

<https://doi.org/10.59298/NIJPP/2024/51496118>

Factors Influencing DPT Immunization Completion among Children: Insights from Nakawa Division, Kampala, Uganda

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ABSTRACT

This study investigates the factors influencing DPT (Diphtheria, Pertussis, Tetanus) immunization completion among children aged 4–23 months in Nakawa Division, Kampala, Uganda. Utilizing a descriptive cross-sectional design with both qualitative and quantitative methodologies, data were collected from 271 participants using researcher-guided questionnaires. The analysis revealed a high DPT immunization completion rate of 94%, meeting WHO targets. Significant factors associated with completion included caretaker age, religion, and attitude toward vaccine safety and acceptability, as well as health service factors like distance to the facility, ANC attendance, convenience of immunization days, and vaccine availability. However, child-related factors such as age, gender, and birth order showed no significant association. These findings underscore the importance of targeted interventions to address caregiver perceptions and improve health service delivery for sustained immunization coverage.

Keywords: Diphtheria; Pertussis-Tetanus (Pertussis is commonly known as whooping cough); DPT Immunization; Completion Status; Nakawa Division, Kampala-Uganda

INTRODUCTION

Immunization is a process by which a person becomes protected against a disease through vaccination. It is an effective public health intervention that has contributed to the substantial reduction in the burden of vaccine-preventable diseases (VPDs) worldwide [1, 2]. It is also a proven tool for controlling and eliminating life-threatening infectious diseases and is estimated to avert 2 to 3 million deaths each year [3]. The Expanded Program of Immunization (EPI) was launched by the World Health Organization (WHO) in 1974 [4], and in Uganda, the Uganda National Expanded Program on Immunization (UNEPI) was established in 1983 [5]. The global immunization target was to reach 90% national coverage for all vaccines by 2020 [6]. However, the goal is still not achieved, and vaccine-preventable diseases remain a major cause of child illnesses and deaths, particularly in low-income countries. Several theories on immunization have been forwarded, for example, the Health Belief Model (HBM) and the Theory of Planned Behavior. According to the HBM, people's specific beliefs, namely the perceived severity and susceptibility of the disease and the perceived benefits and risks of the vaccine, relate to health behaviours [7, 8]. According to Hall [9], the HBM is a cognitive and interpersonal framework that shows that humans are rational beings who use a multidimensional approach to make decisions on whether to participate in a given health behaviour or not, for example, immunity. The HBM proposes that people will take action such as immunization to prevent illness depending on their perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. For instance, some mothers in rural areas believe that immunization of their children using a vaccine containing an inactive polio virus would eventually cause lameness among the children, thus deciding not to participate in the immunization program. Vaccination is the act of introducing a vaccine into the body to produce protection from a specific disease. According to Desalew et al. [10], despite the significant reductions in the incidence of VPDs, a considerable number of children have received incomplete immunization. A child is considered fully immunized if he or she has received the BCG vaccine at birth, the polio vaccine at 0, 6, 10, and 14 weeks, and the DPT-Hep B-Hib vaccine at 6, 10, and 14 weeks [11]. A child should have PCV at 6, 10, and 14 weeks, Rota vaccine at 6–10 weeks and IPV at 14 weeks, which were included in the infant routine

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immunization [12]. Vitamin A supplements at 6 months and MMR at 9 months. This is all dependent on the age of the child at the time of the study. Failure to meet this condition is classified as an incomplete immunization. The impact of immunization extends beyond public health; that is, it affects children's educational achievements and national economic growth. Children suffer from vaccine-preventable disabilities like lameness, impaired growth, and cognitive development [12]. The WHO and United Nations Children's Fund (UNICEF) reported that more than 20 million children have not received a full course of basic vaccines worldwide. Over 24,000 children die of vaccine-preventable diseases every day around the world, and just about 9 million children die every year. In Africa, remarkable progress in immunization services has been noted; however, large numbers of children remain unvaccinated or undervaccinated. The sub-Saharan African region has the highest under-five mortality rate globally and accounts for 52% of this age group's total deaths. In 2018, the region had an average under-five mortality rate of 78 deaths per 1,000 live births [13]. Persistent challenges in the coverage and equity of vaccination are present in Kampala. The Uganda Health Management Information System reports a high full vaccination coverage of over 90% for Kampala city. However, surveys in Nakawa Division show a decline in full vaccination coverage from 77% in 2010 to 51% in 2016 and 48% in 2017 [6]. This indicates the need for research on the DPT immunization completion status and the associated factors among children aged 4–23 months from selected parishes in Nakawa Division, Kampala, Uganda.

According to Shahid et al [14], a child is considered fully immunized if he or she has received the BCG vaccine at birth, the Polio vaccine at (0,6,10,14) weeks, the DPT-Hep B-Hib vaccine at (6, 10,14) weeks, the PCV vaccine at (6, 10,14) weeks, the Rota vaccine at (6,10) weeks, and the IPV vaccine at 14 weeks. Based on this requirement, the general immunization coverage of 90% would be the acceptable point at which we would say a nation or a given region has attained complete immunization coverage. Unfortunately, incomplete immunity remains a major problem worldwide, but most especially in low-income countries (LICs) like Uganda. According to Folorunso et al. [15], the WHO and UNICEF reported that more than 20 million children have not received a full course of basic vaccines worldwide. Similarly, approximately 10 million children remain unvaccinated or partially vaccinated in Africa

Unfortunately, there is currently very little published literature regarding DPT immunization completion status and the associated factors among children aged 4–23 months in selected parishes in Nakawa Division, Kampala, Uganda, hence this study. It is strongly hoped that the findings of this study will trigger policymakers and other relevant stakeholders to act to address vaccination needs to avert the consequences of vaccine-preventable diseases. The study was designed to assess the DPT immunization completion status and associated factors among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda.

METHODOLOGY

Study design

This will be a descriptive cross-sectional study that will include both qualitative and quantitative methodologies. A descriptive cross-sectional research design will be conducted to describe the DPT immunization completion status among children aged 4–23 months. The descriptive design is preferred because it will provide further insights into the research problem by unfolding the variables of interest, estimating, predicting, and examining associative relationships.

Area of Study

Nakawa Division lies in the eastern part of the city, bordering Kira Town to the east, Wakiso District to the north, Kawempe Division to the north-west, Kampala Central Division to the west, Makindye Division across Murchison Bay to the south-west, and Lake Victoria to the south. The coordinates of the division are 0°20'00.0"N, 32°37'00.0"E (latitude: 0.333333; longitude: 32.616667). Nakawa division is made up of parishes that include Banda, Bugoloobi, Bukoto I, Bukoto II, Butabika, Kiswa, Kiwatule, Kyambogo, Kyanja, Luzira, Luzira Prisons, Mbuya I, Mbuya II, Mutungo, Nabisunsa, Naguru I, Naguru II, Nakawa, Nakawa Institutions, and Ntinda. The study will therefore be carried out in randomly selected parishes in the Nakawa division.

Study population

This shows the sets of participants who will or will not be included in this study.

Inclusion criteria

All the children from selected parishes in Nakawa Division with an age under 12 months whose caretakers have consented.

Exclusion criteria

All the children from selected parishes in Nakawa Division with an age above 12 months and those whose caretakers have not consented.

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Sample size determination

The sample size of children being immunized will be determined by using the Kish and Leslie sample size formula given below (Kish and Leslie, 1965).

The sample size (n) = $Z^2 \times P(1-P)/d^2$

- Z-value of the normal distribution as per alpha = 0.05; in this case, the Z value is 1.96.
- P is routine immunization coverage for DPT in children below 2 years of age, which averages 80% (Health Performance Report—MoH, 2018).
- d is the precision of the study, which in this case is taken as 5%. Therefore, substituting in the formula below:

$$n = Z^2 \times P(1-P)/d^2 \quad n = (1.96)^2 \times 0.8(1-0.8)/(0.05)^2 \quad n = 245.86$$

$$n = 246$$

However, to cater for non-response, an additional 10% of the number of participants was added.

$$n = 246 + (10\% \text{ of } 246)$$

$$n = 271$$

Therefore, the number of participants who were enrolled in the study was 271.

Sampling Procedure

Nakawa Division was selected by convenience based on the fact that there was a declining trend in DPT immunization completion coverage compared to other parts of Kampala District. Nakawa Division was then divided into 5 regions, which included Northern, Eastern, Southern, Western, and Central. Thereafter, five parishes were randomly selected from a list containing all the parishes in Nakawa Division. A list of villages from each of the selected parishes was obtained from the LC3's office, and then two villages were randomly selected from each parish. This generated 10 villages or LC1 zones. Households with children between 4 and 23 months of age were identified with the help of LC1 using convenience sampling methods. Caretakers and parents in these households who consented to this research regarding DPT immunization were interviewed using a researcher-guided questionnaire for each village or LC1 zone in the selected parishes. The selected parishes were: Kyanja, Butabika, Bugoloobi, Luzira, and Nakawa.

Data Collection Methods and Management

After the approval of the research proposal by the supervisor, the researcher obtained permission from Kampala International University (KIU) and the division administrations that introduced the researcher to the local leaders and then respondents. The researcher then explained the purpose of the study and the terms involved in obtaining consent from the respondents. The study deployed a researcher-guided questionnaire during data collection to interview the respondents. Using this technique, the researcher interviewed the respondents by asking them specific questions on the DPT immunization completion status and associated factors among children aged 4-23 months in selected parishes in Nakawa Division, Kampala-Uganda. The data collection tool that was used for this study was a well-structured, pretested questionnaire with both open-ended and closed-ended questions. The questionnaires had three sections: the first section was composed of questions on caretaker-related factors; the second section contained questions assessing child-related factors; and the third part contained questions on health service-related factors; while the last and final section contained questions on DPT immunization completion status. The questionnaire was also translated into the most appropriate language to ease communication, particularly English and Luganda, which are the most common languages spoken in that area.

Quality Control

Pre-testing of the study tools was done a week before beginning the study among 20 caretakers in one of the parishes not selected for the study, and adjustments were made where potential errors were identified and corrected. The researcher developed a short training PowerPoint presentation and trained the selected research assistants for one day on each of the data collection tools and the data collection procedure before the study. To ensure the reliability of the data collected, cross-checking was conducted by having two different data collectors assess the same person using the study tool and compare their findings. Sampling validity was also conducted on the tools to assess their capacity to capture the necessary parameters for the study.

Data analysis

A compilation of all the responses from the data collected from the 271 participants was summarized in an Excel sheet, and the entire data set was exported to create an SPSS file for analysis.

Quantitative data analysis plan

Univariate analysis: data on specific objectives was tabulated, and frequency tables, bar charts, and pie charts were generated to assess the statistical distribution followed by the study population. Bivariate analysis: Cross tabulations

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as a standard measure for the association of the two categorical variables under measure were made between the DPT immunization completion status and each of the caretaker-related factors, health service-related factors, and child-related factors. As a result of this comparison, the probability values (P) generated from each of these cross-tabulations were used to determine the significance of the correlation. All probability values $p < 0.05$ were considered significant from the cross-tabulations and therefore considered as actual associated factors with the completion status of DPT immunization. Multivariate analysis: All the significant associated factors with DPT immunization completion status assessed ($p < 0.05$) were then further assessed about the DPT immunization status using a regression equation, and the factor with the highest regression coefficient was considered to have the highest influence on transition status.

Ethical considerations

On finalizing this research proposal, a refined version was presented to the internal research board through my supervisor for approval, after which it was presented to the local authority in the area for approval and permission. A confidentiality clause was put in place to protect the identities and information contained in the individual participants' data. Before data collection, each participant was subjected to verbal and written consent for their approval to take part in the study and was given time to scrutinize and accept their participation as a non-violation of their rights. Access to study data was limited to the researcher and only two other research assistants.

RESULTS

The proportion of DPT immunization completion among children aged 4–23 months from selected parishes in Nakawa Division, Kampala, Uganda

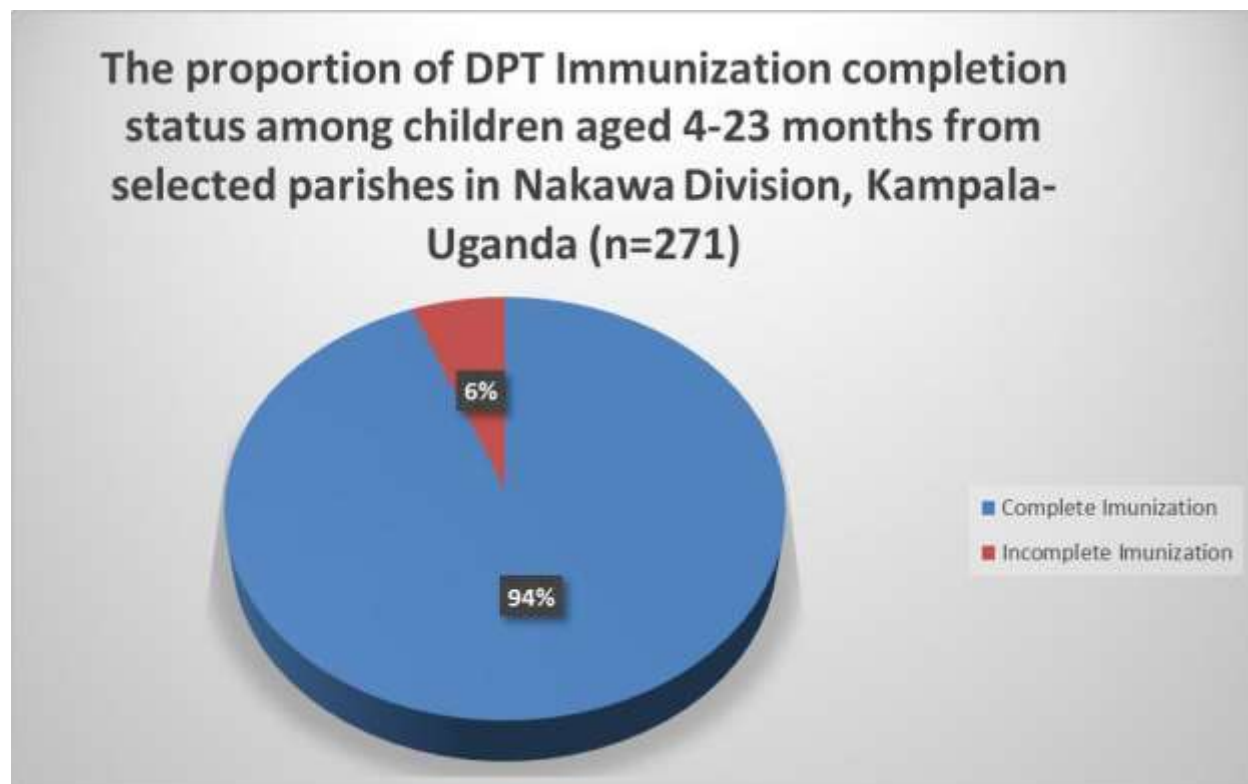


Figure 1: A pie chart showing the proportion of DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda

The majority of 255 (96%) of the participants had a complete DPT vaccination status, while 16 (6%) had incomplete DPT immunization status.

The caretaker-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala, Uganda.

The caretaker-related factors proposed in this study include residence, educational level of the caretaker, marital status, age of the caretaker, income level, religion, occupation of the mother, and attitude towards immunization, as shown in Tables 1 and 2 below

Table 1: Univariate analysis of caretaker-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda(n=271)

| Variable | Frequency , n | Percentage, % |
|---|------------------|---------------|
| Age of the respondents | | |
| 20-29years | 182 | 67% |
| 30-39years | 77 | 28% |
| 40-49years | 12 | 5% |
| Highest level of education attained At least primary | 88 | 32% |
| At least secondary | 183 | 68% |
| Marital Status Married | 187 | 69% |
| Not Married | 84 | 31% |
| Monthly Income: More than UGX. 300,000 Below UGX 300,000 | 112 | 41% |
| | 159 | 59% |
| Type of place of Residence Rural | 184 | 68% |
| Urban | 87 | 32% |
| Religion Catholics | 73 | 27% |
| Non-Catholics+ Others* | 163 | 60% |
| | 35 | 13% |
| Current employment status Employed | 172 | 64% |
| Unemployed | 99 | 36% |
| DPT 3 vaccine is safe for child Yes | 258 | 95% |
| No | 13 | 5% |
| Feel DPT3 vaccination is acceptable Yes | 252 | 93% |
| No | 19 | 7% |

Source: primary data

Most of the respondents (182 (67.0%) were aged between 20 and 29 years; most 183 (68%) of the respondents had at least secondary education; the majority of the respondents 187 (69%) were married; and most of the respondents 159 (59%) earned less than UGX. 300,000. About 184 (68%) of the respondents lived in rural places; more than half of the respondents, 163 (60%), were non-Catholics; most, 172 (64%) of the respondents were employed; the majority of the patients, 258 (95%), thought the DPT vaccine was safe for the children; and most of the respondents, 252 (93%), felt the DPT vaccination was acceptable for the children.

Table 2: Bivariate analysis of caretaker-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda.

| Variable | DPT immunization | | χ^2 | P-value |
|---|-------------------|-----------------|----------|----------------------|
| | Yes, % (n=255) | No, % (n=16) | | |
| Age of the respondents 20-29years 30-39years 40-49years | 177 (69.41%) | 5 (31.25%) | 31.384 | <0.00001 * |
| | 71 (27.84%) | 6 (37.5%) | 8 | |
| | 7 (2.75%) | 5 (31.25%) | | |
| Highest level of education attained At least primary At least secondary | 80 (31.37%) | 8(50%) | 2.3823 | 0.122714 |
| | 175 (68.63%) | 8(50%) | | |
| Marital Status Married Not Married | 178 (69.8%) | 9(56.25%) | 1.2931 | 0.255474 |
| | 77 (30.2%) | 7(43.75%) | | |
| Monthly Income: More than UGX. 300,000 Below 300,000 | 103 (40.39%) | 9(56.25%) | 1.5614 | 0.211466 |
| | 152 (59.61%) | 7(43.75%) | | |
| Type of place of Residence Rural Urban | 174 (68.24%) | 10(62.5%) | 0.2272 | 0.63361 |
| | 81 (31.76%) | 6(37.5%) | | |
| Religion Catholics Non-Catholics+ Others* | 68 (26.67%) | 5(31.25%) | 6.1018 | 0.047316 * |
| | 157 (61.57%) | 6(37.5%) | | |
| | 30 (11.76%) | 5(31.25%) | | |
| Current employment status Employed Unemployed | 163 (63.92%) | 9(56.25%) | 0.3822 | 0.536455 |
| | 92 (30.08%) | 7(43.75%) | | |
| DPT 3 vaccine is safe for child Yes No | 250 (98.04%) | 8(50%) | 76.077 | <0.00001 * |
| | 5 (1.94%) | 8(50%) | | |
| Feel DPT3 vaccination is acceptable Yes No | 247 (96.86%) | 5(31.25%) | 99.415 | <0.00001* |
| | 8 (31.14%) | 11(68.75%) | | |

Source: primary data

Age ($\chi^2=31.3848$), a p-value of <0.00001), religion ($\chi^2=6.1018$, a p-value of **0.047316**), DPT safety ($\chi^2=76.0778$, a p-value of <0.00001), and DPT acceptability ($\chi^2=99.415$, p-value of <0.00001) were the caregiver-related factors significantly associated with DPT immunization completion status.

The health service-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda

The health service-related factors proposed in this study include distance to the health post, place of delivery, antenatal care service, attitude of health workers, and vaccines being out of stock, as shown in Tables 3 and 4 below.

Table 3: Univariate analysis of the health service-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda (n = 271)

| Variable | Frequency, n | Percentage, % |
|--|--------------|---------------|
| Distance to immunization facility from home | | |
| Less than 5km | 198 | 73% |
| 5 –10 km | 45 | 17% |
| More than 15km | 28 | 10% |
| Place of birth | | |
| At home | 35 | 13% |
| At health institution | 236 | 87% |
| Attended antenatal care during pregnancy with this baby | | |
| Yes | 258 | 95% |
| No | 13 | 5% |
| Number of ANC visits | | |
| <4 times | 19 | 7% |
| ≥4 times | 252 | 93% |
| Health facility which does vaccination service near your home | | |
| Yes | 236 | 87% |
| No | 35 | 13% |
| Health workers are friendly | | |
| Yes | 261 | 96% |
| No | 10 | 4% |
| Perceive the operational time of the immunization clinic | | |
| Convenience | 249 | 92% |
| Not convenience | 22 | 8% |
| Vaccine always available for the children | | |
| Yes | 255 | 94% |
| No | 16 | 6% |

Source: primary data

Most of the respondents, 73% (198), were less than 5 km from home to an immunization facility; most 87% (236) of the respondents delivered their babies from a health institute; the majority of the respondents, 95% (258), attended antenatal care during pregnancy; the majority, 93% (252) of the respondents, attended ANC ≥ 4 times; and most of the respondents, 87% (236), had health facilities that provided vaccination services near their homes. About 96% (261) had health workers who were friendly in carrying out vaccination services in the area; the majority (92% (249) of the respondents reported finding the operational time of the immunization center to be convenient; and the majority of the respondents (94% (255) said vaccines were always available for the children.

Table 4: Bivariate analysis of the health service-related factors associated with DPT immunization completion status among children aged 4-23 months from selected parishes in Nakawa Division, Kampala-Uganda

| Variable | DPT immunization | | χ^2 | P-value |
|--|-------------------|-----------------|----------|---------------------|
| | Yes, % (n=255) | No, % (n=16) | | |
| Distance to immunization facility from home | | | 18.41221 | 0.0001* |
| Less than 5km | 193(75.69%) | 5(31.25%) | | |
| 5 –10 km | 40(15.69%) | 5(31.25%) | | |
| More than 15km | 22(8.62%) | 6(37.50%) | | |
| Place of birth At home | 18(7.06%) | 11(68.75%) | 58.3853 | <0.00001* |
| At health institution | 231(90.59%) | 5(31.25%) | | |
| Attended antenatal care during pregnancy with this baby | 250(98.04%) | 8(50%) | 76.0778 | <0.00001* |
| Yes | 5(1.96%) | 8(50%) | | |
| No | | | | |
| Number of ANC visits | 10(3.92%) | 9(56.25%) | 63.234 | <0.00001* |
| <4 times | 245(96.08%) | 7(43.75%) | | |
| ≥4 times | | | | |
| Health facility which does vaccination service near your home | 229(89.80%) | 7(43.75%) | 28.3991 | <0.00001* |
| Yes | 26(10.20%) | 9(56.25%) | | |
| No | | | | |
| Health workers are friendly | 250(98.04%) | 11(68.75%) | 36.3416 | <0.00001* |
| Yes | 5(1.96%) | 5(31.25%) | | |
| No | | | | |
| Perceive the operational time of the immunization clinic | 243(95.29%) | 6(37.50%) | 67.4178 | <0.00001* |
| Convenience | 12(4.71%) | 10(62.50%) | | |
| Not convenience | | | | |
| Vaccine always available for the children | 248(97.25%) | 7(43.75%) | 77.5812 | <0.00001* |
| Yes | 7(2.75%) | 9(56.25%) | | |
| No | | | | |

Distance to immunization facility from home ($\chi^2 = 18.41221$, p-value of 0.0001), place of birth ($\chi^2 = 58.3853$, p-value of <0.00001), going for ANC ($\chi^2 = 76.0778$, p-value of <0.00001), number of ANC visits ($\chi^2 = 63.234$, p-value of <0.00001), having a health facility near home ($\chi^2 = 28.3991$, p-value of <0.00001) friendliness of the health workers ($\chi^2 = 36.3416$, p-value of <0.00001), convenience ($\chi^2 = 67.4178$, p-value of <0.00001), and availability of the vaccine ($\chi^2 = 77.5812$, p-value of <0.00001) were the health service-related factors significantly associated with DPT immunization completion status among children aged 4-23 months from selected parishes in Nakawa Division, Kampala-Uganda.

The child-related factors associated with DPT immunization completion status among children aged 4-23 months from selected parishes in Nakawa Division, Kampala-Uganda

The child-related factors associated with DPT immunization completion status among children aged 4-23 months from selected parishes in Nakawa Division, Kampala-Uganda included age, sex, and the birth order of the child, as shown in Tables 5 and 6 below.

Table 5: Univariate analysis of child-related factors associated with completion status among children aged 6-12 months in selected sub-counties in Wakiso district (n = 384)

| Variable | Frequency, n | Percentage, % |
|---------------------------------|--------------|---------------|
| Age of child in months | | |
| 4-23 months | 153 | 56% |
| 12-23 months | 118 | 44% |
| Sex of the child | | |
| Male | 166 | 61% |
| Female | 105 | 39% |
| Birth order of the child | | |
| One | 90 | 33% |
| Two | 82 | 30% |
| More than two | 99 | 37% |

Source: primary data

Most of the children's respondents 56% (153) were aged between 4-23 months, most of the children's respondents 61% (166) were males, and majority of the children's respondents 37% (99) were above the second birth order.

Table 6: Bivariate analysis of child-related factors associated with DPT immunization completion status among children aged 4-23 months from selected parishes in Nakawa Division, Kampala-Uganda

| Variable | DPT immunization | | χ^2 | P-value |
|---------------------------------|-------------------|-----------------|----------|-----------------|
| | Yes, % (n=255) | No, % (n=16) | | |
| Age of child in months | | | | |
| 4-23 months | 147(57.65%) | 6(37.50%) | 2.4859 | 0.114872 |
| 13-23 months | 108(42.35%) | 10(62.50%) | | |
| Sex of the child | | | | |
| Male | 157(61.57%) | 9(56.25%) | 0.1794 | 0.671851 |
| Female | 98(38.43%) | 7(43.75%) | | |
| Birth order of the child | | | | |
| One | 85(33.33%) | 5(31.25%) | 0.4442 | 0.800831 |
| Two | 76(29.80%) | 6(31.50%) | | |
| More than two | 94(36.86%) | 5(31.25%) | | |

Source: primary data

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The bivariate analysis of the child-related factors associated with DPT immunization completion status among children aged 4–23 months from selected parishes in Nakawa Division, Kampala, Uganda, included age, sex, and the birth order of the child.

DISCUSSION

The proportion of DPT immunization completion among children aged 4–23 months from selected parishes in Nakawa Division, Kampala, Uganda

From the sample size of 271 participants who were presented by 271 caretakers (271 households), the proportion of DPT immunization completion among children aged 4–23 months from selected parishes in Nakawa Division, Kampala-Uganda, were found to be 94% ($n = 255$), with the remaining 6% ($n = 16$) having not completed the full DPT immunization schedule. According to Jammeh [6], the global immunization target is 90% national coverage for all vaccines by 2020. The findings from this study carried out to determine the proportion of children that had completed their DPT immunization schedule (94%) showed that this target had been met in the study area. It is similar to a cross-sectional survey to describe the immunization coverage in India, which found that 95% of eligible children were immunized and had received the required doses of the primary schedule vaccines [16], with a coverage of 92% for DPT3, and also to a cross-sectional study by Li [17] on missed opportunities and immunization coverage of children younger than two years in the slum areas of Kenya, which found that about 9 in 10 of the children were immunized with the DPT vaccine, translating to about 90%, which also meets the target coverage set by the WHO. However, it shows a difference with another cross-sectional study by Ssebagereka et al. [18] on attendance at National Immunization Days and routine immunization involving mothers and fathers in one of the districts in Western Uganda that found an immunization coverage of about 80% for DPT, which was below the target of 90% set by WHO. It is possible that this difference was seen due to the availability of more accessible health centres as well as the higher incidence of educated caretakers who are more likely to take their children for immunization programs within Kampala District compared to other districts in Western Uganda. This study implies that despite having met the target coverage set by WHO, there is a possibility of seeing a declining trend if measures to ensure sustenance of the current coverage, such as maternal education, the construction of health centres up to the parish level to increase the accessibility of health services like child immunization, and job creation opportunities by the government to reduce the incidence of unemployment, community outreaches to encourage the attendance of ANC during pregnancy are not enforced early enough.

The caretaker-related factors associated with DPT immunization completion status among children aged 4–23 months

The caretaker-related factors that were analyzed in this study included the age of the caretaker, their religion, and their attitude towards the safety and acceptability of the vaccine. Details of this follow: Regarding the age of the caretaker, it was found that the majority of caretakers (67%; 182) were between the ages of 20 and 29. From bivariate analysis, the age of the caretaker, religion, and attitude towards the safety and acceptability of the vaccine were significantly associated with DPT immunization completion status among children aged 4–23 months ($p < 0.05$). However, the caretaker-related factors that were not significantly associated with DPT immunization completion status among children aged 4–23 months included: level of education, marital status, place of residence, and employment status ($p > 0.05$). This is similar to a cross-sectional study by Eze et al. [19], which showed that children whose mothers were aged less than 30 years were two times more likely to be fully immunized. It also agrees with another cross-sectional study done in India, which indicated an association between utilization of maternal and child health services such as immunization services, particularly DPT, and maternal or caretaker's age [20]. However, a case-control study done in Southern Ethiopia in 2017 indicated that the age of the mother or immediate caretaker did not show an association with defaulting on immunization [21]. The caretakers' attitude towards the safety and acceptability of the vaccine was significantly associated with DPT immunization completion status among children aged 4–23 months ($p < 0.05$). This agrees with a study by Gelaye [22], which found that when parents refuse to take their children for immunization, it is because they want to protect their children from being harmed, which indicates that some caretakers have a biased attitude towards the safety of the vaccines. This is also seen in India (certain Hindu and Muslim groups), where groups believed that vaccination was a concealed method of family planning, primarily targeting Muslims [23]. This would subsequently lead to defaulting on the health practice. These differences may be seen because younger caretakers commonly have fewer children as well as fewer responsibilities; therefore, they take time to ensure their children's normal health status is maintained, which would prompt them to engage in health programs like child immunization as opposed to older caretakers, who are often too busy with other activities and

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responsibilities like work, which reduces the amount of time they spend with the children, leading to missed immunization schedules. This study implies that, despite the current level of immunization coverage, there are still several caretakers whose attitude is that vaccines are no longer safe for their children due to the adverse side effects seen in some children after being immunized, for example, severe fevers and skin rashes along with unexplained abdominal pains, as seen in the area of study. Therefore, measures to ensure that caretakers are well educated about the benefits of childhood immunization and the consequences of defaulting should be put in place, including in camps, community outreach, and also through religious leaders who tend to have an impact on society through their communication.

The health service-related factors associated with DPT immunization completion status among children aged 4–23 months

The health service-related factors that were significantly associated with DPT immunization completion status included distance to the immunization facility from home, place of birth, going for ANC, convenience of immunization days, attitude of the health workers, and availability of the vaccine. About the distance to the immunization facility from home, 73% (198) of participants lived less than 5 km from the health centre. As far as bivariate analysis was concerned, distance to the health facility, place of birth, going for ANC, convenience of immunization days, attitude of the health workers, and availability of the vaccine were significantly associated with DPT immunization completion status among children aged 4–23 months ($p < 0.05$). Similarly, in a cross-sectional study in Turkey by Gozum [24], it was revealed that distance from the health centre and internal migration from less developed parts to more developed parts of the country were significantly related to the level of immunization coverage. Proximity to the immunization centres was associated with an increased likelihood of complete immunization, as immunization coverage was seen to decline with increasing distance from immunization centres in Egypt [25]. This also agrees with studies in Kenya, where distance to the health post was found to affect immunization coverage [25]. Regarding the attendance of antenatal care, 95% (258) of the mothers had attended antenatal care during the pregnancy of the children enrolled in the study. From bivariate analysis, it was found that the number of times that ANC was attended had a significant impact on the resultant outcome of the DPT immunization completion status ($p < 0.05$). Similarly, in a cross-sectional study conducted in Nigeria by Madubueze et al. [26] most of the mothers interviewed (66%) showed their awareness of immunization at the antenatal clinics and through antenatal care (ANC), and therefore attendance was a positive gesture with the immunization completion status of DPT. The convenience of the immunization days was also significantly associated with the status of DPT immunization completion ($p < 0.05$). The availability of vaccines at the immunization centres was also significantly associated with the DPT immunization completion status of children ($p < 0.05$). This agrees with a cross-sectional study done in Sudan, where the availability of vaccines at the nearest place of vaccination strongly influenced the DPT immunization completion status of the child. It is possible that the high coverage seen in these studies was due to the availability of accessible immunization centres as well as a constant supply of vaccines. There has also been a higher incidence of maternal education in recent years, which has played an important role in elevating the resultant immunization coverage, especially in urban areas. This study implies that even though the target coverage was met, there are still many children who have not attained complete immunization status, and this could be addressed by encouraging mothers to attend antenatal care during pregnancy. This can be done through community outreaches that embark on maternal education about the importance of antenatal care. More health centres in rural areas could be put in place, as well as maintaining a constant supply of vaccines required for immunization, which would, in turn, increase the health service delivery to the poorer communities who may have found it hard to reach health centres that were initially far off, thus increasing the immunization coverage even more.

Child-related factors associated with DPT immunization completion status among children aged 4–23 months

According to this study, the child factors, which included age, gender, and birth order, did not show any association with the completion of the DPT immunization schedule. Most of the participants (153) (56%) were aged between 4 and 23 months; most of the children's respondents (166,61%) were males; and the majority of the children's respondents (99,37%) were above the second birth order. However, bivariate analysis indicated that none of these factors were significantly associated with DPT immunization completion status among children aged 4–23 months ($p > 0.05$). This agrees with a cross-sectional study done in Nigeria in 2019, where there was no significant relationship between sex and full immunization status [26]. Similarly, in 2016, the Ethiopian Expanded Program Immunization Survey also showed no statistically significant difference between girls and boys regarding their immunization status [4]. The implication of determining the association between child-related factors and immunization completion is that there may be a need for more research on the child-related factors associated with DPT immunization completion status in a much larger study area with a much larger sample size.

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CONCLUSION

Generally, the proportion of children who had fully completed their DPT immunization schedules at an appropriate age was 94%, which is in line with the WHO requirement. The caretaker-related factors that were significantly associated with DPT immunization completion status included the age of the caretaker, their religion, and their attitude towards the safety and acceptability of the vaccine ($p < 0.05$). The health service-related factors that were significantly associated with DPT immunization completion status included distance to the immunization facility from home, place of birth, going for ANC, convenience of immunization days, attitude of the health workers, and availability of the vaccine ($p < 0.05$). According to this study, the child factors, which included age, gender, and birth order, did not have any association with the completion of the DPT immunization schedule ($p > 0.05$).

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CITE AS: Okia Jeremiah Newman (2024). Factors Influencing DPT Immunization Completion among Children: Insights from Nakawa Division, Kampala, Uganda. NEWPORT INTERNATIONAL JOURNAL OF PUBLIC HEALTH AND PHARMACY, 5(1):49-61 <https://doi.org/10.59298/NIJPP/2024/51496118>