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Case Study

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Improving Urban Immunization and Reducing the Zero-dose Children: Results from Implementation Study in Dar es-Salaam, Tanzania

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Abstract

Many countries are struggling to reach children that have not received a single vaccine (zero-dose), who mostly live in urban, remote, and conflict areas. This study mapped the zero-dose children in Dar es Salaam region and redesigned and implemented an intervention package to improve urban immunization.

The study was conducted from February to May 2022 in Ilala and Kigamboni districts. Data was collected through the review of documents including routine immunization data and interviews with parents/guardians and healthcare workers in ten health facilities with the highest number of zero-dose children. The evidence gathered was used to redesign an intervention package that was implemented in the study facilities.

A total of 1,266 zero-dose children were identified in the study facilities. In Ilala district, zero-dose children were concentrated in areas with an extensive network of health facilities, while in Kigamboni they were largely in areas with sparse facilities. The designed intervention package involved the provision of vaccinations during weekends i.e., Saturday, the formation of new outreach posts in new settlements where previously there were no health facilities, and the involvement of community health workers to identify and track zero-dose children and conduct social mobilization and advocacy. During the four months of package implementation half of the zero-dose children (i.e., 651) were reintegrated back into health facilities for immunization. Also,

880 children including the under-vaccinated, received vaccines in the newly formed outreach posts and 1,105 more children received vaccinations during weekends.

The provision of immunization during weekends, moving services closer to where people live through outreach and extensive advocacy, sensitization, and tracking by community health workers and leaders helped to improve urban immunization.

Keywords: Tanzania; zero-dose; vaccination; urban; vaccine-preventable diseases; children

Introduction

Immunization is one of the most cost-effective interventions for the reduction of childhood morbidity and mortality. It is reported that immunization averts an estimated 2.5 million deaths every year from diphtheria, tetanus, pertussis (whooping cough), and measles (Global Vaccine Action Plan 2011-2020). Significant improvements in vaccination coverage have been made globally since 1980s due to substantial investment in childhood immunization services. However, in the past decade, progress has stalled, and routine vaccination coverage has declined in many countries. The global coverage of the first dose of a diphtheria-tetanus-pertussis-containing vaccine (DTP1) and the first dose of a measles-containing vaccine (MCV1) fell from 90% and 86% in 2019 and further to 86% and 81% in 2021 [1]. Disruption to routine vaccination activities brought about by the COVID-19 pandemic further contributed to poor immunization performance in many countries [2].

Coverage of the DTP-containing vaccine is one of the main indicators for monitoring the performance of immunization programs because it is universally present in all national vaccination schedules for children under one year and requires three contacts with the healthcare system [3]. Immunization programs use coverage of DTP1 as a proxy for zero-dose children (i.e., those who have not received a single shot of vaccines). Nearly half of these children live in urban areas, remote communities, and conflict-affected setting [4]. In 2020, it was estimated that about 12.4 million children mostly in low-income countries were zero-dose, leaving them exposed to the world's most devastating vaccine-preventable diseases [5]. In 2021, according to UNICEF, 18 million children were zero-dose and 25 million were under-vaccinated (having not received all required vaccines) [1].

Poor coverage of immunization exposes children to deadly vaccine-preventable diseases. The sub-Saharan Africa region has the highest mortality rate for children under five worldwide, accounting for 52% of all deaths in this age group [6]. One in 13 children in this region died before turning five in 2018, according to the region's average under-five mortality rate of 78 deaths per 1,000 live births. This ratio is 16 times greater than the high-income country average of 1 in 199 children. The majority of these fatalities can be avoided with the provision of low-cost, interventions including vaccination, hygienic drinking water, proper nourishment, and appropriate care from qualified health professionals [6].

Tanzania, like many other countries in Sub-Saharan Africa, has experienced rapid urbanization since the 1960s. Several studies have shown that the urban population increased from 5% in 1967 to 23% in 2002 (URT, 2002) and further to 27% in 2012 (URT, 2012). It is projected that the urban population will surpass 20 million by 2030 [7]. Urbanization has been accelerated by rural-urban migration mostly in search of employment opportunities, natural population growth, and expansion of urban administrative boundaries (URT 2013, p.63). Rapid urbanization is surpassing the public sector's ability to provide infrastructures to support the provision of basic social services including health. Rapid urbanization has increased the number of people living in slums and peri-urban poor communities with limited access to immunization services [8] These urban areas with low vaccination coverage have a high potential for transmission and outbreaks of vaccine-preventable diseases.

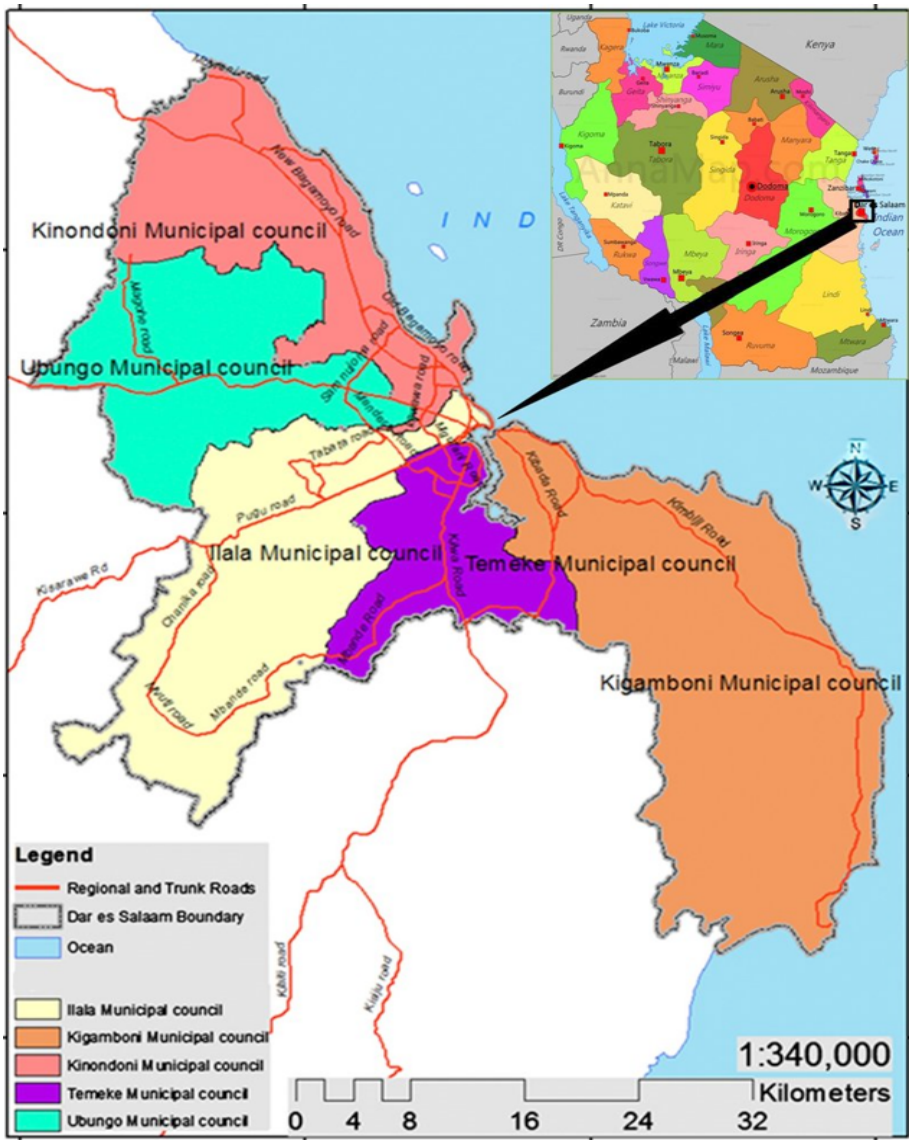
Reaching zero-dose children is a global, and national agenda in Tanzania. The Gavi Board approved a new five-year strategy ('Gavi 5.0') with a vision to 'leave no one behind with immunization' and a mission to save lives and protect people's health by increasing equitable access and sustainable use of vaccines [9]. The new UNICEF Immunization Roadmap 2018-2030 has also placed equity in immunization as one of its key agendas. The roadmap has earmarked communities living in remote rural areas, urban slums, and conflict-affected/insecure settings as the most at-risk population groups that need urgent action [4]. WHOs Immunization Agenda 2030 also focus on leaving no one behind with immunization. The Tanzanian National Immunization Strategy (NIS-2021-2025) also has a focus on reaching zero-dose children. Within the GAVI 5.0, UNICEF Roadmap 2018-2030, the WHOs Immunization Agenda 2030, and NIS strategies, the zero-dose focus is developed, operationalized, and positioned for action. The idea of reaching zero-dose children has been taken forward by CHAI in Tanzania to reflect on outstanding questions regarding urban immunization and zero-dose children, particularly on how to define, target, and implement strategies, including identifying risks that need to be considered and mitigated. Therefore this implementation study aimed at improving urban immunization coverage in Dar es Salaam city by reducing the number of zero-dose children.

The study determined the immunization performance in terms of coverage, and factors behind poor performance and used the evidence gathered to redesign strategies to reach the zero-dose children.

Methodology

Study Setting

Dar es Salaam is the business capital of Tanzania. It is subdivided into five districts namely Ilala, Kinondoni, Temeke, Ubungo, and Kigamboni (Map 1). According to the 2022 census, Dar es Salaam has a population of about 5.3 million people, and a population density of more than 3100 people per km2, thus making it the most densely populated region in Tanzania. Originally, Dar es Salaam was ethnically inhabited by the Zaramo, however, the immigration of other tribes has made the region to be culturally diverse. More than three-quarters of the residents live in informal settlements and are mostly involved in business [10].



Map 1: *Dar es Salaam region and its five districts*

Identification of zero-dose children

We performed a desk review of routine immunization data for Dar es Salaam region to assess immunization performance in the five districts in terms of coverage and number of zero-dose children. We also assessed challenges of service delivery and coverage trends for Bacille Calmette-Guérin (BCG), the first dose of diphtheria-tetanus-pertussis-containing vaccine (DTP1), and DTP3 for the years 2020 and the first quarter of 2021. Dar es Salaam has 783 health facilities in total, but only 318 (41%) offer vaccination services. Kigamboni has the highest proportion of health facilities offering vaccination services at 80%, followed by Temeke (71%), Ubungo (42%), Ilala (37%), and Kinondoni (24%).

With regards to the performance of the immunization program, the aggregate coverage data at the regional level for BCG, DTP1, and DTP3 for the year 2020 was high and a similar trend was observed in the first quarter of 2021 (National Immunization data). The data when disaggregated by districts showed that all three antigens had coverage of above 100% except in Ilala with DTP1 coverage of 93% and DTP3 of 90%, and Ubungo with a BCG coverage of 88%. DTP1 coverage—the proxy for zero-dose children was high, necessitating another way of examining the data to understand the true prevalence of zero-dose children. Therefore, instead of using the estimated target population for DTP1, we used the number of children that were vaccinated with BCG. These two vaccines are both given at birth, hence coverage is supposed to be the same. However, we found that many children who received BCG did not receive the corresponding DTP1 vaccine in Ilala and Kigamboni districts as shown in Table 1. Therefore, the implementation study was focused on these two districts with the highest number of zero-dose children.

Council(s)	**Target (SI)**	**BCG**	**IMR=34.1/1,000 live birth**	**Assuming these children survived**	**DTP1**	**Missed DTP1 from BCG**	**%zero-dose(Missed DTP1 from BCG)**
	A	**B**	**C=B*34.1/1000**	**D=B-C**	**E**	**F=D-E**	**(F/D)%**
Ilala	44,952	65,867	2,246	63,621	41,324	22,297	**35%**
Kinondoni	32,901	36,545	1,246	35,299	33,273	2,026	**6%**
Temeke	45,576	57,980	1,977	56,003	56,598	-595	**-1%**
Ubungo	30,837	29,726	1,014	28,712	30,096	-1,384	**-5%**
Kigamboni	6,059	11,919	406	11,513	7,821	3,692	**32%**

Table 1: Immunization performance in the five districts of Dar es Salaam region in 2020

SI-Surviving infants, IMR-Infant mortality rate, BCG- Bacille Calmette-Guérin, DTP- diphtheria-tetanus-pertussis-containing vaccine.

Site selection and health facilities mapping

Facilities with a high number of zero-dose and under-vaccinated children in the two districts were mapped based on the immunization performance data. QGIS, a free and open-source geographic information system was used to visualize coverage as shown in Figures 1 and 2. In Ilala and Kigamboni districts, coverage for DTP1 and DTP3, was low in the outskirts of the district, particularly in areas that have no nearby health facilities.

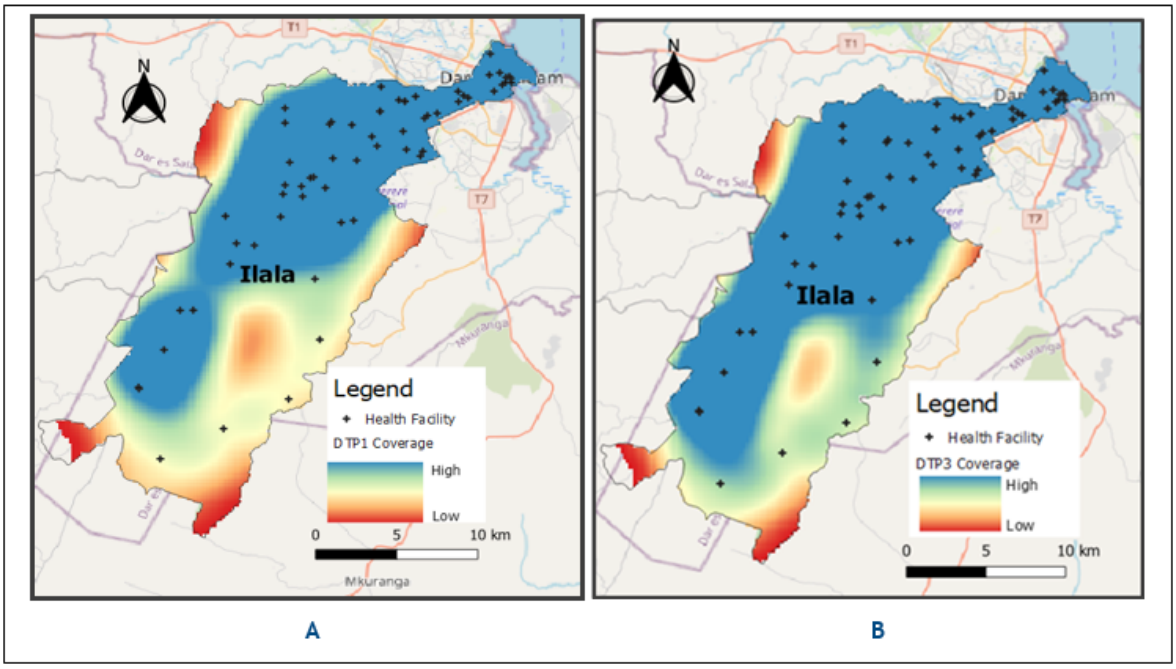


Figure 1: The year 2020 coverage in Ilala (A) DTP1 and (B) DTP3

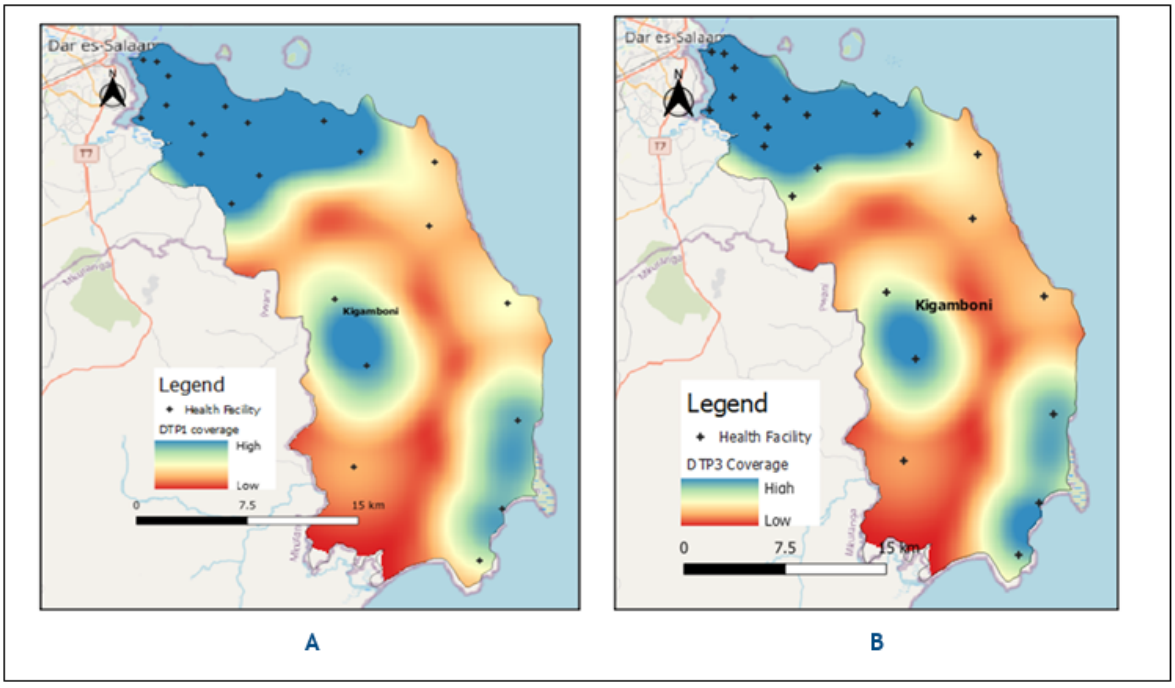


Figure 2: The year 2020 in Kigamboni (A) DTP1 and (B) DTP3

Similarly, we mapped areas with high zero-dose children (DTP1) as of December 2020. As shown in Figure 3, the high number of zero-dose children in Ilala was concentrated in the city center despite the high concentration of vaccination health facilities. In addition, in areas of new settlements and where the network of vaccinating health facilities is dispersed there are as well indications of unvaccinated children. In Kigamboni it was the opposite, zero-dose children were more in areas with sparse distribution of health facilities.

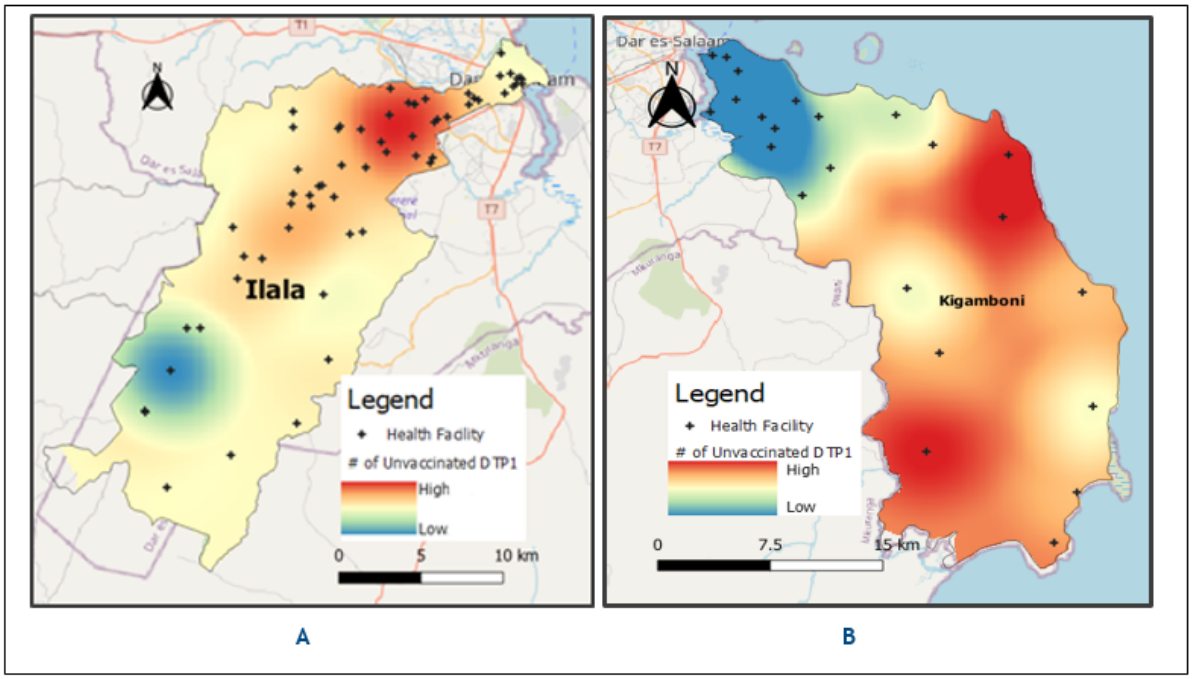


Figure 3: Zero-dose children in Ilala (A) and Kigamboni (B).

Development of an intervention package

To enhance urban immunization and reduce zero-dose children in the city of Dar es Salaam, we revised interventions and tactics being used in the region. To gather information about immunization practices and challenges faced by health facilities and parents/guardians of the children, we conducted field visits to 15 high-volume health facilities, three from each of the five districts of Dar es Salaam region. We conducted interviews with healthcare workers and parents and/or guardians. We included all five districts to get in-depth information to facilitate the formulation of a comprehensive intervention package.

We also conducted meetings with officers from the National Immunization and Vaccine Development Program (IVD), and the Regional and Council Health Management Teams (RHMT/CHMT) from all five districts to come up with best practices, challenges, and strategies to ensure coverage of zero-dose children. The top-performing healthcare facilities from each council discussed their high coverage strategy, which included extensive outreach, mobile clinics, and data-driven decision-making. Low-performing healthcare facilities posed problems such as a scarcity of employees, stockouts of vaccines and supplies, and staff attrition.

Based on these discussions and learnings from the interviews with the healthcare workers, parents/guardians of the children, regional and district health management teams, and IVD officials, we redesigned intervention strategies that were implemented from February to May 2022 in the ten health facilities. The redesigned intervention package targeted to:

- Expand vaccination services to weekends i.e., Saturdays. This aimed to enable parents/caregivers who don't find time during the weekdays to bring their children for vaccination on the weekend.
- Engage the corresponding community health workers within the catchment area (i.e. Community Health Workers in the surrounding areas were involved in making follow-ups of under-vaccinated children and identification of zero-dose children, the CHWs often knew each family member by name, which children still needed to be vaccinated, and gained the trust required to complete vaccinations.).

- Increase the number of outreach posts in new emerging settlements, with healthcare workers assigned to visit each street at least twice a week.
- Increase the number of social mobilizers to conduct public announcements in these new settlements to inform parents/caregivers of expanded services on Saturdays.

Implementation of the intervention package

Based on desk review and mapping, we selected ten health facilities that were documented to have the largest number of zero-dose children based on data extracted from the immunization registers. The comprehensive intervention package that was designed was implemented in these ten health facilities. We held orientation sessions with healthcare workers and community health workers from each of these health facilities that were chosen to learn how immunization sessions were currently run and to come up with ideas for reaching zero-dose children. Similar sensitization meetings were held with community leaders in the catchment areas.

Data collection tools, and analysis

During the implementation phase, numerous instruments for the data collection on under and zero-dose children reached were created. The organization of the data gathered in each geography was spearheaded by facility health professionals, who then reported the monthly data to CHAI. Data collected were compiled and analyzed and findings were shared with facilities and also by regional and council Health Management teams quarterly. Final results were also shared with the Ministry of Health (the IVD program) and with other immunization partners.

Results

From the detailed review of documents and data analysis, we identified 1,266 zero-dose children (as of December 2021) from the ten health facilities in Ilala and Kigamboni districts. Through redesigned intervention package, a total of 651, which is equivalent to 51% of the identified zero-dose children were reached by community health workers and brought back to the health facilities for vaccination. We used the same opportunity to also reach 1,209 under-vaccinated children for OPV3, 912 for DTP3, and 295 for MR2 (Table 2).

Geographical location		**Zero-dose**		**Undervaccinated**		
District	**Facility code**	**OPV 1**	**DTP 1**	**OPV 3**	**DTP3**	**MR 2**
Ilala	1	84	96	193	85	27
Ilala	2	103	103	221	199	58
Ilala	3	113	113	206	153	42
Ilala	4	93	93	184	169	28
Ilala	5	82	89	133	97	31
Kigamboni	6	74	74	65	59	13
Kigamboni	7	23	23	58	51	15
Kigamboni	8	35	35	77	49	32
Kigamboni	9	15	15	31	23	18
Kigamboni	10	10	10	41	27	31
	Total reached	***632***	***651***	**1209**	**912**	**295**

Table 2: Zero-dose and under-vaccinated children reached in ten selected facilities

Effectiveness of strategies used

Vaccination during the weekend i.e., Saturday

During the four months of implementation in the ten selected health facilities, we also introduced vaccination sessions on Saturdays, as most parents in urban areas were busy during weekdays. Through this approach, a total of 1,105 children were vaccinated (Table 3).

District name	Facility code	Rota 1	DTP1	MR1	MR 2	DTP3
Ilala	1	56	56	45	9	12
Ilala	2	75	75	52	10	10
Ilala	3	62	62	67	26	19
Ilala	4	59	59	50	15	19
Ilala	5	39	39	22	5	27
Kigamboni	6	51	51	29	8	13
Kigamboni	7	41	41	37	4	12
Kigamboni	8	30	30	34	5	4
Kigamboni	9	25	25	16	13	23
Kigamboni	10	33	33	27	4	8
	Total vaccinated	**471**	**471**	**379**	**99**	**147**

Table 3: Children reintegrated into health facilities during Saturday vaccination sessions.

Vaccinations in newly established outreach posts in new emerging settlements

Moreover, as Dar es Salaam city is expanding and there are more emerging settlements we established new outreach posts in new emerging settlements outside the city. Through this approach, a total of 880 children were reintegrated into the health facilities for vaccination and received the appropriate vaccination (Table 4).

District name	Facility code	Rota 1	DTP1	MR1	MR 2	DTP3
Ilala	1	29	29	12	11	13
Ilala	2	56	56	40	25	22
Ilala	3	30	30	37	28	21
Ilala	4	26	26	17	22	20
Ilala	5	24	24	22	7	5
Kigamboni	6	45	45	35	29	19
Kigamboni	7	18	18	9	16	23
Kigamboni	8	33	33	29	5	2
Kigamboni	9	13	13	9	23	12
Kigamboni	10	31	31	23	22	17
	Total	**305**	**305**	**233**	**188**	**154**

Table 4: Children vaccinated on newly established outreach posts in new emerging settlements.

The work also revealed low coverage for the measles-rubella vaccine second dose (MR-2) for children under one. These pockets of low coverage create a risk for the reintroduction of vaccine-preventable diseases that have been eradicated, eliminated, or are under epidemiological control. While this intervention revealed children missing DTP1 in two specific municipal councils (Ilala and Kigamboni), there remains a knowledge gap regarding the number of zero-dose in the whole region and countrywide.

Tracking of zero dose and under-vaccinated children

Community health workers serving the catchment areas surrounding the ten health facilities played a big role in tracking the zero-dose and under-vaccinated children in the two study districts. Before this, community health workers were trained on the methods of tracking zero-dose children and on the use of tools to record all eligible children found. They were also given a list of 2,752 children found in the registers who never returned for their subsequent vaccine doses. Apart from these, community health workers were also able to come up with a list of 1,705 children eligible that were not listed in facility registers (Figure 5). These are the ones from new emerging settlements in Ilala and Kigmaboni.

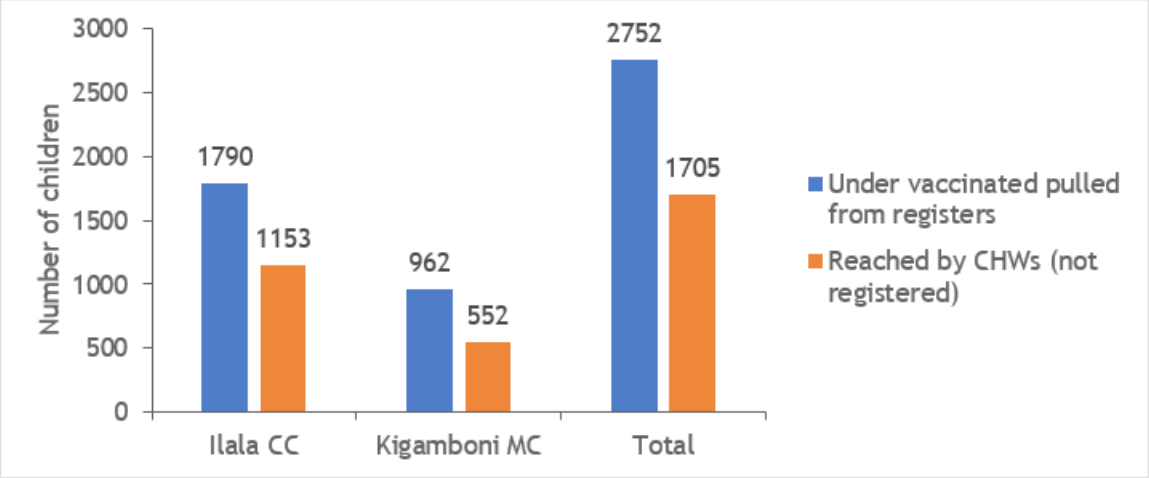


Figure 5: Tracking of eligible children through registers and CHWs.

Discussion

In this study using routine immunization data and mapping, we were able to identify areas with high concentrations of zero-dose and under-vaccinated children in Dar es Salaam region. To reach children who could not be reached by the planned outreach session and in health facilities, we found that the establishment of new outreach posts in newly emerging settlements and vaccination on weekends were effective. This is because people are building settlements far from the places where vaccination services are now administered. Some of the eligible children for vaccination found in the new settlements in Kigamboni and Ilala districts were not previously registered in any health facility around those geographies.

Our results about a high number of zero-dose children in urban areas are not surprising since many studies have reported the same findings previously. Although aggregate coverage levels are usually higher in urban than in rural areas, they tend to mask huge gaps. Disaggregated data often shows that coverage in the slums and peri-urban areas within cities is as bad as that in rural areas [11]. Difficulties in accessing immunization services because of distance to reach the health facilities, costs, and time are some of the main barrier that affects migrants, residents of informal settlements, and urban poor populations [12]. Mobilization and motivation strategies in urban areas should make use of the mass media and workplace networks as well as traditional word-of-mouth strategies.

Further discussion through an article by Crocker-Buque et al [13] found that different factors affect immunization coverage in different urban poor and slums contexts. Immunization services should be designed in collaboration with slum-dwelling communities, considering the local context. Interventions should be designed and tested to increase immunization in migrants from rural areas. Another article by Cutts [14] on "Strategies to improve immunization services in urban Africa" discussed underserved urban slums and squatter settlements whereby drivers of low coverage are consumer characteristics such as competing priorities, migration; target disease epidemiology including crowded living conditions and high prevalence of malnutrition; health service characteristics such as low motivation on health workers, missed opportunities, infrastructures, and pockets of low-income immunization. Proposed interventions were to increase intersectoral collaboration, improve existing services such as daily vaccinations, identify and reach low-coverage neighborhoods and improving disease surveillance. According to Lyimo et al., [15] , the health system factors that have the biggest impact on the uptake of vaccination services

in urban settings are frequent vaccine outages, stock-outs of the necessary equipment and supplies, and vaccination services that aren't offered every day because they result in long wait times because so many clients are scheduled on the same day. People who live in cities are too busy with other income-generating pursuits to put up with such a condition.

*V*arious strategies have been proposed to address urban immunization challenges including tailored delivery strategies, improved use of digital data collection, and child-friendly services [12]. According to Nelson et al (16), several interventions were either explicitly designed for urban areas or were effective in urban areas for specific reasons. Interventions promoting simple, strategic changes aimed at adapting immunization services to special characteristics of urban populations had measurable impacts on immunization uptake. For example, accommodating urban working mothers' schedules by extending health facility hours to nights and weekends improved access to, and utilization of, immunization services. Patel and Nowalk [17] discussed that in theory, Community Health workers can play an integral and dynamic role in overcoming community-specific barriers to expanding immunization coverage. Selected as trusted members of the community, Community Health Workers offer a means of reaching vulnerable individuals in rural populations. As indigenous community members, they are particularly well-suited to aid in identification, tracking, and outreach services as well as to provide information, education, and communication for community members.

Several lessons came from this implementation study that can be leveraged in future immunization work. First, extending vaccination days to include weekends (in this intervention, Saturday) enabled community health workers to reach clients that would have otherwise been missed due to other competing priorities for their parents/caregivers during weekdays. Second, incorporating community leaders in outreach exercises added familiarity and trust to help motivate parents/caregivers to bring their children to the nearest participating vaccination clinics, driving down the number of zero-dose children in both communities. Third, employing community health workers to track children for immunization in the same neighborhoods in which they lived added invaluable knowledge about each household and where zero-dose children could be found. As neighbors, the community health workers often knew each family member by name, which children still needed to be vaccinated, and gained the trust required to complete vaccinations. Fourth, establishing outreach posts in new emerging settlements was essential to bringing vaccination services to far-flung communities that otherwise might have not had the resources or time to travel to clinics. CHAI mapped these new settlements and adapted new strategies to reach them after realizing that current outreach efforts were inadequate. While this study showed promising results in two districts, more research is required to verify the effectiveness and feasibility of the proposed interventions in wider geographical areas.

Limitations

Our study has several limitations, first, the findings are context-specific and hence cannot be generalized elsewhere. The study was conducted in two urban districts in Dar es Salaam region, where numerous new settlements are sprouting up and people are busy with work to provide for their necessities. Apart from health system barriers, there is also the complex interaction of social and economic factors, some of which are gender-specific that may not be uniform across different communities, which contributes to the existing disparities in immunization coverage.

Conclusion

Cities are growing as a result of urbanization, hence forcing people to establish settlements in peripheral areas. It would be impossible to manage the eradication of vaccine-preventable diseases in our society without a proper strategy for reaching children living in these areas with immunization services. This implementation study has demonstrated that by expanding outreach positions in newly emerging settlements, expanding immunization sessions to include weekends, and involving community healthcare workers and leaders in the process, more under-vaccinated and zero-dose children in growing urban cities can be reached. Leveraging the lessons learned from this intervention in Ilala and Kigamboni, the Ministry of Health can quantify and reach the number of zero-dose and under-vaccinated children countrywide in Tanzania.

Disclosure

Abbreviations

CHWs- Community Health Workers

CHAI- Clinton Health Access Initiative

CHMT- Council Health Management Team

DTP- Diphtheria, Tetanus, Pertusis

IVD – Immunization and Vaccine Development program

MC- Municipal Council

MR- Measles Rubella

QGIS – Quantum Geographic Information System

RHMT – Regional Health Management Team

SSA- Sub Saharan Africa

VIMS – Vaccine Information Management System

VPDs- Vaccine Preventable Diseases.

Authors' contributions: Conception and Design: BS, LB, JK, SM. Development of Methodology, analysis, and Interpretation of literature: BS and EM. Writing and review/revision of the manuscript: BS, EM, LB, JK, SM, FT, PK, FK, RM, ATM, AG, SM, and EM.

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Conflict of Interest: *None*

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