

Resilience of Vaccination Services in Crisis Situations in Sub-Saharan Africa: A Scoping Review

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Abstract

Introduction: Vaccination remains one of the most effective public health interventions. Despite progress made in vaccination worldwide, challenges remain, particularly among populations in crisis areas. The resilience of vaccination services in disaster situations appears to be poorly documented in the scientific literature. The objective of this review is to document the current state of resilience of vaccination services in crisis situations in sub-Saharan Africa.

Methodology: We conducted this research following the guidelines provided by the Joanna Briggs Institute (JBI) and the PRISMA approach. We conducted the literature search in electronic databases such as PubMed/Medline, Embase, Scopus, and Research4Life. In addition to the databases, identification was based on the reference lists of all included sources of evidence. We included studies published between January 1, 2016, and December 31, 2024. A narrative synthesis based on the Braun and Clarke model allowed us to map and organize the results thematically. **Results:** In total, we included thirty-six (36) studies. The main crises were the COVID-19 pandemic, the Ebola epidemic, armed conflicts, and terrorist attacks. These crises impacted vaccination coverage, surveillance systems, vaccination service delivery, vaccine supply, and vaccination personnel. The barriers to immunization services identi-

fied were redeployment, shortage of health personnel, travel restrictions, fear of contracting the disease, stigma, vaccine hesitancy, community engagement, and communication. The study identified key strategies such as vaccination campaigns, investment in health personnel, community engagement, communication campaigns, coordination of interventions, and lessons to be learned. **Conclusion:** This study highlighted the impact of health and humanitarian crises on vaccination in sub-Saharan Africa. However, the resilience strategies identified underscore the need to sustainably integrate crisis preparedness, community strengthening, and continuity of vaccination services into health policies.

Keywords

Resilience, Immunization Services, Crises, Sub-Saharan Africa, Scoping Review

1. Introduction

Vaccination remains an important and cost-effective public health intervention for the prevention and control of vaccine-preventable diseases [1]. Despite progress in vaccination worldwide, populations in crisis areas often have limited or no access to these life-saving products, exposing them to an increased risk of morbidity and mortality from vaccine-preventable diseases [2]. Difficult access to vaccination services during times of crisis is one of the main reasons for stagnating vaccination coverage [3].

A crisis is defined as a situation that threatens the health, safety, and well-being of a large number of people and often requires substantial multisectoral assistance [4]. Crises are recognized as a major threat to global public health security [5].

In most cases, crises arise suddenly, unexpectedly, and without warning. When they occur, they disrupt normal operations and the health system is faced with a situation that requires significant mobilization of resources [6] to respond.

Estimates from the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) show that DTP3 vaccination coverage, which measures access to vaccination, has declined in several crisis-affected countries [7]. In 2023, four of the six countries where less than 50% of children had received all doses of DTP were facing profound institutional fragility or conflict. Zero-dose children, *i.e.*, those who have never received a single dose of vaccine, are heavily concentrated in seven countries, five of which are conflict zones [7].

Armed conflict was associated with failure to achieve vaccination targets for national DTP3 coverage $\geq 90\%$ and the elimination of maternal and neonatal tetanus in 13 countries in the WHO African Region [8]. Terrorist acts, for their part, not only cause deaths and injuries on the battlefield, but also have health consequences linked to the displacement of populations and the collapse of essential health services such as vaccination [9].

In Burkina Faso, since the start of terrorist attacks by armed groups in 2015, the

health system has been severely tested, including the provision of vaccination services [10].

Disruptions to vaccination systems can also affect people's confidence in vaccination and compromise the use of vaccines [11]. Vaccination must therefore be one of the top health priorities in order to limit preventable morbidity and mortality from vaccine-preventable diseases. Maintaining or restoring routine immunization services must be the primary objective of any national immunization program in a crisis situation [3].

The resilience of immunization services in the face of disasters is therefore essential to their success [12]. There is an urgent need to make immunization programs more resilient so that they can maintain optimal performance during and after a crisis [13]. Resilience is of paramount societal importance [14]. Strengthening resilience must translate into the ability of immunization services to anticipate, prevent, detect, absorb, adapt, and respond to a wide range of risks and shocks, while ensuring continuity of service delivery, learning, and improving as needed [15]. Health system resilience is the capacity of actors, institutions and populations in the health sector to prepare for and respond effectively to crises; to maintain their essential functions during a crisis; and, by learning from the crisis, to reorganize if necessary [16]. A resilient immunization service is aware, diverse, integrated, self-regulating, and adaptable in all its components [16]. The components of the immunization system are linked to the building blocks of health systems, which are program management and financing; immunization service delivery; data management and surveillance; logistics (cold chain, vaccine and consumables supply chain, transportation); vaccine safety; and demand generation for immunization [17].

This growing focus on resilience must take into account the many and varied changes occurring in systems worldwide, and not just in relation to short-term shocks [18]. A review of the literature revealed a knowledge gap in terms of synthesizing the literature on the resilience of immunization services in crisis or humanitarian emergency situations.

The objective of this study is to document the current state of resilience of immunization services in crisis situations in sub-Saharan Africa. Specifically, it will: 1) identify the different types of crises; 2) analyze their impact on immunization services; 3) identify barriers to access to immunization services; and 4) explore strategies and lessons learned to strengthen the resilience of immunization systems.

2. Methodology

2.1. Design

In this study, we conducted a scoping review. This followed the guidelines provided by the Joanna Briggs Institute (JBI) for scoping studies and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist [19].

2.2. Selection Criteria

The inclusion and exclusion criteria were defined using the Participants-Concept-Context (PCC) approach. This review examined studies published between January 1, 2016, and December 31, 2024, that included the resilience of immunization services in crisis situations. These studies focus on different types of crises, their impact on immunization services, potential barriers, strategies implemented, and lessons learned to strengthen the resilience of immunization systems. The review considers studies addressing all or one of the seven areas of immunization affected by a crisis: management and financing; human resources; quality vaccine supply and logistics; service delivery; monitoring of vaccination coverage and adverse events following immunization; surveillance of vaccine-preventable diseases; and generating community demand for vaccination.

In addition, the focus of interest for this review was resilience. To this end, we included articles that use other concepts of resilience such as adaptation, service delivery, health system strengthening, continuity of care, and health system resilience.

Only studies conducted in English and French were considered. The aim is to ensure the clarity and effectiveness of the analysis [20]. A scoping review may include all types of literature, such as primary research studies, systematic reviews, meta-analyses, guidelines, websites, and blogs. However, researchers are free to impose limitations based on their knowledge of which types of sources would be most useful and appropriate [21]. Thus, for this review, we considered primary sources of published and unpublished evidence (gray literature), peer-reviewed published reviews, and preprints. The identification process covered experimental and quasi-experimental studies, analytical observational studies, including prospective and retrospective cohort studies, case-control studies, and analytical cross-sectional studies. Descriptive observational studies, including case series, individual case reports, and descriptive cross-sectional studies, were also included. Qualitative studies were also considered.

2.3. Types of Sources

The study search was conducted in relevant electronic databases, including PubMed/Medline, Embase, Scopus, and Research4Life. In addition to the databases, identification was based on the reference lists of all included sources of evidence.

2.4. Search Strategy

A preliminary search was conducted in Google Scholar and PubMed/Medline using keywords, free text, and various Medical Subject Headings (MeSH) terms. This yielded a checklist of articles. An analysis was performed of the keywords contained in the titles and abstracts, as well as the indexing terms used to describe the articles on the checklist. The search terms were combined with Boolean operators such as “AND” and “OR,” as well as additional search terms such as MeSH, to construct a search equation.

The search equation was first developed in Google Scholar, then adapted to other databases according to their language (thesaurus). The search was designed to be exhaustive in order to collect as many relevant articles as possible. The different search equations used for the various databases selected for this scoping review are presented in the supplementary documents.

2.5. Studies Selection

At the end of the search, all identified articles were exported from the databases to the Rayyan software. Two independent reviewers screened the articles according to the eligibility criteria. However, before this, an independent reviewer and ourselves conducted a pilot test to ensure a common understanding of the inclusion criteria.

The actual article selection process involved three steps. First, duplicates were eliminated using the software. Next, the titles and abstracts were read according to the selected inclusion criteria. Potentially relevant sources were retrieved in their entirety and the article details were imported back into Rayyan. Finally, the full text of each selected article was read in detail according to the inclusion criteria by two independent reviewers, with the second reviewer randomly evaluating 30% of the articles. Sources excluded during the full-text review were justified, recorded, and reported in the PRISMA-ScR diagram.

2.6. Data Extraction

The data were extracted from the various articles using Rayyan software. The data extracted from the evidence sources were based on the objectives and research question. A standardized data extraction form from JBI [19] was used to minimize potential data bias and record key information from each source. The information extracted from the included evidence sources included data on the authors, country of study, study objectives, study design, sample, type of disaster, impact on immunization services, and strategies for adapting health facilities to provide immunization services to populations in disaster situations. This information is extracted according to the seven areas of vaccination. As with the selection of studies, the data extraction process was carried out by an independent person and ourselves to reduce the risk of errors and bias.

2.7. Data Analysis

The analysis was carried out thematically according to the Braun and Clarke model [22] in order to synthesize and describe the results. This required familiarization with the data, coding, generation of themes, their review, definition and naming, as well as their writing (narration) [23]. We used the elements of Kruk, M.E. *et al.*'s conceptual framework of consciousness, diversity, self-regulation, integration and adaptability [16] as an analytical framework to map, organize and synthesize the results in relation to the types of resilience strategies implemented. Regarding the impact of crises on immunization services, we used the components

of the immunization system.

3. Results

3.1. Articles Selection

A total of 406 articles were identified in PubMed/Medline (n = 58), Embase (n = 130), Scopus (n = 151) and Research4Life (n = 67). The different search equations per database retained are recorded in a table. Also, we identified 12 additional articles from other sources. We removed 73 duplicates. We excluded 278 articles during the reading of titles and abstracts and 31 others during the reading of full texts for reasons irrelevant to the objectives and research questions. At the end of the selection, 36 articles were retained for the study. The article selection process was summarized in the PRISMA-ScR flow diagram shown in **Figure 1** below.

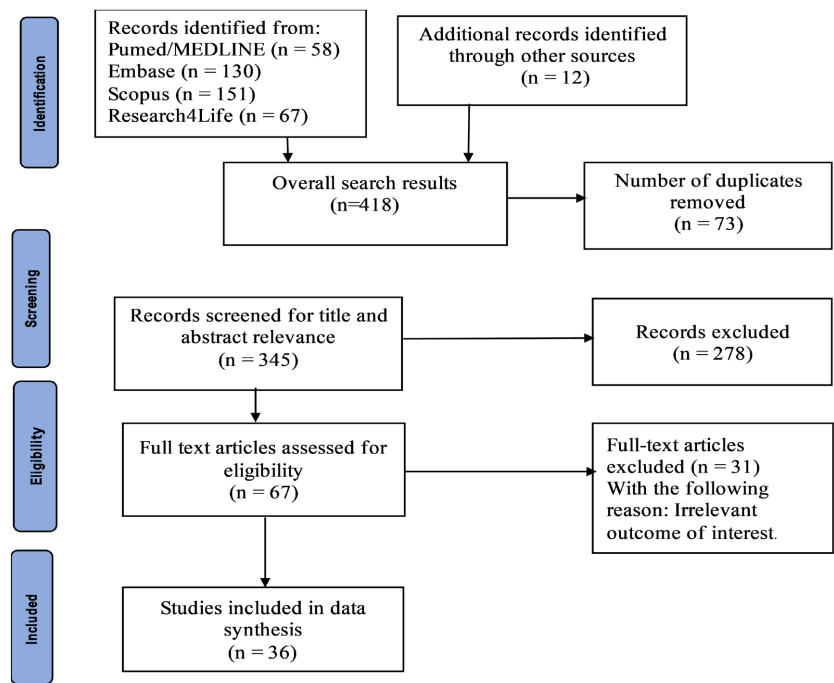


Figure 1. PRISMA-ScR Diagram showing the articles excluded during each step of the screening process.

3.2. Articles Characteristics

The thirty-six (36) studies selected following the selection process were conducted in countries across the four sub-regions of Sub-Saharan Africa: West Africa, Central Africa, East Africa, and Southern Africa. These studies were conducted in thirteen (13) countries in West Africa; thirteen (13) in East Africa; seven (7) in Central Africa; and seven (7) in Southern Africa. Each of these studies focused on either one country only (25) or two or more countries (11).

The vast majority of studies (31/36) were published between 2021 and 2024. The year 2022 recorded the highest number of studies (11), followed by 2023 (9), 2024 (7), and 2021 (6).

The objectives of these studies were to assess the impact, challenges, effect, disruptions linked to crises on maternal and child health care including vaccination on the one hand and on the other hand the strategies, interventions, experiences, best practices to strengthen resilience in order to improve and maintain vaccination coverage.

The studies were of mixed design (8), quantitative (7), cross-sectional (10), literature and health database reviews (4), impact assessment (2), scoping review (2), systematic review (2), randomized controlled trial, and one study with an unspecified design.

The different types of crises that have impacted vaccination services and have been highlighted by the selected studies are primarily the COVID-19 pandemic (28), the Ebola epidemic (2), and human-caused crises including armed conflicts (5) and terrorist attacks (1).

Thematic analysis of the qualitative data allowed for a synthesis and description of the results. The themes that emerged from the content of the different studies have been grouped and described below.

3.3. Impact of Crises on Vaccination Services

The analysis highlighted the affected immunization service compartments and the suffering faced by immunization services in Sub-Saharan Africa by the different types of crises. Almost all components of immunization services were impacted, namely immunization coverage, surveillance systems, immunization service delivery, awareness of immunization services (demand for vaccination), vaccine supply, and immunization personnel. In terms of impact, the themes that emerged from the analysis include declining immunization coverage, disruptions in immunization service delivery and awareness, shortages of vaccines and consumables, destruction of health infrastructure and vaccine logistics, and depletion of human resources. The synthesis of themes according to the studies with relevant findings is presented in text form.

- **Decline in vaccination coverage and emergence of epidemics**

The scoping review highlighted significant disruptions in vaccination coverage due to crises in sub-Saharan Africa. Studies show an overall decline in vaccination coverage related to a prolonged crisis in Angola, Niger, Congo, Burkina Faso, Mali, Ethiopia, Democratic Republic of Congo, Central African Republic, Chad, Cameroon, Nigeria, Somalia, South Sudan, Sudan, Kenya, Rwanda, Tanzania, Uganda, Zambia, Burundi, Liberia, Malawi, Sierra Leone [24] [25]. Following the COVID-19 pandemic, disruptions in polio vaccination and significant declines in vaccination coverage and key indicators of polio-free certification in South Africa and Liberia [26] [27] and declines or decreases in BCG, OPV, IPV, measles, pentavalent, MCV1, pneumococcal, rotavirus, and full vaccination coverage have been described in Ghana, Ethiopia, Nigeria, Guinea, Niger, Ghana, Mozambique, and Kenya [28]-[31].

In Ethiopia, BCG, diphtheria, pertussis, and tetanus 3 and polio (OPV3) vac-

cines showed considerable coverage changes related to the COVID-19 pandemic in most regions. Measles vaccination coverage experienced major changes in almost all regions of Ethiopia. In Kenya, comprehensive vaccination coverage experienced significant changes in eight counties and for measles vaccination coverage [32]. In Sierra Leone, the overall observed decline in vaccination rate was between 23% and 47%, with BCG, OPV0, IPTI1, and IPTI2 being significantly less affected than the others [33]. In Ghana, with the exception of measles and rubella (MR) 2 vaccine, a decline ranging from 47% (2298) to 10.5% (116) was observed, with the largest decline observed for BCG and the smallest for MR1 vaccine. May 2020 recorded the largest decline of 70.6% (813). A decrease of 38.3% (4473) was observed when comparing the pre-pandemic and COVID-19 pandemic periods, for all vaccines [34].

A study conducted in selected African countries meeting the inclusion criteria for the review found that due to the COVID-19 pandemic, there was a decline in the average monthly number of vaccine doses administered in thirteen of the fifteen countries, with six countries recording a decline of more than 10% [35]. This same study showed an average monthly decline in the number of recipients of the first dose of measles vaccine in the second quarter of 2020 in 9 countries compared to the first quarter and in the monthly number of children vaccinated for DTP3 and/or MCV1 of more than 2 standard deviations in Guinea, Nigeria, Ghana, Angola, Gabon and South Sudan [35]. Studies from Nigeria, Côte d'Ivoire, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Democratic Republic of Congo, Nigeria, Chad and Central African Republic report children who were not adequately vaccinated for BCG, Penta and OPV and lower coverage due to armed conflict [36] [37].

In South Africa, a study showed a decrease in the number of children fully vaccinated at one year of age of 4.3% between 2019 and 2020. The largest declines occurred in April, July and August 2020 compared to 2019. Significant declines in vaccination coverage were observed in the Northern Cape (11.8%), Eastern Cape (9.9%) and Mpumalanga (8%) provinces. The North West province was an exception, with an increase of 7.1% [38]. In Ghana during the COVID-19 pandemic, a study noted an overall decline in antigen coverage ranging from a coverage rate of 38.8% recorded for measles-rubella to 53.1% for Penta [39]. In Cameroon, people aged 20 years and older had the lowest vaccination coverage against cholera due to the COVID-19 pandemic [40].

Crises also disrupt population vaccination completeness. The COVID-19 pandemic has led to vaccination defaults; reduced access and quality of services, low utilization of maternal, newborn, and child health (MNCH) services including vaccination, and decreased administration of routine antigen doses according to studies conducted in Rwanda, Ethiopia, and South Africa [41]-[43]. In South Africa, a study showed an exacerbation of the gaping wounds of suboptimal vaccination coverage progress by the COVID-19 pandemic [43]. In Ethiopia, 198 children (44.1%) who had started vaccination before the war dropped out of the vaccina-

tion program. In addition, 64 children (14.3%) born during the war received no vaccination [44].

As for the impact of the Ebola epidemic, a study conducted in Guinea, Liberia, Sierra Leone, Nigeria, Senegal and Mali indicated a significant decrease in the distribution of doses 1 and 3 of the pentavalent vaccine in health centers in Guinea of 18% to 32% ($p < 0.001$), in the number of children receiving dose 3 of the pentavalent vaccine of 21% in Sierra Leone and a decrease of 26% in the number of fully vaccinated children in a hospital in the district of Moyamba [45]. Low vaccination coverage is sometimes the cause of epidemics according to studies. The number of measles cases increased by 400%, particularly in Ethiopia, Somalia and the Democratic Republic of Congo [46].

- **Disruptions in the delivery of vaccination services**

The review identified disruptions in immunization service delivery by crises, primarily the COVID-19 pandemic and terrorist attacks. In South Sudan and Sierra Leone, a study reported aggravation of low capacity by the COVID-19 pandemic, characterized by insufficient uptake of routine immunization services [47]. This decline in routine immunization of children under one year of age due to the pandemic was compounded by the introduction of the COVID-19 vaccine [48]. In Rwanda, a study found a 4% and 5% decline in service delivery, respectively, during the initial period of the pandemic [49]. In Nigeria, missed appointments for childhood immunization were found in 23% of cases [50].

A study in Ethiopia found disruptions in childhood immunization at the beginning of the pandemic, but these were not statistically significant compared to the pre-pandemic period [51]. In sub-Saharan Africa, a study found cancellation of outreach services, postponement and cancellation of supplementary immunization activities (SIAs) [52]. Immunization and outreach services were canceled for reasons related to COVID-19 except Zimbabwe, which was the only country whose guidelines recommended the continuation of immunization outreach services according to a study conducted in Kenya, Mozambique, Uganda and Zimbabwe [53]. A postponement of the national preventive measles vaccination follow-up campaign was reported in Ethiopia [42]. Childhood immunization visits dropped by more than 50% in South Africa [43]. A significant decline in attendance at vaccination services and an increase in dropouts [20] as well as a decrease in scheduled or routine vaccination rates of children [54] have been reported by studies.

Due to the closure of a large number of health facilities in the Sahel region of Burkina Faso, which is plagued by terrorist attacks, the delivery of vaccination services has been affected, resulting in a decline in coverage for the third dose of the diphtheria, tetanus and pertussis vaccine, which was 51% in 2020, compared to a national coverage of 99% [10].

- **Disruption of awareness-raising activities**

The review highlights a decline in demand generation actions by communities during the COVID-19 pandemic. The proportion of childhood vaccination ser-

vices delivered through awareness campaigns has declined sharply, according to a study in Nigeria [29].

- **Out of stock in vaccines and consumables**

The COVID-19 pandemic has impacted the availability of vaccines and consumables, as it has impacted other components of immunization services. In Ethiopia, Nigeria, Ghana, Kenya, Tanzania, Cameroon, Malawi, South Africa, Uganda, Somalia, Gambia, Sierra Leone and Zambia, shortages of BCG, OPV, IPV and pentavalent vaccines have been recorded [20]. In Ethiopia, nearly 47.8% of health workers participating in a study, out of a total of 448, reported that the COVID-19 pandemic had disrupted the availability of vaccines in their respective health facilities [55]. This has led to reduced access and quality of services and low utilization of MNCH services including immunization [56].

- **Destruction of health infrastructure and vaccine logistics**

The review showed that armed conflicts in eleven African countries caused destruction of health infrastructure and vaccine logistics [37].

- **Exhaustion of human resources**

Crises have an impact on human resources for health. The review identified human resource depletion due to armed conflict in eleven African countries [37]. The pandemic led to a shortage of vaccination personnel in sub-Saharan Africa [20] and an increase in working hours for permanent (33.3%) and temporary (6.7%) staff in Ghana [39].

3.4. Barriers to Vaccination during Crisis Situations

Studies have highlighted specific barriers that prevent beneficiaries or communities from accessing vaccination services. In South Africa, a delay in integrating COVID-19 pandemic services with other essential health services including vaccination, the absence of public health emergency response structures, the absence of providers, the lack of preparedness of health facility managers, perceived poor staff attitudes, demotivation of health care providers related to COVID-19, poor access to essential services and the redeployment of service providers for the response have compromised the core business of health systems [26] [32] [33] [39] [40] [44] [45] [47]. Travel restrictions imposed by governments during the early days of the pandemic, political decisions, regulatory measures against the pandemic have been identified by most studies as barriers to access to health services including vaccination [20] [25] [28] [31]-[35] [38] [39] [42] [43] [49] [51]-[53] [55] [57].

Studies have also highlighted COVID-19, the fear of contracting the disease in health centers among the community and health workers, the fear of transmitting the disease to families, confinement and stigma have been identified as no less important obstacles that have hindered access to vaccination by the population during COVID-19.

These identified barriers include concerns that routine childhood vaccines may have been mixed or “contaminated” with COVID-19 vaccines, vaccine hesitancy

related to vaccine misinformation on social media and fear of adverse effects, lack of community vaccination, insufficient information among mothers and caregivers about vaccination campaigns, lack of community engagement to discuss the importance of vaccination, increased rumors and fears related to vaccination, significant delays in vaccine delivery times due to transportation disruptions, reduced communication about existing routine health services due to increased attention and resource allocation to the public health crisis response, funding shortages or lack of resources in health facilities, and reduced donations during the pandemic [10] [20] [29] [34] [36] [41] [52] [56] [57].

Security issues in shipping supplies to health centers in conflict settings [37], lack of COVID-19 guidelines for routine care delivery [31], and suspension of vaccination programs during the outbreak [45] [46] were also identified as barriers to accessing vaccination services. Loss of a family member, not being informed about catch-up vaccination, being a rural resident, giving birth at home, and duration of war were associated with non-access to vaccination [44].

3.5. Strategies Implemented to Strengthen Resilience

The scoping review identified strategies that have either been implemented or proposed to be implemented to strengthen the resilience of immunization services before, during, or after a crisis situation. These strategies include vaccination campaigns, investment in health personnel, regular performance monitoring/evaluation, community engagement, continuity of services, changes in service delivery modalities, communication campaigns, implementation of incentives, strengthening of the supply chain, implementation of recovery plans, and coordination of interventions.

- **Vaccination campaigns**

In response to various crises, vaccination campaigns have been implemented or proposed to provide vaccination services to populations. In the North Wollo region of Ethiopia, a study identified the implementation of campaigns to increase vaccination coverage in the region [44]. According to another study in Ethiopia during COVID-19, the launch of a vaccination campaign for people who had abandoned vaccination proved successful [56]. These campaigns were prepared and implemented taking into account the context of COVID-19 in Ethiopia [42]. Vaccination campaigns planned and implemented in South Africa have positively contributed to maintaining polio vaccination coverage during the COVID-19 pandemic [26].

A study in Liberia identified supplemental catch-up measles vaccination campaigns during the Ebola outbreak for population vaccination [27]. During the recovery phase of the Ebola outbreak, large-scale national vaccination campaigns were organized [45]. Optimization of vaccination campaigns was identified in South Sudan [36]. In Zimbabwe and Uganda, policy mentioned “catch-up” campaigns to reach children who missed their appointments due to COVID-19 [53]. A study in Ghana proposed implementing a catch-up vaccination schedule to

limit possible future outbreaks of vaccine-preventable diseases through mass recalls via the media and professional associations [34].

- **Investment in health professional**

A study in Ghana shows that frontline health workers and laboratory technicians were motivated to make home visits to provide services [28]. Studies reported in Ghana that the provision of personal protective equipment [28] and an adequate supply of personal protective equipment (PPE) and other logistics should be made available to health workers to increase their confidence in service delivery during outbreaks [39]. The same study shows that special arrangements for transporting health workers to their workplaces during outbreaks reduced absenteeism due to lack of access to transport [39]. Accurate and up-to-date training and guidance on vaccine effectiveness should be communicated to health workers via social media [39]. To maintain service delivery including vaccination during the pandemic, strategies include recruitment and retraining of health workers, reports a study in Nigeria [50].

- **Regular monitoring and evaluation of performance**

Monitoring/evaluation will help assess the implementation of resilience actions of immunization services in crisis situations and make corrections if necessary. Studies have reported in some sub-Saharan African countries the need for regular monitoring and evaluation of the performance of service providers, mentoring and supportive supervision [20] [30] [49] and of children who missed vaccination using electronic immunization registers and reports [49] [56]. Monitoring and evaluation in Ethiopia has helped identify services whose recovery is slow and respond to potential fluctuations in the COVID-19 pandemic [30].

Studies have identified active search and vaccination of under-immunized children in South Africa [38], mobile phone reminders of vaccination appointments directly to parents of children in Ghana and some other sub-Saharan African countries [20] [34], use of an appointment system for maternal, newborn, and child health (MNCH) services including facility-based vaccination in Ghana [28], strengthening of measles surveillance in Liberia [27], and monitoring to improve utilization of Expanded Programme on Immunization (EPI) services during epidemics in Ghana [39]. One study highlighted the use of models as a decision aid to inform vaccination strategies [20].

- **Community engagement**

Every community member is a potential actor for the good of their community. Community members are not a target or beneficiary. They are not deficient or ignorant. They are potential allies in the resilience of immunization services in crisis situations. A study conducted in Burkina Faso highlighted the delegation of tasks of immunization services to Community Based Health Workers (CBWs). This delegation of tasks to CBWs was made possible by strengthening their capacity, designing an adapted supply chain, communication, biomedical waste management and data management [10]. In Rwanda, community health workers (CHWs) were used to identify unvaccinated children [49]. Community engage-

ment, involvement of religious leaders, use of volunteer mobilizers and social mobilization have been cited as important pillars in Nigeria and Ethiopia in the context of the COVID-19 pandemic [29] [39] [42]. For successful vaccination programs in South Sudan, a study highlights the need for active involvement of community leaders [36]. In Rwanda, to address the reduction in communication about existing routine health services due to increased attention and allocation of resources to the response to the public health crisis, community interventions remain a solution [41]. Strengthening the community health system in Ethiopia by deploying mobile vaccination teams to remote areas and marginalized communities has helped improve the delivery of vaccination services [32]. The use of existing community structures in the same country helped promote health information during a civil war that lasted about six months [44].

- **Continuity of services**

In the face of a crisis situation, all actors in the health system are mobilized to respond to the threat. In response to the situation, and in order to counter the threat, countries adopt measures. These measures must allow the continuity of essential health services such as vaccination. To ensure the continuity of essential services including vaccination, safety measures have been put in place in Nigeria to protect people against COVID-19, such as handwashing and wearing masks [29] [30]. In Ethiopia, initiatives to increase childhood vaccination rates and restore pre-pandemic services have been intensified in order to regain momentum and avoid future setbacks [51]. In Ghana, new policy guidelines with modified service delivery models have been developed and disseminated. These guidelines recommended the non-closure of health facilities to allow access to essential health services at all times [28]. The establishment of a task force based on working guidelines down to the lower level has been revealed in Ethiopia [56]. Improvement of health infrastructure, logistical support, free, accessible primary health care services, establishment of social safety nets, including transportation and palliative care have been identified as essential for continuity of services in Nigeria during the COVID-19 pandemic [39] [50] [52].

- **Changes in the terms of service provision**

Crisis situations have often led institutions to change service delivery habits. Changes in approaches have been made in the delivery of vaccination services in Ethiopia due to the COVID-19 pandemic [42]. In South Sudan, due to armed conflict, community and mobile services have been favored to offer vaccination to affected populations [36]. In Liberia, in the context of Ebola, an urban vaccination strategy was implemented to reach slums and underserved populations [27]. The reopening of schools and visits to daycare centers to vaccinate children who may have missed certain vaccines have been instituted in Ghana during the COVID-19 period [34].

- **Communication campaigns**

Communication should play a catalytic role in ensuring that community requests, questions, and concerns are addressed during a crisis. Communication ef-

forts should focus on awareness-raising and trust issues. Intensive public education to encourage facility visits and effective government communication and commitment to increasing access to health services during the peak phase of the pandemic that resulted in home visits were highlighted in Ghana [28]. Communication should be multichannel communication using multiple approaches and channels [42]. Studies have identified awareness programs in Cameroon, Democratic Republic of Congo, Liberia, Malawi, Mali, Nigeria, Sierra Leone, and Somalia [25], the development and delivery of communication channels down to the health facility level in Ethiopia [56], and community awareness campaigns [41] [46] [20]. Policy guidelines in Mozambique, Uganda, and Zimbabwe all specify that communication campaigns should be used to promote the importance of childhood vaccination and explain access to childhood vaccination during COVID-19 [53]. A study in Sub-Saharan Africa indicates that trust must be rebuilt and demand for vaccination services created through media and community engagement [52]. In African countries participating in a study, awareness campaigns and services, supported by partnerships with civil society and volunteer networks adapted to local security conditions, were highlighted [37]. Community outreach programs in Kenya by health workers during the pandemic raised awareness about routine vaccinations and administered vaccines to people unable to attend health facilities [32]. Awareness of the importance of vaccination for the prevention of preventable diseases by vaccinating people who missed vaccination was noted in Ghana during the COVID-19 pandemic [34]. In-depth population awareness through community actors during the COVID-19 pandemic was highlighted in Cameroon [40]. In Ethiopia, the continuation of the health extension program and the Women's Development Army to inform mothers about catch-up vaccinations and to vaccinate children born at home and awareness of catch-up vaccinations in the context of a civil war that lasted about six months were highlighted [44]. This same study proposes the management of cultural and structural challenges that reduce the use of health care services by mothers [44].

- **Implementation of incentive measures**

Studies have indicated that financial incentives for health workers and vaccine recipients are effective in boosting vaccination uptake. Financial incentives for both vaccination personnel and vaccine recipients have been cited as contributing to improved vaccination uptake in sub-Saharan African countries (Ethiopia, Nigeria, Ghana, Kenya, Tanzania, Cameroon, Malawi, South Africa, Uganda, Somalia, Gambia, Sierra Leone, Zambia) [10] [34].

- **Strengthening the supply chain**

To ensure a reliable supply system for quality vaccines during times of crisis, a study found the need for strengthening the supply chain in Cameroon, the Democratic Republic of Congo, Liberia, Malawi, Mali, Nigeria, Sierra Leone and Somalia [25]. During COVID-19, the rapid establishment of logistics to avoid stock-outs of essential supplies was highlighted in Ghana [28].

- **Implementation of a recovery plan**

To restore immunization coverage rates, health systems must focus on reviving

routine immunization disrupted by crisis. A immunization recovery plan was developed after the Ebola virus disease (EVD) outbreak in Liberia in 2015. Routine immunization micro-plans were revised and implemented according to the principles of the “Reaching Every District” approach. Polio eradication activities and plans to improve yellow fever control after outbreak control have been described [27]. One study indicated that implementation research is needed to assess and address the burden and factors associated with missed opportunities for immunization among children in primary care, applicable in South Africa and similar settings [43]. In Ghana, it was proposed to conduct a national study to examine the impact of the pandemic on childhood vaccination in the country [34] and to develop detailed micro-planning to be implemented to improve vaccination coverage impacted by COVID-19 [39]. Studies in Ethiopia also indicate the need for large-scale or nationwide studies with more representative samples to consolidate much-needed empirical evidence on the impacts of COVID-19 in the country’s health facilities [55] and to rehabilitate health facilities and infrastructure destroyed during war [44].

- **Coordination of interventions**

The area of intervention coordination has been identified as an important strategic focus. Indeed, the implementation of rigorous coordination between health facilities is proposed in a study in South Sudan, which was affected by armed conflict [36], and the development of partnerships in another study in Ghana [39]. Coordination of national and regional COVID-19 prevention and control task forces has facilitated the rapid availability of additional resources [42]. One study found that international collaboration and partnerships supported the efforts of Ethiopia and Kenya to maintain childhood vaccination coverage during the pandemic, thanks to essential assistance from UNICEF and WHO for vaccine procurement, distribution, and capacity building.

3.6. Lessons Learned to Build Resilience

- **Need for continuity of care**

Studies have highlighted lessons to be taken into account in addressing emerging crises and anticipating the future. The lack of protection of routine services, such as general access to primary health care, including vaccination will increase the burden of morbidity and mortality, highlights a study in South Africa [38].

- **The need to establish a public health body in response to crises**

A study carried out in South Africa shows that to ensure that health systems maintain a balance between controlling pandemics like COVID-19 and maintaining their core activities, it is essential to establish a public health structure, from the national to the community level, to respond to public health emergencies and the early integration of pandemic-related services into the daily activities of health systems [26].

- **Need for integration of health services**

In South Sudan, the integration of health services has been identified as a lesson.

It has contributed to improving routine childhood immunization coverage and adult COVID-19 vaccination coverage, reducing service delivery costs, and increasing access to more comprehensive health services in hard-to-reach communities [48]. Capacity building, recruitment, training, and deployment of an expanded workforce to achieve COVID-19 vaccination targets without impacting routine vaccination coverage were identified in South Sudan and Sierra Leone. Leveraging mobile and outreach approaches to improve COVID-19 vaccination coverage also benefited overall vaccination coverage [47].

- **Strengthening the health system**

Investment in health systems, inputs, and quality; leadership at all levels; coordination of activities; use of data for decision-making; ownership and accountability; timely communication and information; and ensuring public trust were mentioned as levers to address COVID-19 in Rwanda [49].

- **Strengthening community engagement**

Indeed, in Ethiopia, decision-making, coordination and implementation of measles SIAs at the national level were facilitated by multiple factors such as broader consultation among stakeholders, strong commitment of political-administrative leaders, multichannel communication, social mobilization and community engagement; support from partners, availability of digital communication means and availability of PPE and adequate supplies [42]. The development of a dashboard for near real-time data collection, visualization and dissemination to support evidence-based decision-making has helped improve health services in South Sudan and Sierra Leone [47]. In the Sahel region of Burkina Faso, the implementation of the task-shifting strategy to CHWs has helped maintain health protection even in the event of health facility closures or increased terrorist attacks. Continuing activities requires better support for ABSC mobility, as the implementation of the strategy is highly dependent on travel and logistics [10].

- **Requires regular performance monitoring and evaluation**

The development of a dashboard for collecting, visualizing and disseminating data in near real time to support evidence-based decision-making has led to improvements in health services in South Sudan and Sierra Leone [47].

- **Strengthening communication**

In Cameroon, a study identified a lesson to be learned on communication in crisis situations. According to this study, appropriate communication will always overcome hesitation and promote mass vaccination of the population to counteract hesitancy and consolidate herd immunity. Communication regarding vaccination campaigns should begin approximately one month before the start of the campaign. Community, administrative, and religious leaders should be heavily involved in public health activities. The selection of mobilizers and vaccinators should be based on well-defined criteria. Communication tools such as banners, badges, leaflets, and T-shirts are essential for disseminating the right information and building trust within communities [40].

4. Discussion

This review identified the different types of crises that have impacted immunization services in Sub-Saharan Africa, their impact, obstacles, strategies put in place and lessons learned to strengthen the resilience of immunization systems. Immunization services can be affected by a crisis in four (4) ways namely: 1) they are unable to provide the essential services they previously provided; 2) they provide essential services compared to their pre-crisis capacities by targeting specific services; 3) they can maintain the provision of the essential services they previously provided even in the face of the crisis; and 4) the crisis had no effect and the system returns to its pre-shock state [58]. In this part of the review, we will present the discussion of the results according to the objectives of the review. These are the impact of crises on immunization services, obstacles to immunization during crisis situations, strategies put in place or proposed and lessons learned to strengthen resilience.

Impact of crises on vaccination services

The major crises that have impacted immunization services are the COVID-19 pandemic, the Ebola epidemic, armed conflicts, and terrorist attacks. The COVID-19 pandemic is overwhelmingly the crisis that has disrupted immunization services. The COVID-19 pandemic has exacerbated health system challenges by affecting almost all key areas, thus causing disruptions to immunization services [20]. All components of immunization services, such as immunization coverage, health infrastructure and vaccine logistics, immunization service delivery, immunization service awareness, vaccine supply, and immunization personnel, have been impacted to varying degrees. However, the vast majority of studies have mentioned the decline in immunization coverage in many countries in sub-Saharan Africa [24]-[45] [52] [56] [57]. This decline threatens progress made in public health and exposes millions of children to preventable diseases. Several factors explain this decline in vaccination coverage. The COVID-19 pandemic has severely disrupted health systems, diverting human and financial resources to managing the health crisis [26] [31] [34] [35] [39] [52] [56]. Furthermore, armed conflicts and the resulting population displacement and the Ebola virus epidemic have made access to care more difficult, particularly in rural and remote areas [10] [24] [27] [36] [37] [44] [45] [57]. Added to this are structural challenges such as the lack of qualified personnel, insufficient health infrastructure and low awareness among communities of the importance of vaccination [20] [29] [36] [39] [41] [56]. The consequences of this situation are reflected in the existence of millions of children who have received zero doses or are insufficiently vaccinated [59]. This favors the resurgence of vaccine-preventable diseases such as measles and polio.

Adding to this picture are persistent inequalities in access to vaccination. Children living in rural areas, from low-income families, or whose mothers have low levels of education are particularly disadvantaged. In some contexts, cultural and religious factors can also influence perceptions of vaccines and hinder their acceptance.

Faced with this emergency, it is essential to strengthen awareness campaigns, invest in health infrastructure, and support community health workers. Collaboration between governments, international organizations, and local stakeholders is essential to restore confidence in health systems and guarantee every child the fundamental right to protection against disease.

Barriers to vaccination in crisis situations

Crises such as the COVID-19 pandemic, armed conflicts, terrorist attacks, and the Ebola epidemic have severely impacted immunization services in affected countries. In such a context, access to vaccination, although essential for the control of vaccine-preventable diseases, has been faced with multiple complex and interrelated obstacles. These obstacles can be grouped into structural, human, logistical, cultural, and political obstacles. They have contributed to a significant decline in immunization coverage due to the increase in unvaccinated and under-vaccinated children, thus compromising the health of the most vulnerable children [59].

- **Structural and organizational barriers**

Structural and organizationally, the closure of many health facilities due to conflict has reduced access to basic care, including vaccination [10]. Furthermore, the redirection of health personnel's efforts toward pandemic control and management has diverted human resources from essential services, including vaccination [20] [26] [34] [35] [56]. The suspension of vaccination programs has hampered the timely vaccination of many children, increasing the risk of epidemics [45] [46].

- **Human and motivational barriers**

Human and motivational barriers have also played a major role. Health workers, often exhausted, poorly protected, and under-recognized, have seen their commitment reduced. The lack of clear guidelines for routine care has led to uncertainty, affecting service delivery and stakeholder confidence. Logistical and geopolitical constraints should also be noted. Travel restrictions and containment measures taken at the government level have limited the mobility of health teams and beneficiaries [25] [28] [29] [31] [32] [35] [39] [41]-[43] [52] [56].

Transportation disruptions extended vaccine delivery times, compromising the cold chain. In conflict zones, insecurity hampered the delivery of medical supplies, making some areas completely inaccessible [37].

- **Communication barriers**

Communication activities were also challenged. Media attention focused on COVID-19 overshadowed other health services, reducing the visibility of vaccination services [41]. Inadequate outreach activities and insufficient information for mothers and caregivers contributed to low vaccine demand [29] [57]. Insufficient community engagement further widened the gap between populations and health professionals, weakening social mobilization [36]. This situation led to psychosocial and cultural barriers that amplified mistrust of vaccines and vaccination [29] [52]. Indeed, misinformation and rumors have fueled vaccine hesitancy, including suspicions of contamination of childhood vaccines by those against COVID-19

[29] [40].

Fear of adverse effects, fear of illness, and stigmatization of families affected by the virus have reinforced the misperception and rejection of health interventions [28] [29] [31]-[35] [38] [39] [41] [42] [56]. In some situations, grief over the loss of a loved one has led to temporary disengagement of families from health services [44].

- **Political barriers**

Finally, some political decisions have prioritized the response to the pandemic to the detriment of routine care. Financial resources have been redirected to managing the health crisis, leading to reduced donations and a shortage of funding for vaccination programs [41]. The prolonged duration of the conflict in some regions of the country has accentuated the disorganization of the health system, making any intervention even more difficult [10] [37].

Strategies implemented to strengthen resilience

The health, security, and humanitarian crises identified by the review have put a strain on health systems, including immunization services. Strategies have been adopted or proposed to address emergencies and also to strengthen the resilience of the system. For Kruk *et al.*, a health system such as immunization services is resilient if it is aware, diverse, integrated, adaptable, and self-regulating [16]. The strategies highlighted by the review can be grouped according to these dimensions.

For Kruk *et al.*, awareness involves the system's ability to detect weak signals, monitor performance, and understand local dynamics [16]. Thus, regular monitoring and evaluation can identify areas of low vaccination coverage or breakdowns in vaccination services [30]. Communication campaigns and community engagement also strengthen awareness by promoting feedback and raising awareness of vaccination-related issues [20] [25] [28] [29] [32] [34] [36] [37] [39] [40] [42] [44] [52] [57]. These approaches create a health system that is more attentive and responsive to real signals and needs.

A resilient system does not rely on a single intervention modality [16]. The use of a diversity of strategies, such as vaccination campaigns, service delivery by mobile teams, integration with other health services, and established incentives, makes it possible to maintain vaccination coverage even when traditional services are disrupted [25]-[28] [32] [36] [44] [45] [53] [56]. This plurality of approaches provides valuable flexibility in the face of unstable or unpredictable contexts.

Integration refers to the capacity of the system to function coherently across its different components [16]. Coordination of interventions between government actors, non-governmental organizations (NGOs), and technical and financial partners (TFPs) is essential to avoid overlap and duplication in order to optimize resources [32] [42]. The recovery plans highlighted must align with current national health policies [27] [43]. Community engagement [29] [32] [36] [42], by linking formal structures to local realities, also plays a role in social integration.

In the face of evolving crises, system adaptability is crucial. Changing delivery modalities, such as vaccination in schools and sites for displaced people through mobile teams [36], reflect this ability to adjust services. Continuity of services, even during times of crisis, is a form of operational adaptation. Investment in health workers, particularly through training and redeployment, helps meet changing needs on the ground [20] [25] [39] [50].

Finally, a resilient system must be able to stabilize and correct itself after a disruption. Strengthening the supply chain ensures the continued availability of vaccines, avoiding critical disruptions. Recovery plans help to address delays, rebuild confidence, and restore services. Monitoring and evaluation at this level also plays a role of feedback to adjust strategies based on observed results [27] [28] [30] [32] [34] [38] [43] [44] [49] [55] [56].

Lessons learned to build resilience

The resilience of immunization programs in times of crisis is necessary to maintain health and prevent a resurgence of vaccine-preventable diseases. Several lessons have been learned by sub-Saharan African countries. These lessons can be examined through the five dimensions of resilience developed by Kruk *et al.*

From a consciousness perspective, the implementation of near-real-time digital dashboards, such as those developed in South Sudan and Sierra Leone, has significantly strengthened epidemiological surveillance and the responsiveness of health systems [47]. In conflict situations, periodic security assessments and risk mapping have proven important for conducting interventions while preserving the safety of health workers in the face of potential threats [37].

From a diversity perspective, integrating COVID-19 vaccination services with routine immunization services, as observed in South Sudan, not only increased overall vaccination coverage but also contributed to reducing the costs associated with their implementation [48]. Furthermore, mobile initiatives and outreach campaigns were necessary to reach isolated or displaced communities [47]. In border regions or regions characterized by instability, strategies such as cross-border vaccination, collaboration with security forces, and negotiations to ensure access were essential in maintaining vital services [37].

From a self-regulation perspective, the task-shifting strategy to community-based health workers (CBHWs) in Burkina Faso helped maintain health protection even in the face of facility closures or increased terrorist attacks [10].

This decentralized model has shown that a system can continue to function in times of crisis, provided that local capacities are strengthened. Recruiting, training, and deploying an expanded workforce, as in Sierra Leone and South Sudan, also made it possible to continue COVID-19 vaccination campaigns without compromising routine vaccination coverage [47].

For the integration dimension, the establishment of a public health structure ranging from the national to the community level is essential to balance the response to health emergencies and the continuity of essential services [26]. The involvement of community, religious, and administrative leaders, social mobili-

zation, and multichannel communication have facilitated the implementation of vaccination campaigns, particularly against measles [42]. These efforts have been reinforced by the support of technical and financial partners, the availability of personal protective equipment (PPE), and adequate supplies.

Finally, from an adaptability perspective, appropriate and anticipated communication, ideally beginning one month before campaigns, helps counter vaccine hesitancy and strengthen community support. The careful selection of mobilizers and vaccinators, as well as the use of communication tools, help build trust among populations [40]. In unstable environments, this flexibility is crucial to maintaining the effectiveness of interventions.

In summary, the lessons learned from these different contexts show that the resilience of vaccination services relies on a systemic, inclusive, and contextualized approach. It depends not only on technical or financial resources, but also on proximity to communities, flexible strategies, and the ability to intelligently mobilize human and social resources. For countries facing recurring crises, it is essential to capitalize on these lessons to build more robust, equitable health systems capable of facing future challenges.

5. Gaps in Scientific Knowledge

Armed conflict situations such as terrorist attacks severely impact health systems in general and vaccination services in particular. The review highlighted publications in this area that show that the field of vaccination is not sufficiently investigated. Available research often focuses on health crises in general such as pandemics, or those linked to armed conflicts that are at the origin of security challenges. In these conflict situations, local responses, community strategies and spontaneous adaptation mechanisms are rarely analyzed in depth. The results of this review highlight the gaps that should be explored. These gaps can be grouped according to the five dimensions proposed by Kruk *et al.*, which offer a relevant analytical framework for assessing the robustness of health systems in crisis situations [16].

Gaps in awareness of vaccination services are linked to the lack of reliable and up-to-date data and the under-documentation of community alert mechanisms, even though they could play a key role in early risk detection. In the area of diversity, alternative vaccination strategies, local responses, and cultural and social dimensions are little explored in conflict contexts. Regarding self-regulation, documentation of the frequent interruption of vaccination services and spontaneous adjustments made by local structures, the resilience of health personnel, and mechanisms to ensure the continuity of services despite the crisis situation appear to be underdeveloped in the literature. Regarding integration, coordination; interactions between different sectors; the roles of TFPs, community leaders, and informal agents and their contribution to resilience are rarely analyzed in a systemic manner. Finally, in the area of adaptability, reforms undertaken and local innovation after crises are only partially documented. Future research could use a

comparative case study to assess the effectiveness of different adaptation mechanisms implemented by communities.

6. Limitations of the Study

This review only considered publications in French and English, which likely led to the loss of relevant documentary resources. These limitations should therefore be taken into account when interpreting the results. However, the included studies contain recent and relevant information on many countries in Sub-Saharan Africa.

7. Conclusion

This review allowed us to assess the resilience of immunization services in crisis situations in sub-Saharan Africa. Most sub-Saharan African countries present roughly similar contexts and realities. Crisis situations impact immunization services, particularly vaccination coverage, the availability of vaccine supplies, as well as health infrastructure, logistics, and human health resources. Furthermore, the study identified political, organizational, and community factors as barriers to immunization services. To address these barriers, resilience strategies are being implemented at several levels, ranging from the health system to community engagement. In light of these findings, ensuring the continuity of services through political-administrative and community engagement, combined with rigorous monitoring of system performance, should be a priority for policymakers and immunization program managers.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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