May we improve vaccine timeliness among children? A cross sectional survey in northern Saudi Arabia

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Abstract:
BACKGROUND: 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. There is regional variation in the rate of delayed vaccination. The purpose of present study was to determine the timeliness of vaccination and reasons for delay in vaccinating children under the age of 2 years in Sakakah, Northern Saudi Arabia.

MATERIALS AND METHODS: This study included 195 children under 2 years of age consecutively taken from four randomly selected primary health centers in Sakaka, Al Jouf province. A pretested proforma was used to screen the vaccination cards of the children for any delays in vaccination. Parents of children whose vaccinations had been delayed for more than 4 weeks were interviewed to determine the reasons for the delay. The reasons for delay were grouped under three different themes, i.e., child related, facility related and social issues.

RESULTS: The mean age of the children was 8.6 ± 5 months; 45% were girls and 38% were first or second order babies. In our sampled population, 23% children had delayed vaccinations of more than 4 weeks. The delay was similar for both male and female children (21.5% of males and 25% of females). High education of parents, working mothers and low birth order were positively associated with timeliness of vaccine uptake ($P < 0.05$). Of those with delayed vaccination, only 15.6% mentioned facility or appointment related reasons; illness of the child was reported by 46.7%.

CONCLUSION: There is considerable delay in vaccination of children in Sakakah, Northern Saudi Arabia. A third or more birth order of the child, parents having less than university education, and child’s mother being home maker are related with increased risk of delayed vaccination.

Keywords: Delayed vaccination, Expanded Program on Immunization, immunization, infant, vaccination, vaccine timeliness

Introduction

Vaccination is regarded as one of the greatest public health achievements of the 20th century and one of the most cost-effective preventive services for children’s health. It has substantially reduced the global burden of infectious disease. This reduction is attributed to the successful implementation of Expanded Program on Immunization by the World Health Organization (WHO) and Global Alliance Vaccine Initiative. Various indicators measure the success of vaccination. To achieve herd immunity, the population of a community should have immunized children. In general, the status of vaccination is more often evaluated by up-to-date vaccination coverage rather than timeliness of vaccination.

Some diseases like pertussis and Haemophilus influenzae infections occur
with increased frequency if immunization is delayed.\textsuperscript{[10]} It has been found that early immunization with Bacille Calmette-Guérin (BCG), especially during the first 6 months of life prolongs survival, whereas late vaccination increases the risk of death.\textsuperscript{[8,11]} Therefore, the timeliness of vaccination is an important predictor of the prevention of many diseases, particularly pertussis, \textit{H. influenzae} and tuberculosis. Several studies have investigated the importance of timely vaccination.\textsuperscript{[6,12,13]}

The timeliness of children’s immunization varies widely among and even within countries and regions.\textsuperscript{[9,10]} A study done in the western region of the Kingdom of Saudi Arabia (KSA), of most infants (91%), showed that the primary vaccinations were given on time.\textsuperscript{[4]} Parental problems that had social implications were frequently cited as the main reasons for delays in vaccinations. However, there were missed opportunities when inappropriate contraindications were used to deny vaccination to children. General practitioners and pediatricians may have doubts about the real contraindications to primary vaccinations. These authors observed a reluctance to immunize children when presented with some false contraindications.\textsuperscript{[4]}

Only one local study regarding the timeliness of vaccination in children in KSA is available, while the results of studies from other places vary. With this in view, the present study was undertaken to investigate the timeliness of vaccination.\textsuperscript{[4,10]} The study was to evaluate the coverage of immunization for children <2-year-old, to determine whether children were being immunized promptly and to investigate the reasons why there were delays in the schedule of immunizations for those children. The results of this study will assist in dealing with the modifiable factors and improve the timeliness of vaccinations for children. The specific objectives were to determine the timeliness of vaccinations and the reasons for delaying the vaccination of children under the age of 2 years in Sakakah, Northern region of KSA. The results of this study may help improve vaccination coverage and timeliness.

Materials and Methods

An analytical cross-sectional survey was carried out in Sakaka, Al Jouf province, from January 1, 2018, to March 30, 2018. Using the WHO sample size calculator, the sample size was 197 with expected timeliness at about 91% at 4% margin of error and at 95% confidence level.\textsuperscript{[4]} There are nine primary health centers (PHCs) in the city; four were randomly selected using the lottery method. The names of all nine PHCs were written on small slips of paper and four were selected blindly without replacement based on the registered population in each PHC, a proportionate consecutive sampling technique was used to complete the sample size.

Our target population was children of both sexes under 2 years of age, both nationals and residents. Children with lost vaccination cards or infants diagnosed with immune deficiencies or congenital anomalies were excluded. Written informed consent was taken from parents accompanying the children after the study was explained in simple terms to them. Ethical approval was obtained from the Institutional Review Board.

A pretested proforma was used to extract data from vaccination cards and record the responses of the parents. One researcher and a registered nurse screened the vaccination cards to obtain data. Additional recorded variables were birth order, the age of parents, employment, and educational status of both parents. Delay was indicated if the vaccination card showed that the vaccine in the schedule was received 4 weeks later than the recommended time. The parents of children whose immunizations were delayed were interviewed to discover the reasons for the delay and categorized under three headings, i.e., child-related, facility-related and parents-related issues.

We collected 200 participants’ survey forms, five of which (2.5%) were discarded for incompleteness. Data were entered and analyzed using The Statistical Package (SPSS) for Social Sciences version 21.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY, USA). Descriptive statistics of the sampled population were presented as frequencies/percentage for qualitative variables such as gender, delay, reasons, educational status, birth order and as the mean ± standard deviation for quantitative variables such as age. Reasons and qualitative factors affecting timeliness were cross-tabulated using the Chi-square test. A value of $P < 0.05$ was considered statistically significant.

Results

In the study population, 54.9% of the children were male. About 38% were first- or second-order babies. The mean age of the children was 8.6 ± 5 months. The majority of mothers (61.5%) were housewives even though 43.3% of these housewives had had university education. The ages of the children ranged from 3.6 to 13.6 months; the ages of the fathers ranged from 27 to 38 years and the mother’s ages ranged from 24.5 to 34.1 years [Table 1].

In our sampled population, 45 children (23%) had delayed vaccination of more than 4 weeks. The reported reasons for this delay were illness of the child in 46.7%, parents related reasons including illness and travel were
indicated in 8.9% and facility-related reasons including appointment issues shown in 15.6%. Table 2 illustrates the vaccination timeliness and reasons for the delay in the sampled study population.

Work status and education of the mother, birth order and age of the child and the education of the fathers were significantly associated with delay in vaccination. Distribution of vaccination delay >4 weeks was similar for both male and female children (21.5% of males and 25% of females, P = 0.56). Delay was significantly higher in the children of mothers who were homemakers (9.3% in working women while 31.7% in homemakers, P < 0.001 using Chi-square test). Children whose parents were university educated were the least likely to have delayed vaccinations. There was delay in 12.2% of children of mothers with university education as compared to 41.7% of children with mothers with less education (P < 0.001). Similarly, vaccinations of 87.8% of children with fathers who had university education were timely as compared to 58.3% children of fathers with less education (P < 0.001 using the Chi-square test) [Table 3]. The mean age of children who were delayed was higher than those who received timely vaccinations (12.6 ± 5.5 months in delayed while 7.4 ± 4.1 months in the timely group, P < 0.001) [Table 4].

**Discussion**

The timeliness of vaccinations in our study population was not satisfactory. In our sampled population, 45 children (23%) under 2 years of age residing in Sakakah, Al Jouf region, Northern Saudi Arabia had vaccination delays of more than 4 weeks. This means some strategy needs to be found to improve the situation. Because this continued delay in the uptake of vaccines creates a cohort of children with incomplete or no immunization. This cohort of susceptible children becomes predisposed to outbreaks of vaccine-preventable diseases. Once the epidemic threshold is exceeded, outbreaks occur leading to increased morbidity and mortality in unprotected children.

In the previous study carried out in the western part of KSA and published in 2002, vaccine uptake delay of >4 weeks was reported in 9% only. This difference in results confirms the local variation in different parts of the kingdom. Cultural and social norms of the area may contribute to this difference as reported in diverse studies. Similarly, in another study, the delay was found in 5.3% of children only. The delay in the study population is comparable to some previous studies carried out in other countries. Le Polain de Waroux et al. reported a delay of 33% for BCG only. Poorolajal et al. reported vaccine delay from 42% to 67.6% in infants. Pseudo contraindications like mild child illness were also reported as the reason for the delay in our study population. Parents of about 60% of the children with delayed vaccination reported illness and mild fever as the reason for the delay. There are no guidelines displayed in
Table 3: Association of different sociodemographic factors with vaccination delay (n=195)

| Gender of child* | Delay >4 weeks | P-Value |
|------------------|----------------|---------|
| Male             | No N (%)       | Yes N (%) | 0.563 |
|                  | 23 (21.5)      | 84 (78.5) |         |
| Female           | 22 (25.0)      | 66 (75.0) |         |

| Work status of mother** | Delay >4 weeks | P-Value |
|-------------------------|----------------|---------|
| Housewife               | No N (%)       | Yes N (%) | <0.001*** |
|                         | 38 (31.7)      | 82 (68.3) |         |
| Working woman           | 7 (9.3)        | 68 (90.7) |         |

| University education of mother* | Delay >4 weeks | P-Value |
|---------------------------------|----------------|---------|
| Yes                             | No N (%)       | Yes N (%) | <0.001*** |
| 15 (12.2)                       | 108 (87.8)     |         |
| No                              | 30 (41.7)      | 42 (58.3) |         |

| Occupation of father**         | Delay >4 weeks | P-Value |
|--------------------------------|----------------|---------|
| Self employed                  | No N (%)       | Yes N (%) | 0.065 |
| 7 (30.4)                       | 16 (69.6)      |         |
| Employed                       | 31 (19.9)      | 125 (80.1) |         |
| Unemployed                     | 7 (43.8)       | 9 (56.3)  |         |

| Birth Order of child**         | Delay >4 weeks | P-Value |
|--------------------------------|----------------|---------|
| First or second                | No N (%)       | Yes N (%) | 0.003*** |
| 8 (36.5)                       | 66 (63.5)      |         |
| Third or fourth                | No N (%)       | Yes N (%) |         |
| 18 (26.1)                      | 51 (73.9)      |         |
| Fifth or above                 | No N (%)       | Yes N (%) |         |
| 19 (36.5)                      | 33 (63.5)      |         |

| University education of father* | Delay >4 weeks | P-Value |
|---------------------------------|----------------|---------|
| Yes                             | No N (%)       | Yes N (%) | <0.001*** |
| 14 (12.2)                       | 95 (87.8)      |         |
| No                              | 31 (41.7)      | 55 (58.3) |         |

| Primary health center**        | Delay >4 weeks | P-Value |
|--------------------------------|----------------|---------|
| Al Nafel                       | No N (%)       | Yes N (%) | 0.048*** |
| 11 (44.0)                      | 14 (56.0)      |         |
| As Shumali                     | No N (%)       | Yes N (%) |         |
| 9 (16.7)                       | 33 (83.3)      |         |
| Al Laqayat                     | No N (%)       | Yes N (%) |         |
| 13 (23.2)                      | 43 (76.8)      |         |
| Al Maaqela                     | No N (%)       | Yes N (%) |         |
| 12 (21.4)                      | 60 (78.6)      |         |

*Using Chi-square test, **Using Fischer exact test, ***Significant

Table 4: Relation between age of child and parents on vaccination timeliness in sampled study population (n=195)

| Domain                 | Delay >4 weeks | Mean score | SD | P-Value* |
|------------------------|----------------|------------|----|----------|
| Age of child in months | Yes            | 12.62      | 5.55 | 0.005**  |
| No                     | 7.45           | 4.18       |     |          |
| Age of father in years | Yes            | 35.49      | 7.06 | 0.087    |
| No                     | 31.81          | 4.59       |     |          |
| Age of mother in years | Yes            | 31.69      | 5.33 | <0.001** |
| No                     | 28.60          | 4.40       |     |          |

*Using independent samples t-test and assuming equal variance, **Significant, SD=Standard deviation

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We found that children of working mothers, i.e., those who were employed outside the home had better vaccine uptake and timeliness than the children of homemakers. The delay was in 31.7% of the children of homemakers and 9.3% of children of working mothers. The reasons may be multiple, for example, problems with transport, better knowledge about vaccination and time management. University education of parents had a similar effect on the timeliness of vaccinations. University educated parents were found to adhere to immunization schedules than illiterates or those with less formal education. These results are similar to those reported in other studies. Most of the studies have shown that maternal education was associated with better utilization of child vaccination services. Only one study done by Topuzoglu et al. found no association of mother’s education with the timelines of vaccine uptake. Poorolajal et al. in their study found that the delayed vaccination increased with maternal education level.

Birth order also affected the outcome. Children with several siblings were more likely to have delayed vaccinations. A birth order >2 was associated with increased delay. This has been reported by many authors who also indicate that overutilization of resources in families with more children affects healthcare adversely. We also found a highly significant association between the timeliness of the uptake of vaccination and the ages of the child and the mother. A child of 1 year and age of mother >30 years was found associated with delay (P < 0.05).

Conclusion and Recommendations

In northern Saudi Arabia, there is considerable delay in vaccinations. A focused high-risk strategy may help reduce delays. The vaccination team in PHCs should focus on children with either of following characteristics to ensure timeliness of vaccine uptake: a child of more than 1 year of age, birth order of more than 2, uneducated parents and homemakers. Modern communication methods such as short text messages sent as reminders before the date, social media applications, and health tools may help.

Limitations of the current study include data from the urban area, small sample size, and primary health center-based study.

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Conflicts of interest
There are no conflicts of interest.

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