)

Characteristic	Never vaccinated n (%)	One dose n (%)	Two doses/full vaccination n (%)	Total
Age				
14 years	154 (72.6)	37 (17.5)	21 (9.9)	212
15 years	66 (43.4)	43 (28.3)	43 (28.3)	152
16 years	61 (44.9)	18 (13.2)	57 (41.9)	136
Class level				
Form 1	92 (70.8)	26 (20.0)	12 (9.2)	130
Form 2	84 (52.2)	42 (26.1)	35 (21.7)	161
Form 3	82 (53.9)	22 (14.5)	48 (31.6)	152
Form 4	23 (40.4)	8 (14.0)	26 (45.6)	57
School type				
Government	154 (55.0)	63 (22.5)	63 (22.5)	280
Private	127 (57.7)	35 (15.9)	58 (26.4)	220

limited knowledge (aOR 5.38, 95% CI 2.32 to 12.46; $P<.001$). Girls who had visited a health facility in the previous six months were more likely to be fully vaccinated (aOR 2.06, 95% CI 1.21 to 3.51; $P=.008$). Healthcare-provider encouragement also remained independently associated with full vaccination (aOR 2.79, 95% CI 1.59 to 4.87; $P<.001$).

Although class level was related to age, Form 4 remained associated with full vaccination after adjustment, suggesting that class level was not only a marker of age. It may also reflect cumulative exposure to school-based vaccination opportunities, repeated health messages, or school-level organisation of vaccination activities (Table 3).

TABLE 3: Bivariate and Multivariable Logistic Regression Analysis of Factors Associated with Full HPV Vaccination Among Secondary School Girls in Ubungo Municipal Council, Dar es Salaam, Tanzania (N=500)

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age				
14 years	Reference		Reference	
15 years	3.59 (2.02–6.36)	<.001	1.73 (0.86–3.42)	.120
16 years	6.56 (3.73–11.54)	<.001	3.73 (1.77–8.26)	.001
Class level				
Form 1	Reference		Reference	
Form 2	2.73 (1.35–5.51)	.005	1.84 (0.81–4.07)	.143
Form 3	4.54 (2.29–9.01)	<.001	2.69 (1.06–5.77)	.035
Form 4	8.25 (3.74–18.18)	<.001	4.88 (1.65–12.77)	.002
School type				
Government	Reference			
Private	1.23 (0.82–1.86)	.317	Not retained	
HPV vaccine knowledge				
No/limited knowledge	Reference		Reference	
Basic knowledge	11.13 (5.28–23.44)	<.001	5.38 (2.32–12.46)	<.001
Recent health-facility visit				
No	Reference		Reference	
Yes	3.82 (2.49–5.87)	<.001	2.06 (1.21–3.51)	.008
Healthcare-provider encouragement				
No	Reference		Reference	
Yes	5.50 (3.47–8.70)	<.001	2.79 (1.59–4.87)	<.001
Mother present in household				
No	Reference		Reference	
Yes	0.63 (0.38–1.03)	.068	0.78 (0.41–1.49)	.460
Perceived vaccine availability/accessibility				
No	Reference		Reference	
Yes	1.58 (1.04–2.39)	.032	1.46 (0.86–2.48)	.160
Attitude towards HPV vaccination				
Negative	Reference		Reference	
Positive	1.03 (0.39–2.67)	.960	Not independently associated	
Neither positive nor negative	0.25 (0.09–0.69)	.007	Not independently associated	

Willingness and Barriers Among Never-vaccinated Girls

Among the 281 girls who had never received the HPV vaccine, 171 (60.9%) reported that they would accept HPV vaccination if the vaccine were made available, while 110 (39.1%) reported that they would not accept vaccination. Barrier analysis was restricted to the 110 never-vaccinated girls who reported unwillingness to receive the HPV vaccine if it were made available. Because the barrier items were multiple-response yes/no items, the findings are presented as frequency-ranked barriers rather than the respondent-ranked barriers.

The most frequently reported barrier was wanting more information about the HPV vaccine, reported by 88 girls (80.0%). Other common barriers were parental or guardian refusal, 64 (58.2%); fear of side effects, 62 (56.4%); fluctuating vaccine availability, 51 (46.4%); and not knowing where to access the vaccine, 48 (43.6%). Less frequently reported barriers included cultural restrictions, perceived fertility concerns, belief that vaccination was unnecessary, embarrassment to ask parents or guardians, belief that vaccination encourages sexual activity, long distance to the vaccination site, religious restrictions, and belief that the vaccine was only for White people (Table 4).

TABLE 4: Frequency-Ranked Barriers to HPV Vaccination among Vaccine-Unwilling, Never-Vaccinated Secondary School Girls In Ubungo Municipal Council, Dar Es Salaam, Tanzania (N=110)

Barrier	n	%
Wanted more information about HPV vaccine	88	80
Parents/guardians would not allow vaccination	64	58.2
Fear of side effects	62	56.4
Fluctuating vaccine availability/stock	51	46.4
Did not know where to get the vaccine	48	43.6
Culture does not allow vaccination	24	21.8
Believed vaccine affects fertility	21	19.1
Believed vaccination was not necessary	21	19.1
Embarrassed to ask parents/guardians	18	16.4
Believed vaccine encourages sexual activity	9	8.2
Long distance to vaccination site	9	8.2
Religion does not allow vaccination	5	4.5
Believed vaccine is only for White people	2	1.8

DISCUSSION

Principal Findings

This study found low completion of the two-dose HPV vaccination schedule among secondary school girls aged 14 to 16 years in Ubungu Municipal Council. Only 24.2% of participants had received two doses, while 56.2% had never received any HPV vaccine dose. Full vaccination was independently associated with older age, higher class level, basic HPV vaccine knowledge, recent health facility visits, and healthcare provider encouragement. Among never-vaccinated girls who were unwilling to receive the vaccine if it were made available, the leading barriers were wanting more information, parental or guardian refusal, fear of side effects, fluctuating vaccine availability, and not knowing where to obtain the vaccine.

These findings suggest that HPV vaccine uptake in this urban setting was shaped by more than service availability. The pattern points to the combined influence of adolescent knowledge, school exposure, provider communication, parental decision-making, and confidence in vaccine safety. This interpretation is consistent with regional evidence showing that HPV vaccine uptake among adolescent girls is associated with knowledge, attitude, health promotion, family support, and health-system factors.^{5,6}

Uptake in relation to Tanzanian and regional evidence

The 24.2% full vaccination prevalence observed in Ubungu is low when placed against Tanzania's national HPV vaccination ambitions and the WHO cervical cancer elimination target. Tanzania introduced two-dose HPV vaccination nationally in 2018, and national administrative coverage was higher than the full vaccination prevalence observed in this school-based survey.^{3,17} This difference may partly reflect methodological differences between administrative coverage estimates and self-reported school survey data, but it also suggests that local completion gaps may persist even in urban municipalities where schools and health facilities are physically available.

The finding is locally plausible because another Dar es Salaam study, conducted in Ilala Municipality, also reported low second-dose uptake among adolescent girls.⁴ The similarity between Ubungu and Ilala suggests that urban residence alone does not guarantee HPV vaccine completion. Instead, the key programmatic question is how schools, health facilities, parents, and adolescents are linked through communication channels, consent processes, vaccination delivery, and follow-up mechanisms.

The finding also fits the wider regional pattern. A 2024 East African systematic review and meta-analysis reported pooled HPV vaccine uptake of about 35%, with substantial variation across settings.⁵ A separate sub-Saharan African schoolgirl meta-analysis reported low pooled uptake and found that good knowledge and positive attitude were significantly associated with HPV vaccine uptake.⁶ This supports the interpretation that local studies remain necessary because national and regional averages can mask important differences between districts, municipalities, and school systems.

Age, Class Level, and Accumulated Programme Exposure

Older age was independently associated with full vaccination. Girls aged 16 years had higher odds of completing vaccination than girls aged 14 years. Similar

age-related patterns have been reported in Dar es Salaam, where older adolescents were more likely to receive the second HPV vaccine dose.⁴ One plausible explanation is cumulative opportunity: older girls may have had more chances to encounter school vaccination visits, health education messages, or facility contacts after national rollout.

Class level also remained associated with full vaccination after age adjustment, especially among Form 4 students compared with Form 1 students. This finding should not be interpreted as class level causing vaccination. Rather, class may reflect the student's position within the school system and accumulated exposure to school-based health activities. Because Tanzania's HPV vaccination programme relied partly on schools and community platforms, school organisation may influence whether students receive information, parental notification, vaccination opportunities, and follow-up for missed doses.^{3,17}

Knowledge as Practical Vaccine Literacy

Basic HPV vaccine knowledge was strongly associated with full vaccination. This aligns with East African and sub-Saharan African evidence showing that knowledge and awareness are repeatedly associated with HPV vaccine uptake among adolescent girls.^{5,6} In Ilala, awareness of the second HPV vaccine dose was also strongly associated with second-dose uptake.⁴

In this study, knowledge should be interpreted as practical vaccine literacy rather than general academic ability. The knowledge domains assessed whether girls had heard of the HPV vaccine, understood its benefits, knew the dose schedule, knew the target age group, and knew where vaccination could be accessed. These are operational facts that can affect whether an adolescent recognises vaccination opportunities, discusses vaccination with parents or guardians, and follows up after a missed or incomplete dose. The barrier analysis strengthens this interpretation: the most common barrier among unwilling unvaccinated girls was the need for more information about the vaccine.

Provider Recommendation and Health-service Contact

Healthcare-provider encouragement remained independently associated with full vaccination. This finding is consistent with recent HPV vaccine uptake evidence from sub-Saharan Africa, where health-worker recommendation and health promotion are repeatedly identified as important correlates of uptake.^{5,6,16} The recent health-facility visit was also associated with full vaccination. This suggests that contact with the health system may create opportunities for counselling, vaccine referral, and catch-up vaccination.

HPV vaccination should therefore not be treated only as a school-event activity. Even when school-based delivery is central, routine adolescent contact with health facilities can help identify missed girls, address concerns, and reinforce vaccination messages.

Parental Permission, Safety Concerns, and Vaccine Confidence

General household variables were not independently associated with full vaccination in the final model, but the barrier findings show that family decision-making

remained important. Parental or guardian refusal was reported by 58.2% of unwilling unvaccinated girls. This distinction matters: household structure, parental education, or mother's presence may be weak predictors, while specific parental permission, trust, and safety concerns may strongly influence whether vaccination happens.

Earlier Tanzanian HPV vaccination research found that non-vaccination was linked to limited knowledge, fear of side effects, concerns about fertility, and parental refusal.⁷ These concerns also appeared in the present study. Fear of side effects was reported by 56.4% of unwilling unvaccinated girls, and 19.1% believed the vaccine could affect fertility. Such concerns should be treated as vaccine-confidence barriers rather than simple lack of information. They require repeated, trusted, age-appropriate communication with both adolescents and parents or guardians.

Vaccine Availability and Service Navigation

Perceived vaccine availability and accessibility were associated with full vaccination in bivariate analysis but did not remain independently significant after adjustment. However, the barrier analysis showed that fluctuating vaccine availability and not knowing where to obtain the vaccine were common among unwilling unvaccinated girls. This suggests that service availability may operate through communication and navigation pathways rather than as a direct independent predictor.

In an urban municipality, not knowing where to obtain the vaccine is particularly important. It shows that proximity to schools and health facilities does not automatically translate into service literacy. Adolescents may live near services but still lack clear information about eligibility, timing, dose requirements, or follow-up after missed vaccination opportunities. Programme communication should therefore make access points explicit and repeated: where vaccination is offered, when it is offered, who is eligible, and what to do after a missed dose.

Implications in the Changing Single-dose Policy Environment

The findings should be interpreted within the two-dose schedule that was in use in Tanzania at the time of data collection. Since then, HPV vaccination policy has continued to evolve. WHO's 2022 HPV vaccine position paper supports a one- or two-dose schedule for girls aged 9–14 years and girls and women aged 15–20 years, while immunocompromised individuals require at least two doses and, where possible, three doses.¹⁶ Tanzania's 2024 multi-age cohort campaign targeted more than five million girls aged 9–14 years and reported first-dose coverage of 79% and second-dose coverage of 60%, with routine single-dose vaccination planned for nine-year-old girls after the campaign.¹⁷

A simplified schedule may reduce logistical barriers related to returning for a second dose. However, it will not remove the social and informational barriers identified in this study. Girls and parents will still need to know what the vaccine is, trust its safety, understand where it is provided, and receive clear recommendations from health workers and schools. The main programme implication is, therefore not only to simplify the schedule

but also to strengthen the human communication system around HPV vaccination.

Programme Implications

The findings support four practical priorities for urban Tanzanian settings. First, school-based HPV vaccine education should focus on practical vaccine literacy: what HPV vaccine prevents, who should receive it, where it is offered, and what dose schedule applies under current national guidance. Second, parents and guardians should receive targeted communication addressing safety, fertility concerns, and misconceptions that vaccination promotes sexual activity. Third, healthcare providers should be supported to give clear and consistent recommendations during school outreach, routine facility visits, and adolescent health contacts. Fourth, vaccination implementation should be monitored across both government and private schools to ensure that parental notification, school mobilisation, vaccination visits, and missed-dose follow-up are not unevenly implemented.

Strengths and Limitations

This study included a relatively large sample of secondary school girls from both government and private schools across an urban municipality. The two-stage sampling procedure improved representation across wards and school ownership categories. The study also separated full vaccination from partial vaccination and examined factors across child-level, household-level, school-level, and health-service domains. In addition, the barrier analysis distinguished never-vaccinated girls who were willing to receive vaccination from those who were unwilling, allowing more precise interpretation of refusal-related barriers.

Several limitations should be considered. HPV vaccination status was self-reported and not verified using vaccination cards or facility records, which may have introduced recall or misclassification bias. The cross-sectional design limits causal interpretation because exposure and outcome were measured at the same time. The study included only in-school girls aged 14–16 years, and findings may not apply to out-of-school adolescents or to younger girls now targeted under evolving HPV vaccination schedules. Some parental and household variables were reported by adolescents and may not fully capture parental beliefs, consent processes, or decision-making dynamics. Finally, barriers were assessed among unwilling never-vaccinated girls only; they should not be generalised to all unvaccinated girls.

CONCLUSION

Full HPV vaccination among secondary school girls in Ubungo Municipal Council was low. Uptake was associated with older age, higher class level, basic HPV vaccine knowledge, recent health facility visits, and healthcare provider encouragement. Among unwilling unvaccinated girls, barriers were mainly informational, parental, safety-related, and service-navigation-related. Strengthening HPV vaccination in similar urban Tanzanian settings requires more than making vaccine doses available. It requires practical adolescent education, parent-facing communication, trusted provider recommendation, clear information on where vaccination is obtained, and reliable coordination across both government and private schools.

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