

Distribution Strategies and Consumption of Vaccines in Calabar Metropolis, Cross River State, Nigeria

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Abstract

The main objective of this study was to find out whether distribution strategies influenced vaccine consumption in Calabar Metropolis, Nigeria. This objective is subdivided into the following: to determine whether hospital-based vaccine distribution strategy, school-based vaccine distribution strategy, door-to-door vaccine distribution strategy and mobile clinic vaccine distribution strategy influenced vaccine consumption in Calabar Metropolis, Cross River State, Nigeria. The survey research design was employed in this study. The population of the study included persons resident in Calabar Metropolis, who were mothers and had a child who has reached at least the age of two years. The sample size of 349 mothers was determined using the Cochran formula. A multistage non-probability sampling technique was employed in this study. The multiple regression analysis was used for testing hypotheses one to four. Findings of the study included the following: hospital-based vaccine distribution strategy, school-based vaccine distribution strategy, door-to-door vaccine distribution strategy and Mobile clinic vaccine distribution strategy significantly influenced vaccine consumption in Calabar Metropolis, Cross River State, Nigeria. In conclusion, these findings have proven that the marketing toolkit and distribution strategies in particular is a potent tool for increasing vaccine consumption and cannot be forsaken whenever there is a need to achieve a successful vaccination programme. Recommendations made were that Hospital-based, School-based, Mobile and Door-to-door vaccine distribution strategies should be used in increasing vaccine consumption.

Keywords: Hospital, Door-to-Door, Mobile, Mobile-based Distribution Strategies.

Introduction

Ever since the demonstration of the value of immunization by Edward Jenner in 1792, vaccination has increasingly become a key strategy in the prevention and control of infectious diseases globally (Eboreime et al., 2015). Vaccination has reduced mortality from infectious diseases such as: smallpox, rabies, typhoid, etc. (Uchida et al., 2018). Despite the effectiveness of vaccination, there are some challenges associated with achieving adequate and complete vaccination coverage (Maserat, et al., 2021). One of such challenges is the inability to reach the most disadvantaged segment of the population (World Health Organization [WHO], 2020). As of 2022, there were 20.5 million children missing out on life saving vaccines globally, 2.1 million more than in 2019 (United Nations International

Children's Emergency Fund [UNICEF], 2023). The Director General of the Cross River State Primary Health Care Development Agency stated that all 774 Local Government Area in Nigeria still have zero dose children (Mesembe, 2024). This establishes the fact that low vaccine uptake is still a problem in Nigeria. More so, Udonwa et al., (2010) found that the majority of clients at primary health facilities in Calabar were dissatisfied due to inaccessibility of immunization services and long waiting time. The consequence of this is that, it may be impossible to achieve the World Health Organization's IA2030 goal of reaching all persons, wherever they are with vaccines by 2030.

To solve some of the aforementioned issues, researchers from the University of Notre Dame, United States of America suggests that experts from varying fields need to work together to overcome public health crises and that the health system can benefit by adopting marketing strategies in vaccine holdouts, much like brands do with customers (Roddel, 2021). Still in the same vein, Zheng et al., (2023) found that vaccine hesitancy of the target population decreased and degree of coverage significantly increased after implementing "4Ps" social marketing strategy. Marketing strategy has four basic components. These are: product, price, promotion and place strategies. The distribution strategy of marketing is a potent tool that can be used to improve the consumption of health services. This is due to its ability to make the health services accessible and also improve the consumers' satisfaction at a lower cost to the organization. For instance, Mesembe (2024) averred that due to frequent vaccines stockout, Cross River State has accumulated a number of zero doses children. Unfortunately, many organizations fail to establish or maintain the effective distribution strategies (Baker & Hart, 2008; Bikram, 2013).

According to Greene et al., (2021) strategies for vaccine distribution generally fall into two models: Pull models allow the public to retrieve vaccines from Point of Deliveries (e.g., drive-through clinics, clinics established at schools, and other areas); Push models require state and local officials to coordinate with providers and organizations (e.g. primary care doctors, community health centers, home health care workers, community organizations and others) to deliver the vaccine to populations that may be unable or unwilling to receive a vaccine at a Point of Deliveries. Thus, vaccines can be delivered to consumers in both traditional (Pull models) and non-traditional settings (Push models). Management decision on how to select the right distribution strategy that will largely contribute to availability of products to the consumer at the right time and right quantity and quality is the thrust of this study. Even though there are several other factors which serve as barriers to vaccine consumption. This study centres on the access barrier. In other words, the aim of this study is to develop a well-planned and organized distribution strategy which can get vaccination services to the final consumers.

Statement of the Problem

While vaccines play a pivotal role in safeguarding public health, not everyone has equal access to them (Springett, 2023). Springett maintains that some people live far from

healthcare facilities, while others simply cannot find the time to get a vaccine. Thus, poor access to facilities providing vaccination is a serious concern to healthcare service managers (Anand & Barnighausen, 2007). Populations in urban slums in Nigeria are underserved, with poor access to essential health services and even poorer health-seeking behaviour (Ozoh et al., 2023; Balogun et al., 2023). It has been found that most mothers in Cross River State fail to present their children for vaccination due to lack of money, time wastage at health centres, long distance to health facilities, lengthy waiting times and non-availability of vaccines. (Osuchukwu et al., 2024; Osuchukwu et al., 2023). Also, Mesembe (2024) averred that due to frequent vaccines stockout, Cross River State has accumulated a number of zero doses children.

There are individuals in Calabar who actually want to take their child to health facility to take a vaccine, but do not have the time to visit a health centre, or other vaccine point of deliveries (PODs) including mobile clinics. This has contributed to increasing the low vaccine uptake. Many children have missed out of vaccination due to long queues at vaccine PODs, inconvenience of vaccination centre, distance to health centres, and lack of money to pay their way to the closest vaccination centres. Many a times, mobile clinics are cited in places that are not safe for vaccinees. In other cases, when consumers visit health centres or other PODs for vaccination, those vaccines needed by the child are not available. More so, when vaccines are administered in schools, many out of school children miss the opportunity to take the vaccines. The consequence of these is that, it may be impossible to achieve the World Health Organization's IA2030 goal of reaching all persons, wherever they are with vaccines by 2030.

Research on equitable vaccine distribution is new and scarce in the literature (Baharmand et al., 2021). Previous studies of pandemic influenza vaccination have identified population-level determinants of vaccine coverage, for example Brien et al., (2012), without addressing the accessibility and other characteristics of healthcare services. Also, Joseph et al., (2020) assert that strategies that address access barriers in the hardest to reach communities are needed to enhance equitable access to immunisation services. So far, studies related to vaccine distribution have identified that health centre based, school-based, door-to-door, and mobile vaccine delivery influences vaccine consumption (Soofi et al., 2012; O'Reilly et al., 2023; Isaac et al., 2015; [Sato, 2019](#); Kulle et al., 2023). However, there is currently no study which attempts to find out the level of effectiveness of all these distribution strategies put together in improving vaccine consumption. All these aforementioned distribution strategies are being used for improving child vaccine consumption in the Nigerian health system. But what is not known is the level of effectiveness of these distribution strategies.

Aim/Hypothesis

The main objective of this study is to find out whether distribution strategy influenced vaccine consumption in Calabar Metropolis, Nigeria.

The following are the research hypotheses for the study. They are stated in their null forms.

1. Hospital-based vaccine distribution strategy does not significantly influence vaccine consumption in Calabar Metropolis, Nigeria.
2. School-based vaccine distribution strategy does not significantly influence vaccine consumption in Calabar Metropolis, Nigeria.
3. Door-to-door vaccine distribution strategy does not significantly influence vaccine consumption in Calabar Metropolis, Nigeria.
4. Mobile clinic vaccine distribution strategy does not significantly influence vaccine consumption in Calabar Metropolis, Nigeria.

Theoretical Framework

Theory of planned behavior (Icek Ajzen, 1985)

The Theory of Planned Behavior (TPB) posits that attitude toward the behavior, subjective norm, and perceived behavioral control influence behavioral intention. The first construct of the theory is behavioral intention, which is the motivational factors that influence behavior (Ajzen, 1991). The second construct is attitude towards the behavior which is the extent to which a person has a favorable or unfavorable appraisal of a given behavior. Subjective norm is the third construct which is a social pressure to perform or not to perform a given behavior. Perceived behavioral control also plays a key role in the TPB and it refers to people's perception of the ease or difficulty of performing the behavior of interest. That perception varies by environmental circumstances and the behavior involved (Ajzen, 1991). This theory implies that mother's attitude towards distance to health centres, vaccine availability, queues at vaccine PODS, convenience of vaccine PODs influence vaccine consumption behaviour. Perceived behavioral control also plays a key role in the TPB and it refers to people's perception of the ease or difficulty of performing the behavior of interest. So, peoples' perception of the ease or difficulty of having access to make their child take a vaccine may influence their intention to present the child for vaccination.

Conceptual Framework

Hospital-based vaccine distribution

Primary care providers may be key to reaching vaccinees, because they can offer vaccinations as part of the routine care they deliver (Klein & Hostetter, 2021). Patients can be vaccinated at a place they regularly receive healthcare (Minnesota Department of Health [MDH], 2022). Miller (2022) asserts that many major medical centers have the capacity to efficiently store vaccines. Miller further explains that this makes it possible for vaccines to be given at hospitals, doctor's office and even dentist's office. DHHS (2021) adds that federally funded health centers provide a variety of healthcare services, including vaccination. Also, a large proportion of Covid-19 vaccinations are carried out by local general practitioners, this includes vaccinations administered by doctors at nursing care facilities (Federal Ministry of Health [FMH], 2023). According to results of a survey, the preference to be vaccinated in a medical office was three to five times higher among unvaccinated Americans than other strategies such as vaccinations at retail pharmacies or

drug stores, drive-up clinics and large public vaccination sites (Terry, 2021). This center fosters vaccine consumption (Anyadighibe et al, 2024).

School-based vaccine distribution

According to Centre for Disease Control (CDC, n.d.), School-located vaccination programs are events held at a school campus to remove logistical barriers and increase vaccine uptake. These can be open to students only or offered to faculty, families, and the greater community as well. The school also offers a convenient option for parents to have their children receive needed vaccinations without having to arrange for a healthcare provider visit or take off time from work (Fiala et al., 2013). Soofi et al., (2012) avers that in areas of high school enrolment, schools provide an opportunity for a catch-up vaccination for routine vaccines such as measles and routine vaccination for vaccines that cannot be administered under EPI such as typhoid. In most developed countries, immunization record is a requirement for school enrolment, and additionally, schools have been used as a platform for immunization for measles, Japanese Encephalitis, influenza, and HPV (Soofi et al., 2012). Such a strategy for developing countries has been under discussion and several assessments have been made by the World Health Organization (WHO) (WHO, n.d.).

Door-to-door vaccine distribution

Door-to-door vaccine distribution refers to home-delivered vaccination efforts which reach populations where they live. They are traditionally used when barriers to transportation and access exist (CDC, n.d.). Lirri, (2022) states that the door-to-door vaccination strategy is the gold standard that has been tested globally and used by many countries. Liri maintained that this vaccination strategy is designed to reach every single child in the villages and settlements. Also, this strategy can be applied to homebound people and to neighborhoods with low vaccination rates (CDC, n.d.). Yusuf (2023) advises that 'the government should deploy a strategy to take the vaccine campaign to people's doorsteps, so that some people that cannot pay for transportation to go and get the vaccine will get it when you take it to their doorsteps.

Pop up/mobile vaccine clinic distribution

"Pop-up clinics" often refer to non-traditional clinics that have modified locations, time of operation, recruitment strategies, personnel, and other characteristics (Demeke et al., 2022). An example of this is a mobile vaccine clinic. Mobile vaccination is a catch-all term for initiatives that attempt to reach a large number of people in a short period of time while using minimal resources (National Center for Immunization and Respiratory Diseases [NCIRD], 2021). Kwereba and Shah (n.d.) states that a mobile clinic is a customised motor vehicle, motor bike or rickshaw that travels to communities to provide healthcare including vaccination. Springett (2023) adds that mobile vaccine clinics are specially designed vehicles equipped to deliver vaccines to various locations across the U.S. One reason why

vaccine buses are operated is to increase convenience and enable patients not able to travel to be vaccinated (University College London Hospital [UCL], 2022).

Mobile pop-up vaccination clinics take place in a community-based setting like a community centre, auditorium or tent (Commonwealth of Massachusetts [CoM], 2024). Pop-up vaccination sites can also be at religious sites, community centers, public housing complex and other local sites (New York State, 2022) as well as mass vaccination sites. Agnes et al (2024) opined that mobile based intervention by health care personnel will increase patronage behavior.

Vaccine consumption

Vaccine uptake is used to refer to the proportion of a population that has received a specific vaccine. The success of vaccination uptake hinges strongly on the trust people have about the safety and efficacy of vaccines, trust in the health professionals who administer vaccines, the wider health system and the political environment within which vaccine development and deployment decisions are made (Larson et al., 2014; Paterson et al., 2016, Thomson et al., 2016). Over the past few decades, while vaccination services have shown progress in sub-Saharan Africa, basic childhood vaccination coverage remains low in many countries in the region (Machingaidze et al., 2018). Many of these countries are struggling or unable to reach the most disadvantaged segments of their populations (WHO, 2020). In 2019, 19.7 million children remained under-vaccinated or unvaccinated for DPT 3 vaccine worldwide, of whom 48% were in Africa (WHO, 2020). The majority of these children lived in Nigeria, Ethiopia, the Democratic Republic of Congo, Angola, and Guinea (Hosseini et al., 2016; WHO, 2020).

Empirical Review

Kim et al., (2023) examined and quantified the relationship with the School Vaccination Check Program (SVCP) and the vaccination uptake by comparing the vaccination coverage of 2021 and 2022. Based on the standard schedule, the vaccination records of DTaP5, IPV4, MMR2 and IJEV4 were evaluated for elementary school students. The Tdap6, IJEV5 and HPV1 were evaluated for the students from middle school. Using a difference-in-difference study design and national level big data, the study compared vaccination coverage as of August 2021 and 2022. The study found that the SVCP was effective in increasing vaccination coverage for targeted vaccinations such as DTaP5, IPV4, MMR2 and IJEV4 for elementary school students, and Tdap6, IJEV5 for middle school students. However, the SVCP did not show a statistically significant effect on increasing vaccination coverage on HPV1 for middle school students. School can play an important role to improve vaccination coverage. Therefore, close collaboration with health and education authority is crucial to accomplish successful vaccination program reducing vaccine preventable disease outbreaks in schools.

Bryan et al., (2022) examined inpatient vaccine delivery across a national sample of children's hospitals. They conducted a retrospective cohort study examining vaccine

administration at 49 children's hospitals in the Pediatric Health Information System database. Children <18 years old admitted between July 1, 2017, and June 30, 2019, and age eligible for vaccinations were included. They used logistic and linear regression models to examine characteristics associated with vaccine administration. According to the result there were ≥ 1 vaccine doses administered in 12.9% (95% confidence interval: 12.8–12.9) of hospitalizations, ranging from 1% to 45% across hospitals. The most common vaccines administered were hepatitis B and influenza. Vaccine doses other than the hepatitis B birth dose and influenza were administered in 1.9% of hospitalizations. Children had higher odds of receiving a vaccine dose other than the hepatitis B birth dose or influenza if they were <2 months old, had public insurance, were non-Hispanic Black race, were medically complex, or had a length of stay ≥ 3 days.

Lim et al (2014) assessed HPV vaccine series completion and on-time dosing in Canada's largest publicly funded, school-based HPV vaccination program. Using administrative health and immunization databases, they identified a population-based cohort of girls eligible for Ontario's Grade 8 HPV vaccination program in the 2007/08-2009/10 program years who received at least one dose of the vaccine. They determined the number of doses received and calculated the percentage of girls that completed the three-dose series in Grade 8 and Grades 8–9. To assess on-time dosing, the number of days between doses 1–2, 2–3, and 1–3 was calculated and categorized (e.g., too short, on schedule, too long) based on the manufacturer's recommendations. Analyses were also stratified by program year. They identified a cohort of 55,798 girls who initiated the vaccination series. Series completion was high in the Grade 8 window (81.8%) and increased by approximately 6% in Grade 9. Series completion was similar across the three program years. 70.8%, 98.5%, and 86.1% of girls were classified as 'on schedule' for dosing intervals 1–2, 2–3, and 1–3, respectively; 70.0% of girls received all three doses in perfect accordance with dosing recommendations. Stratification revealed that on-time dosing was highest in the first two years of the program (85.6% and 80.6%), but dropped to 42.1% in the 2009/10 year when H1N1 vaccination programs were prioritized. This study demonstrates that delivery of the HPV vaccine through a free, school-based program is an effective method of ensuring high completion and on-time dosing but may not be sufficient to guarantee high coverage.

In a paper by Harvey-Vera et al., (2022) COVID-19 vaccine uptake among PWID in Tijuana following implementation of a pop-up vaccination clinic was studied. Beginning in October 2020, Persons who inject drugs PWID in Tijuana aged ≥ 18 years were enrolled into a longitudinal cohort study. At baseline and semiannually, participants underwent interviewer-administered interviews on health behaviors and COVID-19 exposures through April 5, 2022. From June 21–September 20, 2021, staff referred PWID to a temporary COVID-19 vaccine pop-up clinic. Poisson regression was used to evaluate the Effect of the pop-up clinic on COVID-19 vaccination uptake, controlling for potential confounders. Results indicate that of 344 participants, 136 (39.5%) reported having received at least one COVID-19 vaccine dose during the 10 months follow-up period, of whom 113 (83.1%) received vaccine at the pop-up clinic and 23 (16.9%) elsewhere. One third of those receiving

COVID-19 vaccine during the pop-up clinic were previously vaccine hesitant. Attending the pop-up clinic was independently associated with higher rates of COVID-19 vaccination Adjusted Rate Ratio (AdjRR: 9.15; 95% CI: 5.68–14.74).

In this study by, Isaac et al., (2015) population-based data are used to examine the effect of a home visiting program on vaccination rates in children. Home visiting program data from Manitoba, Canada were linked to several databases, including a provincial vaccination registry to examine vaccination rates in a cohort of children born between 2003 and 2009. Propensity score weights were used to balance potential confounders between a group of children enrolled in the program ($n = 4,562$) and those who were eligible but not enrolled ($n = 5,184$). Complete and partial vaccination rates for one- and two-year-old children were compared between groups, including stratification into area-level income quintiles. Results showed that complete vaccination rates from birth to age 1 and 2 were higher for those enrolled in the Families First program [Average Treatment Effect Risk Ratio (ATE RR) 1.06 (95 % CI 1.03–1.08) and 1.10 (95 % CI 1.05–1.15) respectively]. No significant differences were found between groups having at least one vaccination at age 1 or 2 [ATE RR 1.01 (95 % CI 1.00–1.02) and 1.00 (95 % CI 1.00–1.01) respectively]. The interaction between program and income quintiles was not statistically significant suggesting that the program effect did not differ by income quintile.

According to Lee et al., (2015) voluntary on-site school-based mass vaccination programs have demonstrated high coverage. Here, the authors tested whether this could be an option for countries without a government-supported vaccination program as in Hong Kong. A Home-School-Doctor model was evolved based on extensive literature review of various health promotion models together with studies on HPV vaccination among adolescent girls. The outcome measure was uptake of vaccination. Factors associated with the outcome were measured by validated surveys in which 4,631 students from 24 school territory wide participated. Chi-square test was used to analyze association between the categorical variables and the outcome. Multivariate analysis was performed to identify independent variables associated with the outcome with vaccine group as case and non-vaccine group as control. Results indicate that in multivariate analysis, parental perception of usefulness of the Home-School-Doctor model had a very high odds ratio for uptake of HPV vaccination (OR 26.6, 95 % CI 16.4, 41.9). Paying a reasonable price was another independent factor associated with increased uptake (OR 1.71, 95 % CI 1.39, 2.1 for those with parents willing to pay US\$125-250 for vaccination). For parents and adolescents who were not sure where to get vaccination, this model was significantly associated with improved uptake rate (OR 1.66, 95 % CI 1.23, 2.23). Concerns with side effects of vaccine (OR 0.70, 95 % CI 0.55, 0.88), allowing daughters to make their own decisions (OR 0.49, 95 % CI 0.38, 0.64) and not caring much about daughters' social life (95 % CI 0.45, 0.92) were factors associated with a lower uptake. The findings of this study have added knowledge on how a school-based vaccination program would improve vaccine uptake rate even when the users need to pay.

Sato (2019) conducted a study which examines the association between access to a health facility and the continuum of child vaccination behaviors, which include: uptake of each vaccine, dropout, and timing of vaccine take-up in Nigeria. The health facility census data (2014) was merged into the Nigeria Demographic and Health Survey (2013) to calculate the distance between respondents' locations and the nearest health facility, and to evaluate its impact on the series of vaccination behaviors, using logistic and OLS regression. Results indicates that among 21,369 children aged 12 to 59 months old, 78.2% of them were never vaccinated. An additional distance of 1 km to the nearest clinic reduces the likelihood that one receives a vaccine by about 5% [OR: 0.952, 95% CI = 0.935 – 0.969]. Distance to the nearest clinic is mostly not associated with dropout rates in the vaccination series, but it delays the timing of vaccination, especially in the later stages of the vaccination series and Polio vaccination which require the mobilization from the supply side.

In a randomized controlled trial (RCT) with 20 Swiss communities (10 treatment, 10 control) conducted by Kulle et al., (2023) in August 2021, MVUs were sent to treatment communities for 4 hours on a single day. The experimental sample comprises 20 414 adults who were unvaccinated against COVID-19 at this point. The researchers designed the RCT and the government introduced the idea to test the effectiveness of MVUs and was responsible for administering the vaccines. Results revealed that the vaccination rate in the sample of the treatment group surpassed the rate in the control group by a factor of 3.4 (+9.0 percentage points) over 3 weeks. The increase was present and highly statistically significant for women, men and for all age groups. The researchers found no evidence of cannibalization of vaccinations at other service locations.

Research Methodology

To effectively address the research problem, the cross-sectional survey research design was employed in this study. The survey research design provided data that was used to describe the population and also serve the purpose of making inference from the sample. This study was carried out in Calabar Metropolis, Nigeria. Calabar is a capital of Cross River State in Nigeria. Calabar Metropolis comprises of Calabar South and Calabar Municipality. The population of Calabar South is 191,630 and Calabar Municipal is 179, 392 (NPC, 2006). This 2023 population is projected using the formular $P_t = P_o(1+r)^t$, at NPC's annual population growth rate of 2.4 %. This provided the population of 268, 474 and 286, 789 for Calabar Municipal and Calabar South respectively. Calabar Metropolis was used for this study because it is the capital of the state, and it is also the administrative headquarters of the state. The population of the study included persons resident in Calabar Metropolis, who were mothers and had a child who had reached at least the age of two years. The population was drawn from the 16 areas in Calabar Metropolis. The areas in Calabar Metropolis include the following: Airport, Bogobiri, Ediba, Essien Town, Ikot Ansa, Ikot Omin, Stadium, State Housing Estate, Ekorinim, Eta Agbor, Dan Archibong, Egerton Area I, Egerton Area II, Ekpo Abasi, Goldie, and Uwanse. (Nigerian Postal Service, 2024).

Though this population is finite, it was not possible to obtain it from a secondary source, so there was no guiding figure. Thus, the sample size was determined using the Cochran (1977) formula. This is a sample size determination method used when the population is not known. This is stated as:

$$n = \frac{z^2 \cdot p \cdot (1-p)}{e^2}$$

$$n = \frac{1.96^2 \cdot 0.65(0.35)}{0.05^2} = 349$$

A multistage non-probability sampling technique was employed in this study. This is because, it was impractical to obtain a random sample of the population. To minimize the bias due to non-probability sampling two streets were selected from each of the sixteen communities in Calabar Metropolis, so that the respondents are spread across the entire study area. Also, respondents in each of the thirty-two streets were selected based on every third occurrence of the population unit.

The two-stage cluster sampling was used. For this study, since the sample size was 349, to create a two-stage cluster sampling design, a product of two numbers which is above 349 is required. The primary sample unit was the street, while the secondary sample unit will be the respondent. To get the primary sample unit-street. The number of areas-16 was doubled (32), so that an average of two streets will be obtained from each area. This means that 32 streets were selected (clusters) from all the streets. Daily, new streets are created, most streets are not officially registered, other streets which were single previously have been separated as well as many other controversies. This in turn makes it difficult to get a sampling frame for streets and that is why using simple random sampling is impracticable. Thus, the next task was to determine what will be multiplied by 32 to provide a number higher than or equal to 349. Thus, $32 \times 13 = 416$ was arrived at. This was chosen so that even if nonresponse of questionnaire exists the remaining will not fall below the sample size. This method was used because using Taro Yamene to determine the number of streets to sample produced a very high and an unrealistic result. The 32 streets were sampled with probability proportionate to the size of the population of the people in each L.G.A. this resulted in an allocation of 17 streets to Calabar South and 15 streets to Calabar Municipal. The streets to be sampled for each L.G.A were shared across all the areas in each L.G.A, with cognizance to the size of the streets in each area which are residential. In each area, it was ensured that streets picked in the area could produce a respondent of 13. Also, it was ensured the streets are not close to each other. This was to avoid intra-cluster correlation. Selection of the 13 respondents in each street was based on every third reoccurrence of members of the population. A next household was defined as the one whose front door is closest to the one just visited. Also, the circular systematic sampling was employed in cases where the enumerators got to the end of the street. Also, the allocation of the number of streets to each area was also based on the number or size of the streets in each area. Areas with large, moderate and small number of streets that are residential were allocated with three, two and one streets respectively.

Data for the study were obtained from primary source. The primary data are more reliable and have more confidence level of decision making. Primary data for this study were obtained through questionnaire administered to mothers who are vaccine customers and have a child who have reached at least the age of two years. Data for vaccine consumption was obtained through recall by the mothers or vaccination cards.

The independent variables included school-based vaccine delivery, health centre-based vaccine delivery, mobile vaccine delivery, and door-to-door vaccine delivery. The questionnaire items in the independent variables were based on the following dimensions: 1. Distance to vaccine point of delivery, 2. Waiting time in queue, 3. Convenient location, 4. Vaccine availability.

For the dependent variable (vaccine consumption). The items were based on: 1. Timeliness of vaccine consumption, 2. Completeness of vaccine consumption

Table 1.1: Dimensions of vaccine distribution strategy (independent variables)

S/N	Dimensions of vaccine distribution strategy	Sources
1	Distance to vaccine point of delivery	Davis et al., (2022) explained how self-reported distance to vaccine point of delivery were used as a means of measuring perceived access to vaccine. Alice Tobin et al., (2021) asked respondents if they were willing to travel for more than one hour to get a covid-19 vaccine. Anjorin et al., (2021) asked two similar questions about typical travel time to nearest health centres and the amount of time participants would be willing to travel to get the coronavirus vaccine.
2	Waiting time in queue	Deml and Githaiga (2022) found that in measurement of access to covid-19 vaccination, several studies have used time waiting for vaccine as an index. Also, Davis et al (2022) explained how self-reported waiting times in queue were used as a means of measuring perceived access to vaccine
3	Convenient location	Anderson & Thomley (2014) in the study's questionnaire asked if convenient location is a reason for visiting a pharmacy for flu immunization. Lee et al., (2015) in the questionnaire asked parents whether the availability of home-school-doctor model had a strong impact on their decisions to have their daughter vaccination. Wiysonge et al. (2022) in the questionnaire asked 'visiting the vaccination clinic will make me feel uncomfortable; this will keep me from getting vaccinated against covid-19'. Anjorin et al. (2021) asked respondents if they would prefer community workers to come to their house or place of work to give the coronavirus vaccine, as opposed to going to a health centre.
4	Vaccine availability	Anderson and Thomley (2014) in the questionnaire asked if vaccine availability is a reason for visiting a pharmacy for flu immunization.

Source: Data collected by the researcher (2024)

On the other hand, completion and timeliness of routine vaccination as recommended by the World Health Organisation are very crucial for maximum protection of children against

specific infections (Dolan et al., 2019). Koulidiati et al., (2022) suggests that timeliness of vaccine should be considered as a metric to assess the status of immunization in a country. Zhao et al., (2010) called for timeliness to be considered as an indicator of performance of EPI. Balogun et al., (2023) asked respondents to provide data on whether vaccines were obtained 'timely', 'not timely' or 'not given'.

The reliability of the instrument was ascertained by test–retest reliability technique. The instrument was administered at two points in time on the same population (3- week interval) using a sample of thirty-five respondents. This provided a correlation coefficient of 0.873.

The multiple regression analysis was used for the analysis of data obtained from the section 'B' of the questionnaire. There were four hypotheses in this study. The hypotheses were tested using 0.05 level of significance.

Results and Discussion of Findings

This section presents the result of data analyzed using SPSS software. A total of 400 mothers participated in the study.

TABLE 1

Model Summary showing the effect of distribution strategy on vaccine consumption in Calabar Metropolis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.741 ^a	.549	.544	2.19498

Source: Researcher's SPSS computation from data collected (2024)

TABLE 2

ANOVA showing the effect of vaccine distribution strategies on vaccine consumption in Calabar Metropolis

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2313.816	4	578.454	120.063	.000 ^b
	Residual	1903.081	395	4.818		
	Total	4216.898	399			

Source: Researcher's SPSS computation from data collected (2024)

TABLE 3

Coefficient showing the effect of vaccine distribution strategies on vaccine consumption in Calabar Metropolis

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.529	1.206		-2.927	.004
	MOBILE VACCINE DELIVERY	.209	.060	.190	3.470	.001
	DOOR TO DOOR DELIVERY	.350	.074	.184	4.710	.000
	HOSPITAL CENTRE DELIVERY	.284	.051	.281	5.618	.000
	SCHOOL VACCINE DELIVERY	.321	.061	.249	5.249	.000

Dependent variable: vaccine consumption

Source: Researcher's SPSS computation from data collected (2024)

Interpretation of results

Results from Table 3 indicates that Hospital-based vaccine delivery makes the greatest contribution to the model as it records the highest Beta of 0.281, followed by school-based vaccine delivery with $B=0.249$, mobile vaccine delivery with $B=0.190$ came third, and door to door vaccine delivery with $B=0.184$ came fourth. The ANOVA table labeled Table 2, further report a significant F statistic, indicating the model's strength. R^2 of 54.9 percent (Table 1) is obtained in the model summary. This implies that 54.9 percent of every variation in vaccine consumption is jointly explained by hospital-based, mobile, door-to-door and school-based vaccine delivery.

Table 3 reports the results of the linear regression analysis carried out to test hypothesis one. The result shows that Hospital-based vaccine distribution strategy significantly influences vaccine consumption in Calabar Metropolis, Nigeria. The result shows $t = 5.618$, $\beta = 0.281$, which was significant ($p < 0.05$). Thus, null hypothesis one was rejected.

Table 3 reports the results of the linear regression analysis carried out to test hypothesis three. The result shows that school-based vaccine distribution strategy significantly influences vaccine consumption in Calabar Metropolis, Nigeria. The result shows $t = 5.249$, $\beta = 0.249$, which was significant ($p < 0.05$). Thus, null hypothesis two was rejected.

Table 3 reports the results of the linear regression analysis carried out to test hypothesis four. The result shows that door-to-door vaccine distribution strategy significantly

influence vaccine consumption in Calabar Metropolis, Nigeria. The result shows $t = 4.710$, $\beta = 0.184$, which was significant ($p < 0.05$). Thus, null hypothesis three was rejected.

Table 3 reports the results of the linear regression analysis carried out to test hypothesis five. The result shows that mobile vaccine distribution strategy significantly influence vaccine consumption in Calabar Metropolis, Nigeria. The result shows $t = 3.470$, $\beta = 0.190$, which was significant ($p < 0.05$). Thus, null hypothesis four was rejected.

Discussion of results

The aim of the study was to investigate the extent to which distribution strategies can influence vaccine consumption in Calabar Metropolis, Cross River State, Nigeria. The distribution strategies considered in this study includes: hospital-based, mobile, door-to-door, and school-based vaccine distribution. The respondents for the study were made up of 400 mothers who have a child who is at least two years of age. Four hypotheses were tested in the study. All four hypotheses were significant.

Hospital-based vaccine distribution strategy and vaccine consumption

Analysis of the first hypothesis, shows that Hospital-based vaccine distribution strategy significantly influences vaccine consumption in Calabar Metropolis, Nigeria. This implies that hospital-based vaccine delivery is making a statistically significant unique contribution to the prediction of vaccine consumption. In tandem with this finding is Bryan et al., (2022) who found that there were ≥ 1 vaccine doses administered in 12.9% (95% confidence interval: 12.8–12.9) of hospitalizations, ranging from 1% to 45% across hospitals. Also, children had higher odds of receiving a vaccine dose other than the hepatitis B birth dose or influenza if they were < 2 months old or had a length of stay ≥ 3 days. Results by Sato (2019) indicates that among 21,369 children aged 12 to 59 months old, 78.2% of them were never vaccinated. An additional distance of 1 km to the nearest clinic reduces the likelihood that one receives a vaccine by about 5% [OR: 0.952, 95% CI = 0.935 – 0.969].

School-based vaccine distribution strategy and vaccine consumption

Analysis of the second hypothesis, shows that school-based vaccine distribution strategy significantly influences vaccine consumption in Calabar Metropolis, Nigeria. This implies that school-based vaccine delivery is making a statistically significant unique contribution to the prediction of vaccine consumption. This is in line with the findings of Lim et al (2014) which demonstrated that delivery of the HPV vaccine through a free, school-based program is an effective method of ensuring high completion and on-time dosing. Also, the study by Kim et al., (2023) found that the School Vaccination Check Program (SVCP) was effective in increasing vaccination coverage for targeted vaccinations such as DTaP5, IPV4, MMR2 and IJEV4 for elementary school students, and Tdap6, IJEV5 for middle school students. However, the SVCP did not show a statistically significant effect on increasing vaccination coverage on HPV1 for middle school students.

Door-to-door vaccine distribution strategy and vaccine consumption

Analysis of the third hypothesis, shows that door-to-door vaccine distribution strategy significantly influence vaccine consumption in Calabar Metropolis, Nigeria. This implies that door-to-door vaccine delivery is making a statistically significant unique contribution to the prediction of vaccine consumption. Isaac et al., (2015) results is in line with this finding, because it showed that complete vaccination rates from birth to age one and two were higher for those enrolled in the Families First program (home visiting programs) [Average Treatment Effect Risk Ratio (ATE RR) 1.06 (95 % CI 1.03–1.08) and 1.10 (95 % CI 1.05–1.15) respectively]. Also, according to Lee et al., (2015) the multivariate analysis conducted, indicates that parental perception of usefulness of the Home-School-Doctor model had a very high odds ratio for uptake of HPV vaccination (OR 26.6, 95 % CI 16.4, 41.9).

Mobile vaccine distribution strategy and vaccine consumption

Analysis of the fourth hypothesis, provides results that mobile vaccine distribution strategy significantly influences vaccine consumption in Calabar Metropolis, Nigeria. This implies that mobile vaccine delivery is making a statistically significant unique contribution to the prediction of vaccine consumption. In line with this finding, Harvey-Vera et al., (2022) found that attending the pop-up clinic was independently associated with higher rates of COVID-19 vaccination Adjusted Rate Ratio (AdjRR: 9.15; 95% CI: 5.68–14.74). The researchers observed a significant increase in vaccine uptake associated with attending a temporary pop-up vaccine clinic in Tijuana. More so, Kulle et al., (2023) in testing the effectiveness of MVUs revealed that the vaccination rate in the sample of the treatment group surpassed the rate in the control group by a factor of 3.4 (+9.0 percentage points) over 3 weeks.

Conclusion

Even though vaccines are of great importance to mankind. There are still some persons who do not have access to them. In this study, a sample of 400 respondents were obtained from Calabar Metropolis. with the aim of finding out, the extent to which distribution strategy influences vaccine consumption in Calabar Metropolis, Nigeria. Results of the study indicates that there is a significant relationship between hospital-based, school-based, door-to-door, mobile clinic vaccine distribution strategy and vaccine consumption in Calabar Metropolis. Since all hypotheses are significant, it is vital to provide vaccination services at all the vaccine distribution channels, so that the service will reach a larger number of consumers. However, results from Table 3 indicates that Hospital-based vaccine delivery makes the greatest contribution to the model, followed by school-based vaccine delivery, mobile vaccine delivery came third, and door to door vaccine delivery came fourth. These findings implies that adequate distribution strategy has the potentials to foster increased vaccine consumption, which will in turn lead to better health in the society. These findings underline the urgent need for policy makers and vaccine healthcare institutions to ensure that more functional health centres are established with facilities to

provide vaccination services. Health centres should be convenient. There should be sits and ventilation. To avoid queues, services should be delivered based on first come, first serve basis. Adequate health workers lunch and break shifts should be organized. Also, there should be sufficient health workers in health centres. There should also be adequate inventory management to avoid stock outs of vaccines and other vaccination materials. Out of school children and children who do not attend preschool cannot benefit from school-based vaccination. So, there should be ways to ensure that these children attend school. Adequate forecast of vaccines and vaccination materials needed in school vaccination is necessary to avoid stock out. In the case of Mobile Vaccination. The site used should be convenient. The site must be safe and not exposed to rain or sunlight. The location should be around places that are experiencing low vaccination uptake. Sufficient health workers should be available during mobile vaccination and there should be adequate forecast of materials needed. During door-to-door vaccination, children that are overdue for immunization should be priority. Also, defaulter tracing should be done at least monthly. Putting all of this in place will facilitate increased vaccination rate.

As a result of these findings, it is recommended further investigation should be conducted to unravel the possible solutions to the other factors except access that prevent vaccine uptake in Nigeria. In conclusion, these findings have proven that the marketing toolkit and distribution strategies in particular is a potent tool for increasing vaccine consumption and cannot be forsaken whenever there is a need to achieve a successful vaccination programme.

Recommendations

The following recommendations were made based on the findings of the study:

1. Hospital-based vaccine distribution strategy should be used by healthcare service organisations to increase vaccine consumption in Calabar metropolis, Cross River State, Nigeria.
2. School-based vaccine distribution strategy should be used by healthcare service organisations to increase vaccine consumption in Calabar metropolis, Cross River State, Nigeria.
3. Door-to-door vaccine distribution strategy should be used by healthcare service organisations to increase vaccine consumption in Calabar metropolis, Cross River State, Nigeria.
4. Mobile clinic vaccine distribution strategy should be used by healthcare service organisations to increase vaccine consumption in Calabar metropolis, Cross River State, Nigeria.

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