Original Article

Exploring influential factors in childhood vaccine delays in Riyadh, Saudi Arabia

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Abstract

Introduction: Infectious diseases present a substantial worldwide health challenge, yet vaccines have played a crucial role in significantly decreasing illness rates. Despite their effectiveness, global vaccination coverage stands at 85%, leaving a considerable number of infants without routine immunization. Our study seeks to examine the occurrence of delayed primary vaccination and the factors influencing it in Riyadh, Saudi Arabia addressing a critical void in current research. **Methodology:** A cross-sectional investigation was carried out in the primary care facilities of the first health cluster in Riyadh, Saudi Arabia. Information was gathered utilizing a well-structured questionnaire, modified from a prior study. The study encompassed children aged two years and younger, accompanied by their parents who brought their vaccination cards for the visit. Non-probability convenience sampling was employed for data collection. Subsequently, the data underwent thorough cleaning in Excel (Microsoft Excel) and was subjected to analysis using IBM SPSS 29 (IBM SPSS Statistics 29). **Results:** The study involved 402 participants, primarily over 12 months old, with a balanced gender distribution. Noteworthy findings indicate a 20.9% prevalence of childhood vaccine delays, with reasons such as high-grade fever (33.3%) and travel (26.2%). Significant associations were found in children aged 6–12 months (25.8%, $P = 0.039$), families with over four children (31%, $P = 0.010$), perceptions of vaccine harm (50.0%, $P = 0.013$), and acknowledgment of neglect (96.4%, $P = 0.001$). **Conclusion:** The research illuminates the complex factors influencing childhood vaccine delays in Saudi Arabia. Stressing the significance of personalized interventions, it underscores the necessity to tackle challenges specific to age, parental perspectives, and access issues for improved vaccination outcomes.

Keywords: Childhood vaccination, contributing factors, delay, Saudi Arabia

Introduction

Infectious diseases represent a major leading cause of mortality and morbidity worldwide, particularly among young children. Vaccines play a crucial role in significantly reducing the risk of infection by collaborating with the body to develop immunity against various diseases.[1,2] According to estimates from the Centers for Disease Control and Prevention (CDC), vaccines administered to children born in the last 20 years are projected to prevent 322 million diseases and save 732 thousand lives.[3]

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Received: 17-01-2024 **Revised:** 16-03-2024
Accepted: 18-03-2024 **Published:** 26-07-2024

Access this article online

Quick Response Code:

Website: http://journals.lww.com/JFMPC

DOI: 10.4103/jfmpc.jfmpc_95_24

When comparing morbidity rates in the USA between 2016 and the twentieth century, it is evident that vaccine-preventable diseases have significantly decreased. Notably, diseases such as smallpox, diphtheria, and polio have been eradicated. The incidences of measles, rubella, congenital rubella syndrome, and Haemophilus influenzae type b have seen a remarkable reduction of 99%. Similarly, mumps, pertussis, and tetanus have been reduced by more than 92%.[4] Furthermore, a recent economic analysis of low- and middle-income countries estimated that a $34 billion investment in vaccination programs resulted in saving $586 billion by reducing the cost of illness. This equates to saving 16 times greater than the initial investment.[5] Nevertheless, achieving sufficient vaccination coverage continues to be a challenge. According to the World Health Organization (WHO), global vaccination coverage

How to cite this article: Basham K, Al Mutairi F, Baw B, Al Said L. Exploring influential factors in childhood vaccine delays in Riyadh, Saudi Arabia. J Family Med Prim Care 2024;13:3165-72.

stands at only 85%, leaving 19.9 million infants worldwide without access to routine immunization services.[6] In the USA, the estimated vaccination coverage among children aged 19–35 months from 2012 to 2016 is as follows: ≥90% for ≥3 doses of the poliovirus vaccine, ≥3 doses of hepatitis B (Hep B) (90.5%), varicella vaccine (90.6%), and MMR (measles, mumps, and rubella) (91.1%). However, coverage was lower for a completed series of the rotavirus vaccine (74.1%), the combined seven-vaccine series (70.7%), the Hep B birth dose (71.1%), and lowest for ≥2 doses of hepatitis A vaccine (Hep A) (60.6%).[7] In a Canadian cohort study investigating the impact of the coronavirus (COVID-19) pandemic on children's vaccine schedules, a total of 1,277 children were analyzed. The study revealed a significant increase in vaccine delays, with a rate of 18.2% before the onset of the COVID-19 pandemic compared to 37.9% after its emergence. Remarkably, the most prevalent age for vaccine delay was identified as 12 months. Further analysis indicated that the DTaP-IPV-Hib vaccine combination was the most commonly delayed among the studied cohort.[8] Conducting a comprehensive analysis incorporating data from 33 Sub-Saharan African countries, the study sheds light on concerning rates of delayed vaccinations among children: 25.9% for Bacille-Calmette-Guerin (BCG) (at birth), 49.1% for the third pentavalent dose (at 14 weeks), and 63.9% for the initial measles vaccine (at 9 months). Notably, delays were more prevalent among children born to mothers with lower educational and wealth levels, emphasizing the urgent need for targeted interventions.[9] Furthermore, a recent study conducted in Jeddah on children under 3 years old reported an overall vaccination delay rate of 24%. This delay was frequently observed for MMR, the fourth dose of pneumococcal conjugate vaccine (PCV), the second dose of meningococcal vaccine (MCV), and the second dose of oral poliovirus vaccine (OPV). Additionally, the same study found that 69% of the children experienced a delay in at least one vaccination, with 30.5% having delayed vaccinations on multiple occasions.[10] Indeed, delaying or forgoing vaccinations can have severe consequences, including but not limited to deafness, brain damage, paralysis, and other serious health implications.[11] Limitations faced by healthcare providers in administering immunizations include insufficient understanding of when vaccinations are needed or should be avoided, inadequately trained medical personnel, and the absence of systems to remind patients about missed vaccinations. Additionally, some parents and medical staff remain uneasy about the volume of recommended immunizations during early childhood check-ups. It is crucial for physicians to effectively communicate to both parents and office staff the importance of adhering to vaccination schedules outlined in established guidelines.[12] To address the existing gap in research on vaccine delays, our study aims to assess vaccination timelines by scrutinizing children's vaccination cards. Our focus is on identifying the percentage of delayed vaccinations among children, pinpointing the most frequently delayed vaccines, and thoroughly evaluating the circumstances and contributing factors. This in-depth analysis will provide valuable insights into designing effective preventative measures. Specifically targeting children below a certain age, the study seeks to illuminate the reasons behind delayed vaccinations and associated risk factors.

Methodology

Study design

This cross-sectional study was conducted in Riyadh, Saudi Arabia, at primary healthcare centers (PHCC) in the first cluster between January and November 2023. The target population included children aged two years and younger, accompanied by their parents who brought their vaccination cards to the visit. Children above two years old or those whose parents did not bring their vaccination cards or did not agree to participate were excluded from the study.

Study sample and setting

The study included individuals who met specific inclusion and exclusion criteria. A sample size of 386 was calculated using epidemiological analysis software, considering a 95% confidence level and a 5% margin of error to represent the entire relevant population. To address potential data errors, 450 questionnaires were initially collected, resulting in 402 questionnaires being included in the final analysis after exclusions. This approach ensured a robust representation of the target population, facilitating meaningful statistical analyses regarding the prevalence and factors influencing the health condition of interest.

Questionnaire and data collection

Data collection involved a self-administered questionnaire in Arabic, obtained with prior permission. Structured into five sections, it gathered personal details about the child, parental biodata, caregiver perceptions on vaccinations, factors influencing vaccination status, and reasons for potential delays. The questionnaire, originating from Riyadh's first health cluster, was distributed to participants recruited from nine randomly selected PHCC. Researchers explained the study's objectives, obtained consent, and distributed and collected completed forms from parents.

Data management and statistical analysis

A comprehensive statistical analysis was conducted on the dataset, encompassing both descriptive and inferential methodologies. Firstly, a descriptive analysis is conducted to summarize the demographic characteristics of the participants, which include age, gender, and other features. This provides an overview of the study population. Subsequently, inferential analyses such as the Chi-square test or Fisher's exact test are employed to examine the associations between vaccine delay and other features. Statistical significance is established at a *P* value of 0.05 or lower and a 95% confidence interval. All statistical analyses are executed using IBM's SPSS Software, version 29.0.0.

Assessment of delay

Vaccinations were categorized as delayed if they were administered 30 days after the scheduled time, following the

established immunization schedule. This definition aligns with criteria employed in comparable studies.[8,10,13] The evaluation in this study specifically focused on vaccinations administered during the initial two years of a child's life. Objective assessment of vaccination cards was conducted by data collectors, and parents were directly queried about the reasons for any observed delays in each vaccine. The assessment considered each vaccine individually, ensuring the child was of an appropriate age for its administration.

Ethical considerations

This study received approval from the Ethics Committee at King Saud Medical City. The objectives of the study were clearly communicated to all participants, and inclusion was strictly based on obtaining informed consent. Confidentiality of participants was assured, and the questionnaire abstained from soliciting any personal information.

Vaccination schedule

The Ministry of Health in Saudi Arabia implemented the official vaccination schedule in 1991, with the latest update in January 2019.[14,15] This comprehensive schedule encompasses 24 vaccines to be administered during the first two years of a child's life. It includes a single dose each of BCG, Hepatitis B vaccine (HBV), and Hepatitis A vaccine (HAV). Furthermore, it involves four doses of the hexavalent vaccine, which combines Diphtheria-Tetanus-Pertussis (DTaP), HBV, inactivated poliovirus vaccine (IPV), and Haemophilus influenzae type B (Hib) vaccines. The schedule also prescribes three doses of OPV, two doses of rotavirus vaccines, and three doses of PCV. Additionally, it recommends one dose each of measles and varicella vaccines, and two doses each of MCV and MMR vaccines. The Ministry of Health disseminates the current vaccination schedule to all families with children, offering these vaccines free of charge across all levels of healthcare. A concise summary of these vaccinations is presented in Table 1.

Results

Our study aimed to assess the prevalence of childhood vaccine delay among 402 participants in Saudi Arabia. The majority of the children are over 12 months old (37.8%), and there is a fairly balanced gender distribution (53.7% male, 46.3% female). Saudi nationals constitute 65.4% of the participants. Maternal age spans various ranges, with 32.3% aged 26–30, and educational attainment shows 42.8% with a college degree. About 17.2% of mothers work, 8.5% report chronic illness, and 97.8% are married. Fathers, predominantly aged over 36 (47.0%), often have a college degree (45.5%), with 96.3% employed full-time. Family incomes vary, with 45.3% earning 5000–10,000 SAR monthly. Most families have 1–2 children (49.8%) [Table 2].

Table 3 shows the prevalence of vaccine delay and various characteristics. In terms of healthcare access, the majority (81.6%) can reach facilities within 20 min, and most (66.6%) spend less than 30 min at the facility. Notably, only 3.5% perceive vaccines as harmful. A significant proportion (20.9%) believes they are late in vaccinating their children, while a smaller percentage (7.0%) admits neglecting vaccines. Pregnancy-related factors indicate that 87.6% experienced a full-term pregnancy, 12.2% had jaundice in the first month after birth, and 15.7% had low birth weight.

Figure 1 shows the reasons for vaccination delay among 84 participants. The most prevalent factor was a child experiencing high-grade fever during vaccination, accounting for 33.3%. Following closely, traveling at the time of vaccination constituted 26.2%, while transportation issues contributed to delays in 17.9% of cases. Additionally, vaccine unavailability in health facilities affected 14.3%, and other factors such as distance from home (3.6%), child antibiotic usage (3.6%), and the time required in the health facility (1.2%) were also reported as reasons for delayed vaccinations.

Figure 2 shows the vaccination delay timeline for 84 children, showcasing the percentage of delays at distinct ages. Notable delays are observed, including Hep B at birth with 4.7%, Hexa 1, PCV 1, and Rota 1 at 2 months, with percentages ranging from 20.2% to 21.4%. Similar delays occur at 4 and 6 months for Hexa 2, PCV 2, Rota 2, BCG, Hexa 3, PCV 3, and OPV. At 9 and 12 months, MCV 1, Measles, OPV 2, PCV 4, MCV 2, and MMR experience delays. By 18 months, delays are observed for OPV 3, DTaP, Hib, MMR 2, Varicella, and HAV 1.

Table 4 shows significant associations ($P < 0.05$) between distinct sociodemographic features and vaccination delays

Table 1: Vaccination Schedule

Timing	Vaccine Names
Birth	BCG, HBV 1
2 Months	Hexa 1 (HBV, DTaP, HiB, IPV), Rota 1, PCV1
4 Months	Hexa 2 (HBV, DTaP, HiB, IPV), Rota 2, PCV2
6 Months	Hexa 3 (HBV, DTaP, HiB, IPV), PCV3, BCG
9 Months	Measles, MCV 1
12 Months	OPV 2, MMR 1, PCV 4, MCV 2
18 Months	OPV 3, DTaP, Hib, MMR 2, Varicella, HAV 1
24 Months	HAV 2

BCG-Bacillus Calmette-Guérin, Hep B-Hepatitis B, DTaP-Diphtheria, Tetanus, Pertussis, Hib-Haemophilus influenzae type b, IPV-Inactivated poliovirus vaccine, Rota-Rotavirus, PCV-Pneumococcal, MMR-Measles, Mumps, Rubella, HAV-Hepatitis A

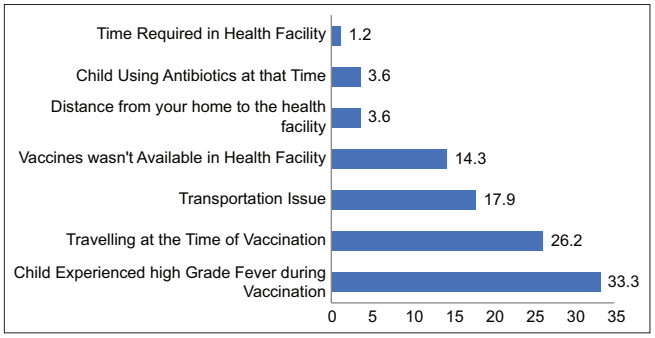

Figure 1: Different Reasons for Vaccination Delay ($n = 84$)

Table 2: Sociodemographic characteristics of patients (*n*=402)

	Frequency *n* (%)
Age of Child (months)	
<6	130 (32.3)
6–12	120 (29.9)
>12	152 (37.8)
Gender	
Male	216 (53.7)
Female	186 (46.3)
Nationality	
Saudi	263 (65.4)
Non-Saudi	139 (34.6)
Mother's Age (years)	
<20	13 (3.2)
21–25	75 (18.7)
26–30	130 (32.3)
31–35	106 (26.4)
>36	78 (19.4)
Mother's Educational Status	
Non-Educated	15 (3.7)
Elementary	15 (3.7)
Intermediate	32 (8.0)
High School	155 (38.6)
College	172 (42.8)
Higher Studies	13 (3.2)
Is the mother working?	
Yes	69 (17.2)
Job Type	
Full-Time	52 (12.9)
Part-Time	18 (4.5)
Mother's Having Chronic Illness	
Yes	34 (8.5)
Marital Status of Mother	
Married	393 (97.8)
Divorced	6 (1.5)
Widow	3 (0.7)
Father's age (years)	
<20	1 (0.2)
21–25	11 (2.7)
26–30	86 (21.4)
31–35	115 (28.6)
>36	189 (47.0)
Father's Education	
Non-Educated	3 (0.7)
Elementary	3 (0.7)
Intermediate	20 (5.0)
High School	162 (40.3)
College	183 (45.5)
Higher Studies	31 (7.7)
Is the father working?	
Yes	387 (96.3)
Job Type	
Full-Time	333 (82.8)
Part-Time	54 (13.4)
Father Having Chronic Illness	
Yes	53 (12.2)
Marital Status of Father	
Married	395 (98.3)
Divorced	6 (1.5)
Widow	1 (0.2)
Family Monthly Income (SAR)	
<5000	108 (26.9)
5000–10,000	182 (45.3)
10,000–25,000	100 (24.9)
>25,000	12 (3.0)
No. of Child	
1–2	200 (49.8)
3–4	144 (35.8)
>4	58 (14.4)

Frequency=*n*, percentage=%

Table 3: Prevalence of Vaccine Delay and Other General Features (*n*=402)

	Frequency (*n*=402)
Time to Reach Healthcare Facility (minutes)	
<20	328 (81.6)
20–40	61 (15.2)
>40	13 (3.2)
Time Spent in Healthcare Facility (minutes)	
<30	268 (66.6)
30–60	116 (28.9)
>60	18 (4.5)
Vaccine Can be Harmful to Your Child	
Yes	14 (3.5)
No	388 (96.5)
You are Late in Vaccinating Your Child	
Yes	84 (20.9)
No	318 (79.1)
You Neglect your Child's Vaccine	
Yes	28 (7.0)
No	374 (93.0)
Full-term pregnancy?	
Yes	352 (87.6)
No	50 (12.4)
Jaundice during the 1st month after birth?	
Yes	49 (12.2)
No	353 (87.8)
Low Birth weight? (below 2.5 kg)	
Yes	63 (15.7)
No	339 (84.3)

Frequency=*n*, percentage=%

in a cohort of 402 children. Noteworthy findings include delays in vaccinations for children aged 6–12 months (25.8%, $P = 0.026$), families with more than four children (31%, $P = 0.010$), mothers grappling with chronic illnesses (44.1%, $P = 0.001$), fathers aged over 36 years (24.9%, $P = 0.025$), and fathers with elementary education (100%, $P = 0.022$). Conversely, variables such as gender, nationality, mother's age, education, working status, fathers working status, and family income exhibited no significant associations with vaccination delays ($P > 0.05$).

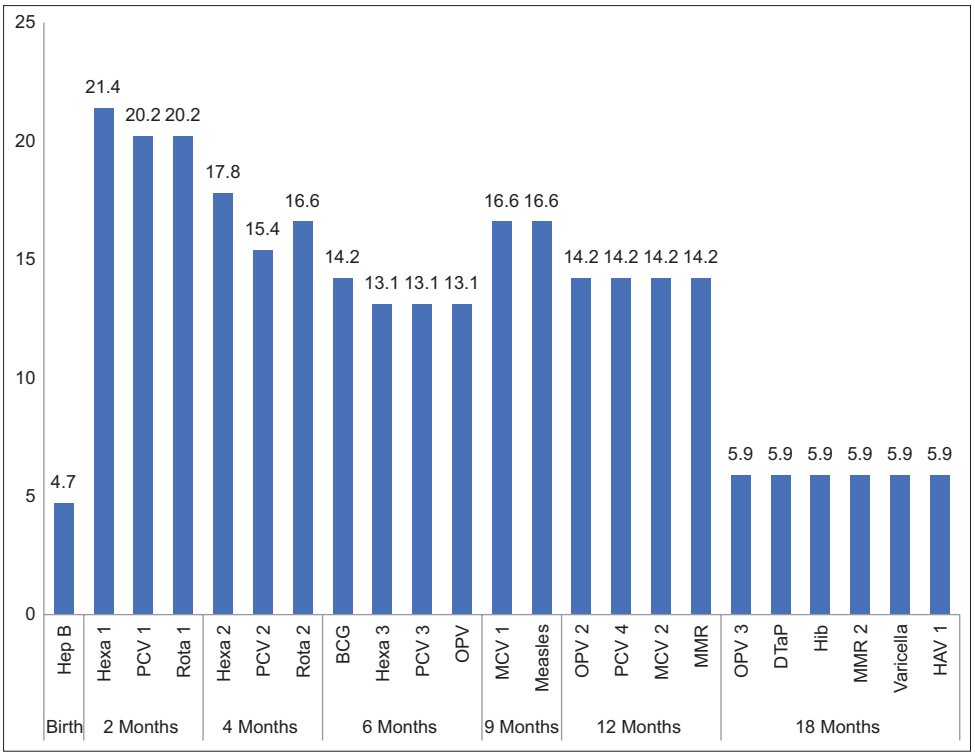

Figure 2: Timeline of Vaccination Delay in Children ($n = 84$)

Table 5 shows significant associations ($P < 0.05$) between various health-related features and vaccination delays among children. Notable findings include a significant association between the perception of vaccines being harmful to children and delays (50.0%, $P = 0.013$), as well as an association between acknowledging neglect of the child and delays (96.4%, $P = 0.001$). However, health conditions such as jaundice, full-term pregnancies, and other features did not show significant associations with vaccination delays.

Discussion

Infectious diseases pose a significant global health concern, particularly affecting children. According to Bhutta *et al.* (2008),[16] a substantial portion of the annual burden, which accounts for 10 million deaths among children under 5 years, is attributed to infectious diseases. Vaccination plays a crucial role in significantly reducing the risks of infection, preventing millions of diseases, and saving lives. According to Rodrigues *et al.* (2020),[17] the perceived benefits of vaccination are centered on reducing morbidity and mortality from infections, and these factors continue to drive the innovation of new vaccines. Despite notable successes, global vaccination coverage stands at only 85%, leaving 19.9 million infants without routine immunization. Within the USA, there is variation in coverage, and delays are evident. Recognizing the potential consequences, our study aims to assess the prevalence of delayed primary vaccination in Riyadh and identify the contributing factors.

Our study sheds light on various sociodemographic factors, access to healthcare, parental perceptions, and specific health-related features. The majority of children in our sample were over 12 months old, with a balanced gender distribution and a predominant representation of Saudi nationals. Maternal age and education exhibited diverse patterns, with a notable proportion working and reporting chronic illnesses. Fathers, predominantly aged over 36, commonly held a college degree and were employed full-time. Family income distribution varied, and the majority of families had 1–2 children. Our findings align with existing literature, emphasizing the importance of understanding sociodemographic factors in influencing vaccination behaviors. The diverse age distribution of children in our study reflects the need for tailored vaccination strategies across different age groups. This finding is consistent with previous research, such as Kiely *et al.* (2018),[18] which shows that vaccine delays are more prevalent in later visits, and incomplete vaccination status by 24 months often results from delays at those later stages.

Access to healthcare emerged as a critical factor influencing vaccination timeliness in our study. The majority of participants reached healthcare facilities within 20 min, and most spent less than 30 min at the facility. However, delays in reaching healthcare facilities exceeding 40 min were associated with vaccination delays. A previous study by Sato *et al.* (2020)[19] demonstrated that a longer distance to the nearest health facility is associated with lower vaccine uptake and delayed timing of vaccinations. This underscores the significance of geographical accessibility and its impact on timely vaccinations, aligning with findings from studies that emphasize the role of travel time to healthcare facilities.

Table 4: Association of Different Sociodemographic Features with Vaccination Delay among Children

	Delayed/Late Vaccination		Sig. Value
	Yes *n* (%)	No *n* (%)	
Age of Child (months)			
<6	17 (13.1)	113 (86.9)	0.026[a]
6–12	31 (25.8)	89 (74.2)	
>12	36 (23.7)	116 (76.3)	
Gender of Child			
Male	47 (21.8)	169 (78.2)	0.646[a]
Female	37 (19.9)	149 (80.1)	
No. of Children			
1–2	30 (15.0)	170 (85.0)	0.010[a]
3–4	36 (25.0)	108 (75.0)	
>4	18 (31.0)	40 (69.0)	
Nationality			
Saudi	60 (22.8)	203 (77.2)	0.193[a]
Non-Saudi	24 (17.3)	115 (82.7)	
Mother's Age (years)			
<20	0 (0.0)	13 (100.0)	0.253[a]
21–25	15 (20.0)	60 (80.0)	
26–30	24 (18.5)	106 (81.5)	
31–35	26 (24.5)	80 (75.5)	
>36	19 (24.4)	59 (75.6)	
Mother's Educational Level			
Non-Educated	3 (20.0)	12 (80.0)	0.104[a]
Elementary	6 (40.0)	9 (60.0)	
Intermediate	3 (9.4)	29 (90.6)	
High School	38 (24.5)	117 (75.5)	
College	30 (17.4)	142 (82.6)	
Higher Studies	4 (30.8)	9 (69.2)	
Working Mother			
Yes	9 (13.0)	60 (87.0)	0.078[a]
No	75 (22.5)	258 (77.5)	
Mother Having Chronic Illness			
Yes	15 (44.1)	19 (55.9)	0.001[a]
No	69 (18.8)	299 (81.3)	
Mother's Marital Status			
Married	82 (20.9)	311 (79.1)	1.000[b]
Divorced/Widow	2 (22.2)	7 (77.8)	
Father's Age (years)			
<20	1 (100)	0 (0.0)	0.025[a]
21–25	0 (0.0)	11 (100.0)	
26–30	19 (22.1)	67 (77.9)	
31–35	17 (14.8)	98 (85.2)	
>36	47 (24.9)	142 (75.1)	
Father's Education			
Non-Educated	0 (0.0)	3 (100.0)	0.022[a]
Elementary	3 (100.0)	0 (0.0)	
Intermediate	5 (25.0)	15 (75.0)	
High School	36 (22.2)	126 (77.8)	
College	34 (18.6)	149 (81.4)	
Higher Studies	6 (19.4)	25 (80.6)	
Father Working			
Yes	79 (20.4)	308 (79.6)	0.327[b]
No	5 (33.3)	10 (66.7)	
Father's Having Chronic Disease			
Yes	16 (30.2)	37 (69.8)	0.074[a]
No	68 (19.5)	281 (80.5)	
Father's Marital Status			
Married	83 (21.0)	312 (79.0)	1.000[b]
Divorced	1 (14.3)	6 (85.7)	
Family Income (SAR)			
<5000	22 (20.4)	86 (79.6)	0.955[a]
5000–10,000	40 (22.0)	142 (78.0)	
10,000–25,000	20 (20.0)	80 (80.0)	
>25,000	2 (16.7)	10 (83.3)	

Frequency=*n*, percentage=%, [a]Chi-Square Test, [b]Fisher's Exact Test

Table 5: Association of other Health-related Features with Vaccination Delay among Children

	Delayed/Late Vaccination		Sig. value
	Yes *n* (%)	No *n* (%)	
Time to Reach Primary Care Center (minutes)			
<20	64 (19.5)	264 (80.5)	0.191[a]
20–40	15 (24.6)	46 (75.4)	
>40	5 (38.5)	8 (61.5)	
Time Spent in Primary Care Center (minutes)			
<30	62 (23.1)	206 (76.9)	0.295[a]
30–60	19 (16.4)	97 (83.6)	
>60	3 (16.7)	15 (83.3)	
Vaccine is Harmful to Your Child			
Yes	7 (50.0)	7 (50.0)	0.013[b]
No	77 (19.8)	311 (80.2)	
You are Neglecting Your Child			
Yes	27 (96.4)	1 (3.6)	0.001[a]
No	57 (15.2)	317 (84.8)	
Full-term Pregnancy			
Yes	12 (24)	38 (76)	0.564[a]
No	72 (20.5)	280 (79.5)	
Child Suffering from Jaundice			
Yes	13 (26.5)	36 (74.5)	0.300[a]
No	71 (20.1)	282 (79.9)	
Low Birth Weight			
Yes	18 (28.5)	45 (71.4)	0.103[a]
No	66 (19.5)	273 (80.5)	

Frequency=*n*, percentage=%, [a]Chi-Square Test, [b]Fisher's Exact Test

Perceptions and attitudes toward vaccines played a pivotal role in vaccination delays. A relatively low percentage perceived vaccines as harmful, consistent with overall positive attitudes toward immunization. However, a significant proportion believed they were late in vaccinating their children, indicating potential misconceptions or concerns about the timing of vaccinations. This finding resonates with studies highlighting the influence of parental beliefs and attitudes on vaccine delays. Additionally, Smith *et al.* (2011)[20] found that parents who delayed and refused vaccine doses were more likely to have concerns about vaccine safety and perceive fewer benefits associated with vaccines.

There are various reasons for vaccination delays among a subset of participants. Predominant factors include a child experiencing high-grade fever during vaccination, traveling at the time of vaccination, and transportation issues. This aligns with existing literature, which often cites illness and logistical challenges as common barriers to timely vaccinations.[12,21]

The timeline of vaccination delays elucidated specific points in a child's development where delays were more prevalent. This information is crucial for developing targeted interventions to address delays at different stages. Previous research has emphasized the importance of understanding the specific vaccines and ages at which delays commonly occur. For instance, a study by Alghofaili *et al.* (2023)[22] found that the most delayed vaccines were the inactivated poliovirus vaccine (IPV), OPV, and MCV, followed by DTP, hepatitis B, and HIB.

Various sociodemographic features were associated with vaccination delays. Notably, delays were more prevalent in children aged 6–12 months, families with more than four children, and those with mothers facing chronic illnesses. A study by Janusz *et al.* (2021)[9] found that 63.9% of children experienced a vaccine delay for the first dose of measles, scheduled at 9 months. Fathers aged over 36 and those with elementary education also showed significant associations with delays. In contrast, a study by Hazan *et al.* (2019)[23] found that fathers' education was not associated with delays. These findings add to the expanding body of literature emphasizing the multifaceted nature of sociodemographic influences on vaccination behaviors. Various associations between health-related features and vaccination delays were observed. Perceiving vaccines as harmful and admitting neglect were significantly associated with delays. A previous study by Alghofaili *et al.* (2023)[22] found that parental carelessness or negligence is associated with vaccination delay. This underscores the necessity for targeted educational campaigns to address parental concerns and misconceptions, aligning with the findings of previous studies that emphasize the pivotal role of parental attitudes in vaccine delays. Our study has several limitations, including the potential for recall bias in participant responses, limited generalizability due to the specific geographic focus on Riyadh, and reliance on self-reported vaccination data, which may introduce inaccuracies in the results. Future research should explore interventions aimed at improving vaccination coverage by addressing factors contributing to delays. Developing targeted educational campaigns, enhancing accessibility, and involving healthcare providers can help mitigate delays. Implementing these strategies holds the potential to enhance overall vaccination rates, contributing to improved public health outcomes.

Conclusion

Our study offers valuable insights into the intricate interplay of sociodemographic, access-related, and attitudinal factors influencing childhood vaccine delays in Riyadh, Saudi Arabia. The findings underscore the necessity for tailored interventions addressing specific age groups, parental beliefs, and healthcare access barriers. Understanding these factors is crucial for the development of effective strategies to improve vaccination timeliness and coverage, ultimately contributing to public health efforts in controlling and preventing vaccine-preventable diseases.

Ethical approval

An IRB approval was obtained by King Saud Medical Research Center, Ministry of Health, Riyadh, Saudi Arabia, preference No. H1R1-02-Jan23-01.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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