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Knowledge, Attitude, and Acceptance of COVID-19 Vaccines among School-Going Adolescents and Youths: Opportunities to Address Vaccine Hesitancy

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Abstract

Introduction: Coronavirus disease 2019 (COVID-19) is a highly contagious infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Following its emergence in December 2019, the disease rapidly spread worldwide, prompting the World Health Organization (WHO) to declare it a global pandemic on 11 March 2020. COVID-19 vaccines were developed to reduce disease severity and mortality; however, their effectiveness depends on public knowledge, trust, and acceptance. This study assessed the knowledge, attitudes, and acceptance of COVID-19 vaccines among school-going adolescents and youths in the Kitwe and Ndola districts of Zambia. **Materials and Methods:** A descriptive cross-sectional study was conducted among 754 adolescents and youths (361 from Kitwe and 393 from Ndola) between April and October 2023 using a structured questionnaire. Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 23.0, with findings presented using descriptive statistics. **Results:** Among the 754 participants, 649 (86.1%) had good knowledge, and 382 (50.7%) demonstrated a positive attitude towards COVID-19 vaccines. Only 159 (21.1%) had received the vaccine, while 595 (78.9%) were unvaccinated. A total of 231 (30.6%) participants expressed willingness to be vaccinated, whereas 69.1% were hesitant or uncertain. Fear of side effects (50.4%) and concerns about vaccine safety (62.4%) were major barriers to vaccination. The majority (84.9%) had never contracted

COVID-19. Mass media (51.1%) and social media (21.5%) were the main sources of vaccine information. **Conclusion:** Despite high levels of knowledge and moderate positive attitudes, vaccine uptake among adolescents and youths remained low. Fear of side effects and misinformation significantly influenced vaccine hesitancy. Targeted educational and behavioural interventions delivered through mass media, social media, and school-based campaigns are essential to enhance vaccine confidence, acceptance, and uptake among young people in Zambia.

Keywords

COVID-19, Vaccine Acceptance, Adolescents, Knowledge, Attitudes, Zambia

1. Introduction

The coronavirus disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) [1]. In December 2019, the initial cases of COVID-19 were first identified and reported in Wuhan, China [2]. The WHO declared it a global pandemic on 11th March 2020 [3]. A developing infectious disease outbreak, such as COVID-19, raises public health concerns about people's hesitancy to be vaccinated [4]-[7]. Such hesitation endangers the safety of both the vaccinated and unvaccinated people, puts further strain on the already overburdened healthcare system, and jeopardises virus control [2]. COVID-19 led to an increase in morbidity and mortality, resulting in it being a major public health issue [8]. Significant efforts have been made to develop safe and effective vaccines [9]. By mid-2021, over three billion doses of COVID-19 vaccines had been administered [10].

The development of herd immunity after vaccinating the majority of the population made the vaccination of children and teenagers essential in stopping the COVID-19 pandemic [11] [12]. However, vaccine hesitancy (VH), which is defined as a delay in accepting or refusing vaccines despite the availability of vaccine services, continues to be a barrier [7]. Children and teenagers under the age of 18 showed a high rate of parental VH against SARS-CoV-2 (40%), according to a survey of more than 5000 families in Bologna, Italy. Most notably, this was found in female parents of younger children (6 to 10 years old), parents under the age of 29, parents with low educational levels, and parents who primarily relied on information from the internet and social media and disapproved of mandatory vaccination policies [13].

Reasons for VH among young adults and teenagers have included underestimating the risk of infection, believing that innate immunity will provide enough protection, having special physical conditions that preclude vaccination and conspiracy theories [14]. A study reported that teenagers' readiness to receive vaccinations is largely influenced by their level of trust in the effectiveness and safety

of the vaccines [14]. Widespread mistrust of vaccines in Africa has led to widespread reports of high reluctance and low vaccination rates, which have been made worse by the dissemination of false information and myths [15]-[20].

Zambia reported its first case of COVID-19 on 18 March 2020 [21] [22]. Concerns about COVID-19 and its effects in Zambia led to the implementation of preventive measures, including school closures, social distancing and a work-from-home policy among other control measures [23] [24]. However, it is concerning that during the second and third waves in Zambia, the morbidity and mortality linked to COVID-19 rose considerably [15]. Lack of information, worries about the vaccine's safety, scepticism of Western medicine, a preference for faith in God over conventional medicine, unclear eligibility information, and the perception that public figures used in the campaigns were not receiving injections were among the obstacles to the uptake COVID-19 vaccines [25]. Few studies have been conducted regarding the knowledge, attitudes, and acceptance of the COVID-19 vaccine among Zambian school-going children and adolescents [15] [26]. Given this background, this study assessed the knowledge, attitude, and acceptance of the COVID-19 vaccines among pupils in the Kitwe and Ndola districts of Zambia.

2. Materials and Methods

2.1. Study Design, Site, and Population

This cross-sectional study was conducted from 1st April 2023 to 31st October 2023 in Kitwe and Ndola districts of the Copperbelt Province in Zambia. According to the 2022 census, there were 2,757,539 people across the Copperbelt Province, of which 735,000 and 571,000 people in Kitwe and Ndola districts, respectively [27]. The schools included in the study are registered with the district education board in each district and were either exclusively a boy's or girl's school in the urban and rural areas of Kitwe and Ndola districts. The study population included pupils aged 13 years and above from six schools in both districts. Only pupils who provided assent from parents/guardians and those who consented were enrolled in the study. The study excluded all pupils who were not available during the data collection period.

2.2. Sample Size Determination and Sampling Criteria

The sample size was determined using Cochran's Formula [28]. We used a conservative prevalence of 50% prevalence due to the absence of similar studies in this setting and a margin of error of 5% to estimate the sample size of 385 per district, translating to a sample size of 770 pupils. This study utilised a multi-stage sampling method, first stratifying pupils based on their grades. After that, the pupils were selected using simple random sampling methods to increase the chances of every student being sampled.

2.3. Data Collection Tool

This was conducted using a structured questionnaire adopted from a previous

study on knowledge, attitude, and acceptance of COVID-19 vaccines among pupils reported earlier in Zambia [15]. The questionnaire contained closed-ended questions, comprising 4 parts, namely Part I: socio-demographic characteristics, Part II: participant's knowledge of COVID-19 vaccines, Part III: Participant's attitude towards the COVID-19 vaccine and Part IV: factors that influence participants' acceptance of the COVID-19 vaccine. The participants were given and asked to respond to the questionnaires; they all had the same set of options for their responses. Closed-ended questions offered participants several alternative replies, and they had to choose the one that closely matched their suitable answers. Each variable was measured, and scores were assigned to give an operational definition. The questionnaire consisted of 6 questions on social demographics and participants were supposed to write short-word answers and their details. The level of knowledge had 5 multiple choice questions, including sources of information, 5 multiple choice questions on attitude, 7 multiple choice questions on factors influencing participants' acceptance of the COVID-19 vaccine and 2 multiple choice questions on the acceptance of the COVID-19 vaccine. Multiple choice questions had one correct answer with 1 mark for each question answered correctly and a zero mark when answered incorrectly or "I don't know". There were questions on COVID-19 vaccine-related knowledge with a total of 5 points. Overall score as a good level of knowledge was when a participant scored 3/5 points or greater. COVID-19 attitude related questions had 5 points and similarly 3/5 points or greater were considered as having a positive attitude. For acceptance levels those who said yes had 1 mark while those who said no or didn't know as to whether they could accept being vaccinated scored zero [29].

2.4. Data Management and Analysis

Data were collected from every questionnaire that was answered by potential participants and then entered into Microsoft Excel and exported to Social Package for Social Sciences (SPSS) version 23.0 (IBM, USA) for analysis. The findings were presented in tables and charts. A Chi-square test was used to test the relationship between independent and dependent variables. The statistical significance was at a 95% confidence level ($p < 0.05$) with a margin of error of 5%. The awareness and acceptability of the COVID-19 vaccines among pupils were determined by descriptive analysis.

2.5. Ethical Approval

Ethical approval was obtained from the University of Zambia Health Sciences Research Ethics Committee (UNZAHSREC) (protocol ID 202301270010). Permission to conduct data collection was sought from the District Education Boards (DEBs) in each district and management at each of the schools through the Head teacher. The aim of this study was explained to the participants in the information sheet and consent form, and participation was done voluntarily. For participants who were below the age of consent, assent was obtained from their parents for

them to be recruited into the study. All the information given was kept confidential and restricted to the study team. No personal identifiers were collected to adhere to the principle of anonymity.

3. Results

3.1. Sociodemographic Characteristics of Participants

The results in Table 1 show socio-demographics characteristics of the participants. From a target of 770 pupils, 754 participated in the study, giving a response rate of 98%. Of the 754 participants, 393 (52.1%) were from Ndola while 361 (47.9%) were from Kitwe. The majority of the participants 418 (55.4%) were male. The age range of 13 - 17 years had 580 (76.9%) participants while 174 (23.1%) were among participants in the age range 18 - 21 years. A majority of the study participants were in 12th grade 365 (48.2%), while 11th graders 24 (3.2%) were the least. Most participants 592 (78.5%) lived with their parents, while Kitwe Boys had the highest number of participants 221 (29.3%) as shown in Table 1.

Table 1. Sociodemographic characteristics of participants.

Variables	Attribute	Frequency	Percentage	P-values
Age (years)	13 - 17	589	4.1	0.001
	18 - 21	174	76.9	
Grade	9	250	23.1	0.001
	10	115	15.3	
	11	24	3.2	
	12	365	48.2	
Gender	Female	336	44.6	0.003
	Male	418	55.4	
School	Helen Kaunda	116	15.4	0.001
	Kitwe boys	221	29.3	
	Parklands	23	3.1	
	Kansenshi Sec	205	27.3	
	Kanini Sec	110	14.6	
	Milemu Sec	79	10.5	
Residential Area	Kitwe	361	47.9	0.001
	Ndola	393	52.1	
Lives with	Guardians	162	21.5	0.001
	Parents	592	78.5	

3.2. Knowledge of Participants on COVID-19 Vaccines

The results in Table 2 show the responses participants gave to the knowledge questions; all participants admitted to having heard of COVID-19 vaccines 754 (100%). The majority of the participants 389 (51.1%) heard about COVID-19 vaccines from the TV/Radio. Pupils who said that they knew someone who was currently taking the vaccine were the majority 364 (48.3%). A total of 199 (26.4%) didn't know whether the COVID-19 vaccine reduces disease transmission or not, 348 (46.2%) thought it does, while 207 (27.5%) thought it doesn't. On whether the use of COVID-19 vaccines has side effects or not, about two-thirds 471 (62.5%) thought it has side effects.

Table 2. Knowledge of participants on COVID-19 vaccines.

Knowledge questions	Attribute	Frequency	Percentage	P-values
1) Have you heard about the COVID-19 vaccine?	No	0	0	0.001
	Yes	754	100	
2) If said "yes" to question 1 above, what's the main source of information?	Family/Friend	51	6.8	0.001
	Healthcare workers	136	18.5	
	Others	16	2.1	
	Social Media	162	21.5	
	TV/Radio	389	51.1	
3) Do you know currently people taking the vaccine?	I don't know	116	22.0	0.001
	No	224	29.7	
	Yes	364	48.3	
4) Do you think COVID-19 vaccine reduces disease transmission?	I don't know	199	26.4	0.001
	No	207	27.5	
	Yes	348	46.2	
4) Do you think the use of the COVID-19 vaccine has side effects?	I don't know	171	22.7	0.001
	No	112	14.9	
	Yes	471	62.5	

Of the total study participants, 649 (86.07%) had good knowledge about the COVID-19 vaccines. All study participants (754) had heard about COVID-19 vaccines. It also showed that 390 (51.7%) of the participants did not know anyone taking the COVID-19 vaccine, and 547 (72.2%) didn't know if the vaccine reduces disease transmission.

3.3. Attitude of Participants towards the COVID-19 Vaccines

Table 3 shows the attitude of participants towards taking the COVID-19 vaccines.

Out of 754 participants, more than half, 437 (58.0%) said taking the COVID-19 vaccine is important for health. When asked about taking the vaccine without fear, 380 (50.4%) said they can't take it without fear while 226 (30.0%) said they can take the vaccine without fear. Participants who said they would encourage their family/friends to take the COVID-19 vaccine were close to half, 346 (45.9%). On whether the COVID-19 vaccines should be distributed fairly to all of us, 452 (59.9%) participants said "yes". Participants who currently support recommended COVID-19 vaccine campaigns and programs were 395 (52.4%).

Table 3. Attitude of participants towards the COVID-19 vaccines.

Attitude questions	Attribute	Frequency	Percentage	P-value
Taking the COVID-19 vaccine is important for our health.	I don't know	168	22.3	0.001
	No	149	19.8	
	Yes	437	58.0	
I will take the COVID-19 vaccine without fear.	I don't know	148	19.6	0.001
	No	380	50.4	
	Yes	226	30.0	
I will encourage my family/friends to take the COVID-19 vaccine.	I don't know	136	18.0	0.001
	No	272	36.1	
	Yes	346	45.9	
COVID-19 vaccine should be distributed fairly to all of us.	I don't know	145	19.2	0.001
	No	157	20.8	
	Yes	452	59.9	
I support currently recommended COVID-19 vaccine campaigns and programs.	I don't know	143	19.0	0.001
	No	216	28.9	
	Yes	395	52.4	

About 50.7% (382/754) of participants had a positive attitude towards COVID-19 vaccines. The Mean was 39.54, and the SD of 9.37. (30.0%) said that they would take the vaccine without fear, (58.0%) agreed that the vaccine is important for our health and (52.4%) supported the recommended COVID-19 campaigns and programs.

3.4. Factors Influencing Participants' Acceptance of COVID-19 Vaccines

Table 4 displays the factors that influence pupils' acceptance of the COVID-19 vaccine. The majority of the pupils reported that they had suffered from COVID-19 80 (10.6%), and those who didn't know whether they had ever had COVID-19 were 640 (84.9%). When asked if any of the participants' friends or relatives suf-

fered from COVID-19 disease, over half of the participants, 409 (54.2%) said "No" while 290 (38.5%) said "Yes". If any of the participants' friends or relatives had died from COVID-19 disease, three-quarters of the participants, 574 (76.1%) said "No". About 544 (72.1%) have never been quarantined as a result of COVID-19 disease. Of participants practicing physical and social distancing, 547 (72.5%) said that they do practice social distancing. When asked about the preventive measures of COVID-19 being stressful to follow, 393 (52.1%) said they are not stressful. Furthermore, participants without any chronic conditions were 649 (86.1%).

Table 4. Factors influencing participant's acceptance of COVID-19 vaccines.

Factors influencing questions	Attribute	Frequency	Percentage	P-values
Have you ever suffered from COVID-19?	I don't know	34	4.5	0.001
	No	640	84.9	
	Yes	80	10.6	
Did any of your friends or relatives suffer from COVID-19?	I don't know	55	7.3	0.001
	No	409	54.2	
	Yes	290	38.5	
Has any of your friends or relatives died from COVID-19?	I don't know	41	5.4	0.001
	No	574	76.1	
	Yes	139	18.4	
Were you ever quarantined as a result of COVID-19?	I don't know	62	8.2	0.001
	No	544	72.1	
	Yes	148	19.6	
Are you able to practice physical and social distancing?	I don't know	40	5.3	0.001
	No	167	22.1	
	Yes	547	72.5	
Are the preventive measures of COVID-19 stressful to follow?	I don't know	55	7.3	0.001
	No	393	52.1	
	Yes	306	40.6	
Do you suffer from ANY chronic condition (tuberculosis, diabetes mellitus, HIV/AIDS, asthma, bronchitis, hypertension, cancer)?	I don't know	41	5.4	0.001
	No	649	86.1	
	Yes	64	8.5	

3.5. Acceptance of the COVID-19 Vaccine

Among the 754 participants, 595 (78.9%) had not been vaccinated against COVID-19. The participants were then asked if they could accept being vaccinated against COVID-19, 371 (49.2%) said they couldn't accept, and 231 (30.6%) said they could be vaccinated (Table 5).

Table 5. Acceptance of the COVID-19 vaccines among adolescents and youths.

Acceptance questions	Attribute	Frequency	Percentage	P-values
Have you been vaccinated against COVID-19?	No	595	78.9	0.001
	Yes	159	21.1	
Would you accept being vaccinated against COVID-19?	I don't know	152	20.2	0.001
	No	371	49.2	
	Yes	231	30.6	

Our findings in Table 6 demonstrate how living with either parents or guardians is related to the participant's level of knowledge concerning the COVID-19 vaccine. Of the total number of participants 162 who lived with their guardians 134 (82.7%) of them had good knowledge while those that lived with their biological parents 592, 79.4% had good knowledge. Concerning grade and knowledge of the COVID-19 vaccines, out of 250 9th-grade participants, 223 (89.2%) of them had good knowledge. In 10th grade 93/115 (80.9%) had good knowledge concerning the COVID-19 vaccines. Among the 11th grade, 19/24 (79.2%) and 12th grade 314/365 (86.02%) had good knowledge concerning the COVID-19 vaccine. Overall, 649/754 (86.1%) study participants had good knowledge. On how gender related to the level of knowledge towards the COVID-19 vaccines, a total number of 418 males participated, 366 (87.6%) had good knowledge while 283/336 (84.2%) female participants had good knowledge concerning the COVID-19 vaccines. Therefore, there is no relationship between gender, grade, whom the participants lived with and the level of knowledge for the p-values all were above 0.05.

The results also indicated how participants who lived with their parents/guardians related to their level of attitude towards the COVID-19 vaccines. Out of 592 participants who lived with their parents, 295 (49.8%) had a positive attitude towards the vaccine while 87/162 (53.7%) participants who lived with their guardians had a positive attitude. On how gender related to the participant's level of attitude towards the COVID-19 vaccines. From the total number of female participants 181/336 (57.7%) had a positive attitude towards the COVID-19 vaccine while the male participants had 201/418 (48.1%) positive attitude towards the COVID-19 vaccine. Concerning how suffering from chronic conditions related to participant's level of attitude towards the COVID-19 vaccines. Participants with chronic condition 30/64 (46.9%) had a positive attitude towards COVID-19 and those without any chronic condition 352/690 (51%) had a positive attitude towards COVID-19. There was no relationship between the participant's gender (P = 0.114), whom they lived with (P = 104), grade (0.131) and the level of attitude. Concerning how gender and participant's willingness to take the COVID-19 vaccine are related. Out of the 336 female participants, 96/336 (28.6%) were willing to get vaccinated while 130/418 (31.1%) male participants were willing to get vaccinated (Table 6).

Table 6. Relationships between the level of knowledge, attitude and gender, grade and who lived with their parents or guardians.

Correlations Level of knowledge		**Good**	**Poor**	P-**value**
Lives with Parents/Guardians	Guardians	134 (82.7%)	28 (17.3%)	0.104
	Parents	515 (79.4%)	77 (20.6%)	
Grade	9	223 (89.2%)	27 (10.8%)	0.131
	10	93 (80.9%)	22 (19.1%)	
	11	19 (79.2%)	5 (20.8%)	
	12	314 (86.02%)	51 (13.98%)	
Gender	Female	283 (84.2%)	53 (15.8%)	0.114
	Male	366 (87.6%)	52 (12.4%)	
Level of attitude		**Negative Attitude**	**Positive Attitude**	**P-value**
Lives with Parents/Guardians	Guardians	75 (46.3%)	87 (54.7%)	0.100
	Parents	297 (50.2%)	295 (49.8%)	
Gender	Female	155 (46.1%)	181 (53.9%)	0.110
	Male	217 (51.9%)	201 (48.1%)	
Suffer from a chronic condition	Yes	34 (53.1%)	30 (46.9%)	
	No/I don't know	338 (49%)	352 (51%)	
Willingness to take the vaccine		**Yes**	**No/I don't know**	
Gender	Female	96 (28.6%)	240 (71.4%)	0.001
	Male	130 (31.1%)	288 (68.9%)	

4. Discussion

This study assessed the knowledge, attitude and acceptance of the COVID-19 vaccine among pupils in Kitwe and Ndola districts of Zambia.

Overall, this study found that 86.1% of the pupils who participated had good knowledge about the COVID-19 vaccines. These findings are higher than the 68.2% reported from a study conducted in the Lusaka district [26]. Data in the Lusaka study was collected between September and November 2022 [26] while that in our Kitwe and Ndola districts study was collected in August 2023; this entails that with time, there's an increase in opportunities to get information concerning the COVID-19 vaccines. Similarly, another study in New Delhi, India found high knowledge levels (99.5%) among participants regarding COVID-19 vaccines, but 60% were not aware of the possibility of breakthrough infection, which can be targeted while educating adolescents about vaccination [30]. In contrast, a study in Bangladesh among rural adolescents found that only a few respondents (11%) had adequate knowledge about the COVID-19 vaccines [31].

This can be because the information in the rural areas isn't easily accessible, compared to our study, which was conducted in urban areas, where information can easily be obtained.

The present study found that there was no relationship between the gender of participants and their level of knowledge. contrary to findings in a similar study among pupils in Lusaka, where females had a higher knowledge compared to males [26]. Overall, none of the socio-demographics was associated with knowledge such as the grade of the participants, whether the participants lived with their parents or guardians. On the contrary, a study in Bangkok, Thailand found that an increase in the grade of the participants was an increase in levels of knowledge towards COVID-19 vaccines [32]. A study in China also found that sociodemographics have an influence on the knowledge of individuals concerning COVID-19 vaccines [33].

When participants were asked about their primary sources of information, mass media (TV and radio) emerged as the most common, followed by social media. This finding aligns with the observation that social media serves as the main source of information among participants with higher Vaccine Consistency Belief Scale (VCBS) scores [34]. Healthcare workers ranked third as sources of information, while family, friends, and other channels were the least cited. Understanding these information sources is crucial for designing effective future vaccination programs, as it enables targeted communication strategies that address the most influential and trusted platforms within the community [35]. The results indicate that mass media and social media are the primary sources of information among participants. To enhance adolescent engagement, public health communication strategies should leverage these platforms by incorporating youth-oriented formats such as short, visually engaging videos and interactive content. Collaborating with trusted online personalities and peer influencers could further strengthen message credibility and promote positive health behaviours, including vaccine acceptance.

In this study, it is shown that TV/Radio were the main sources of knowledge among participants and social media, therefore more awareness must be made on TV/Radio programs and social media platforms. The school populace should limit the mongers with the help of the school administration and also reassure the school-going pupils about the effectiveness and side effects of the COVID-19 vaccines. Having good knowledge about COVID-19 vaccines is cardinal to increase acceptance of the vaccines and it is important to provide reliable and scientific sources of information that are peer-reviewed to reach the public at large.

Concerning the attitude towards the COVID-19 vaccines, half (50.7%) of the total participants had a positive attitude towards the vaccines, which is contrary to the findings in Thakurgon district, Bangladesh, 27% of the participants had a positive attitude towards COVID-19 [31]. However, similar findings of half participants having a positive attitude towards COVID-19 and vaccines were found

in Hubei province of China [36]. Higher findings of (68%) were reported in the United States [35]. In the Lusaka district, similar findings were also found (49.96%), where half of the participants had a positive attitude [26]. The difference in these findings may be due to differences in sample size and socio-demographic characteristics.

In this study, the acceptance rate was 30.6% which was low. Although the study found high knowledge levels about COVID-19 vaccination (86.1%), uptake remained low due to misinformation and fear. This indicates that general awareness can coexist with specific, influential misbeliefs that strongly shape behavior. Misconceptions about vaccine safety or long-term effects may persist despite adequate knowledge, underscoring the need for targeted communication strategies that address and dispel these fears through trusted and relatable sources. The low acceptance of COVID-19 vaccines reported in our study is contrary to the findings in China (75.59%), Saudi Arabia (64.7%) [37] [38], and acceptance rate of 69.1% in Korea [39]. In Ethiopia, an acceptance rate of 71% was reported [40] and in Germany, 68.3% were willing to take the vaccine [41]. The variation in the present study might be due to socioeconomic differences, which usually determine accessibility to health services and health information.

The uptake level of the vaccine in this study was 21.1%, on the other hand, in the United States of America, at least 26.1% received a dose and 29.2% of the participants in the Lusaka district had received at least one dose of COVID-19 vaccine [26] [42]. In another study among Sub-Saharan Africans between rural and urban residents, uptake of COVID-19 vaccines varied among the rural 14.2% and urban 25.3% [43]. However, in a study, 74.8% of adolescents were vaccinated in the United States [44].

In this study, female participants who were willing to be vaccinated were 96/336 (28.6%) while male participants were 130/418 (31.1%). These findings are in line with reports that indicated that males are more likely to accept the vaccine compared to females [45] although other findings reported that females were more likely to accept vaccination against COVID-19 compared to males [38]. A study done in Ethiopia reported that being female increases the odds of vaccine acceptance [40]. Therefore, strategic methods should be used to increase vaccination uptake among school-going children and adolescents in Zambia, these findings contribute to the existing knowledge by broadening the ongoing plans on the motivation for and hesitancies of obtaining the COVID-19 vaccine and thereby promoting vaccination uptake.

In the present study, most participants had not suffered from COVID-19 640/754 (84.9%), this can influence their acceptance because they feel they do not need the vaccine. Those who do not think the preventive measures are stressful to follow were 393/754 (52.1%), these findings are higher than the ones found in the Lusaka district 36.3% [26]. However,50.7% in Addis Ababa, Ethiopia did follow the preventive measures [46]. 380/754 (50.4%) of the participants were afraid of the vaccine, and when asked why they felt that way, they said the vaccine has ter-

rible side effects. This mirrors the findings that people's intention to get vaccinated is influenced by variables as such side effects [47].

In the current study, participants who suffered from chronic conditions had (46.9%) positive attitude towards the COVID-19 vaccine while those who did not have any chronic condition had (51%) positive attitude and a study in the USA among adolescent cancer survivors reported 37.1% vaccine hesitancy [48]. Limited understanding of diseases and their prevention, coupled with misconceptions and parental disapproval, can significantly affect the acceptance of COVID-19 vaccines among pupils. Parental or guardian consent serves as a key structural determinant of vaccine uptake, particularly among adolescents, whose decisions are often shaped by family attitudes and beliefs. Supportive parental perspectives can enhance vaccine confidence and participation, while disapproval or misinformation within households may restrict access even when adolescents are personally receptive. Strengthening parental engagement and education, alongside adolescent-focused interventions, is therefore critical to improving vaccine acceptance and coverage.

We are aware that this study had some limitations that should be considered when interpreting the findings. First, the study employed a cross-sectional design, which captures data at a single point in time and therefore cannot establish causal relationships between knowledge, attitudes, and vaccine uptake. Second, data were self-reported, which may be prone to recall bias and social desirability bias, as participants could have provided responses they perceived as more acceptable. Third, the study was conducted among school-going adolescents and youths in selected districts (Kitwe and Ndola) of the Copperbelt Province; therefore, the findings may not be generalisable to out-of-school adolescents or other regions of Zambia with different sociodemographic characteristics.

Additionally, the study mainly focused on quantitative data and did not include qualitative interviews that could have provided deeper insights into the cultural, psychological, and contextual factors influencing vaccine hesitancy and acceptance. Finally, the study only assessed COVID-19 vaccine attitudes and uptake, and thus, its findings may not fully reflect perceptions toward other routine adolescent vaccines such as HPV or tetanus.

Table 7 shows the policy implications and recommendations of this study. This study highlights key policy implications for improving vaccine uptake among adolescents and youths in Zambia. Despite high knowledge levels, vaccine uptake remained low, underscoring the need for policies that address fear, misinformation, and structural barriers. Strengthening school-based vaccination programmes through collaboration between the Ministries of Health and Education, enhancing risk communication via mass and social media, and engaging trusted figures such as teachers, parents, and community leaders can build vaccine confidence. Additionally, gender-sensitive and community-driven approaches, supported by robust monitoring and data systems, are essential to bridge the gap between awareness and actual vaccine uptake among young people.

Table 7. Policy implications, recommendations, and future directions for improving vaccine uptake among adolescents and youths.

Key Area	Policy Implications	Recommendations	Future Directions
Health Education and Awareness	Limited vaccine uptake despite high knowledge highlights the need for continuous and targeted health education campaigns.	- Strengthen school-based health education on vaccines and public health. - Utilize trusted channels such as TV/radio and social media for accurate vaccine information.	- Develop adolescent-friendly education materials integrating digital and peer-led approaches. - Evaluate the effectiveness of different communication platforms in changing vaccine attitudes.
Misinformation and Fear of Side Effects	Persistent fears about side effects undermine confidence in vaccines and delay uptake.	- Implement evidence-based communication addressing myths and misinformation. - Train teachers and healthcare workers to serve as credible sources of vaccine information.	- Establish monitoring systems for vaccine misinformation on social media. - Conduct behavioral studies to identify effective fear-reduction communication strategies.
Access and Delivery of Vaccines	Inequities in vaccine access, particularly in schools and communities, hinder adolescent vaccination.	- Integrate COVID-19 and other routine vaccines into school health programs. - Conduct mobile vaccination campaigns in schools and youth centers.	- Assess the feasibility of mandatory school-based vaccination programs. - Explore partnerships between ministries of health and education for sustained vaccine delivery.
Parental and Community Influence	Parental attitudes and community perceptions significantly affect adolescent vaccine acceptance.	- Design community engagement programs involving parents, religious, and traditional leaders. - Promote family-centered vaccine advocacy interventions.	- Study intergenerational vaccine hesitancy patterns in Zambian households. - Strengthen family-based education and counselling models.
Gender and Social Determinants	Gender differences in vaccine acceptance suggest that social and cultural factors shape vaccine decisions.	- Promote gender-sensitive vaccine education addressing both male and female adolescents. - Engage youth role models and influencers to normalize vaccination.	- Investigate the impact of gender norms and peer influence on vaccine uptake among Zambian youths.
Policy and Governance	Current policies lack adolescent-focused vaccination frameworks beyond child immunization programs.	- Develop national adolescent immunization policies and guidelines. - Align school vaccination initiatives with Zambia's Expanded Programme on Immunization (EPI).	- Integrate adolescent vaccination into national health and education strategic plans. - Evaluate policy implementation and its effect on vaccine coverage trends.

Continued

Health System Strengthening	Inadequate coordination between education and health sectors limits vaccine delivery efficiency.	- Enhance intersectoral collaboration between Ministries of Health and Education. - Train school health personnel to support vaccination drives.	- Institutionalize school health units as vaccination hubs within the national EPI framework. - Pilot digital tracking systems for school-based vaccination.
Monitoring and Research	Insufficient local data on adolescent vaccine hesitancy limits evidence-informed policy.	- Promote operational research on determinants of vaccine hesitancy among adolescents. - Establish continuous surveillance systems for vaccine uptake.	- Conduct longitudinal studies to track trends in adolescent vaccine acceptance. - Evaluate interventions aimed at improving trust and vaccine confidence.

5. Conclusion

The study revealed that most participants had good knowledge of COVID-19 vaccines, and about half demonstrated a positive attitude; however, a low vaccine acceptance was recorded and only 21.1% had been vaccinated. Fear of side effects significantly influenced vaccine acceptance, particularly among those who had experienced or been exposed to COVID-19 cases. Mass media, especially television and radio, were identified as the main sources of vaccine information. These findings highlight the need for targeted educational and behavioural interventions that leverage mass media and social media platforms to dispel misinformation, reduce fear, and promote vaccine confidence and uptake among adolescents and youths in Zambia.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Data Collection Tool

Questionnaire

Knowledge, Attitude, and Acceptance of COVID-19 Vaccines among School-going Adolescents and Youths: Findings and Implications

Part I: Sociodemographic characteristics of pupils				
SN	**Questions**	**Answers/choice**		
1	Age	years		
2	Grade			
3	School			
4	Gender	1) Male	2) Female	
5	Where do you live?			
7	Who do you live with?	1) Parents	2) Guardians	
Part II: Knowledge questions about the COVID-19 vaccine [circle the correct answer]				
1	Have you ever heard about the COVID-19 vaccine?	1) Yes	2) No	
2	If said "yes" to question 1 above, what is the main source of information?	1) Healthcare workers 2) TV/radio 3) Social media 4) Family/friends 5) Others……		
3	Do you know currently people taking the COVID-19 vaccine?	1) Yes	2) No	3) I don't know
4	Do you think COVID-19 vaccines reduce disease transmission?	1) Yes	2) No	3) I don't know
5	Do you think the use of COVID-19 vaccines has side effects?	1) Yes	2) No	3) I don't know
Part III: Attitude questions about the COVID-19 vaccine				
1	Taking the COVID-19 vaccine is important for our health.	1) Yes	2) No	3) I don't know
2	I will take the COVID-19 vaccine without any fear.	1) Yes	2) No	3) I don't know
3	I will encourage my family /friends to take the COVID-19 vaccine.	1) Yes	2) No	3) I don't know
4	COVID-19 vaccine should be distributed fairly to all of us.	1) Yes	2) No	3) I don't know
5	I support currently recommended COVID-19 vaccine campaigns and programs.	1) Yes	2) No	3) I don't know
Part IV: Factors influencing participants' acceptance of COVID-19 vaccines				
1	Have you ever suffered from COVID-19?	1) Yes	2) No	3) I don't know
2	Did any of your friends or relatives suffer from COVID-19?	1) Yes	2) No	3) I don't know
3	Has any of your friends or relatives died from COVID-19?	1) Yes	2) No	3) I don't know
4	Were you ever quarantined as a result of COVID-19?	1) Yes	2) No	3) I don't know

Continued

5	Are you able to practice physical and social distancing?	1) Yes	2) No	3) I don't know
6	Are the preventive measures of COVID-19 stressful to follow?	1) Yes	2) No	3) I don't know
7	Do you suffer from ANY chronic condition (tuberculosis, diabetes mellitus, HIV/AIDs, asthma, bronchitis, hypertension, cancer)?	1) Yes	2) No	3) I don't know
	Acceptance of the COVID-19 vaccine			
	Would you accept being vaccinated against COVID-19?	1) Yes	2) No	3) I don't know