

Barriers and Facilitators of Pentavalent-3 and Full Immunization Uptake in Northern Nigeria: A Mixed-Methods Study Guided by the 5A Taxonomy

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Abstract

Background: Vaccine-preventable diseases remain a major cause of avoidable morbidity and mortality among under-five children, particularly in sub-Saharan Africa, including Nigeria. Understanding the barriers and facilitators to immunization coverage is crucial for reducing these preventable deaths. This study employed the “5A” taxonomy framework, complemented by focus group discussions (FGD), and key informant interviews (KII) to identify key barriers and facilitators of immunization uptake in order to propose well-targeted interventions.

Objectives: To examine the barriers and facilitators to immunization coverage among children aged 12–23 months in Northern Nigeria using the 5A taxonomy. To explore caregivers’ perspectives and experiences regarding childhood immunization and access challenges.

Methods: This mixed-method, community-based study recruited 675 participants through a multistage cluster sampling technique across five wards in Keffi Local Government Area, Northern Nigeria. Quantitative data were collected using a semi-structured questionnaire based on the 5A taxonomy and analyzed with SPSS version 25.0, with statistical significance set at $p < 0.05$. Qualitative data were obtained from focus group discussions (FGDs) and key informant interviews (KIIs) and analyzed thematically to capture key insights from participants.

Results: Result of the 675 respondents, 327 (48.4%) were males and 348 (51.6%) were females. The independent predictor of Penta3 uptake was activation [OR 3.14; 95% CI: 1.14–8.67], while both activation [OR 8.72; 95% CI: 5.35–14.20] and affordability [OR 3.13; 95% CI: 1.57–6.25] independently predicted full immunization coverage.

Conclusion: Caregiver reminders, incentives (i.e. activation), and cost reduction (affordability) significantly improve immunization coverage in semi-urban communities of Northern Nigeria. Strengthening policies that address the activation and affordability dimensions of the 5A taxonomy could further enhance vaccine uptake and coverage in similar settings.

Keywords: Immunization, 5a Taxonomy, FGD, KII

1. Introduction

The rising trend in avoidable childhood death from Vaccine-Preventable Disease (VPD) is a burdensome public health challenge that has generated research interest around the globe. There is now a strong consensus on the need to identify and address both the barriers and facilitators of immunization coverage [1]. This is because despite global efforts at massive campaigns and advocacy for immunization, immunization coverage has remained low, especially in low- and middle-income countries (LMIC) of

the world, Nigeria inclusive [1]. The resultant effect is that vaccine preventable diseases continue to be a leading cause of death in under-five children [1-3]. According to the World Health Organization (WHO, 2017), approximately 19.9 million children worldwide remain either unimmunized or under-immunized, with Nigeria accounting for nearly one-fifth of this number—about four million children making it the country with the highest burden of under-immunized children globally [4]. Consequently, Nigeria continues to lag behind many nations even as countries of the world advance

in achieving healthy living and promoting wellbeing for all at all ages which is the sustainable development goal (SDG) 3 [5,6]. Achieving high full immunization coverage rates will result in the reduction of both infant and under-5 mortality and aid in attainment of the child survival target, SDG 3.2.5,6 Available estimates are that with Pentavalent vaccine on the routine immunization schedule 30,000 deaths will be prevented annually resulting in a 17% reduction in child mortality rate [7].

Numerous studies have attributed Nigeria's persistently low immunization coverage to multiple factors, collectively referred to as predictors of immunization coverage [8-17]. These predictors include both demand- and supply-side barriers, such as inadequate vaccine availability, limited access to immunization services, mistrust in the health system, and various socio-demographic factors parental education, socioeconomic status, ethnicity, and religious beliefs. Recognizing the complexity of these factors, researchers have developed several frameworks to categorize and better understand the determinants of immunization uptake [8-11]. Such classification systems not only provide a comprehensive means of analyzing barriers and facilitators but also simplify findings, making them more actionable for policymakers and program designers seeking to enhance immunization coverage [8-11]. Prominent classification frameworks include the supply-demand model, client-provider models, and psychological-based frameworks such as the 3Cs, 5Cs, and 5A taxonomies [8-12]. The 5 C system utilizes the terminology calculation, complacency, confidence, constraints, and collective responsibility to explain the barriers to immunization. The 5 "C" model was created by Betsch, by building on the Strategic Advisory Group of Experts on immunization (SAGE) 3 "C" model of complacency, confidence and constraints [10,12]. The 5 "A" taxonomy was developed by Thomson using a systematic review of the literature. It offers a more programmatic and operational lens by categorizing determinants into five major dimensions: acceptance, access, activation, affordability and awareness [9]. Within this framework, acceptance assesses the extent to which caregivers trust and perceive vaccination as beneficial and safe for their children. Access examines the ease with which caregivers can obtain immunization services, including proximity and transportation challenges. Affordability evaluates both direct and indirect costs such as transportation, opportunity costs, and ancillary expenses—that may limit caregivers' ability to complete vaccination schedules. Awareness explores caregivers' knowledge and understanding of immunization benefits, schedules, and service locations. Finally, activation focuses on interventions that prompt caregivers to vaccinate, such as reminders, incentives, or community mobilization efforts [10].

The 5A taxonomy was selected as the guiding framework for this study due to its broad applicability, simplicity, and inclusion of evidence from Nigerian studies in its formulation. Its comprehensive structure provides an effective approach for identifying and addressing the multifaceted barriers and facilitators influencing immunization coverage. To enrich the

findings and provide a deeper understanding of caregivers' real-world experiences, this study adopted a mixed-methods design. In addition to quantitative assessment, qualitative data were gathered through focus group discussions with caregivers across five selected wards in Keffi Local Government Area, Nasarawa State. This bi-faceted approach integrates both statistical and experiential perspectives, offering a holistic understanding of the factors shaping Pentavalent-3 and full immunization uptake among children aged 12–23 months in Northern Nigeria.

2. Methods

A community based mixed method study which involved random selection of 5 wards in the Keffi Local Government Area – (Angwa Iya II, Angwa Rimi, Liman Abaji, Sabon Gari and Yara wards) in Nasarawa State, Northern Nigeria. The study participants were children aged 12 – 23 months and their primary caregivers residing in the five (5) randomly selected wards of Keffi LGA at the time of the study.

2.1. Sampling Technique

2.1.1. For Quantitative Data

A multi-staged sampling technique was used for the purpose of this study.

SAMPLING TECHNIQUE (QUANTITATIVE DATA)

A multi-stage sampling technique was employed for this study.

Stage 1: Selection of Wards

Out of the ten (10) wards in Keffi, five (5) were selected using simple random sampling by balloting. Since eight (8) wards are located in the densely populated areas of Keffi town and two (2) are in the less populated outskirts, wards were selected in a 4:1 ratio using proportional sampling.

The selected wards were:

- Densely populated areas: Angwa Iya II, Angwa Rimi, Liman Abaji, and Yara.
- Less populated area: Sabon Gari.

Stage 2: Selection of Settlements (Primary Sampling Units – PSUS)

Each of the five selected wards was mapped using computer-generated maps from the Nasarawa Geographic Information Service (NAGIS). Wards were divided into settlements (clusters) of approximately 20–30 houses each, and every ward had 30 clusters. From each ward, 27 clusters were randomly selected using a computer-generated random sampling method, forming the primary sampling units (PSUs).

Stage 3: Selection of Households (Secondary Sampling Units–SSUS)

The selected PSUs were located using GPS coordinates and local landmarks. Within each PSU, buildings were identified as residential or non-residential, and the residential ones were numbered. From these, five (5) households were randomly selected using simple random sampling by balloting, giving a total of 135 households per ward. A household was defined as related or unrelated persons sharing the same living

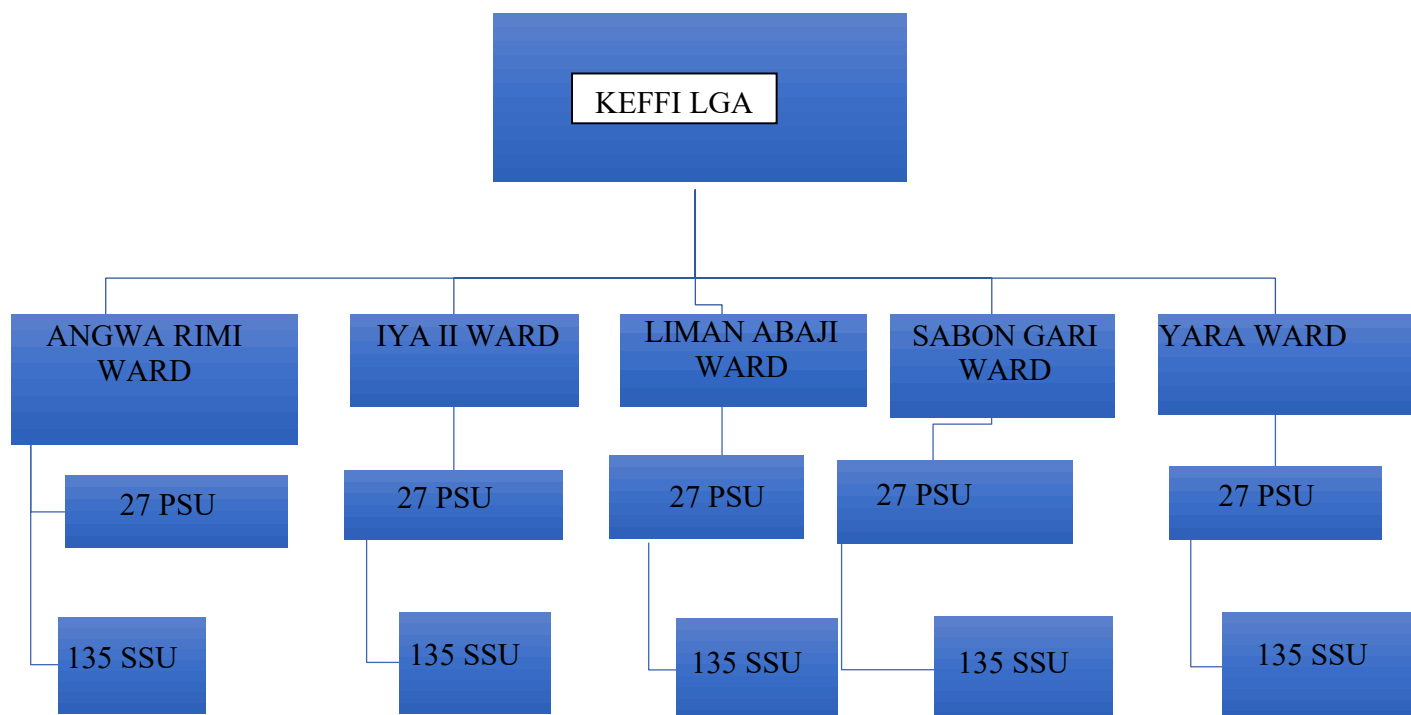
space and housekeeping arrangements, with one adult (male or female) aged 15 years or older recognized as the head.

Stage 4: Selection of Respondents

In each selected household (SSU), one eligible respondent the caregiver of a child aged 12–23 months was interviewed,

totaling 135 respondents per ward. If a selected household had no eligible child or declined participation, the nearest household with an eligible child was recruited as a replacement.

Schema for Sampling



Each selected participant was administered the questionnaire based on the 5A taxonomy. It was developed by the researchers to collect information on the possible predictors of immunization in this study. The instrument contained structured questions designed to assess how accessible, affordable, and acceptable immunization services are, in order to analyze their effects on immunization coverage. It also included questions related to awareness and activation (such as reminders about immunization days). This study adopted the taxonomy developed by Thomson et al. to categorize the predictors of immunization coverage.

Each domain of the taxonomy contained a minimum of five questions to determine its presence or absence. Specifically:

- Acceptability included 8 questions; if 5–8 responses aligned with vaccine acceptance, the respondent was coded as Yes for acceptability.
- Affordability comprised 6 questions; at least 4 affirmative responses indicated immunization was affordable (Yes).

- Accessibility, Awareness, and Activation each included 5 questions, and were coded as Yes if at least 3 responses aligned with the presence of that factor.

3. Results

3.1. Association Between the 5A Taxonomy and Penta3 Uptake

The relationship between the 5A taxonomy domains and Penta3 vaccine uptake was examined (Table I). Bivariate analysis showed that four of the five domains were significantly associated with Penta3 uptake. Specifically, acceptance ($\chi^2 = 18.65$, $df = 1$, $p < 0.001$), accessibility ($\chi^2 = 23.10$, $df = 1$, $p < 0.001$), activation ($\chi^2 = 5.97$, $df = 1$, $p = 0.015$), and awareness ($\chi^2 = 39.25$, $df = 1$, $p < 0.001$) demonstrated statistically significant associations with vaccine uptake. These findings suggest that improved acceptance, better access to services, timely activation or reminders, and higher awareness levels are important facilitators of Penta3 immunization coverage among the study population.

Variable	Penta3		χ^2	df	p-value
	Yes n = 647	No n = 28			
Acceptance					
Yes	474 (73.3)	18 (64.3)			
No	173 (26.7)	10 (35.7)	18.65	1	<0.001*
Access					
Yes	626 (96.8)	22 (78.6)			
No	21 (3.2)	6 (21.4)	23.10	1	<0.001*
Activation					
Yes	307 (47.4)	8 (28.6)			
No	340 (52.6)	20 (71.4)	5.97	1	<0.015*
Affordability					
Yes	591 (91.3)	23 (82.1)			
No	56 (8.7)	5 (17.9)	2.76	1	<0.090
Awareness					
Yes	639 (98.8)	23 (82.1)			
No	8 (1.2)	5 (17.9)	39.25	1	<0.001*

*Statistically significant difference (p value < 0.05), χ^2 – Chi-square test, df – differential

Table 1: Association Between 5 A Taxonomy and Penta3 Uptake

3.2. The Predictors of Penta3 Uptake

On multivariate logistic regression analysis, activation was the only 5A taxonomy domain found to be an independent predictor of Penta3 uptake. Children whose caregivers were motivated through reminders or incentives—such as phone calls or receiving small tokens were approximately

three times more likely to have received the Penta3 vaccine compared with those who were not activated [OR 3.14, 95% CI: 1.14–8.67, $p = 0.027$]. Other domains of the taxonomy acceptance, accessibility, and awareness—did not retain statistical significance on multivariate analysis.

Variable	Odds Ratio	Std. Err.	z	P value	[95% Conf. Lower]	Interval] Upper
Acceptance						
Yes	2.377	1.110	1.85	0.064	0.952	5.936
Access						
Yes	2.465	1.778	1.25	0.211	0.600	10.134
Activation						
Yes	3.143	1.627	2.21	0.027*	1.140	8.667
Affordability						
Yes	0.883	0.568	-0.19	0.847	0.250	3.117
Awareness						
Yes	4.883	4.445	1.74	0.082	0.820	29.082

*Statistically significant, $p < 0.05$; Conf. Interval = Confidence Interval, std. err. = standard error, z = standard score

Table 2: The Predictors of Penta3 Uptake

3.3. Association Between 5 A Taxonomy and Full Immunization

All domains of the 5A taxonomy accessibility, acceptability, affordability, awareness, and activation were significantly associated with full immunization ($p < 0.05$) (Table III).

Children whose caregivers reported better access to immunization services, higher acceptability and affordability of vaccines, greater awareness of immunization schedules, and effective activation through reminders or incentives were more likely to be fully immunized.

Variable	FULL IMMUNIZATION		χ^2	df	p-value
	YES	NO			
Acceptance					
Yes	360 (75.3)	124 (62.9)	10.52	1	0.001*
No	118 (26.7)	73 (37.1)			
Access					
Yes	466 (97.5)	182 (92.4)	9.46	1	0.002*
No	12 (2.5)	15 (7.6)			
Activation					
Yes	277 (57.9)	36 (18.3)	86.81	1	<0.001*
No	201 (42.1)	159 (80.7)			
Affordability					
Yes	453 (94.8)	161 (81.7)	28.87	1	<0.001*
No	25 (5.2)	36 (18.3)			
Awareness					
Yes	474 (98.8)	188 (95.4)	10.29	1	†0.001*
No	4 (1.2)	9 (4.6)			

*Statistically significant difference (p value < 0.05), χ^2 = Chi-square test, df = degree of freedom, † Fisher exact p

Table 3: Association Between 5 A Taxonomy and Full Immunization

3.4. Predictors of Full Immunization

On multivariate logistic regression analysis activation, and affordability were identified as independent predictors of full immunization. Children whose caregivers were activated through reminders or incentives were about nine times more likely to be fully immunized compared with those who were not [OR 8.72, 95% CI: 5.35–14.20, p = 0.001]. Affordability

of immunization also significantly increased the likelihood of full immunization, with children from households reporting vaccines were affordable being approximately three times more likely to be fully immunized [OR 3.13, 95% CI: 1.57–6.25, p = 0.001]. Other domains of the 5A taxonomy acceptability, accessibility, and awareness did not retain statistical significance on multivariate analysis. (Table IV)

Variable	Odds Ratio	Std. Err.	z	P value	[95% C.I Lower – Upper]	
Acceptance						
Yes	1.220	0.294	0.83	0.409	0.761	1.955
Access						
Yes	1.651	0.965	0.86	0.391	0.525	5.192
Activation						
Yes	8.716	2.172	8.69	<0.001*	5.348	14.203
Yes	3.127	1.105	3.23	0.001*	1.565	6.250
Awareness						
Yes	2.095	1.590	0.97	0.330	0.473	9.270

*Statistically significant; Conf. Interval = Confidence Interval, std. err. = standard error, z = standard score

Table 4: The Predictors of Full Immunization

3.5. Caregivers' Perspectives and Experiences on Childhood Immunization

To investigate caregivers' perspectives and experiences on childhood immunization and access challenges, five focus group discussions (FGDs) were conducted with caregivers of children aged 12–23 months, one in each selected ward. Additionally, key informant interviews were held with health care workers involved in immunization. Open-ended questions were employed to gather participants'

perspectives, offering a contextual understanding of caregivers' experiences with childhood immunization. These experiences were analyzed according to the 5A taxonomy: acceptance, access, awareness, affordability, and activation.

➤ A Thematic Summary of the Discussions is Presented Below

• Acceptance

Most caregivers demonstrated strong acceptance of

immunization, acknowledging its preventive benefits and receiving support from their spouses and communities. “We are happy with the immunization; we see the effect on our babies, and even my husband encourages me and reminds me of our immunization date.” (FGD, Mother of three, Age 27) Community-level sensitization, particularly through local leaders, was reported to have improved uptake. Health workers agreed that community acceptance had grown but noted lingering misconceptions. “Many accept, but some do not. Some still believe that immunization will make their children sterile. More effort is needed to ensure that belief is completely erased.” (KII, Female HCW, 15 years in immunization services). However, fear of side effects such as fever, swelling, and prolonged crying sometimes discouraged mothers from completing schedules: “Some mothers do not believe in it... they start and do not finish because their children are crying.” (FGD, Mother of six, Age 42). These perspectives reinforce the quantitative findings where acceptance influenced by perceptions of safety and benefit—was a significant enabler of immunization uptake.

• Access

Caregivers generally rated immunization services positively, appreciating provider attitudes and service availability. “The provision of the services in the health facility is really good; they attend to us well.” (FGD, Mother of one, Age 31). Nevertheless, issues such as long waiting times, occasional vaccine shortages, and transport difficulties affected attendance. “Some hospitals you will spend a lot of time when you come for immunization, leaving the rest of the children at home.” (FGD, Mother of four, Age 42). Health workers confirmed these barriers, citing logistical limitations and resource shortages: “There is good turnout in the clinic, but the staff are mostly volunteers and we lack tools like gloves and syringes.” (KII, Male HCW, 2 years in immunization

services). These findings mirror the quantitative analysis where access and affordability were key determinants of immunization completion.

• Awareness

Awareness and understanding of immunization benefits were enhanced through antenatal sessions and community health talks. However, caregivers noted inconsistencies in health education delivery. “The health talk is very important... when you know the importance of what you are doing it will give you more energy to do it.” (FGD, Mother of five, Age 42). Health workers emphasized ongoing sensitization efforts involving community and religious leaders, which have improved awareness and trust.

• Affordability

Although vaccines were provided free of charge, indirect costs such as transport and time away from income-generating work presented challenges for some caregivers. “We spend a lot of time when we come for immunization, and sometimes transport is costly.” (FGD, Mother of two, Age 30). These constraints particularly affected families in lower socio-economic groups, consistent with the statistical evidence where affordability emerged as a significant independent predictor of full immunization.

• Activation

Reminders and small incentives were powerful motivators for completing immunization schedules. Caregivers appreciated phone reminders and encouragement from health workers. “At the facility where I immunize my child, if you forget they will call you—it helps.” (FGD, Mother of two, Age 34). Health workers also suggested providing tokens such as mosquito nets or certificates to enhance participation. “Giving mothers incentives like mosquito nets and certificates used to encourage them; they should be restored.” (KII, Male HCW, 2 years in immunization services).

5A Taxonomy Domain	Emergent Qualitative Themes	Representative Quotes (FGD/KII)	Interpretation / Link to Quantitative Findings
Acceptance	General community acceptance; perceived benefits of immunization; minor resistance due to fear of side effects	<i>“We are happy with the immunization; we see the effect on our babies, and even my husband encourages me and reminds me of our immunization date.” (FGD, Mother of 3, 27years) “Some mothers do not believe in it... they start and do not finish because their children are crying.” (FGD, Mother of 6, 42y)</i>	High perceived benefit reinforced acceptance. Side effects discouraged some caregivers. These findings align with quantitative evidence that acceptance significantly predicts immunization uptake.

Access	Good availability of services but hindered by long waiting times, distance, and occasional stock-outs	<i>"The provision of the services in the health facility is really good; they attend to us well." (FGD, Mother of 1, 31y) "Some hospitals you will spend a lot of time when you come for immunization." (FGD, Mother of 4, 42y) "There is good turnout... but staff are mostly volunteers and we lack tools like gloves." (KII, Male HCW, 27y)</i>	Physical access was mostly adequate, but service inefficiencies discouraged attendance. Quantitatively, access and affordability were significant in predicting immunization completion.
Awareness	Knowledge from health talks and community sensitization; inconsistent health education	<i>"The health talk is very important... when you know the importance of what you are doing it gives you more energy to do it." (FGD, Mother of 5, 42y) "Community leaders hold meetings with men... which has led to wide acceptance." (KII, Female HCW, 13y)</i>	Awareness-building activities improved trust and uptake. Quantitative data indicated that awareness interacts with activation to enhance completion rates.
Affordability	Direct costs minimal but indirect costs (transport, waiting time) were barriers	<i>"We spend a lot of time when we come for immunization, and sometimes transport is costly." (FGD, Mother of 2, 30y)</i>	While vaccines were free, opportunity costs affected utilization. Quantitative results confirmed affordability as an independent predictor of full immunization.
Activation	Reminder systems, incentives, and spousal encouragement motivated completion	<i>"At the facility where I immunize my child, if you forget they will call you—it helps." (FGD, Mother of 2, 34y) "Giving mothers incentives like mosquito nets and certificates used to encourage them." (KII, Male HCW, 2y)</i>	External motivators (calls, tokens) enhanced participation and completion. Quantitative findings also identified activation as a strong independent predictor of Penta3 and full immunization.

Table 5: Summary of Qualitative Themes Mapped to the 5A Taxonomy Domains

4. Discussion

This study examined barriers and facilitators to immunization coverage among children aged 12–23 months in Northern Nigeria, using the 5A taxonomy (Access, Acceptance, Awareness, Affordability and Activation), and explored caregivers' perspectives and experiences related to childhood immunization. Using open-ended questions and thematic analysis, the 5A framework provided a structured understanding of factors influencing uptake and completion of childhood immunizations. All domains of the taxonomy except affordability were significant predictors of Penta3 uptake, while all except access were associated with full immunization, highlighting the interdependence of these determinants.

• Affordability

Affordability though not an independent predictor of Penta3 uptake, remained relevant when considering full immunization. This finding was collaborated by the FGD and KIIs where mothers and health care workers mentioned increased transport costs especially due to re-visits to the facility occasioned by stock-outs as barriers. Although routine immunization services in Keffi are provided free of charge, caregivers reported indirect costs such as payment for ancillary items (gloves, syringes) and transport expenses. These findings are consistent with Abdulraheem and Akwataghibe who found that even small, unplanned expenditures deterred caregivers from completing immunizations [13,14]. Time costs were also cited, with long waiting periods at facilities discouraging mothers from returning.

• Acceptance

Acceptance of immunization was generally high, and most caregivers perceived vaccine refusal as uncommon. The few who declined vaccines cited adverse reactions or lingering misconceptions such as fears of sterility or paralysis previously reported in other northern Nigerian studies [15,16]. High acceptance in Keffi likely reflects extensive community mobilisation and may explain why it did not independently predict uptake.

• Access

Access did not independently predict either Penta3 uptake or full immunization, likely due to Keffi's relatively dense health facility network 25 facilities in total which offer immunization services occurring within 5 km for most households and routine outreach activities. This contrasts with findings from other regions where distance and poor transport were major barriers [17-19]. Temporary service interruptions during the COVID-19 lockdown, however, did affect access for some caregivers.

• Awareness

Measured by mothers' knowledge of vaccine-preventable diseases, was associated with uptake in univariate analysis but lost significance after adjustment. Qualitative data suggest that effective community engagement—through trusted ward development committees (WDCs), religious leaders and traditional heads—compensated for limited biomedical knowledge. Previous studies have similarly shown that endorsement by community leaders can enhance confidence and participation [20-23].

• Activation

Activation emerged as a key facilitator. Caregivers who received reminders by phone, text, or tokens were significantly more likely to complete the immunization schedule. Retention of the immunization card also served as an activation cue; conversely, losing the card or being reprimanded for it discouraged follow-up. The strong association between activation and coverage aligns with evidence from other low-resource settings showing that reminder systems and incentives improve immunization uptake [24,25].

Integration of quantitative and qualitative findings underscores the complexity of immunization behaviour. Overall, this study highlights activation, and affordability and as the most critical levers for improving immunization coverage in this context. While acceptance, access and awareness were found to be less limiting likely due to community leader involvement and participation. Hence sustaining motivation, reducing hidden costs, and strengthening reminder systems could improve immunization uptake and support the attainment of WHO's 90% coverage target.

5. Conclusion

This study examined the barriers and facilitators influencing Pentavalent-3 and full immunization coverage among children aged 12–23 months in Keffi Local Government Area, Nasarawa State, using the 5A taxonomy Access, Acceptance, Awareness, Affordability, and Activation as an

analytical framework. The integration of quantitative and qualitative methods provided a holistic understanding of the factors shaping immunization uptake in this Northern Nigerian context. Findings revealed that all aspects of the taxonomy had some effect on immunization uptake though with varied levels of influence. Activation and affordability emerged as the most critical determinants of immunization uptake underscoring the importance of reminder systems, gift tokens, and reduction of direct costs to caregivers. The qualitative aspect of this study also emphasized these findings and brought to fore the effect of community mobilization and participation on immunization acceptance and uptake.

Recommendations

Based on this study's findings, recommendations are proposed as follows:

- **Strengthen Activation Strategies:** Incorporating reminder systems such as phone calls, SMS alerts, community health worker visits and immunization card tracking as a major aspect of immunization health services.
- **Reduction of Indirect Costs:** Provision of transportation stipends, increasing funding for community health outreach programs, and ensuring full provision of vaccination materials to completely eliminate hidden costs which fall back on caregivers.
- **Sustain Community Participation:** Maintenance and expansion of collaboration with the Ward Development Committees (WDCs), traditional rulers, and religious leaders who serve as trusted advocates for immunization within their communities.
- **Adoption of the 5A Taxonomy Framework:** Policymakers and immunization program managers should adopt the 5A taxonomy framework in the planning and evaluation of immunization initiatives. This approach will promote uniformity in identifying and reporting barriers and facilitators of immunization, thereby ensuring a balanced emphasis on behavioural, economic, and service delivery factors, and facilitating more effective resolution of challenges.

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References

1. Ophori, E. A., Tula, M. Y., Azih, A. V., Okojie, R., & Ikpo, P. E. (2014). Current trends of immunization in Nigeria: prospect and challenges. *Tropical medicine and health*, 42(2), 67-75.
2. Chido-Amajuoyi, O. G., Wonodi, C., Mantey, D., Perez, A., & Mcalister, A. (2018). Prevalence and correlates of never vaccinated Nigerian children, aged 1–5 years. *Vaccine*, 36(46), 6953-6960.
3. Ibe O. Child Survival in Nigeria: Situation, Response, and Prospects [Internet]. Policy Project; 2002 [cited 2021 Jan 20].

4. VanderEnde, K. (2018). Global routine vaccination coverage—2017. *MMWR. Morbidity and mortality weekly report*, 67.
5. Advisory, P. A. N. (2012). Paediatric Association of Nigeria (PAN) recommended routine immunization schedule for Nigerian children. *Niger J Paed*, 39(4), 152-158.
6. Liu, L., Oza, S., Hogan, D., Chu, Y., Perin, J., Zhu, J., ... & Black, R. E. (2016). Global, regional, and national causes of under-5 mortality in 2000–15: an updated systematic analysis with implications for the Sustainable Development Goals. *The Lancet*, 388(10063), 3027-3035.
7. Muhammad, N. A. (2015). New vaccines introduction in Nigeria: catalyst for improving immunization coverage and child survival. *J Pain Relief*, 4(185), 2.
8. Eboreime, E., Abimbola, S., & Bozzani, F. (2015). Access to routine immunization: a comparative analysis of supply-side disparities between Northern and Southern Nigeria. *PloS one*, 10(12), e0144876.
9. Thomson, A., Robinson, K., & Vallée-Tourangeau, G. (2016). The 5As: A practical taxonomy for the determinants of vaccine uptake. *Vaccine*, 34(8), 1018-1024.
10. Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. *PloS one*, 13(12), e0208601.
11. Mazige, F. M., Kalwani, J. D., & Kakoko, D. C. V. (2016). Social determinants of immunization services uptake in developing countries: A systematic review. *The Pan African Medical Journal*, 24(197).
12. MacDonald, N. E. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, 33(34), 4161-4164.
13. Abdulraheem, I. S., Onajole, A. T., Jimoh, A. A. G., & Oladipo, A. R. (2011). Reasons for incomplete vaccination and factors for missed opportunities among rural Nigerian children. *J Public Health Epidemiol*, 3(4), 194-203.
14. Akwataghibe, N. N., Ogunsola, E. A., Broerse, J. E., Popoola, O. A., Agbo, A. I., & Dieleman, M. A. (2019). Exploring factors influencing immunization utilization in Nigeria—a mixed methods study. *Frontiers in public health*, 7, 392.
15. Gidado, S., Nguku, P., Biya, O., Waziri, N. E., Mohammed, A., Nsubuga, P., ... & Sabitu, K. (2014). Determinants of routine immunization coverage in Bungudu, Zamfara state, northern Nigeria, may 2010. *The Pan African Medical Journal*, 18(Suppl 1), 9.
16. Babalola, S. (2009). Determinants of the uptake of the full dose of Diphtheria–Pertussis–Tetanus vaccines (DPT3) in northern Nigeria: a multilevel analysis. *Maternal and child health journal*, 13(4), 550-558.
17. Legesse, E., & Dechasa, W. (2015). An assessment of child immunization coverage and its determinants in Sinana District, Southeast Ethiopia. *BMC pediatrics*, 15(1), 31.
18. Adedokun, S. T., Uthman, O. A., Adekanmbi, V. T., & Wiysonge, C. S. (2017). Incomplete childhood immunization in Nigeria: a multilevel analysis of individual and contextual factors. *BMC public health*, 17(1), 236.
19. Adenike, O. B., Adejumo, J., Olufunmi, O., & Ridwan, O. (2017). Maternal characteristics and immunization status of children in North Central of Nigeria. *The Pan African Medical Journal*, 26, 159.
20. Akinyemi, O. O., Adebayo, A., Bassey, C., Nwaiwu, C., Kalbarczyk, A., Fatiregun, A. A., ... & Owoaje, E. (2021). Assessing community engagement in Nigeria polio eradication initiative: application of the Consolidated Framework for Implementation Research. *BMJ open*, 11(8), e048694.
21. Bello, S., Hassan, I., Ogunkunle, T., Ibrahim, O., Lawal, A., & Issah, Y. (2021). Factors affecting the vaccination status of under five children in Nasarawa State, Nigeria. *African Journal of Medical and Health Sciences*, 20(8), 98-104.
22. Baguune, B., Ndago, J. A., & Adokiya, M. N. (2017). Immunization dropout rate and data quality among children 12–23 months of age in Ghana. *Archives of Public Health*, 75(1), 18.
23. Maina, L. C., Karanja, S., & Kombich, J. (2013). Immunization coverage and its determinants among children aged 12-23 months in a peri-urban area of Kenya. *The Pan African Medical Journal*, 14, 3.
24. Uwemedimo, O. T., Findley, S. E., Andres, R., Irigoyen, M., & Stockwell, M. S. (2012). Determinants of influenza vaccination among young children in an inner-city community. *Journal of community health*, 37(3), 663-672.
25. Ibraheem, R., Akintola, M., Abdulkadir, M., Ameen, H., Bolarinwa, O., & Adeboye, M. (2021). Effects of call reminders, short message services (SMS) reminders, and SMS immunization facts on childhood routine vaccination timing and completion in Ilorin, Nigeria. *African Health Sciences*, 21(2), 951-959.