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Knowledge, Attitudes, and Acceptance of COVID-19 Vaccines among Secondary School Pupils in Zambia: Implications for Future Educational and Sensitisation Programmes

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Abstract: The coronavirus disease 2019 (COVID-19) pandemic resulted in the closure of schools to slow the spread of the virus across populations, and the administration of vaccines to protect people from severe disease, including school children and adolescents. In Zambia, there is currently little information on the acceptance of COVID-19 vaccines among school-going children and adolescents despite their inclusion in the vaccination programme. This study assessed the knowledge, attitudes, and acceptance of COVID-19 vaccines among secondary school pupils in Lusaka, Zambia. A cross-sectional study was conducted from August 2022 to October 2022. Of the 998 participants, 646 (64.7%) were female, and 127 (12.7%) would accept to be vaccinated. Those who were willing to be vaccinated had better knowledge (68.5% vs. 56.3%) and a positive attitude (79.1% vs. 33.7%) compared to those who were hesitant. Overall, the odds of vaccine acceptance were higher among pupils who had higher knowledge scores (AOR = 11.75, 95% CI: 6.51–21.2), positive attitude scores (AOR = 9.85, 95% CI: 4.35–22.2), and those who knew a friend or relative who had died from COVID-19 (AOR = 3.27, 95% CI: 2.14–5.09). The low vaccine acceptance among pupils is of public health concern, emphasising the need for heightened sensitisation programmes that promote vaccine acceptance among pupils in Zambia.

Keywords: adolescents; attitude; children; COVID-19 vaccines; hesitancy; knowledge; pupils; secondary schools; vaccine acceptance; Zambia

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic appreciably increased morbidity and mortality as well as associated costs [1–7]. Public health measures, including lockdowns, border closures, contact tracing and quarantining measures as well as the wearing of personal protective equipment, were introduced across countries, including among African countries, in an attempt to slow the spread of the severe acute respiratory coronavirus type 2 (SARS-CoV-2) in the absence of effective treatments and vaccines [8–13].

Vaccines were developed as one of the key solutions to prevent severe disease, hospitalisation, and death due to COVID-19 along with controlling the spread of the disease in the absence of effective treatments [14–21]; however, this could be changing [22–27]. These combined developments should help to address the adverse consequences of lockdown and social distancing measures, including the closure of clinics, which in turn negatively impacted routine immunisation programmes among children, including those in Africa [28,29]. Alongside this, helping to address the negative impact on education following school closures and concerns exacerbated by the lack of computers and the costs of internet bundles across Africa [30,31]. These concerns resulted in the development, deployment and administration of COVID-19 vaccines across countries [15,32–38], although there have been concerns with the vaccines and their uptake in some countries [34,35,39].

Vaccines are critical in addressing vaccine-preventable disease outbreaks caused by micro-organisms [38,40–42]. However, the use of vaccines and their success in the immunisation of populations requires that individuals are sensitised to their importance, have good knowledge about them and have confidence in their safety and efficacy [43–46]. This though is not always the case among the general population as well as among healthcare workers (HCWs), some of whom have been hesitant to receive COVID-19 vaccines despite their undoubted effectiveness and good safety profiles [46–50].

Currently though, acceptance of COVID-19 vaccines is variable across countries [34,35,39,51–54], with many individuals hesitant due to a lack of awareness of the vaccines and their potential impact, limited knowledge and concerns regarding their safety and effectiveness, negative attitudes towards the vaccines as well as fears of adverse effects [35,46,55–57]. As a result, high hesitancy and low vaccination rates have been reported across countries and continents including Africa [39,48,58–65], exacerbated by the spreading of misinformation and myths [39,64,66–69]. In addition, the development of mutations among the Alpha, Beta, Gamma, Delta, and Omicron variants has raised further questions about the effectiveness of vaccines long-term and also contributed to hesitancy [70,71]. Consequently, this requires that all vaccine candidates that are being developed must take into consideration the evolution of SARS-CoV-2 variants [70,72].

Among school-going children and adolescents, there is currently limited information available about vaccines, including those for COVID-19 [73,74], which can affect children's knowledge, attitudes, and acceptance of vaccines. Consequently, there is a need to develop strategies that will improve vaccine acceptance among school pupils including for COVID-19, specially tailored to hesitant children [75,76]. Potential strategies include improving secondary school pupils' knowledge about COVID-19 infections as studies have shown poor knowledge among the hesitant groups [77,78]. On the other hand, a study reported a vaccination acceptance rate of over 50% among older pupils, with only 12.9% of surveyed pupils opting out of vaccination [76]. Understanding these issues going forward is important. We do know that preventive measures associated with the COVID-19 pandemic negatively impacted secondary school pupils and educational systems generally [77,79,80], affecting nearly 1.6 billion school students globally [81]. Consequently, this needs to be urgently addressed, with effective vaccines part of the strategy to alleviate the need for future lockdown and other measures including new potential treatments [38,82,83].

Zambia, a country in sub-Saharan Africa, reported its first case of COVID-19 on 18 March 2020. Concerns with COVID-19 and its impact in Zambia led to the introduction of preventive measures, including the closure of schools as well as the implementation of other control measures [84,85]. However, the morbidity and mortality associated with

COVID-19 increased significantly during the second and third waves in Zambia, which is a concern [11,85]. The rollout and administration of COVID-19 vaccines commenced in April 2021 in Zambia [39,86]. Since then, vaccine acceptance rates of 33.4% and 66% have been reported across the general population in Zambia [62,86] and 24.5% among university students, respectively [63]. In January 2022, the health authorities in Zambia started vaccinating secondary school children and adolescents [39]. However, there is currently a dearth of information regarding the knowledge, attitudes, and acceptance of COVID-19 vaccines among children and adolescents attending secondary schools in Zambia. Consequently, this study aimed to address this deficit by assessing the knowledge, attitudes, and acceptance of COVID-19 vaccines among secondary school pupils in Zambia. Without this baseline information, it would be difficult to design programmes to increase vaccine acceptance and uptake among secondary school pupils where this is an issue, with hesitancy concerns already reported in East Africa among citizens not educated above secondary school levels [87].

2. Materials and Methods

2.1. Study Design, Setting and Population

This cross-sectional study was conducted among secondary school pupils in Lusaka, Zambia, from August 2022 to October 2022, following the rollout of COVID-19 vaccination in January 2022, amongst children and adolescents aged from 12 to 17 years [39]. In Zambia, secondary schools educate pupils from Grade 8 to Grade 12.

Since Lusaka is the capital city of Zambia, it was purposefully selected for this study, assuming that should there be knowledge, attitude, and acceptance deficits concerning COVID-19 vaccines among pupils attending secondary schools in Lusaka, this is likely to be worse among rural-dwelling pupils. All vaccinated pupils (29.2%, $n = 411$) were excluded from this study.

2.2. Sampling and Sample Size Consideration

A multi-stage random sampling approach was used in this study. Firstly, we randomly selected 32 secondary schools from a total of 111 secondary schools in Lusaka city. From each school, 2–4 classes were randomly selected to participate in the research using proportion to school size. From each class, all potential pupils were considered for sampling using a simple random sampling technique to ensure that each pupil in the class will have the same chance of being selected for the study. Before conducting the study, a representative sample size was estimated using Ausvet Raosoft software (<http://www.raosoft.com/samplesize.html> (accessed on 22 July 2022)). The sample size was estimated at a 95% confidence level, with a margin of error of 5%, and a finite population of 10,000 for the locality. A 10% incomplete, loss, or non-response was taken into consideration. With an assumed moderate design effect of 1.5, a minimum sample size of 814 pupils was estimated. The participants had to be registered in a secondary school in Lusaka, Zambia, during the study to be eligible for the study.

2.3. Data Collection Tool

This study used a validated self-administered questionnaire from a similar study consisting of four parts [88]. Part I had five questions on the sociodemographic characteristics of participants; Part II had five questions regarding the knowledge of participants concerning the COVID-19 vaccines with yes or no response options; Part III had five questions on the attitudes of participants towards COVID-19 with “yes” or “no” or “I do not know” response options, and Part IV had questions on factors that affect acceptance of COVID-19 vaccines among secondary school pupils. Finally, vaccine acceptance was assessed by the question, “Would you accept to be vaccinated against COVID-19?” as shown in Table S1.

To check for the simplicity of the questions, we conducted a pilot study among 50 pupils from different secondary schools in Lusaka. These pupils did not form part of the principal study. Each child took approximately 20 to 30 min to respond to the questionnaire.

The questionnaire had a Cronbach's alpha of 0.76 for knowledge and 0.84 for attitude scales, indicating acceptable reliability.

The questionnaire was subsequently distributed to all unvaccinated eligible pupils in the selected schools after they provided assent. The consent to participate in the study was given by the pupils' parents and/or their guardians. Data collection was undertaken by two data collectors who were trained by the main author (SM).

2.4. Data Management and Analysis

Stata version 17/BE (Stata Corp., College Station, TX, USA) was used for the statistical analysis. All analyses accounted for the clustering of pupils within schools by using robust estimation of standard errors.

Knowledge and attitude scales were scored as follows; for each correct answer, a "yes" for knowledge questions and a positive "yes" for attitude questions were assigned a score of one, while an incorrect "no" for knowledge and a negative "no/don't know" for attitude questions were assigned a score of zero. The knowledge and attitude scores were subsequently calculated as the sum of the total scores from all the questions.

Continuous variables (age, knowledge and attitude score) were summarised using means and 95% confidence intervals (95% CI) and whether or not the pupil would accept COVID-19 vaccination. We fitted logistic regression models with robust estimation of standard errors with "COVID-19 vaccine acceptance" as the outcome variable and one of the predictor variables at a time, adjusting for age, to assess for any evidence of an association between the variable and COVID-19 vaccine acceptance.

Following this, a multivariable logistic regression model was fitted with the knowledge and attitude scores, age and other variables that were significant in single age-adjusted models. Interactions between knowledge and attitude scores and the confounding variables that remained in the final model were considered one by one.

3. Results

The study enrolled 998 (95% response rate) unvaccinated pupils of whom 127(12.7%) would accept the COVID-19 vaccine if it was made available. The largest proportion of those who would accept the vaccine were females (85; 66.9%) in Grade 8 (39; 30.7%) and with a mean age of 15.3 years [95% CI: 15.0–15.6].

The characteristics of the surveyed pupils, their socio-demographics, sources of information about COVID-19, and average total scores of knowledge and attitudes towards the COVID-19 vaccine are provided in Table 1. Overall, pupils who would accept vaccination reported good knowledge (68.5% vs. 56.3%) and positive attitude scores (79.1% vs. 33.7%) compared to those who would refuse vaccination.

Table 1. Socio-demographics, knowledge and attitude scores by vaccine acceptance.

Variables	Total Population (N = 998); n (%)	COVID-19 Vaccine Acceptors; n (%)	
		No (n = 871)	Yes (n = 127)
Sex			
Female	646 (64.7)	561 (64.4)	85 (66.9)
Male	352 (35.3)	310 (35.6)	42 (33.1)
Living with			
Guardian	43 (4.3)	37 (4.3)	6 (4.7)
Parents	955 (95.7)	834 (95.8)	121 (95.3)
School level			
Grade 8	185 (18.5)	146 (16.8)	39 (30.7)
Grade 9	200 (20.0)	182 (20.9)	18 (14.2)

Table 1. Cont.

Variables	Total Population (N = 998); n (%)	COVID-19 Vaccine Acceptors; n (%)	
		No (n = 871)	Yes (n = 127)
Grade 10	163 (16.3)	145 (16.7)	18 (14.2)
Grade 11	252 (25.3)	219 (25.4)	33 (26.0)
Grade 12	198 (19.8)	179 (20.6)	19 (15.0)
Source of information about COVID-19			
Healthcare workers			
No	651 (65.2)	575 (66.0)	76 (59.8)
Yes	347 (34.8)	296 (34.0)	51 (40.2)
Mass media (TV/radio)			
No	469 (47.0)	407 (46.7)	62 (48.8)
Yes	529 (53.0)	464 (53.3)	65 (51.2)
Social media			
No	635 (63.6)	546 (62.7)	89 (70.1)
Yes	363 (36.4)	325 (37.3)	38 (30.0)
Family/friends			
No	749 (75.0)	652 (75.0)	97 (76.4)
Yes	249 (25.0)	219 (25.0)	30 (23.6)
Age			
Mean [95% CI]	15.6 [15.5–15.7]	15.7 [15.6–15.8]	15.3 [15.0–15.6]
Total knowledge score %			
Mean [95% CI]	57.8 [56.1–59.5]	56.3 [54.5–58.0]	68.5 [63.5–73.5]
Total attitude score %			
Mean [95% CI]	39.4 [37.4–41.5]	33.7 [31.6–35.7]	79.1 [74.6–83.5]

The pupils' experiences during the COVID-19 pandemic are summarized in Table 2. The majority 855 (85.7%) of the participants had not suffered from COVID-19 but among these, 467 (46.8%) knew a friend or relative who had previously suffered from COVID-19. A small proportion of participants 158 (15.8%) reported knowing a relative or friend who had died of COVID-19, and 558 (55.9%) mentioned that preventive measures were not stressful to follow. A larger proportion 779 (78.1%) were able to practice social distancing and 710 (71.1%) were never in quarantine during the pandemic.

Table 2. COVID-19 experiences of respondents according to vaccine acceptance.

Experiences/Condition	Total Population (N = 998); n (%)	COVID-19 Vaccine Acceptors; n (%)	
		No (n = 871)	Yes (n = 127)
Suffered from COVID-19 before			
I do not know	45 (4.5)	41 (4.7)	4 (3.2)
No	855 (85.7)	747 (85.8)	108 (85.0)
Yes	98 (9.82)	83 (9.5)	15 (11.8)
Friend/relative suffered from COVID-19			
I do not know	60 (6.0)	60 (6.9)	0
No	471 (47.2)	420 (48.2)	51 (40.2)
Yes	467 (46.8)	391 (44.9)	76 (59.8)
A friend/relative died from COVID-19			
I do not know	107 (10.7)	99 (11.4)	8 (6.3)
No	733 (73.5)	644 (74.0)	89 (70.0)

Table 2. Cont.

Experiences/Condition	Total Population (N = 998); n (%)	COVID-19 Vaccine Acceptors; n (%)	
		No (n = 871)	Yes (n = 127)
Yes	158 (15.8)	128 (14.7)	30 (23.6)
Quarantined as a result of COVID-19			
I do not know	95 (9.5)	87 (10.0)	8 (6.3)
No	710 (71.1)	624 (71.6)	86 (67.7)
Yes	193 (19.3)	160 (18.4)	33 (26.0)
Able to practice physical and social distancing			
I do not know	52 (5.2)	49 (5.6)	3 (2.4)
No	167 (16.7)	151 (17.3)	16 (12.6)
Yes	779 (78.1)	671 (77.0)	108 (85.0)
Preventive measures were stressful to follow			
I do not know	85 (8.5)	76 (8.7)	9 (7.1)
No	558 (55.9)	481 (55.2)	77 (60.6)
Yes	355 (35.6)	314 (36.1)	41 (32.3)
Suffer from a chronic condition			
I do not know	52 (5.2)	50 (5.7)	2 (1.6)
No	888 (89.0)	776 (89.1)	112 (88.2)
Yes	58 (5.8)	45 (5.2)	13 (10.2)

The logistic regression model that adjusted for age, considering one variable at a time, found that attitude and knowledge scores, knowing a friend/relative who died from COVID-19, being in quarantine due to COVID-19 infection and having a chronic condition were associated with COVID-19 vaccine acceptance (Table 3).

Table 3. Association between respondent's knowledge and attitude scores and acceptance of COVID-19 vaccines, adjusting for potential confounding variables.

Characteristics	OR Adjusted for Age [95% CI]	p-Value	Adjusted OR [95% CI]	p-Value
Knowledge score	5.44 [2.41–12.3]	<0.001	11.75 [6.51–21.2]	0.001
Attitude score	11.19 [4.87–24.82]	<0.001	9.85 [4.35–22.2]	<0.001
Socio-demographics				
Age	0.90 [0.82–1.00]	0.040	0.85 [0.71–1.01]	0.072
Sex				
Female	Ref			
Male	0.94 [0.64–1.37]	0.730		
Living with				
Guardian	Ref			
Parents	0.80 [0.33–1.89]	0.604		
School level				
Grade 8	Ref		Ref	
Grade 9	0.38 [0.21–0.70]	0.002	0.45 [0.22–0.93]	0.031
Grade 10	0.51 [0.26–1.00]	0.049	0.60 [0.26–1.40]	0.235
Grade 11	0.65 [0.33–1.29]	0.217	0.86 [0.36–2.09]	0.743
Grade 12	0.47 [0.21–1.05]	0.067	0.77 [0.29–2.07]	0.610
Source of information about COVID-19				
Healthcare workers				
No	Ref			
Yes	1.28 [0.89–1.86]	0.889		

Table 3. Cont.

Characteristics	OR Adjusted for Age [95% CI]	<i>p</i> -Value	Adjusted OR [95% CI]	<i>p</i> -Value
Mass media (TV/radio)				
No	Ref			
Yes	0.91 [0.63–1.31]	0.605		
Social media				
No	Ref			
Yes	0.72 [0.49–1.08]	0.114		
Family/friends				
No	Ref			
Yes	0.86 [0.56–1.34]	0.516		
COVID-19 experiences				
Suffered from COVID-19 before				
I do not know	Ref			
No	1.47 [0.53–4.10]	0.464		
No	1.84 [0.59–5.78]	0.294		
A friend/relative died from COVID-19				
I do not know	Ref		Ref	
No	1.76 [0.84–3.67]	0.132	2.53 [0.93–7.34]	0.172
No	2.85 [1.28–6.37]	0.010	3.27 [2.14–5.09]	0.013
Quarantined as a result of COVID-19				
I do not know	Ref			
No	1.54 [0.74–3.21]	0.252	1.42 [0.64–3.19]	0.390
Yes	2.36 [1.07–5.20]	0.033	1.72 [0.69–4.25]	0.243
Able to practice physical and social distancing				
I do not know	Ref			
No	1.81 [0.52–6.32]	0.352	2.44 [0.48–12.3]	0.280
Yes	2.29 [0.87–8.95]	0.084	5.28 [0.90–8.50]	0.065
Preventive measures are stressful to follow				
I do not know	Ref			
No	1.42 [0.69–2.91]	0.337		
Yes	1.14 [0.54–2.41]	0.720		
Suffer from a chronic condition				
I do not know	Ref			
No	3.73 [0.94–14.84]	0.062		
Yes	7.37 [1.66–32.78]	0.009		

NB: 95% CI—95% confidence interval, OR—odds ratio.

After controlling for the modifying variables that were statistically significant at the 5% level in the univariable logistic regression model (age, attitude and knowledge score, knowing a friend/relative who died from COVID-19, being in quarantine due to COVID-19 and having a chronic condition), the multivariable logistic regression model showed that independent factors associated with COVID-19 vaccine acceptance were knowledge, attitudes, knowing a friend or relative who died from COVID-19 and being in Grade 9 compared to Grade 8.

Pupils with higher knowledge scores (AOR = 11.75, 95% CI: 6.51–21.2), higher attitude scores (AOR = 9.85, 95% CI: 4.35–22.2) and those who knew a friend or relative who died from COVID-19 (AOR = 3.27, 95% CI: 2.14–5.09) were more likely to accept a COVID-19 vaccine. However, being in Grade 9 compared to Grade 8 (AOR = 0.45, 95% CI: 0.22–0.93) was associated with lower odds of accepting the COVID-19 vaccine.

4. Discussion

To the best of our knowledge, this is the first study conducted in Zambia to assess the knowledge, attitudes, and acceptance of COVID-19 vaccines among pupils attending secondary schools in Zambia. We found that only 12.7% of surveyed pupils would accept to be vaccinated if the vaccine was made available. Non-acceptance of the COVID-19 vaccine was associated with poor knowledge in our study, similar to the findings in other countries [89,90]. Of interest is that pupils who would accept the COVID-19 vaccine had good knowledge regarding the vaccine compared to those who were hesitant (68.5% vs. 56.3%), similar to studies in Canada, China (including Hong Kong), and Sweden [89–92]. In addition, in our study, pupils who would accept the COVID-19 vaccine had good attitudes towards the vaccine compared to those who were hesitant (79.1% vs. 33.7%), which is encouraging. Alongside this, participants who were in Grade 9 and had higher scores of knowledge and attitudes, and those who knew a friend or relative who died from COVID-19, also had higher odds of accepting the vaccine.

These findings are consistent with the findings in a systematic review and meta-analysis of studies in sub-Saharan Africa where hesitancy was associated with only attending secondary schools and not higher education [87]. However, this was different to studies in Korea among secondary school pupils (69.1% acceptance) with pupils perceiving the vaccines as safe and effective [93], in China (60% acceptance) [89], and England where more than half (50.1%) of those surveyed were willing to be vaccinated and only 12.9% were hesitant [76]. These appreciable differences between countries could potentially be due to differences in culture, socio-economic status, and robust vaccine promotion messages. In addition, we have seen appreciable vaccine hesitancy among adults across sub-Saharan Africa [39].

Most of the participants in our study accessed information about COVID-19 vaccines through mass and social media, which can be a concern due to the extent of unverified messages [94]. These findings corroborate reports from others indicating the importance of social and mass media in disseminating information and misinformation concerning vaccines [56,95–98], similar to the situation regarding treatments for patients with COVID-19 [94,98,99]. Social media can potentially be used to increase the awareness of individuals regarding COVID-19 vaccines and change their behaviour [98]. This makes social media platforms potentially one of the best and most efficient platforms for addressing vaccine hesitancy by increasing confidence in vaccine safety and effectiveness. However, any youth-friendly COVID-19 messaging should use pertinent platforms and contain appropriate language style to effectively convey key messages regarding the safety and effectiveness of COVID-19 vaccines [88,100]. Our findings also indicate that the participants accessed information regarding COVID-19 vaccines from HCWs. This is similar to other findings that have reported HCWs, including school nurses, as one of the main sources of reliable and trusted information concerning COVID-19 vaccines [101,102]. This shows that HCWs must champion the promotion of vaccine acceptance and uptake by providing COVID-19 vaccine education, which has not always been the case [46,49,103–105]. Given this, steps need to be taken to ensure that HCWs do not enhance hesitancy rates given concerns in some studies, including among African countries [46–49].

Interestingly in our study, pupils who knew a friend or relative who died from COVID-19 had higher odds of accepting to be vaccinated, which corroborate observations from Pakistan and Italy in which adult participants whose friends or family died due to the COVID-19 pandemic had higher odds of accepting the vaccine [106,107]. Such observations can potentially be used in future messaging campaigns to pupils and their parents. However, in other studies, adults who lost a loved one due to the COVID-19 pandemic did not typically see a need to be vaccinated [108]. In contrast, adolescents in one study who strongly believed that COVID-19 is a high-risk infection and can lead to death, had higher vaccine acceptance rates [93].

The authors are aware of some limitations of this study. Firstly, it was only conducted in Lusaka, which may affect the generalisation of findings to the rest of the secondary

schools in the country. Secondly, this was a survey rather than an in-depth discussion with pupils. However, despite this, we believe the findings are robust, providing direction for future nationwide studies.

5. Conclusions

This study found a low COVID-19 vaccine acceptance among secondary school children and adolescents in Lusaka City, Zambia. Despite most of the pupils having good scores for knowledge and attitudes, and all of them had heard about COVID-19 vaccines, their low acceptance of the vaccine is of public health concern. The current findings demonstrate the need for heightened vaccine uptake campaigns in secondary schools throughout Zambia, which has started to be enacted. We will be following this up in future studies.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/vaccines10122141/s1>, Table S1—Study Questionnaire.

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Informed Consent Statement: All participants were informed of the objectives of the study and informed consent was provided after the pupils took the questionnaire home for approval by their parents and guardians.

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References

1. Ataguba, J.E. COVID-19 Pandemic, a War to be Won: Understanding its Economic Implications for Africa. *Appl. Health Econ. Health Policy* **2020**, *18*, 325–328. [[CrossRef](#)] [[PubMed](#)]
2. WHO. WHO Coronavirus (COVID-19) Dashboard. 2022. Available online: <https://covid19.who.int> (accessed on 6 December 2022).
3. Malik, P.; Patel, K.; Pinto, C.; Jaiswal, R.; Tirupathi, R.; Pillai, S.; Patel, U. Post-acute COVID-19 syndrome (PCS) and health-related quality of life (HRQoL)-A systematic review and meta-analysis. *J. Med. Virol.* **2022**, *94*, 253–262. [[CrossRef](#)] [[PubMed](#)]
4. de Oliveira Almeida, K.; Nogueira Alves, I.G.; de Queiroz, R.S.; de Castro, M.R.; Gomes, V.A.; Santos Fontoura, F.C.; Brites, C.; Neto, M.G. A systematic review on physical function, activities of daily living and health-related quality of life in COVID-19 survivors. *Chronic Illn.* **2022**. [[CrossRef](#)] [[PubMed](#)]
5. Khan, M.; Adil, S.F.; Alkhathlan, H.Z.; Tahir, M.N.; Saif, S.; Khan, M.; Khan, S.T. COVID-19: A Global Challenge with Old History, Epidemiology and Progress So Far. *Molecules* **2020**, *26*, 39. [[CrossRef](#)] [[PubMed](#)]
6. Richards, F.; Kodjamanova, P.; Chen, X.; Li, N.; Atanasov, P.; Bennetts, L.; Patterson, B.J.; Yektashenas, B.; Mesa-Frias, M.; Tronczynski, K.; et al. Economic Burden of COVID-19: A Systematic Review. *Clin. Outcomes Res.* **2022**, *14*, 293–307. [[CrossRef](#)]
7. Shang, W.; Wang, Y.; Yuan, J.; Guo, Z.; Liu, J.; Liu, M. Global Excess Mortality during COVID-19 Pandemic: A Systematic Review and Meta-Analysis. *Vaccines* **2022**, *10*, 1702. [[CrossRef](#)]
8. Ogunleye, O.O.; Basu, D.; Mueller, D.; Sneddon, J.; Seaton, R.A.; Yinka-Ogunleye, A.F.; Wamboga, J.; Miljković, N.; Mwita, J.C.; Rwegerera, G.M.; et al. Response to the Novel Corona Virus (COVID-19) Pandemic Across Africa: Successes, Challenges, and Implications for the Future. *Front Pharmacol.* **2020**, *11*, 1205. [[CrossRef](#)]

9. Ayouni, I.; Maatoug, J.; Dhouib, W.; Zammit, N.; Fredj, S.B.; Ghammam, R.; Ghannem, H. Effective public health measures to mitigate the spread of COVID-19: A systematic review. *BMC Public Health* **2021**, *21*, 1015. [[CrossRef](#)]
10. Girum, T.; Lentiro, K.; Geremew, M.; Migora, B.; Shewamare, S.; Shimbire, M.S. Optimal strategies for COVID-19 prevention from global evidence achieved through social distancing, stay at home, travel restriction and lockdown: A systematic review. *Arch. Public Health* **2021**, *79*, 150. [[CrossRef](#)]
11. Mudenda, S.; Chileshe, M.; Mukosha, M.; Hikaambo, C.N.; Banda, M.; Kampamba, M.; Mwila, K.; Banda, D.C.; Mufwambi, W.; Daka, V.; et al. Zambia's Response to the COVID-19 Pandemic: Exploring Lessons, Challenges and Implications for Future Policies and Strategies. *Pharmacol. Pharm.* **2022**, *13*, 11–33. [[CrossRef](#)]
12. Talic, S.; Shah, S.; Wild, H.; Gasevic, D.; Maharaj, A.; Ademi, Z.; Li, X.; Xu, W.; Mesa-Eguiagaray, I.; Rostron, J.; et al. Effectiveness of public health measures in reducing the incidence of COVID-19, SARS-CoV-2 transmission, and COVID-19 mortality: Systematic review and meta-analysis. *BMJ* **2021**, *375*, e068302. [[CrossRef](#)] [[PubMed](#)]
13. Nussbaumer-Streit, B.; Mayr, V.; Dobrescu, A.I.; Chapman, A.; Persad, E.; Klerings, I.; Wagner, W.; Siebert, U.; Ledingger, D.; Zachariah, C.; et al. Quarantine alone or in combination with other public health measures to control COVID-19: A rapid review. *Cochrane Database Syst. Rev.* **2020**, *4*, CD013574. [[PubMed](#)]
14. Fatima, S.; Zafar, A.; Afzal, H.; Ejaz, T.; Shamim, S.; Saleemi, S.; Butt, A.S. COVID-19 infection among vaccinated and unvaccinated: Does it make any difference? *PLoS ONE* **2022**, *17*, e0270485. [[CrossRef](#)] [[PubMed](#)]
15. Martínez-Baz, I.; Miqueleiz, A.; Casado, I.; Navascués, A.; Trobajo-Sanmartín, C.; Burgui, C.; Guevara, M.; Ezpeleta, C.; Castilla, J.; Working Group for the Study of COVID-19 in Navarra. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection and hospitalisation, Navarre, Spain, January to April 2021. *Euro. Surveill.* **2021**, *26*, 2100438. [[CrossRef](#)]
16. Tregoning, J.S.; Brown, E.S.; Cheeseman, H.M.; Flight, K.E.; Higham, S.L.; Lemm, N.M.; Pierce, B.F.; Stirling, D.C.; Wang, Z.; Pollock, K.M. Vaccines for COVID-19. *Clin. Exp. Immunol.* **2020**, *202*, 162–192. [[CrossRef](#)]
17. Korang, S.K.; von Rohden, E.; Veroniki, A.A.; Ong, G.; Ngalamika, O.; Siddiqui, F.; Juul, S.; Nielsen, E.E.; Feinberg, J.B.; Petersen, J.J.; et al. Vaccines to prevent COVID-19: A living systematic review with Trial Sequential Analysis and network meta-analysis of randomized clinical trials. *PLoS ONE* **2022**, *17*, e0260733. [[CrossRef](#)]
18. WHO. Statement for Healthcare Professionals: How COVID-19 Vaccines are Regulated for Safety and Effectiveness (Revised March 2022). 2022. Available online: <https://www.who.int/news/item/17-05-2022-statement-for-healthcare-professionals-how-covid-19-vaccines-are-regulated-for-safety-and-effectiveness> (accessed on 2 December 2022).
19. Antonelli, M.; Penfold, R.S.; Merino, J.; Sudre, C.H.; Molteni, E.; Berry, S.; Canas, L.S.; Graham, M.S.; Klaser, K.; Modat, M.; et al. Risk factors and disease profile of post-vaccination SARS-CoV-2 infection in UK users of the COVID Symptom Study app: A prospective, community-based, nested, case-control study. *Lancet Infect Dis.* **2022**, *22*, 43–55. [[CrossRef](#)]
20. Johnson, A.G.; Amin, A.B.; Ali, A.R.; Hoots, B.; Cadwell, B.L.; Arora, S.; Avoundjian, T.; Awofeso, A.O.; Barnes, J.; Bayoumi, N.S.; et al. COVID-19 Incidence and Death Rates Among Unvaccinated and Fully Vaccinated Adults with and Without Booster Doses During Periods of Delta and Omicron Variant Emergence—25 U.S. Jurisdictions, 4 April–25 December 2021. *MMWR Morb. Mortal. Wkly. Rep.* **2022**, *71*, 132–138. [[CrossRef](#)]
21. Dyer, O. COVID-19: Unvaccinated face 11 times risk of death from delta variant, CDC data show. *BMJ* **2021**, *374*, n2282. [[CrossRef](#)]
22. Quan, B.X.; Shuai, H.; Xia, A.J.; Hou, Y.; Zeng, R.; Liu, X.L.; Lin, G.-F.; Qiao, J.-X.; Li, W.-P.; Wang, F.-L.; et al. An orally available M(pro) inhibitor is effective against wild-type SARS-CoV-2 and variants including Omicron. *Nat. Microbiol.* **2022**, *7*, 716–725. [[CrossRef](#)]
23. Ma, Y.; Yang, K.S.; Geng, Z.Z.; Alugubelli, Y.R.; Shaabani, N.; Vatansever, E.C.; Ma, X.R.; Cho, C.-C.; Khatua, K.; Xiao, J.; et al. A multi-pronged evaluation of aldehyde-based tripeptidyl main protease inhibitors as SARS-CoV-2 antivirals. *Eur. J. Med. Chem.* **2022**, *240*, 114570. [[CrossRef](#)] [[PubMed](#)]
24. Wang, Z.; Wang, N.; Yang, L.; Song, X.-Q. Bioactive natural products in COVID-19 therapy. *Front. Pharmacol.* **2022**, *13*, 926507. [[CrossRef](#)] [[PubMed](#)]
25. Schäfer, A.; Martínez, D.R.; Won, J.J.; Meganck, R.M.; Moreira, F.R.; Brown, A.J.; Gully, K.L.; Zweigart, M.R.; Conrad, W.S.; May, S.R.; et al. Therapeutic treatment with an oral prodrug of the remdesivir parental nucleoside is protective against SARS-CoV-2 pathogenesis in mice. *Sci. Transl. Med.* **2022**, *14*, eabm3410. [[CrossRef](#)] [[PubMed](#)]
26. Riva, L.; Yuan, S.; Yin, X.; Martín-Sancho, L.; Matsunaga, N.; Pache, L.; Burgstaller-Muehlbacher, S.; De Jesus, P.D.; Teriete, P.; Hull, M.V.; et al. Discovery of SARS-CoV-2 antiviral drugs through large-scale compound repurposing. *Nature* **2020**, *586*, 113–119. [[CrossRef](#)] [[PubMed](#)]
27. Wang, Z.; Yang, L. In the age of Omicron variant: Paxlovid raises new hopes of COVID-19 recovery. *J. Med. Virol.* **2022**, *94*, 1766–1767. [[CrossRef](#)] [[PubMed](#)]
28. Abbas, K.; Procter, S.R.; van Zandvoort, K.; Clark, A.; Funk, S.; Mengistu, T.; Hogan, D.; Dansereau, E.; Jit, M.; Flasche, S.; et al. Routine childhood immunisation during the COVID-19 pandemic in Africa: A benefit-risk analysis of health benefits versus excess risk of SARS-CoV-2 infection. *Lancet Glob. Health* **2020**, *8*, e1264–e1272. [[CrossRef](#)]
29. Olorunsaiye, C.Z.; Yusuf, K.K.; Reinhart, K.; Salihu, H.M. COVID-19 and Child Vaccination: A Systematic Approach to Closing the Immunization Gap. *Int. J. Matern. Child Health AIDS (IJMA)* **2020**, *9*, 381–385. [[CrossRef](#)]
30. Mudenda, S.; Zulu, A.; Phiri, M.N.; Ngazimbi, M.; Mufwambi, W.; Kasanga, M.; Banda, M. Impact of Coronavirus Disease 2019 (COVID-19) on College and University Students: A Global Health and Education Problem. *Aquademia* **2020**, *4*, ep20026. [[CrossRef](#)]

31. Etando, A.; Amu, A.A.; Haque, M.; Schellack, N.; Kurdi, A.; Alrasheedy, A.A.; Timoney, A.; Mwita, J.C.; Rwegerera, G.M.; Patrick, O.; et al. Challenges and Innovations Brought about by the COVID-19 Pandemic Regarding Medical and Pharmacy Education Especially in Africa and Implications for the Future. *Healthcare* **2021**, *9*, 1722. [[CrossRef](#)]
32. Kashte, S.; Gulbake, A.; El-Amin, S.F., III; Gupta, A. COVID-19 vaccines: Rapid development, implications, challenges and future prospects. *Hum Cell* **2021**, *34*, 711–733. [[CrossRef](#)]
33. Barrett, A.D.T.; Titball, R.W.; MacAry, P.A.; Rupp, R.E.; von Messling, V.; Walker, D.H.; Fanget, N.V.J. The rapid progress in COVID vaccine development and implementation. *NPJ Vaccines* **2022**, *7*, 20. [[CrossRef](#)] [[PubMed](#)]
34. Wang, Q.; Hu, S.; Du, F.; Zang, S.; Xing, Y.; Qu, Z.; Zhang, X.; Lin, L.; Hou, Z. Mapping global acceptance and uptake of COVID-19 vaccination: A systematic review and meta-analysis. *Commun. Med.* **2022**, *2*, 113. [[CrossRef](#)] [[PubMed](#)]
35. Sallam, M. COVID-19 Vaccine Hesitancy Worldwide: A Concise Systematic Review of Vaccine Acceptance Rates. *Vaccines* **2021**, *9*, 160. [[CrossRef](#)] [[PubMed](#)]
36. Bono, S.A.; Faria de Moura Villela, E.; Siau, C.S.; Chen, W.S.; Pengpid, S.; Hasan, M.T.; Sessou, P.; Ditekemena, J.D.; Amodan, B.O.; Hosseinipour, M.C.; et al. Factors Affecting COVID-19 Vaccine Acceptance: An International Survey among Low- and Middle-Income Countries. *Vaccines* **2021**, *9*, 515. [[CrossRef](#)]
37. Ayoubkhani, D.; Bermingham, C.; Pouwels, K.B.; Glickman, M.; Nafilyan, V.; Zaccardi, F.; Khunti, K.; Alwan, N.A.; Walker, A.S. Trajectory of long COVID symptoms after COVID-19 vaccination: Community-based cohort study. *BMJ* **2022**, *377*, e069676. [[CrossRef](#)]
38. Mohammed, I.; Nauman, A.; Paul, P.; Ganesan, S.; Chen, K.-H.; Jalil, S.M.S.; Jaouni, S.H.; Kawas, H.; Khan, W.A.; Vattoth, A.L.; et al. The efficacy and effectiveness of the COVID-19 vaccines in reducing infection, severity, hospitalization, and mortality: A systematic review. *Hum Vaccin Immunother.* **2022**, *18*, 2027160. [[CrossRef](#)]
39. Ogunleye, O.O.; Godman, B.; Fadare, J.O.; Mudenda, S.; Adeoti, A.O.; Yinka-Ogunleye, A.F.; Ogundele, S.O.; Oyawole, M.R.; Schönfeldt, M.; Rashed, W.M.; et al. Coronavirus Disease 2019 (COVID-19) Pandemic across Africa: Current Status of Vaccinations and Implications for the Future. *Vaccines* **2022**, *10*, 1553. [[CrossRef](#)]
40. Rodrigues, C.M.C.; Plotkin, S.A. Impact of Vaccines; Health, Economic and Social Perspectives. *Front. Microbiol.* **2020**, *11*, 1526. [[CrossRef](#)]
41. Greenwood, B. The contribution of vaccination to global health: Past, present and future. *Philos. Trans. R Soc Lond B Biol. Sci.* **2014**, *369*, 20130433. [[CrossRef](#)]
42. Schuchat, A. Human Vaccines and Their Importance to Public Health. *Procedia Vaccinol.* **2011**, *5*, 120–126. [[CrossRef](#)]
43. Singh, P.; Dhalaria, P.; Kashyap, S.; Soni, G.K.; Nandi, P.; Ghosh, S.; Mohapatra, M.K.; Rastogi, A.; Prakash, D. Strategies to overcome vaccine hesitancy: A systematic review. *Syst. Rev.* **2022**, *11*, 78. [[CrossRef](#)] [[PubMed](#)]
44. Elgendy, M.O.; Abdelrahim, M.E.A. Public awareness about coronavirus vaccine, vaccine acceptance, and hesitancy. *J. Med. Virol.* **2021**, *93*, 6535–6543. [[CrossRef](#)] [[PubMed](#)]
45. Haile, Z.T.; Ruhil, A.; Bates, B.R.; Hall, O.; Grijalva, M.J. Correlates of COVID-19 Vaccine Acceptance among Residents of Ohio: A Cross-sectional Study. *BMC Public Health* **2022**, *22*, 226. [[CrossRef](#)] [[PubMed](#)]
46. Adane, M.; Ademas, A.; Kloos, H. Knowledge, attitudes, and perceptions of COVID-19 vaccine and refusal to receive COVID-19 vaccine among healthcare workers in northeastern Ethiopia. *BMC Public Health* **2022**, *22*, 128. [[CrossRef](#)]
47. Ackah, M.; Ameyaw, L.; Salifu, M.G.; Asubonteng, D.P.A.; Yeboah, C.O.; Annor, E.N.; Ankapong, E.A.K.; Boakye, H. COVID-19 vaccine acceptance among health care workers in Africa: A systematic review and meta-analysis. *PLoS ONE* **2022**, *17*, e0268711. [[CrossRef](#)]
48. Kabamba Nzaji, M.; Kabamba Ngombe, L.; Ngoie Mwamba, G.; Banza Ndala, D.B.; Mbidi Miema, J.; Luhata Lungoyo, C.; Mwimba, B.L.; Bene, A.C.M.; Musenga, E.M. Acceptability of Vaccination Against COVID-19 Among Healthcare Workers in the Democratic Republic of the Congo. *Pragmat Obs Res.* **2020**, *11*, 103–109. [[CrossRef](#)]
49. Amuzie, C.I.; Odini, F.; Kalu, K.U.; Izuka, M.; Nwamoh, U.; Emma-Ukaegbu, U.; Onyike, G. COVID-19 vaccine hesitancy among healthcare workers and its socio-demographic determinants in Abia State, Southeastern Nigeria: A cross-sectional study. *Pan Afr. Med. J.* **2021**, *40*, 10. [[CrossRef](#)]
50. Li, M.; Luo, Y.; Watson, R.; Zheng, Y.; Ren, J.; Tang, J.; Chen, Y. Healthcare workers' (HCWs) attitudes and related factors towards COVID-19 vaccination: A rapid systematic review. *Postgrad. Med. J.* **2021**. [[CrossRef](#)]
51. Jain, V.; Schwarz, L.; Lorgelly, P. A Rapid Review of COVID-19 Vaccine Prioritization in the U.S.: Alignment between Federal Guidance and State Practice. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3483. [[CrossRef](#)]
52. Bayou, F.D.; Amare, S.N. Acceptance of COVID-19 Vaccine and Its Associated Factors Among Ethiopian Population: A Systematic Review. *Patient Prefer. Adherence.* **2022**, *16*, 1093–1103. [[CrossRef](#)]
53. Abebe, H.; Shitu, S.; Mose, A. Understanding of COVID-19 Vaccine Knowledge, Attitude, Acceptance, and Determinates of COVID-19 Vaccine Acceptance Among Adult Population in Ethiopia. *Infect. Drug Resist.* **2021**, *14*, 2015–2025. [[CrossRef](#)] [[PubMed](#)]
54. Wu, J.; Ma, M.; Miao, Y.; Ye, B.; Li, Q.; Tarimo, C.S.; Wang, M.; Jianqin Gu, J.; Wei, W.; Zhao, L.; et al. COVID-19 Vaccination Acceptance Among Chinese Population and Its Implications for the Pandemic: A National Cross-Sectional Study. *Front. Public Health* **2022**, *10*, 796467. [[CrossRef](#)]
55. Orangi, S.; Pinchoff, J.; Mwangi, D.; Abuya, T.; Hamaluba, M.; Warimwe, G.; Austrian, K.; Barasa, E. Assessing the Level and Determinants of COVID-19 Vaccine Confidence in Kenya. *Vaccines* **2021**, *9*, 936. [[CrossRef](#)] [[PubMed](#)]

56. Cascini, F.; Pantovic, A.; Al-Ajlouni, Y.; Failla, G.; Ricciardi, W. Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: A systematic review. *EClinicalMedicine* **2021**, *40*, 101113. [CrossRef] [PubMed]
57. Paul, E.; Steptoe, A.; Fancourt, D. Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. *Lancet Reg. Health Eur.* **2021**, *1*, 100012. [CrossRef]
58. Kanyanda, S.; Markhof, Y.; Wollburg, P.; Zezza, A. Acceptance of COVID-19 vaccines in sub-Saharan Africa: Evidence from six national phone surveys. *BMJ Open* **2021**, *11*, e055159. [CrossRef] [PubMed]
59. Dinga, J.N.; Sinda, L.K.; Titanji, V.P.K. Assessment of Vaccine Hesitancy to a COVID-19 Vaccine in Cameroonian Adults and Its Global Implication. *Vaccines* **2021**, *9*, 175. [CrossRef]
60. Cooper, S.; van Rooyen, H.; Wiysonge, C.S. COVID-19 vaccine hesitancy in South Africa: How can we maximize uptake of COVID-19 vaccines? *Expert. Rev. Vaccines* **2021**, *20*, 921–933. [CrossRef]
61. Raja, S.M.; Osman, M.E.; Musa, A.O.; Hussien, A.A.; Yusuf, K. COVID-19 vaccine acceptance, hesitancy, and associated factors among medical students in Sudan. *PLoS ONE* **2022**, *17*, e0266670. [CrossRef]
62. Mudenda, S.; Hikaambo, C.N.; Daka, V.; Chileshe, M.; Mfunne, R.L.; Kampamba, M.; Kasanga, M.; Phiri, M.; Mufwambi, W.; Banda, M.; et al. Prevalence and factors associated with COVID-19 vaccine acceptance in Zambia: A web-based cross-sectional study. *Pan. Afr. Med. J.* **2022**, *41*, 112. [CrossRef]
63. Mudenda, S.; Mukosha, M.; Hikaambo, C.; Meyer, J.; Fadare, J.; Kampamba, M.; Kalungia, A.; Munsaka, S.; Okoro, R.; Daka, V.; et al. Awareness and acceptance of COVID-19 vaccines and associated factors among pharmacy students in Zambia. *Malawi Med. J.* **2022**, *34*, 236–243.
64. Al-Kassim Hassan, M.; Adam Bala, A.; Jatau, A.I. Low rate of COVID-19 vaccination in Africa: A cause for concern. *Ther. Adv. Vaccines Immunother.* **2022**, *10*, 25151355221088159. [CrossRef]
65. Ajeigbe, O.; Arage, G.; Besong, M.; Chacha, W.; Desai, R.; Doegah, P.; Hamoonga, T.E.; Hussein, H.; Matchado, A.; Mbotwe-Sibanda, S.; et al. Culturally relevant COVID-19 vaccine acceptance strategies in sub-Saharan Africa. *Lancet Glob. Health* **2022**, *10*, e1090–e1091. [CrossRef] [PubMed]
66. Ackah, B.B.B.; Woo, M.; Stallwood, L.; Fazal, Z.A.; Okpani, A.; Ukah, U.V.; Adu, P.A. COVID-19 vaccine hesitancy in Africa: A scoping review. *Glob. Health Res. Policy* **2022**, *7*, 21. [CrossRef] [PubMed]
67. Sallam, M.; Dababseh, D.; Eid, H.; Hasan, H.; Taim, D.; Al-Mahzoum, K.; Al-Haidar, A.; Yaseen, A.; Ababneh, N.A.; Assaf, A.; et al. Low COVID-19 Vaccine Acceptance Is Correlated with Conspiracy Beliefs among University Students in Jordan. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2407. [CrossRef]
68. Wonodi, C.; Obi-Jeff, C.; Adewumi, F.; Keluo-Udeke, S.C.; Gur-Arie, R.; Krubiner, C.; Jaffe, E.F.; Bamiduro, T.; Karron, R.; Faden, R. Conspiracy theories and misinformation about COVID-19 in Nigeria: Implications for vaccine demand generation communications. *Vaccine* **2022**, *40*, 2114–2121. [CrossRef]
69. Nuwarda, R.F.; Ramzan, I.; Weekes, L.; Kayser, V. Vaccine Hesitancy: Contemporary Issues and Historical Background. *Vaccines* **2022**, *10*, 1595. [CrossRef]
70. Malik, J.A.; Ahmed, S.; Mir, A.; Shinde, M.; Bender, O.; Alshammari, F.; Ansari, M.; Anwar, S. The SARS-CoV-2 mutations versus vaccine effectiveness: New opportunities to new challenges. *J. Infect. Public Health* **2022**, *15*, 228–240. [CrossRef]
71. Konishi, T. Mutations in SARS-CoV-2 are on the increase against the acquired immunity. *PLoS ONE* **2022**, *17*, e0271305. [CrossRef]
72. Gong, W.; Parkkila, S.; Wu, X.; Aspatwar, A. SARS-CoV-2 variants and COVID-19 vaccines: Current challenges and future strategies. *Int. Rev. Immunol.* **2022**. [CrossRef]
73. Remes, P.; Selestine, V.; Changalucha, J.; Ross, D.A.; Wight, D.; de Sanjosé, S.; Kapiga, S.; Hayes, R.J.; Watson-Jones, D. A qualitative study of HPV vaccine acceptability among health workers, teachers, parents, female pupils, and religious leaders in northwest Tanzania. *Vaccine* **2012**, *30*, 5363–5367. [CrossRef] [PubMed]
74. Choi, S.-H.; Jo, Y.H.; Jo, K.J.; Park, S.E. Pediatric and Parents' Attitudes Towards COVID-19 Vaccines and Intention to Vaccinate for Children. *J. Korean Med. Sci.* **2021**, *36*, e227. [CrossRef] [PubMed]
75. Cole, J.W.; Chen, A.M.H.; McGuire, K.; Berman, S.; Gardner, J.; Teegala, Y. Motivational interviewing and vaccine acceptance in children: The MOTIVE study. *Vaccine* **2022**, *40*, 1846–1854. [CrossRef] [PubMed]
76. Fazel, M.; Puntis, S.; White, S.R.; Townsend, A.; Mansfield, K.L.; Viner, R.; Herring, J.; Pollard, A.J.; Freeman, D. Willingness of children and adolescents to have a COVID-19 vaccination: Results of a large whole schools survey in England. *EClinicalMedicine* **2021**, *40*, 101144. [CrossRef]
77. Getawa, S.; Aynalem, M.; Bayleyegn, B.; Adane, T. Knowledge, attitude and practice towards COVID-19 among secondary school students in Gondar town, Northwest Ethiopia. *PLoS ONE* **2022**, *17*, e0268084. [CrossRef]
78. Handebo, S.; Adugna, A.; Kassie, A.; Shitu, K. Determinants of COVID-19-related knowledge and preventive behaviours among students in reopened secondary schools: Cross-sectional study. *BMJ Open* **2021**, *11*, e050189. [CrossRef]
79. Khan, M.J.; Ahmed, J. Child education in the time of pandemic: Learning loss and dropout. *Child. Youth Serv. Rev.* **2021**, *127*, 106065. [CrossRef]
80. Omang, T.A. Assessing the Impact COVID-19 Pandemic on the Educational Development of Secondary School Students. *INAV: J. Inf. Vis.* **2021**, *2*, 25–32. [CrossRef]
81. United Nations. Policy Brief—Education during COVID-19 and Beyond. 2020. Available online: https://unsdg.un.org/sites/default/files/2020-08/sg_policy_brief_covid-19_and_education_august_2020.pdf (accessed on 23 November 2022).

82. Wang, K.; Wang, L.; Li, M.; Xie, B.; He, L.; Wang, M.; Zhang, R.; Hou, N.; Zhang, Y.; Jia, F. Real-World Effectiveness of Global COVID-19 Vaccines Against SARS-CoV-2 Variants: A Systematic Review and Meta-Analysis. *Front. Med.* **2022**, *9*, 820544. [[CrossRef](#)]
83. Zeng, B.; Gao, L.; Zhou, Q.; Yu, K.; Sun, F. Effectiveness of COVID-19 vaccines against SARS-CoV-2 variants of concern: A systematic review and meta-analysis. *BMC Med.* **2022**, *20*, 200. [[CrossRef](#)]
84. Simulundu, E.; Mupeta, F.; Chanda-Kapata, P.; Saasa, N.; Changula, K.; Muleya, W.; Chitanga, S.; Mwanza, M.; Simusika, P.; Chambaro, H.; et al. First COVID-19 case in Zambia—Comparative phylogenomic analyses of SARS-CoV-2 detected in African countries. *Int. J. Infect. Dis.* **2021**, *102*, 455–459. [[CrossRef](#)] [[PubMed](#)]
85. Chileshe, M.; Mulenga, D.; Mfuno, R.L.; Nyirenda, T.H.; Mwanza, J.; Mukanga, B.; Mudenda, S.; Daka, V. Increased number of brought-in-dead cases with COVID-19: Is it due to poor health-seeking behaviour among the Zambian population? *Pan. Afr. Med. J.* **2020**, *37*, 136. [[CrossRef](#)] [[PubMed](#)]
86. Carcelen, A.C.; Prosperi, C.; Mutembo, S.; Chongwe, G.; Mwansa, F.D.; Ndubani, P.; Simulundu, E.; Chilumba, I.; Musukwa, G.; Thuma, P.; et al. COVID-19 vaccine hesitancy in Zambia: A glimpse at the possible challenges ahead for COVID-19 vaccination rollout in sub-Saharan Africa. *Hum. Vaccines Immunother.* **2022**, *18*, 1–6. [[CrossRef](#)] [[PubMed](#)]
87. Alemayehu, A.; Demissie, A.; Yusuf, M.; Lencha, A.G.; Oljira, L. COVID-19 Vaccine Acceptance and Determinant Factors among General Public in East Africa: A Systematic Review and Meta-Analysis. *Heal. Serv. Res. Manag. Epidemiol.* **2022**, *9*, 23333928221106269. [[CrossRef](#)] [[PubMed](#)]
88. Aklil, M.B.; Temesgan, W.Z. Knowledge and Attitude towards COVID-19 Vaccination and Associated Factors among College Students in Northwest Ethiopia, 2021. *Health Serv. Res. Manag. Epidemiol.* **2022**, *9*, 23333928221098903. [[CrossRef](#)] [[PubMed](#)]
89. Rehati, P.; Amaerjiang, N.; Yang, L.; Xiao, H.; Li, M.; Zunong, J.; Wang, L.; Vermund, S.H.; Hu, Y. COVID-19 Vaccine Hesitancy among Adolescents: Cross-Sectional School Survey in Four Chinese Cities Prior to Vaccine Availability. *Vaccines* **2022**, *10*, 452. [[CrossRef](#)]
90. Nilsson, S.; Mattson, J.; Berghammer, M.; Brorsson, A.L.; Forsner, M.; Jenholt Nolbris, M.; Kull, I.; Olinder, A.L.; Ragnarsson, S.; Rullander, A.-C.; et al. To be or not to be vaccinated against COVID-19—The adolescents' perspective—A mixed-methods study in Sweden. *Vaccine X* **2021**, *9*, 100117. [[CrossRef](#)]
91. Afifi, T.O.; Salmon, S.; Taillieu, T.; Stewart-Tufescu, A.; Fortier, J.; Driedger, S.M. Older adolescents and young adults willingness to receive the COVID-19 vaccine: Implications for informing public health strategies. *Vaccine* **2021**, *39*, 3473–3479. [[CrossRef](#)]
92. Wong, W.; Leung, D.; Chua, G.; Duque, J.; Peare, S.; So, H.; Chan, S.M.; Kwan, M.Y.W.; Ip, P.; Lau, Y.L. Adolescents' attitudes to the COVID-19 vaccination. *Vaccine* **2022**, *40*, 967–969. [[CrossRef](#)]
93. Lee, H.; Choe, Y.J.; Kim, S.; Cho, H.-K.; Choi, E.H.; Lee, J.; Bae, H.; Choi, S.-R.; You, M. Attitude and Acceptance of COVID-19 Vaccine in Parents and Adolescents: A Nationwide Survey. *J. Adolesc. Health* **2022**, *71*, 164–171. [[CrossRef](#)]
94. Schellack, N.; Strydom, M.; Pepper, M.S.; Herd, C.L.; Hendricks, C.L.; Bronkhorst, E.; Meyer, J.C.; Padayachee, N.; Bangalee, V.; Truter, I.; et al. Social Media and COVID-19; Perceptions and Public Deceptions of Ivermectin, Colchicine and Hydroxychloroquine: Lessons for Future Pandemics. *Antibiotics* **2022**, *11*, 445. [[CrossRef](#)] [[PubMed](#)]
95. Wawrzuta, D.; Klejdysz, J.; Jaworski, M.; Gotlib, J.; Panczyk, M. Attitudes toward COVID-19 Vaccination on Social Media: A Cross-Platform Analysis. *Vaccines* **2022**, *10*, 1190. [[CrossRef](#)] [[PubMed](#)]
96. Ahmed, S.; Rasul, M.E.; Cho, J. Social Media News Use Induces COVID-19 Vaccine Hesitancy Through Skepticism Regarding Its Efficacy: A Longitudinal Study from the United States. *Front. Psychol.* **2022**, *13*, 900386. [[CrossRef](#)]
97. Hernandez, R.G.; Hagen, L.; Walker, K.; O'Leary, H.; Lengacher, C. The COVID-19 vaccine social media infodemic: Healthcare providers' missed dose in addressing misinformation and vaccine hesitancy. *Hum. Vaccines Immunother.* **2021**, *17*, 2962–2964. [[CrossRef](#)] [[PubMed](#)]
98. Al-Dmour, H.; Masa'Deh, R.; Salman, A.; Abuhashesh, M.; Al-Dmour, R. Influence of Social Media Platforms on Public Health Protection Against the COVID-19 Pandemic via the Mediating Effects of Public Health Awareness and Behavioral Changes: Integrated Model. *J. Med. Internet Res.* **2020**, *22*, e19996. [[CrossRef](#)]
99. Gonzalez-Padilla, D.A.; Tortolero-Blanco, L. Social media influence in the COVID-19 Pandemic. *Int. Braz. J. Urol.* **2020**, *46* (Suppl. 1), 120–124. [[CrossRef](#)]
100. Scherer, A.M.; Gedlinske, A.M.; Parker, A.M.; Gidengil, C.A.; Askelson, N.M.; Petersen, C.A.; Woodworth, K.R.; Lindley, M.C. Acceptability of Adolescent COVID-19 Vaccination Among Adolescents and Parents of Adolescents—United States, April 15–23, 2021. *MMWR Morb. Mortal. Wkly. Rep.* **2021**, *70*, 997–1003. [[CrossRef](#)]
101. Saleh, A.S.A.; Mahmoodi, A.H.; Alradadi, A.H.A.; Al-Ansari, M.M.; Majrashi, A.M.H.; Mohammed, K.E.; Alkudari, M.W.S.; Garout, W.M.; Felemban, E.J.; Almalayo, M.S.; et al. Assessment of Perception of COVID-19 Infection and Vaccination among Health Care Workers in Makkah Al-Mokarramah, Saudi Arabia. *Anna. Rom. Soc. Cell Biol.* **2022**, *26*, 3103–3120.
102. Park, K.; Cartmill, R.; Johnson-Gordon, B.; Landes, M.; Malik, K.; Sinnott, J.; Wallace, K.; Wallin, R. Preparing for a School-Located COVID-19 Vaccination Clinic. *NASN Sch. Nurse* **2021**, *36*, 156–163. [[CrossRef](#)]
103. İkişik, H.; Sezerol, M.A.; Taşçı, Y.; Maral, I. COVID-19 vaccine hesitancy and related factors among primary healthcare workers in a district of Istanbul: A cross-sectional study from Turkey. *Fam. Med. Commun. Health* **2022**, *10*, e001430. [[CrossRef](#)]
104. Yendewa, S.A.; Ghazzawi, M.; James, P.B.; Smith, M.; Massaquoi, S.P.; Babawo, L.S.; Deen, G.F.; Russell, J.B.W.; Samai, M.; Sahr, F.; et al. COVID-19 Vaccine Hesitancy among Healthcare Workers and Trainees in Freetown, Sierra Leone: A Cross-Sectional Study. *Vaccines* **2022**, *10*, 757. [[CrossRef](#)] [[PubMed](#)]

105. Blake, H.; Fecowycz, A.; Starbuck, H.; Jones, W. COVID-19 Vaccine Education (CoVE) for Health and Care Workers to Facilitate Global Promotion of the COVID-19 Vaccines. *Int. J. Environ. Res. Public Health* **2022**, *19*, 653. [[CrossRef](#)] [[PubMed](#)]
106. Tahir, M.J.; Saqlain, M.; Tariq, W.; Waheed, S.; Tan, S.H.; Nasir, S.I.; Ullah, I.; Ahmed, A. Population preferences and attitudes towards COVID-19 vaccination: A cross-sectional study from Pakistan. *BMC Public Health* **2021**, *21*, 1759. [[CrossRef](#)] [[PubMed](#)]
107. Contoli, B.; Possenti, V.; Minardi, V.; Binkin, N.J.; Ramigni, M.; Carrozzi, G.; Masocco, M. What Is the Willingness to Receive Vaccination Against COVID-19 Among the Elderly in Italy? Data from the PASSI d'Argento Surveillance System. *Front. Public Health* **2021**, *9*, 736976. [[CrossRef](#)]
108. Tibbels, N.J.; Dosso, A.; Fordham, C.; Benie, W.; Brou, J.A.; Kamara, D.; Hendrickson, Z.M.; Naugle, D.A. "On the last day of the last month, I will go": A qualitative exploration of COVID-19 vaccine confidence among Ivoirian adults. *Vaccine* **2022**, *40*, 2028–2035. [[CrossRef](#)]