ISSN-E: 2617-9563

“Prevalence and determinants of delayed vaccination among children aged 0-24 months in Riyadh City, Saudi Arabia”

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ISSN-E: 2617-9563

Abstract:
Background: Immunizations protect children from deadly infectious diseases. The timeliness of vaccinating children is the pillar of the cost-effective strategy of decreasing the burden of many infectious diseases. Delayed immunization creates the risk of failure.
Methodology: This cross-sectional study was conducted at the Primary Health Care Centers in Riyadh city, kingdom of Saudi Arabia, from January to March 2023. The participants including 593 parents with children 2 years or below. A self-administered questionnaires were conducted using a 5 parts questionnaire that contains socio-demographic characteristics, the vaccination statuses of their children, and the causes of delayed vaccinations.
Results: The results showed that most of the study sample were 18 to 24 months with a rate of 20%, most of them are female. 7.1% had a delay in the previous vaccination. 81% had a delay in some vaccines, most of them were IPV, OPV, and MCV. The delay was mostly caused by an illness of the child at vaccination day, carelessness of parents, or long postpone.
In unadjusted analysis, it was found that both parents' education, family income, child's gestational age at delivery, child's current nutritional intake, and mother thinking that giving multiple vaccine was harmful to the child were significantly associated ($p<0.05$) with vaccination delay. Factors which had a p value of <0.02 were considered for the adjusted analysis. In the adjusted analysis, it was found that father having high school or bachelor's level education (POR = 1.18, 95% CI: 1.03, 1.36), child receiving mix-type of nutrition (POR = 1.06, 95% CI: 1.02, 1.10) and mother thinking that giving multiple vaccine was harmful to the child (POR = 1.03, 95% CI: 1.01, 1.06) were positively associated with vaccination delay.

Conclusion: The prevalence of vaccine delay was low since the main concern of parents is their children's health.

Keywords: Vaccination, delayed vaccination, child vaccination, vaccination prevalence, vaccine coverage, vaccine timeliness.

الملخص:

الخلفية: تحمي التطعيمات الأطفال من الأمراض المعدية المميتة. يعد توقيت تلقيح الأطفال ركيزة استراتيجية فعالة من حيث التكلفة لتقليل عبء العديد من الأمراض المعدية. يؤدي التمنيع المتأخر إلى خطر الفشل.

المنهجية: أجريت هذه الدراسة المقطعية في مراكز الرعاية الصحية الأولية في مدينة الرياض، المملكة العربية السعودية، من يناير إلى مارس 2023. وكان المشاركون فيها 593 من الآباء والأمهات مع أطفال 2 سنة أو أقل. تم إجراء استبيانات ذاتية باستخدام استبيان مكون من 5 أجزاء يحتوي على الخصائص الاجتماعية والديموغرافية، وحالات التطعيم لأطفالهم، وأسباب التطعيمات المتأخرة.

النتائج: أظهرت النتائج أن معظم أفراد عينة الدراسة تراوحت أعمارهم بين 18 و24 شهرًا بنسبة 20٪، ومعظمهم من الإناث. 7.1٪ لديهم تأخير في التطعيم السابق. 81 ٪ لديهم تأخير في بعض اللقاحات، معظمهم من IPV وOPV. كان سبب التأخير في الغالب هو مرض الطفل في يوم التطعيم، أو إهمال الوالدين، أو التأجيل الطويل. MCVو في التحليل غير المعدل، وجد أن تعليم الوالدين، ودخل الأسرة، وعمر الحمل عند الولادة، والمتناول الغذائي الحالي بتأخير التطعيم. ($P <0.05$) للطفل، والأم التي تعتقد أن إعطاء لقاح متعدد كان ضارًا للطفل، ارتبطت بشكل كبير في الاعتبار للتحليل المعدل. في التحليل المعدل، وجد أن الأب حاصل $p <0.02$ تم أخذ العوامل التي لها قيمة ، يتلقى الطفل نوعًا مختلطًا من التغذية(، CI: 1.031.36 ، 95٪ = 1.18POR) على تعليم ثانوي أو بكالوريوس ارتبطت واعتقدت الأم أن إعطاء لقاحات متعددة كان ضارًا للطفل (، CI: 1.021.10 ، 95٪ = 1.06POR) (، CI: 1.011.06 ، 95٪ = 1.03POR) بشكل إيجابي بتأخير التطعيم.

الخاتمة: كان انتشار تأخير اللقاح منخفضًا لأن الشغل الشاغل للوالدين هو صحة أطفالهم.

الكلمات المفتاحية: التطعيم، التطعيم المتأخر، تطعيم الأطفال، انتشار التطعيم، تغطية اللقاح، توقيت التطعيم.

Introduction

Background

In 1974, The Expanded Program on Immunization (EPI) was initiated by the World Health Organization (WHO) to save and protect children from life threatening disease (1)

It aims to reach 90% vaccination coverage in every country around the world. It is estimated that over 2.5 million deaths are avoided through vaccination every year. The World Health Organization reported in 2016 that around 19.5 million infants worldwide are still not getting basic vaccines although the whole world is moving forward in this matter (2.3)

In the Kingdom of Saudi Arabia in 1979, immunization started including Diphtheria, tetanus, and pertussis (DTP). These were the first vaccines introduced and it was expanded to include additional vaccines later on. Remarkably, vaccination is considered as a prerequisite for school entry at the age of six years in Saudi Arabia (4). However, according to the "WHO vaccine-preventable diseases: monitoring system" in 2019, the vaccination coverage rates for those in Saudi Arabia was 52% for BCG compared to 98% in 2018, and the coverage rates for DTP and measles, mumps, and rubella vaccine (MMR) were 98% and 96%, respectively. Although this is a high immunization rate, the number of reported cases in 2019 was 1035 for measles, 187 for mumps, 326 for pertussis, and 62 for rubella (5).

The Saudi National Immunization Program recommends many vaccines to be administered in the first 24 months of life, including Hepatitis B vaccine at birth, Pneumococcal conjugate, Rotavirus, IPV, OPV, Diptheria, Tetanus, Polio, HiB vaccines, BCG, Measles and Meningococcal disease, Varicella, MMR and Hepatitis A. (6) vaccination programs are monitored by timely vaccination. Assessing the time

between the recommended age and the age at which a dose was administered presents the best time during which children are protected (7.8)

Timely vaccination is often evaluated using vaccine delays for which several definitions exist. The most common used definition is a delay of 30 days or more after the recommended age for each dose (9.10) Delaying vaccine doses could affect the subsequent doses which increase the child's risk of disease (11.12)

The vaccination trend is affected by some factors such as education, economy, and culture. unwilling to vaccinate among well-educated upper and middle-income people was related to health believes (13). Another most common reason for these delays are difficulties with the appointments, respiratory tract infections, late birth orders, delays based on the advice given by physicians, transport problems, negligence, and not remembering the vaccination schedules (8.9). Moreover, other reasons include medical, socioeconomic, or religious reasons. Children with mothers who had lower educational backgrounds, children within larger households, and children who belong to minority groups and immigrants were less likely to receive their vaccination on time. (14.15.16) It is believed, by most of parents in KSA, that vaccines can cause autism and disabilities (17).

The SARS-CoV-2 pandemic has shown that the immunization systems is vulnerable around the world even though it is not described globally (18).

According to a new survey conducted by UNICEF, WHO and Gavi pulse with the collaboration of the US Centers for Disease Control, three quarters of the 82 countries that responded reported COVID-19 related disruptions in their immunization programmes as of May 2020. The reasons for disrupted services differ. Although services are presented, people are either unable to access them because of reluctance to leave home, transport interruptions, economic hardships, restrictions on movement, or fear of COVID-19 exposed exposure. Due to restrictions on travel, redeployment to COVID response duties and the lack of protective equipment, many health workers became unavailable (19).

problem statement

A child who does not receive all of their recommended immunizations is in danger of contracting the diseases the vaccine is meant to prevent. Infants can be exposed to vaccine-preventable infections from nearly anyone, and a vaccine is termed delayed if it is received later than 30 days after the recommended age. Vaccine delays allow for an evaluation of the timeliness with which recommended vaccinations are given. Vaccine-preventable diseases can range in severity from relatively harmless to potentially fatal, and some can even spread rapidly in large populations. In unvaccinated populations, measles, for instance, can spread quickly and cause widespread illness. Vaccination schedule slip-ups should be avoided at all costs.

Aims of the study

- **General objective**

To estimate the prevalence of vaccination delay in children aged 2 years or less in selected primary health care centers in Riyadh city, Saudi Arabia.

- **Specific objectives**

1. To estimate the prevalence of vaccination delay among children aged 2 years old or less in selected primary health care centers in Riyadh city.
2. To identify the reasons of vaccination delay among children ages 2 years old or less in selected primary health care centers in Riyadh city.
3. To assess the awareness of parents about the importance of vaccination among children ages 2 years old or less in selected primary health care centers in Riyadh city.

Literature review

The study of Banjari et al (2018) that took place in Jeddah, Saudi Arabia, shows important data. Using a structured approach, this data got collected from parents of children under the age of three. A vaccination is considered delayed if it is more than 30 days after the primary immunization schedule deadline. Yet, there are plenty of risk factors for delayed vaccination that were assessed using logistic regression. This study of 351 children clarified that vaccination was delayed in 24.2% of the sample. The (MCV4), second dose of oral polio vaccine (OPV) and the fourth dose were also delayed in 15.2% of the observed samples. Delayed observation of Moreover, the delayed pneumococcal conjugate vaccine (PCV) was about 21.3% of the sample. (20)

Another study done by Aloufi, K. M., & Mosleh, H. (2019) was applied at the Maternity and Children Hospital in Al-Madinah Al-Munawarah, Kingdom of Saudi Arabia. The participants included 149 mothers with their children under 24 months. The results showed that only 40.9% of children were vaccinated on time or after a couple days of the given timeline, while 59.1% of other children were delayed by more than a month or even more. Around (42.2% of the children did not get the vaccine because of the signs of sickness that they show, 22.9% because of negligence and 17.4% delay is due to doctor's advice. (21)

In a study done by Alrowaili, et al., (2019) which took place in Sakaka, Al Jouf province in northern Saudi Arabia, 195 children under the age of two are recruited from four randomly selected primary health facilities. pretested tables were used to show the children's immunization charts for delays in vaccination. The study showed that both genders male and female children experienced the same delay of 21.5% in males and 25% in females. Parental education, working motherhood, and low fertility rates have all been linked to timely vaccinations. Only 15.6% of those who delayed vaccinations gave a reason for the facility or appointment, while 46.7% said the child was sick and so he can’t get vaccinated. (22)

A more recent study done by Alsuhaibani & Alaqeel, (2020) that took place in Qasim region, Saudi Arabia. parents of little children of two or even younger are asked to complete a self-administered online questionnaire. The study shows that during the pandemic, nearly 73.2% of parents made an appointment for their child's vaccination, yet, around 23.4% of parents reported that their child's vaccination was delayed by more than a month. The results of this study indicate that the most common reason (about 60.9%) for delaying vaccination is fear of contracting 'COVID-19’. In Saudi Arabia, 'COVID-19' outbreak affects children’s routine vaccination. The study concludes by assuring that child’s immunization should be a priority that must be targeted to achieve significant immunization rates during the pandemic. (23)

Another study that is based on a cross-sectional questionnaire-done by Hobani, F., & Alhalal, E. (2022) addressed 22 randomly selected primary health care centers from the "Jizan region, Saudi Arabia". Among Saudi children, 1.6% to 31.3% were unvaccinated, 23.7% were partially immunized, and 2.5% to 59.1% were behind schedule. According to the study, approximately 51.8 percent of children had at least one missed or delayed vaccination. The results showed that 23.7% of people do not attend appointments, also 18.4% of them were unable to get the vaccine. This was the most popular reason for reporting delays in vaccination. (24)

Thus, determining the reasons for delaying vaccinations allow us to take a better approach to the at-risk populations for such delays.

Reduced vaccination coverage increases the risk of diseases that can be prevented by vaccines. Therefore, it is essential to distinguish the reasons of delaying vaccinations in order for the policymakers to implement appropriate intervention.

This study was conducted to estimate the proportion of children, two years old and less, who delayed vaccinations. Moreover, it investigates the delay in order to provide policymakers with insights to design interventions.

Materials and methods

- **Study design:**

Analytical cross-sectional study

- **Study setting:**

The present study will target parents attending the Primary Health Care Centers (PHCCs) at vaccination and well-baby clinic in Riyadh city accompanied by their children who are 2 years or less between January to March 2023.

- **Inclusion criteria:**
  - Parents of children 2 years old or less
  - Saudi citizens
  - Have vaccination cards
  - Apparently healthy children
- **Exclusion criteria:**
  - Children not accompanied by parents
  - Sick children and those with special needs
  - Non-Saudi children
  - Sample Size:

Assuming the prevalence of delayed vaccination as 24% (from a study conducted in Jeddah primary health care centers), alpha level 5%, precision of 4% and a design effect of 1.5, the estimated sample size was 576.
The formula used was n = (4pq/d*d) * DE, where
n=total sample size, p=expected proportion, q=1-p, d=precision, DE=design effect
we collected 593 inticipate data quality low.

- **Population and sampling:**

The study population includes parents attending primary health care centers under cluster 2 with their 2 years old or less children in Riyadh city. A convenient sample used, we screened all primary center under cluster 2 and sent an invitation to all centers to participate which are included in our study.

- **Data Collection tool:**

Data collection will be through a self-administered questionnaire in Arabic. The questionnaire consisted of five parts: the first part included child characteristics, parental information, child's physical well-being, socioeconomic status, number of delayed vaccinations, duration and reasons for vaccine delays, and finally, parent's awareness. Data on vaccination timing will be collected from the vaccination cards carried by the parents.
The questionnaire was prepared by the authors, reviewed for validity by three consultants in family and community medicine, and then pre-tested for comprehension on 15 subjects who were not included in the study.

- **Data collection technique:**

In each PHC center, the parents will be invited to participate in the study during the waiting time. The questionnaire sheet will be collected immediately after being filled.

- **Data Management and Statistical Analysis:**

Data entry and analysis will be done using the Statistical Package of Social Sciences (SPSS version 23), Data will be presented in tables and graphs as appropriate, Statistical significance will be considered when p-values are less than 0.05.

Ethical Considerations:

Every participant will be informed about the purpose of the study, written consent to participate in the study will be obtained and confidentiality will be assured. No private questions will be included. No obligation of any kind for participation and free will to withdraw from the study at any time will be notified.

All necessary official approvals will be fulfilled before start of data collection. Ethical approval will be obtained from the MOH IRB.

Budget:

This study is self-funded.

Results:

Table 1. Background characteristics of the children (N = 593)

Characteristic	n (%)
Age of the child	
Birth to 2 months	48 (8.1)
2 to 4 months	73 (12)
4 to 6 months	70 (12)
6 to 9 months	88 (15)
9 to 12 months	104 (18)
12 to 18 months	93 (16)
18 to 24 months	117 (20)
Sex of the child	
Female	315 (53)
Male	278 (47)
Order of birth	
First	181 (31)
Second	212 (36)
Third	129 (22)
Fourth or more	71 (12)
Mother's age	
<= 25 years old	103 (17)
26 – 35 Years old	317 (53)
36-45 years old	151 (25)
>= 46 years old	22 (3.7)
Mother's education	
Not educated	8 (1.3)
Below high school	49 (8.3)
High school	230 (39)
Bachelor's degree	259 (44)
Above bachelor's degree	47 (7.9)
Mother's employment	
Employed	336 (57)
Not employed	257 (43)
Father's age	

<=25 years old	11 (1.9)
26 – 35 years old	197 (33)
36-45 years old	317 (54)
>=46 years old	67 (11)
Unknown	1
Father's education	
Not educated	0 (0)
Below high school	17 (2.9)
High school	130 (22)
Bachelor's degree	363 (61)
Above bachelor's degree	83 (14)
Father's employment	
Employed	574 (97)
Not employed	19 (3.2)
Family income	
Less than 5000 SR	40 (6.7)
Between 5000– 10000 SR	189 (32)
More than 10000 to 25000 SR	272 (46)
More than 25000 SR	92 (16)
Number of children in family	
Only one child	182 (31)
Two to four children	359 (61)
Five or more children	52 (8.8)

Table1: The results showed that most of the study sample were 18 to 24 months with a rate of 20%, followed by 9 t o 12 months with a rate of 18%. Regarding the sex of the children, it was found that most of them are female with a percentage of 53%. In addition, the mother's age was mostly 26-35 years old with a rate of 53%, followed by 36-45 years old with a rate of 25%. The mother's education was mostly bachelor's degree at 44%, high school at 39%, belo w high school at 8.3%, above bachelor's degree at 7.9%, and not educated at 1.3%. 57% of mother were employed. The father's age was mostly 36-45 years old by 54%, 26-35 years old by 33%, above 46 years old by 11%, below th an25 years old by 1.9%. The education was mostly bachelor's degree at 61%, high school at 22%, above bachelor's degree at 14%, below high school at 2.9%, and 97% of fathers were employed. Most of the family income was more than 10,000 SR at a rate of 46%, between 5000 – 10,000 SR at a rate of 32%. The number of children in the family was mostly two to four children at a rate of 61%.

Table 2. Health and nutritional status of the children (N = 593)

Characteristic	N	n (%)
Child was sick on interview day	593	18 (3.0)
Child has allergies	593	25 (4.2)
Child is allergic to	7	
Chocolate		1 (14)
Egg		2 (29)
Nuts		1 (14)
Strawberry		3 (43)
Child had serious reaction to past vaccination	593	3 (0.5)
Child has health problem or chronic disease	593	11 (1.9)
Health problems of the child	9	
Asthma		4 (44)
Diabetes		1 (11)
Down syndrome		3 (33)
G6PD		1 (11)
Child has vaccination in the past 4 weeks	593	12 (2.0)
Child is currently on medication	593	5 (0.8)
Child's gestational age at delivery	593	
Full-term		480 (81)
Premature		113 (19)
Child's birth weight	555	
<1.5kg		0 (0)
<2.5kg		156 (28)
2.5-3.5kg		352 (63)
>3.5kg		47 (8.5)
Child's current nutrition intake	593	
Breastfeeding		123 (21)
Mix		249 (42)
Formula feed		221 (37)

Table2: It was found that the percentage of infected children on the day of the interview was 3 %, and of those, 4.2 % were suffering from allergies, and 43% of them were allergic to strawberry and 29% were allergic to egg. 0.5% of children had a serious reaction to past vaccination, 1.9% of them have health problem or chronic disease, and 44% h ad health problems represented by Asthma, Down syndrome by 33%, and Diabetes and G6PD by 11%. 2.0% had be en vaccinated in the past 4 weeks and 0.8% are currently on medication.Full-term delivery was 81%. The birth weig ht was mostly 2.5-3.5kg by 63%, <2.5kg by 28%, and >3.5kg by 8.5%. The nutrition intake was mostly formula and breast feeding with 42% and Breastfeeding alone with 21%.

Table 3. Vaccination details of the children (N = 593)

Characteristic	N	n (%)
Parent thinks that the child's vaccination is delayed	593	37 (6.2)
Duration of delay, median (IQR)	34	14 (6, 56)
Previous delay in vaccination	593	42 (7.1)
Vaccine delay	52	
Delay in all vaccines		10 (19)
Delay in some vaccines		42 (81)
Vaccines that were delayed (multiple response)	42	
BCG	1	45.24
DtaP	5	33.33
Hepatitis A	1	23.81
Hepatitis B	4	16.67
Hib	4	11.90
IPV	19	9.52
MCV	10	9.52
MMR	3	9.52
OPV	14	7.14
Reasons for vaccination delay	52	
No appointment available	1	71.15
Negligence (Not given)	9	17.31
Other reasons	2	5.77
delayed by the time of appointment	3	3.85
fear from side effect	1	3.85
illness of the child at the vaccination time	37	1.92
unavailability of the vaccine	2	1.92
very far center /difficult transportation	1	1.92

Table3*:* Parents believe that children's vaccinations were delayed by 6.2%, the duration of delay (IQR) by (6,56). T he previous delay in vaccination was 7.1% for delays in some vaccines it showed that 81%. As for the vaccines that were delayed, most of them were IPV, OPV ,MCV, followed by DtaP, Hepatitis B and HIB. The delay was mostly c aused by an illness of the child at vaccination day, carelessness of parents, or long postpone.

Table 4. Parent's awareness about childhood vaccination (N = 593)

Characteristic	N	n (%)
Reason for thinking why vaccinations are important	593	
Prevent infections		486 (81.9)
It's just protocols to follow		155 (26.2)
To complete the table to attend school		152 (25.6)
I don't know		40 (6.8)
Believes there is a link between MMR vaccine and Autism	593	92 (16)
Worries about side effects of vaccine	593	51 (8.6)
Side effects they think are caused by vaccines	51	
Fever		24 (47.1)
Don't know		18 (35.3)
Autism		4 (7.8)
Pain		2 (3.9)
Rash		2 (3.9)
Face swelling		1 (1.9)
Heart problems		1 (1.9)
Nausea		1 (1.9)
Swelling		1 (1.9)
Thinks the child needs vaccine as in the schedule	593	397 (67)
What they do when vaccine is not available	593	
Try to find it in other center or clinic to give him on time		360 (61)
You come back after month to check		140 (24)
Wait until the next vaccination date		93 (16)
What they do at home 48 hours after vaccination	593	
Paracetamol to avoid fever		333 (56.2)
Cold compression on the injection site		265 (44.7)
Call your doctor for any concerns		153 (25.8)
Nothing to do		52 (8.8)
Others		9 (1.5)
Impact of Covid-19 pandemic on decision to vaccinate	593	
I don't know		315 (53)
Negative		80 (13)
Positive		198 (33)
Thinks giving multiple vaccines is harmful to the child	593	175 (30)

Table4:
With regard to the reason why vaccinations are important, 81.9% said to prevent infections, 26.2% are just following protocols, 25.6% want to complete the table to attend school, 16% believe that there is a link between MMR vaccine and Autism, 8.6% are afraid of side effects.
The side effects they think are caused by vaccines were mostly fever by 47.1%, autism by 7.8%, pain and rash by 3.9%. When the vaccine is not available, most people try to find it in another center or clinic to give on time at a rate of 61%, and some will come back after a month at a rate of 24%, and only 16% will wait until next vaccination,

56.2% will give paracetamol to prevent fever, some will do cold compression by 44.7%, 25.8% will call doctors to ask. 53% of people don't know about the impact of Covid-19 pandemic on their decision. 33% of people thinks that giving multiple vaccines is harmful to the child.

Table 5. Factors associated with vaccination delay (N = 593)

Characteristic	Overall N = 593 n (%)	Delayed N = 52 n (%)	No delay N = 541 n (%)	p-value
Age of the child				0.057
>9 months	314 (100)	21 (6.7)	293 (93)	
≤9 months	279 (100)	31 (11)	248 (89)	
Sex of the child				0.3
Female	315 (100)	31 (9.8)	284 (90)	
Male	278 (100)	21 (7.6)	257 (92)	
Order of birth				>0.9
First	181 (100)	15 (8.3)	166 (92)	
Second	212 (100)	21 (9.9)	191 (90)	
Third	129 (100)	10 (7.8)	119 (92)	
Fourth or more	71 (100)	6 (8.5)	65 (92)	
Mother's age				0.4
<= 25 years old	103 (100)	7 (6.8)	96 (93)	
26 – 35 Years old	317 (100)	34 (11)	283 (89)	
36-45 years old	151 (100)	10 (6.6)	141 (93)	
>= 46 years old	22 (100)	1 (4.5)	21 (95)	
Mother's education				<0.001
Not educated	8 (100)	2 (25)	6 (75)	
Below high school	49 (100)	15 (31)	34 (69)	
High school	230 (100)	22 (9.6)	208 (90)	
Bachelor's degree	259 (100)	11 (4.2)	248 (96)	
Above bachelor's degree	47 (100)	2 (4.3)	45 (96)	
Mother's employment				0.2
Employed	336 (100)	25 (7.4)	311 (93)	
Not employed	257 (100)	27 (11)	230 (89)	
Father's age				0.6
<=25 years old	11 (100)	1 (9.1)	10 (91)	
26 – 35 years old	197 (100)	18 (9.1)	179 (91)	
36-45 years old	317 (100)	30 (9.5)	287 (91)	
>=46 years old	67 (100)	3 (4.5)	64 (96)	
Father's education				<0.001
Below high school	17 (100)	7 (41)	10 (59)	
High school	130 (100)	16 (12)	114 (88)	

Bachelor's degree	363 (100)	23 (6.3)	340 (94)	
Above bachelor's degree	83 (100)	6 (7.2)	77 (93)	
Father's employment				0.076
Employed	574 (100)	48 (8.4)	526 (92)	
Not employed	19 (100)	4 (21)	15 (79)	
Family income				<0.001
Less than 5000 SR	40 (100)	6 (15)	34 (85)	
Between 5000– 10000 SR	189 (100)	30 (16)	159 (84)	
More than 10000 to 25000 SR	272 (100)	11 (4.0)	261 (96)	
More than 25000 SR	92 (100)	5 (5.4)	87 (95)	
Number of children in family				0.5
Only one child	182 (100)	16 (8.8)	166 (91)	
Two to four children	359 (100)	34 (9.5)	325 (91)	
Five or more children	52 (100)	2 (3.8)	50 (96)	
Child has allergies				0.059
No	568 (100)	47 (8.3)	521 (92)	
yes	25 (100)	5 (20)	20 (80)	
Child has health problem or chronic disease				0.2
No	582 (100)	50 (8.6)	532 (91)	
yes	11 (100)	2 (18)	9 (82)	
Child's gestational age at delivery				0.024
Full term delivery	480 (100)	36 (7.5)	444 (92)	
Premature delivery	113 (100)	16 (14)	97 (86)	
Child's birth weight				0.8
<2.5kg	156 (100)	13 (8.3)	143 (92)	
2.5-3.5kg	352 (100)	33 (9.4)	319 (91)	
>3.5kg	47 (100)	5 (11)	42 (89)	
Child's current nutrition intake				0.001
Breastfeeding	123 (100)	18 (15)	105 (85)	
Mix	249 (100)	10 (4.0)	239 (96)	
Formula feed	221 (100)	24 (11)	197 (89)	
Believes there is a link between MMR vaccine and Autism				0.2
No/ Don't know	501 (100)	47 (9.4)	454 (91)	
Yes	92 (100)	5 (5.4)	87 (95)	
Worries about side effects of vaccine				0.8
No/ Don't know	542 (100)	47 (8.7)	495 (91)	
Yes	51 (100)	5 (9.8)	46 (90)	
Thinks giving multiple vaccines is harmful to the child				0.008
No/ Don't know	418 (100)	45 (11)	373 (89)	

Yes	175 (100)	7 (4.0)	168 (96)	

Table5:

In unadjusted analysis, it was found that both parents' education, family income, child's gestational age at delivery, child's current nutritional intake, and mother thinking that giving multiple vaccine was harmful to the child were significantly associated ($p<0.05$) with vaccination delay. Factors which had a p value of <0.02 were considered for the adjusted analysis.

Table 6. Regression analysis for factors associated with vaccine delay

	Adjusted prevalence odds ratio			p-value
	Estimate	95% CI		
(Intercept)	1.55	1.29	1.87	<0.001
Age of the child				
>9 months	1			
≤9 months	0.98	0.96	1.01	0.162
Mother's education				
Not educated	1			
Below high school	0.95	0.82	1.09	0.438
High school	1.06	0.93	1.20	0.377
Bachelor's degree	1.08	0.95	1.22	0.260
Above bachelor's degree	1.10	0.97	1.26	0.142
Father's education				
Below high school	1			
High school	1.18	1.03	1.36	0.015
Bachelor's degree	1.18	1.03	1.35	0.018
Above bachelor's degree	1.15	1.00	1.32	0.053
Father's employment				
Employed	1			
Not employed	0.95	0.86	1.05	0.326
Family income				
Less than 5000 SR	1			
Between 5000 – 10000 SR	0.94	0.88	1.01	0.079
More than 10000 to 25000 SR	0.98	0.92	1.05	0.607
More than 25000 SR	0.97	0.90	1.04	0.414
Child has allergies	0.94	0.87	1.02	0.114
Child was delivered premature	0.96	0.93	0.99	0.031
Baby nutrition				
Breastfeeding	1			
Mix	1.06	1.02	1.10	0.001
Formula feed	1.03	0.99	1.07	0.203
Thinks giving multiple vaccines is harmful to the child	1.03	1.01	1.06	0.005

Table6:

In the adjusted analysis, it was found that father having high school or bachelor's level education (POR = 1.18, 95% CI: 1.03, 1.36), child receiving mix-type of nutrition (POR = 1.06, 95% CI: 1.02, 1.10) and mother thinking that giving multiple vaccine was harmful to the child (POR = 1.03, 95% CI: 1.01, 1.06) were positively associated with vaccination delay whereas child born prematurely (POR = 0.96, 95% CI: 0.93, 0.99) was negatively associated with vaccination delay.

Discussion:

Preventive care is a major issue in pediatrics. (25) Childhood vaccination is one of the most beneficial public health strategies to keep diseases under-control. (26) To reduce childhood morbidity and mortality, the Centers for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices (ACIP) issues annual recommendations and guidelines for childhood and adolescent immunizations. (27)

This study targeted children 24 months old and below. Moreover, the study revealed that all of the infants had got their immunizations on time at birth as a result of the necessary vaccines that are required to be given to newborns before leaving the hospital. However, children who did not receive vaccinations on time are about 7.1% which was lower than the results of previous studies in KSA. In Jeddah, a study at King Abdul-Aziz University Hospital investigated the delay in primary vaccination among 227 infants. It concluded that 9% of them were not given vaccinations on time. (28) Another study in Jeddah investigated 351 children at five primary health care centers and two tertiary governmental hospitals reported that 24.2% of the children had delayed vaccination. (20) However, in 2009, the National Immunization Survey reported higher frequencies of delayed vaccination to assess Parental Delay or Refusal of Vaccine Doses (30), in which the data of 11,206 children aged 24–35 months were analyzed where 39.8%. 25.8% of them had only delayed vaccination, 8.2% had only refused, and 5.8% had both delayed and refused vaccines. Moreover, a study conducted in 2015 in the Expanded Program of Immunization (EPI) evaluated the incidence of delayed vaccination among children under 4 (n = 3,610) covering the outskirts of Iranian cities concluded that 56.6% of vaccines were delayed (31). In the current study, the main reason the delay was illness of the child at vaccination day. In contrast, in 2018 in different locations of Jeddah, a study showed that 21.3% delayed vaccination due to traveling at the recommended time (20). At King Abdul-Aziz University Hospital in Jeddah, a study conducted in 2017 revealed that 30% of children had delayed vaccines due to difficulties with the appointment (28). Therefore, the most common reasons for the delay are transportation problems, negligence, late birth orders, difficulties with the appointments, upper respiratory tract illnesses, physicians' advice to delay, and forgetting the vaccination schedules. (14). In unadjusted analysis, it was found that both parents' education, family income, child's gestational age at delivery and child's current nutritional intake were significantly associated ($p<0.05$). Also, In the adjusted analysis, it was found that father having high school or bachelor's level education (POR = 1.18, 95% CI: 1.03, 1.36), child receiving mix-type of nutrition (POR = 1.06, 95% CI: 1.02, 1.10) and mother thinking that giving multiple vaccine was harmful to the child (POR = 1.03, 95% CI: 1.01, 1.06) were positively associated with vaccination delay. A study in 2019 resulted that only the age of the child was found to be a statistically significant determinant of complete vaccination ($p = 0.012$) (32) Similarly, a study conducted in 2013 in Athens, Greece, concluded that the child's age was strongly associated with incomplete vaccination for all vaccines ($p < 0.001$) (33). If the number of children in the household is hold, the accessibility to health- care settings is affected, including vaccination services. Moreover, vaccine delays are high in children with older siblings or single parent (versus living with a partner). The results could be linked with some conditions to get to access the vaccination services. (34) Low birth weight are known for vaccination delay, especially premature children and those below 2000 g at birth. The reason for that is parental concern about the safety and benefit of vaccination (35) Early age at first childbirth and lower maternal education was associated with delayed vaccination (36) A literature review found that the high maternal level of education was linked to vaccine hesitancy which led to vaccine delays (37) Iranian study concluded that birth order and the mother's educational level were the major factors for delayed vaccination (31).

There are some limitations to the study. For instance, the use of a convenience sample limits the generalizability of the findings to the entire population. Moreover, using cross-sectional study design does not permit drawing conclusions about the causality of the emergent predictive relationship.

Conclusion:

Assuming that all children are vaccinated at birth, a small proportion of children aged ≤24 months have delayed their vaccination. One of the major reasons for delayed vaccination is the illness of the child.

The results of the study show that the prevalence of vaccine delay was low since the main concern of parents is their children's health.

Acknowledgment:

The authors wish to thank Najla Saud BinDalah and Maha Bakheet Alzahrani for helping in collecting data.

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Draft questionnaire

Section 1: Socio-demographic characteristics of child

Age (months):
Birth to 2 months
2 to 4 months
4 to 6 months
6 to 9 months
9 to 12 months
12 to 18 months
18 to 24 months

Sex:
Male
Female

Child order: first -second – third - more

Section 2: Parents Information:

Mothers age: <= 25 years' old
26– 35 Years old
36-45 years' old
> 46 years' old

Mothers education:
Not educated
below high school
High school
bachelor's degree
Above bachelor's degree

Mothers employment:
Employed
Not employed

Fathers age: <=25 years' old
26– 35 years' old
36-45 years' old
>46 years' old

Fathers education:
Not educated
below high school
High school
bachelor's degree
Above bachelor's degree

Fathers employment:
Employed
Not employed

Family income:
less than 5000 SR
Between 5000– 10000 SR
Between 10000 -25000 SR
More than 25000 SR

Number of children in the family:
Only one child
Two to four children
Five or more children

Section 3: Child wellbeing:

1. Is the child sick today? Yes, No
2. Does the child have allergies to medications, food? Yes, no
3. If yes (specify) …….
4. Has the child had a serious reaction to a vaccine in the past? Yes, no

5. If yes (specify) ……
4. Has the child had a health problem or chronic disease? Yes, no
6. If yes(specify) ……
5. Has the child received vaccinations in the past 4 weeks? Yes, no
6. Is the child on current medication? Yes, no
7. Did you go full term or deliver early? -full term delivery -premature delivery
8. Baby weight at birth: <1.5 kg <2.5kg 2.5-3.5kg >3.5kg
9. Baby nutrition: breastfeeding – on formula – mix

Section 4: reasons of delay:

Do you think is your child delayed for his\her current vaccination? -Yes -no -I don't know

If yes continue:

How long is the delay? …… days

Does he have previous delay in his\her schedule? Yes, no

Timing based on schedule	Vaccination name	Date supposed to be received in	Actual receiving time	Reasons of vaccination delay if any
Birth	Hepatitis B			- illness of the child at the vaccination time - unavailability of the vaccine - negligence
2 months	IPV DTaP Hepatitis B Hib PCV Rota			- physician's advice -fear from side effect -very far center/difficult transportation -delayed by the time of appointment -it cause diseases like autism -causes weakness in the immune system -other reasons: ……
4 months	IPV DTaP Hepatitis B Hib PCV Rota			
6 months	OPV IPV DTaP BCG Hepatitis B Hib PCV			
9 months	Measles MCV			
12 months	OPV MMR PCV MCV			
18 months	OPV DTaP Hib MMR Varicella Hepatitis A			
24 months	Hepatitis A			

Details of vaccinations timeliness based on the vaccination's cards

Section 5: Awareness about vaccination:

1. why do you believe it is important for my child to receive all the necessary vaccinations? (Choose more than one)
Prevent infections
It's just protocols to follow
To complete the table to attend school
2. I still believe there could be a link between the MMR vaccination and autism.
Yes
No
I don't know
3.I worry about the possible side effects of vaccinations. If Yes Explain which symptoms?
Yes …….....
No
I don't know
4. do you think that your kid needs to take the vaccine as scheduled?
Yes
No
I don't know
5. if the vaccine is not available in your visit, what is your action?
Try to find it in other center or clinic to give him on time
You come back after month to check
Wait until the next vaccination date
6. what do you do at home after vaccine appointment in 48 hours? Choose more than one.
Cold compression on the injection site
Paracetamol to avoid fever
Call your doctor for any concerns
Nothing to do
Others……
7. how does COVID-19 pandemic vaccination strategy impact your decision to vaccinate your child?
Positive - Negative -I don't know -
8. Do you think giving multiple vaccines at same visit is harmful for your child?
-Yes - No. -I don't know