Nouf Fahad Bin Muammar et al, 2021;2(1):018–025.
https://doi.org/10.24911/SJEMed/72-1603445943

ORIGINAL ARTICLE

Factors associated with delayed child vaccine during coronavirus disease-2019 pandemic

Nouf Fahad Bin Muammar[1,4], Abdulaziz Ali Ajeebi[1,4], Ashah Lail Aladwany[1,4], Amal Abobakr Yousif[2,4*], Nesrin Abdulrahman Alharthy[2,4], Winnie Phillip[3,4]

ABSTRACT

Background: Basic vaccinations are essential for child well-being and delaying these vaccines during coronavirus disease-2019 (COVID-19) pandemic will lead to vaccine-preventable diseases. This study was conducted to identify the factors that contribute to delay of vaccination during COVID-2019 pandemic and assess the prevalence of participants who have positive attitude towards continuing the vaccination during the pandemic.

Methods: A cross-sectional study was conducted during May 2020 in all regions of Saudi Arabia through a self-administered intent-based questionnaire. Data were acquired from participants who take care of a child from birth to 4 years old, reside in Saudi Arabia. The questionnaire was structured to collect socioeconomic data, child information, vaccination information, and reasons of delaying vaccination schedule during the pandemic.

Results: A total of 820 were included in the study, where 75.6% of participants in our survey had a positive attitude toward completing their children's vaccination even during the COVID-19 pandemic. Participants elected not to continue the vaccine comprised 24.4% of the study. The main reasons for vaccine postponement were the fear of getting infected by COVID-19 virus if they visit health facilities (45.1%) and planning to delay vaccination till the pandemic ends (28.8%). There was a significant association between continuing vaccination during the pandemic and level of education, transportation, and age of the child.

Conclusion: High level of education was strongly associated with continuing vaccination even in a such outbreak. Increasing the awareness will improve the vaccination coverage and prevent the appearance of preventable diseases.

Keywords: Vaccination, COVID-19, delay, children, Saudi Arabia.

Introduction

Vaccination is a crucial and most cost-effective method for controlling life-threatening infectious diseases [1,2]. More than 120 vaccines have shown the effectiveness of preventing and disappearing of many infectious diseases [2,3]. For instance, the incidence of measles in the USA declined by 95% after 5 years of the vaccine approval [4]. Although about 25% of annual deaths worldwide are directly associated with infectious diseases, the morbidity and mortality rates of infectious diseases decreased mostly in infants and children [5]. This decline as a direct effect of vaccination is not only protecting a child, but it is protecting the community by decreasing the exposure to disease. By getting vaccinated, children will protect the community by breaking the chain of organism's transmission [6]. Most countries in the world have developed a national policy for immunization based on the World Health Organization (WHO) recommendation [7].

Correspondence to: Amal Yousif
*Pediatric Emergency Department, King Abdullah Specialist Children Hospital, King Abdulaziz Medical City, Riyadh, Saudi Arabia; King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia.
Email: Yousifa@ngha.med.sa, Dr.amalyousif@gmail.com
Full list of author information is available at the end of the article.
Received: 05 November 2020 | **Accepted:** 27 December 2020

Locally, the Ministry of Health approved the first vaccination schedule in 1991, and it was modified in 2013 as the last update [8]. In Saudi Arabia, vaccinations are available and free in all regions, and it became obligatory to get a birth certificate and get into school. Even though this step is very effective to keep the rate of vaccination high, some local studies have reported delay in immunizations of infants and children [2,8,9]. Globally, vaccine-preventable diseases (VPDs) are still the cause of two million pediatric deaths every year due to skipping or delaying vaccination [10]. Vaccination delay increases the time between the depletion of the mother's antibodies and vaccines' protection, leading to the outbreak of VPDs [11].

Many factors could lead to vaccination delay, including not being a first child, not having insurance, and living in peripheral zones [12]. Additionally, some logistic reasons were reported to be behind the delayed vaccination among children, where difficulty in getting next vaccination appointment was reported as reason for this problem by 60% of the children's caregivers [13]. However, such factors could differ from nation to another depending on the nation's health strategies and protocols. Not only this but also outbreaks of infectious disease were found to be a strong factor that could have a negative impact on adherence to vaccination schedule among children. For instance, in 2017, the rate of vaccination after the Ebola Virus Disease outbreak in West Africa was relatively low compared with the rate before the outbreak [14].

Recently, the world is facing the outbreak of coronavirus disease-2019 (COVID-19) that affects health care and lead to restricting all daily activities [15,16]. COVID-19 is a very contiguous and higher pandemic risk than other coronavirus types [15]. The transmission between human-to-human mainly spreads through the respiratory tract by droplets, respiratory discharges, and direct contact. The rate of infection transmission is fast, especially in the elderly and people with low immunity [17]. The clinical presentation of COVID-19 includes fever, dry cough, fatigue, headache, and a few patients presenting with gastrointestinal symptoms and upper respiratory tract signs and symptoms (e.g., rhinorrhea, sneezing, or sore throat) [16-18]. However, some adults and children may present with mild flu-like symptoms, and a few may even do not manifest fever and present with atypical presentation of asymptomatic presentation [16]. In January 2020, the WHO officially announced the COVID-19 outbreak as a public health crisis of universal concern. According to Wang et al. [19] and Adhikari et al. [20] the only way to be protected from COVID-19 is through prevention of spreading and decreasing transmission in the community.

Worldwide, Governments take different precautions at different times to restrict the spread of infection by limiting the movement of people, close public places, transportation, and airports [19]. Also, schools and workplaces have been suspended, and lockdown forced on all society except for health care providers, national safety responders, and police officers. In addition, hospital visits have been limited to emergency care and urgent procedures to minimize crowding and close contact as much as possible. Not only the government, nowadays, but even media campaigns also play a major role to increase awareness and reminding society about prevention methods and encourage people to stay at home and maintain social distance.

As a result of this huge awareness, the quick spread of COVID-19, and strict precautions around the world, the outbreak is inducing a considerable degree of fear, anxiety, depression, and other psychological issues among the population in general and increasing to some extent among certain groups [21,22]. Such a negative impact could affect the families decision to adherence to their children's vaccination schedule. Therefore, this study aims to investigate the factors that are associated with delayed vaccination in children during COVID-19 pandemic.

Material and Methods

This cross-sectional study was conducted during May 2020 including all the 13 regions of the Kingdom of Saudi Arabia. It was conducted using a self-administered online questionnaire that was distributed through social media. This study (RC20/264/R) was approved by the Institutional Review Board in King Abdullah International Medical Research Center.

According to the Saudi Arabia General Statistical Authority, there were 34,218,169 adults in 2019 [23]. Based on Raosoft, a sample size online calculator [24] with an acceptable error margin of error 5% and 95% confidence level, a sample size of at least 385 was required. Participants who were addressed in this study were caregivers or parents who take care of a child from birth to 4 years old and reside in Saudi Arabia at the time of quarantine. The total number of respondents was 2,352.

The data were collected through a structured questionnaire that was adopted from a previous study that was conducted in the western region of Saudi Arabia with permission of original developer [25]. The questionnaire was modified to fit the purpose of our research and was reviewed by a specialized physician. A pilot study was conducted including 20 participants to assure consistency and clarity of the questionnaire. The questionnaire is available in both Arabic and English languages. It consisted of two parts: the first part is showing the purpose of the research. The second part consisted of three sections: the first section included socioeconomic variables including: nationality, age, sex, relation to the child, marital status, region, residence, level of education, occupation, health insurance, and financial income. The second section included child information that contains age, number of other siblings and if she/he had any infections, asthma, or any neurological diseases. The last section included immunization history which focused on where vaccination is taken, duration of the vaccination process, whether the child had delayed or missed immunization before pandemic or not, reasons of not continuing immunization during the pandemic which included six prespecified reasons, if a participant has his/her own car for transportation, the awareness of the importance of vaccination, and if a participant knows how to take an appointment during the pandemic.

Participants are considered late in vaccinating their children when they plan to not to continue vaccination during the pandemic in the next upcoming months, while participants who will to continue vaccination have positive attitude towards vaccination during pandemic.

The analysis was performed using the statistical package of social science version 25 (IBM corporation, Armonk, NY). The categorical data are presented as numbers and percentages. Chi-square test was performed to analyze data, compare, and find an association between variables. *p*-value that is less than 0.05 was considered significant.

Results

Of 2,352 contacted participants, 2,325 agreed to participate and filled up the questionnaire. Eight hundred twenty of participants were included in the criteria. Majority of the participants were Saudis (*n* = 766, 93.4%). Most of participants were aged 21-25 years (*n* = 230, 28.0%). Female participants accounted for more than 70% of the surveyed cohort (*n* = 607, 74%). Most of study participants were mothers (*n* = 456, 55.6%). The vast majority of the participants were married at 75.6% and resided in urban area at 84.1%. More than one quarter of the studied sample was from Eastern region at 21.5%, followed by Riyadh, Najran, Makkah region, Tabuk, and Hail.

Majority of participants had bachelor's degree (*n* = 517, 63%). Moreover, most of the participants were employed (*n* = 502, 61.2%). A total of 56.8% did not have health insurance (*n* = 466), but most of the participants' monthly financial income was between 10,000 and 25, 000 SR (*n* = 365, 44.5%). Half of the sample size have children between age 6 and 11 months (*n* = 364, 44.4%) and have 2-4 children (*n* = 384, 46.8%). Seven hundred sixty nine of children do not have skin rash and hay fever. Majority of children were healthy with no chronic diseases (*n* = 795, 97%), and minority suffers from neurological diseases such as cerebral palsy or genetic disorders such as Down syndrome (*n* = 25, 3.0%). More than 90% of the participants had vaccination cards (*n* = 738). Participants showed a commitment to vaccination before COVID-19 pandemic in around 59.3% of the study sample. (Table 1)

Appointments for vaccination by the current study participants were taken mostly in primary healthcare centers (PHC) (*n* = 607, 74%), with a travel distance to hospital or Primary health care centers (PMC) of less than 20 minutes in more than half of the study sample (*n* = 548, 66.8%) with private car as the most common mode for transportation in 93.2% of participants (*n* = 764). A total of 75.6% of parents participated in this study had a positive attitude towards completing their children vaccination even during the COVID-19 pandemic. Participants elected not to adhere to the vaccination schedule in 24.4%. The main reasons for not giving the vaccine was the fear of getting the child and caregiver exposed to infection by COVID-19 virus if they visit the health care facilities and planning to postpone vaccination till the pandemic ends (Figure 1).

Figure 2 shows participants who continued and did not continue the vaccination during COVID-19 pandemic.

Table 1. *Sociodemographic characteristics of the participants (n= 820).*

General characteristics		
Nationality	***n***	**%**
Non-Saudi	54	6.6
Saudi	766	93.4
Age		
<=20	70	8.5
21-25	230	28.0
26-30	214	26.1
31-35	166	20.2
>=36	140	17.1
Sex		
Male	213	26.0
Female	607	74.0
Relation to the child		
Father	155	18.9
Mother	456	55.6
Grandparent	10	1.2
Uncle/aunt	107	13.0
Others	92	11.2
Marital status		
Single	154	18.8
Married	620	75.6
Divorced	32	3.9
Widowed	14	1.7
Region		
Riyadh	135	16.5
Qassim	52	6.3
Eastern region	176	21.5
Tabuk	57	7
Madinah	21	2.6
Makkah	89	10.9
Northern borders	45	5.5
Jawf	21	2.6
Hail	56	6.8
Bahah	9	1.1
Jazan	33	4
Aseer	36	4.4
Najran	90	11
Residence		
Rural	130	15.9
Urban	690	84.1
Level of education		
Pre high school	31	3.8
High school diploma	183	22.3
Bachelor's degree	517	63.0
Post graduate education	89	10.9
Occupation		
Unemployed	311	37.9
Employed	502	61.2
Retired	7	0.9

(Continued)

General characteristics		
Nationality	***n***	**%**
Financial income		
<5,000	173	21.1
5,000–10,000	228	27.8
10,000–25,000	365	44.5
>=25,000	54	6.6
Health insurance		
Yes	354	43.2
No	466	56.8
Child information		
Age of your infant or child?		
<2 months	132	16.1
2–3 months	142	17.3
4–5 months	182	22.2
6–11months	364	44.4
Number of other siblings		
only child	358	43.7
2–4 children	384	46.8
5 or more children	78	9.5
Does your child suffer from asthma, skin rash, hay fever?		
Yes	51	6.2
No	769	93.8
Does your child suffer from any neurological diseases such as cerebral palsy or genetic diseases such as Down syndrome?		
Yes	51	2.2
No	2,274	97.8
Do you have the vaccination card?		
Yes	738	90.0
No	82	10.0
Did you miss or were you late on vaccinating your child before? (before corona virus pandemic)?		
I have not vaccinated my children	37	4.5
Yes, I was late vaccinating my child before	186	22.7
I missed one of the vaccinations	111	13.5
I was never late for vaccinating my child	486	59.3

According to age, participants who have children from age 2 to 3 months old have higher number in refusing to continue vaccination than 4-5 months, 6-11 months and the least are <2 months. Having said that, 47.3% of the study participants declare some difficulties completing their child's vaccination during pandemic (n = 388). Despite that, 72% of participants were aware of the online appointment system provided by Ministry of Health (MOH) for vaccination. Overall, 94.3% of participants had strong knowledge about the importance of the vaccination (Table 2).

To explore more on the study variables that had led to positive knowledge and attitude towards pursuing the child's vaccine, a Chi-square test is performed to test the association between study variables and

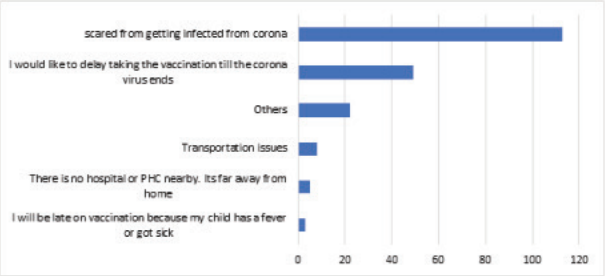

Figure 1. *Factors contributing on vaccine delay.*

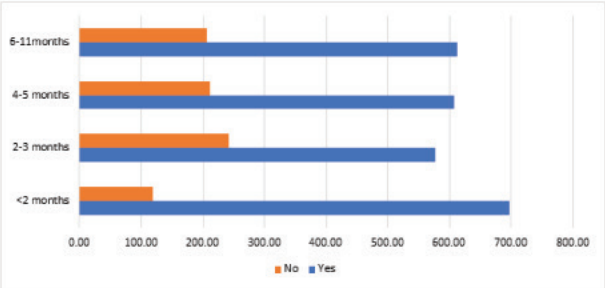

Figure 2. *Participants who continued and did not continue the vaccination during COVID-19 pandemic.*

participant univariate variable for positive attitude and knowledge. There is a significant association between level of education and continuing the vaccination during COVID-19 pandemic (p-value = 0.008). So, people who have a higher level of education are 12 times more likely to continue vaccination during the pandemic. There was a significant association between having a private car for transportation and continuing the vaccination during pandemic (p-value = 0.001). People who have their own cars for transportation had 21 times higher chances to continue vaccination. People who declare their awareness about the importance of vaccination were five times higher to continue vaccination during the pandemic (p-value = 0.022). There was a significant association between financial income and continuing immunization with p-value 0.007. Parents with children less than 1 year were more than 80% keen to pursue vaccination with statistical significance (p-value = 0.022). There was no statistical significance association between health insurance, number of children, and travel distance taken to reach health facility and continuing vaccination with p-value = 0.228, p value = 0.828, and p-value = 0.352, respectively (Table 3).

Discussion

To after extensive literature review, this is the first study that has investigated factors that contribute to vaccination delay in children during COVID-19 pandemic. The current study was conducted in all regions of Saudi Arabia during the pandemic of COVID-19 period. Despite the vaccination delay in Saudi Arabia before the outbreak of COVID-19 based on previous studies [2,8], our result showed that 24.4% of participants preferred not to continue the vaccination of their children during the period of COVID-19 pandemic.

Table 2. *Response of study participants to questions focused on vaccination.*

Questions	*n*	%
Where do you usually take appointment for immunization?		
Hospital	213	26.0
PHC	607	74.0
The amount of time taken from home to the hospital/PHC clinic?		
<20 minutes	548	66.8
20–40 minutes	226	27.6
>40 minutes	46	5.6
Do you have a car for transportation?		
Yes	764	93.2
No	56	6.8
Do you continue the immunization on your child/infant during the corona pandemic?		
Yes	620	75.6
No	200	24.4
Reasons for not continuing immunization		
Scared from getting infected from corona	113	56.5
I will be late on vaccination because my child has a fever or got sick	3	1.5
There is no hospital or PHC nearby. Its far away from home	5	2.5
Transportation issues	8	4.0
I would like to delay taking the vaccination till the corona virus ends	49	24.5
Others	22	11.0
Are you having difficulty completing your child's vaccination during the Corona pandemic?		
Yes	388	47.3
No	432	52.7
Do you know the importance of vaccination in infants and children?		
Yes	773	94.3
No	47	5.7
Do you know that Ministry of Health allowed you to take an appointment online to go to the hospital or primary healthcare to continue vaccination?		
Yes	590	72.0
No	74	9.0
I don't know	156	19.0

Table 3. *Association between variables and continuing vaccination during pandemic.*

Variables	Do you continue the immunization on your child/infant during the corona pandemic?		Chi square	*p* value
	NO %	Yes %		
Education level			11.748	0.008
Per high school	35.5	64.5		
High school	31.1	68.9		
Bachelor	23.0	77.0		
Post graduate	14.6	85.4		
Health insurance			1.453	0.228
Without	26.0	74.0		
With	22.3	77.7		
Financial income			12.118	0.007
<5,000	34.1	65.9		
5,000-10,000	22.8	77.2		
10,000-25,000	21.9	78.1		
>25,000	16.7	83.3		
Distance to health facility			2.086	0.352
<20 minutes	23.4	76.6		
20-40 minutes	25.2	74.8		
>40 minute	32.6	67.4		
Car for transportation			10.636	0.001
No car	50.0	50.0		
With car	22.5	77.5		
Age of infant or child			9.582	0.022
<2 months	14.4	85.6		
2-3 months	29.6	70.4		
4-5 months	25.8	74.2		
6-11 months	25.3	74.7		
Number of siblings			0.378	0.828
Only child	25.4	74.6		
2-4 children	23.7	76.3		
5 & more	23.1	76.9		
Parent knowledge about vaccine importance			5.229	0.022
No	38.3	61.7		
Yes	23.5	76.5		

Expectedly, our result showed that among our participants, the main reason to not continue the vaccination during COVID-19 period is the fear of being infected if they visit PHC units. This fact was supported by a previous study which was conducted during Ebola outbreak, the author found that the main factors that contribute to vaccination delay are interruption of child's immunization system, parents' fear of being infected if they go to the health unit for vaccination, and health care provider were too busy to fight Ebola outbreak [14].

Our data found a significant association between caregiver's level of education and continuing vaccination during pandemic. The result showed that those who have higher education level are 12 times more to continue vaccination. This appears to be in line with many previous literatures who found a positive relationship between parent's education and continuing vaccination [26-29]. The explanation of this concurrent finding is based on the fact that well-educated parents are aware of importance of immunization and complications of skipping the routine vaccination.

This study found another significant association between transportation and continuing vaccination. Our result showed that parents who have private car are 21 times more to be on-time regarding their children's immunization schedule. This fact has been found by a previous Gambian study, which stated that mothers with

private transportation are one-third less likely to delay their children's vaccination.

Our result found no significant association between the continuing vaccination and having health insurance. This fact is not in line with a study conducted by Gustavo et al. which found that families who do not have health insurance are more likely to delay their children's vaccination [13]. The disagreement in this point might be explained by the fact that in Saudi Arabia, the vaccinations are given free of charge for all children, so expectedly there will be no significant association with vaccination delay. On the other hand, our result showed a significant association between financial status and continuing vaccination. While this finding is not in line with a previous local study conducted in Riyadh, it is worth to mention that the reason behind this disagreement might be related to the fact that wealthy families tend to vaccinate their children in private clinics which have much lower cases of COVID-19 than governmental (free) centers.

Many previous studies have showed that families with more children are less likely to vaccinate their children on-time [8,13,30-32]. However, our result opposed this fact by finding no association between number of children and continuing vaccination. It is not surprising finding for co-authors, because in such a pandemic if the family decide to not continue the vaccination, does not matter how many children they have, the decision would include whole family members.

During quarantine, the MOH has still keened to continue vaccination during COVID-19 pandemic in hospitals and PHC. According to MOH statistical yearbook of 2018, the total number of hospitals in all regions of Saudi Arabia, including private and governmental hospitals, is 494 and 2,390 PHC which are distributed geographically around all regions [33]. Our study assessed the association between the travel distance to the nearest health center and continuing vaccination, and the result was non-significant. Although many previous studies have shown the opposite, it is not surprising to find no significant association between the distance and continuing vaccination [3,32,34]. Despite that vaccination centers geographically are available for all children, the distance in such a pandemic period would not have a great impact on the decision to continue the vaccination or not.

One of the ways to make an appointment without going to the hospital is by using Mawid service. Mawid service is an e-service which is available as an application provided by the MOH. It is used for booking, cancelling, or rescheduling appointments at PHC. It was launched in May 2019 [35]. The current study assessed the extent of people's awareness of this service. The result showed that 72% of participants do know and how to use the application which shows high awareness of participants and high improvement of health care systems.

Limitation

The data of study have collected online during quarantine and in very short and critical time which might increase bias, but it is considered the first research which focused on vaccination coverage during COVID-19 pandemic. This study did not include which vaccination missed before and in quarantine, to show more specific vaccinations that are considered delayed as other studies did by vaccination card. That is why it was not included in our survey. The family of the participants who got infected from COVID-19 was not specified in our study, which plays a big role in deciding taking vaccine or not. Health care workers were not specified in the study. long working hours in hospitals during the pandemic might cause to delay of vaccinating their children. And lastly, our research was done in all regions of Saudi Arabia, which might lead to different results due to different time of lockdown period in each region. Weekly, MOH take decisions regarding the pandemic in every region. Example; Makkah was lockdown more than the other regions.

Conclusion

The current study was conducted in a very critical and short period, but the finding was obvious that 24.4% of participants are not planning to continue vaccination during the pandemic. This might increase the number of preventable diseases in the new generation. Notably, more educated parents are strongly associated with continuing immunization even in such a pandemic period. The awareness about importance of immunization will improve the childhood vaccination coverage. Therefore, launching awareness programs targeting this topic will have a great impact. MOH once did a home vaccination service for influenza to cover largest number as possible. Therefore, we recommend doing home vaccination service for children by MOH for covering the basic immunization in all regions of Saudi Arabia. This will reduce the hospital load and decrease the possibility of virus transmission. Moreover, although awareness of immunization was established before pandemic, it should be more during these days through social media and other means.

Acknowledgements

The authors would like to thank Abdulrahman Mohammed Alsawidan, Maha Saleh Almutairi, Ruba Abdrabuh Alhamdi, Saad Murayh Al Bishri, Nuwayyir Essa Aqeel, Faisal Ayed Almazariqi, Hadi Mohammed Al Khamsan, Rawan Hamoud Alshammari, Dakhel Fahad Almubarak, Thamer Ahmed Al Sayari, Abdulmajeed Saud Altamimi, Abeer Fahad Al Mutairi, Tahani Ahmed Douf, Ibtisam Khulaif Alruwaili, Fatma Mohammed Thani Sokail, Abdulaziz Mohammed Al Dehailan, Faris Zuhair Alsaedi, Afnan Hamdan Alshammari, Asma Mudhfi Alshammari, Futon Hamad Alomran, Osama Abdullah Alzahrani, Malak Mansour Alhaddab, Amerah sulaiman Al-Alwai, Osama Abdullah Alzahrani, Manal Dhyem Alshammari, Waleed Abdullah Alharthi, and Rimaz Muteb Aldosari for working as data collectors. Also, we would like to thank Dr. Abdullah Saleh for his expertise and assistance throughout all aspects of our study.

List of Abbreviation

VPD	Vaccine preventable disease
COVID-19	Corona virus disease-19
WHO	World Health Organization
MOH	Ministry of Health

Conflict of interest
The authors declare that there is no conflict of interests.

Funding
None.

Consent to participate
Written consent was taken from all the participants.

Ethical approval
Ethical approval was granted by the Institutional Review Board of King Abdullah International Medical Research Center, National Guard Health Affairs, Riyadh, Saudi Arabia (RC/20/264/R). Date of approval 14 May 2019.

Author details
Nouf Fahad Bin Muammar[1,4], Abdulaziz Ali Ajeebi[1,4], Ashah Lail Aladwany[1,4], Amal Abobakr Yousif[2,4], Nesrin Abdulrahman Alharthy[2,4], Winnie Phillip[3,4]
1. College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
2. Pediatric Emergency Department, King Abdullah Specialized Children Hospital, Riyadh, Saudi Arabia
3. College of Applied Medical Science, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
4. King Abdullah International Medical Research Center, Riyadh, Saudi Arabia

References

1. Zheng Z, Diaz-Arévalo D, Guan H, Zeng M. Noninvasive vaccination against infectious diseases. Hum Vaccin Immunother. 2018;14(7):1717–33. https://doi.org/10.1080/21645515.2018.1461296
2. Hasanain FH, Jan MM. Delays in primary vaccination of infants living in Western Saudi Arabia. Saudi Med J. 2002;23(9):1087–9.
3. Riedmann EM. Report: State of the world's vaccines and immunization. Hum Vaccin. 2010;6:157–63. https://doi.org/10.4161/hv.6.2.11326
4. Milteer RM, Jonna S. Parental reasons for delayed immunizations in children hospitalized in a Washington, DC, public hospital. J Natl Med Assoc. 1996;88(7):433.
5. Morens DM, Folkers GK, Fauci AS. The challenge of emerging and re-emerging infectious diseases. Nature. 2004;430(6996):242–9. https://doi.org/10.1038/nature02759
6. Anderson EJ, Daugherty MA, Pickering LK, Orenstein WA, Yogev R. Protecting the community through child vaccination. Clin Infect Dis. 2018;67(3):464–71. https://doi.org/10.1093/cid/ciy142
7. Vaahtera M, Kulmala T, Maleta K, Cullinan T, Salin ML, Ashorn P. Childhood immunization in rural Malawi: time of administration and predictors of non-compliance. Ann Trop Paediatr. 2000;20(4):305–12. https://doi.org/10.1080/02724936.2000.11748152
8. Banjari MA, Alamri AA, Algarni AY, Abualjadayel MH, Alshardi YS, Alahmadi TS. How often do children receive their vaccinations late, and why? Saudi Med J. 2018;39(4):347. https://doi.org/10.15537/smj.2018.4.21473
9. Al-Shehri SN, Al-Shammari SA, Khoja TA. Missed opportunities for immunization: a Saudi Arabia survey. Can Fam Physician. 1992;38:1087.
10. WHO. (2018). The World Health Organization; immunization. Geneva, Switzerland: World Health Organization; 2018. Available from: http://www.who.int/gho/immunization/en/
11. Hu Y, Li Q, Chen Y. Timeliness of childhood primary immunization and risk factors related with delays: evidence from the 2014 Zhejiang provincial vaccination coverage survey. Int J Environ Res Public Health. 2017;14(9):1086. https://doi.org/10.3390/ijerph14091086
12. Odutola A, Afolabi MO, Ogundare EO, Lowe-Jallow YN, Worwui A, Okebe J, Ota MO. Risk factors for delay in age-appropriate vaccinations among Gambian children. BMC Health Serv Res. 2015;15(1):346. https://doi.org/10.1186/s12913-015-1015-9
13. Dayan GH, Shaw KM, Baughman AL, Orellana LC, Forlenza R, Ellis A, et al. Assessment of delay in age-appropriate vaccination using survival analysis. Am J Epidemiol. 2006;163(6):561–70. https://doi.org/10.1093/aje/kwj074
14. Sun X, Samba TT, Yao J, Yin W, Xiao L, Liu F et al. Impact of the ebola outbreak on routine immunization in western area, Sierra Leone-a field survey from an Ebola epidemic area. BMC Public Health. 2017;17(1):363. https://doi.org/10.1186/s12889-017-4242-7
15. Team N. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. 2020. [cited 2020 May 5]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/32064853
16. She J, Liu L, Liu W. COVID-19 epidemic: disease characteristics in children. J Med Virol. 2020;92(7):747–54. https://doi.org/10.1002/jmv.25807
17. Guo Y, Cao Q, Hong Z, Tan Y, Chen S, Jin H et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. Mil Med Res. 2020;7(1):11. https://doi.org/10.1186/s40779-020-00240-0
18. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506. https://doi.org/10.1016/S0140-6736(20)30183-5
19. Wang C, Horby P, Hayden F, Gao G. A novel coronavirus outbreak of global health concern. Lancet. 2020;395(10223):470–73. https://doi.org/10.1016/S0140-6736(20)30185-9
20. Adhikari S, Meng S, Wu Y, Mao Y, Ye R, Wang Q et al. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: a scoping review. Infect Dis Poverty. 2020;9(1):29. https://doi.org/10.1186/s40249-020-00646-x
21. Liu X, Kakade M, Fuller C, Fan B, Fang Y, Kong J et al. Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic. Compr Psychiatry. 2012;53(1):15–23. https://doi.org/10.1016/j.comppsych.2011.02.003
22. Brooks S, Webster R, Smith L, Woodland L, Wessely S, Greenberg N et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet. 2020;395(10227):912–20. https://doi.org/10.1016/S0140-6736(20)30460-8
23. General Authority for Statistics. Population estimates. Riyadh, Saudi Arabia: General Authority for Statistics; Available from: https://www.stats.gov.sa/en/43

24. Raosoft Sample Size Calculator [Internet]. 2004. [cited 2020 July 28]. Available from: http://www.raosoft.com/samplesize.html

25. Banjari M, Alamri A, Algarni A, Abualjadayel M, Alshardi Y, Alahmadi T. How often do children receive their vaccinations late, and why? Saudi Med J. 2018;39(4):347–53. https://doi.org/10.15537/smj.2018.4.21473

26. Moisi JC, Kabuka J, Mitingi D, Levine OS, Scott JAG. Spatial and socio-demographic predictors of time-to-immunization in a rural area in Kenya: is equity attainable? Vaccine. 2010;28:5725–30. https://doi.org/10.1016/j.vaccine.2010.06.011

27. Le Polain de Waroux O, Schellenberg JR, Manzi F, Mrisho M, Shirima K, Mshinda H et al. Timeliness and completeness of vaccination and risk factors for low and late vaccine uptake in young children living in rural southern Tanzania. Int Health. 2013;5(2):139–47. https://doi.org/10.1093/inthealth/iht006

28. Rammohan A, Awofeso N, Fernandez RC. Paternal education status significantly influences infants' measles vaccination uptake, independent of maternal education status. BMC Public Health. 2012;12;336. https://doi.org/10.1186/1471-2458-12-336

29. Nankabirwa V, Tylleskar T, Tumwine JK, Sommerfelt H, Promise-ebf Study Group. Maternal education is associated with vaccination status of infants less than 6 months in eastern Uganda: a cohort study. BMC Pediatr. 2010;10:92. https://doi.org/10.1186/1471-2431-10-92

30. Babirye JN, Engebretsen IM, Makumbi F, Fadnes LT, Wamani H, Tylleskar T, et al. Timeliness of childhood vaccinations in Kampala Uganda: a community-based cross-sectional study. PloS One. 2012;7(4):e35432. https://doi.org/10.1371/journal.pone.0035432

31. Ndiritu M, Cowgill KD, Ismail A, Chiphatsi S, Kamau T, Fegan G, et al. Immunization coverage and risk factors for failure to immunize within the expanded programme on immunization in Kenya after introduction of new haemophilus influenzae type b and hepatitis b virus antigens. BMC Public Health. 2006;6(1):132. https://doi.org/10.1186/1471-2458-6-132

32. Rahman M, Obaida-Nasrin S. Factors affecting acceptance of complete immunization coverage of children under five years in rural Bangladesh. Salud Pública Méx. 2010;52:134–40. https://doi.org/10.1590/S0036-36342010000200005

33. Ministry of Health. 2018 . Ministry Of Health Statistical Yearbook 2018 [cited 2020 July 28]. Available at: https://www.moh.gov.sa/en/Ministry/Statistics/book/Pages/default

34. Reichler MR, Darwish A, Stroh G, Stevenson J, Al Nasr MA, Oun SA, et al: Cluster survey evaluation of coverage and risk factors for failure to be immunized during the 1995 National Immunization Days in Egypt. Int J Epidemiol. 1998;27(6):1083–9. https://doi.org/10.1093/ije/27.6.1083

35. Ministry of Health. [cited 2020 July 28]. Available from: https://www.moh.gov.sa/en/ eServices/Pages/cassystem.aspx