



Child Vaccination Tracking System

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Abstract: Childhood vaccination is one of the most effective methods for preventing vaccine-preventable diseases and reducing child mortality. However, maintaining complete and timely vaccination records can be difficult because of missed appointments, misplaced vaccination cards, lack of awareness, migration, and limitations in manual record-keeping. This paper proposes a Child Vaccination Tracking System (CVTS), a digital health information system designed to maintain vaccination records and assist parents, healthcare workers, and administrators in monitoring children's immunization status. The proposed system stores child details, vaccination history, vaccine schedules, upcoming doses, and missed vaccinations in a centralized database. It can generate automatic reminders through SMS or application notifications and provide alerts when a vaccination becomes overdue. A QR-based identification mechanism can also be incorporated to quickly retrieve a child's authorized vaccination record at participating healthcare centers. The system provides dashboards and reports to help healthcare workers identify children who have missed vaccinations and support follow-up activities. Recent studies indicate that mobile reminders and electronic immunization registries can improve vaccination timeliness, data availability, and identification of under-immunized children [1]– [10]. The proposed system integrates these concepts into a child-centered platform with emphasis on usability, security, privacy, interoperability, and accessibility. The system can contribute to improved vaccination adherence, better record management, and efficient immunization monitoring.

Keywords: Child vaccination, immunization tracking, electronic immunization registry, mHealth, SMS reminder, digital health, vaccine schedule, QR code.

I. INTRODUCTION

Vaccination is an important public-health intervention for protecting children against several infectious diseases. Childhood immunization programs depend on children receiving the correct vaccines at the recommended ages and intervals. Although vaccination programs are widely implemented, children may fail to receive one or more recommended doses because of forgotten appointments, lack of information, relocation, loss of vaccination cards, transportation difficulties, and inadequate follow-up.

Traditional vaccination records are commonly maintained using paper cards, registers, or disconnected healthcare records. These methods may make it difficult for parents and healthcare workers to determine which vaccines have already been received and which vaccines are due. Manual systems can also increase the possibility of missing records, duplicate entries, calculation errors, and delays in identifying children who have missed vaccinations.

Digital health technologies provide an opportunity to improve vaccination tracking. Electronic immunization information systems can maintain longitudinal records and provide information for both individual care and public-health management. Atkinson et al. proposed a patient-centric and interoperable digital immunization information system that connects individual vaccination information with broader health information systems [1]. Mobile-phone reminder interventions have also demonstrated potential for improving childhood immunization uptake, completeness, and timeliness [2], [3].

The Child Vaccination Tracking System (CVTS) proposed in this research is designed to address these problems through a centralized digital platform. The system maintains child information, caregiver details, vaccination history, vaccine schedules, and upcoming vaccination dates. Based on the recorded information, the system can generate reminders before a vaccination is due and alerts when a vaccination is overdue.

The proposed system can support three major groups of users: parents or caregivers, healthcare workers, and administrators. Parents can view vaccination information and receive reminders. Healthcare workers can update vaccination records and identify children requiring follow-up. Administrators can monitor vaccination statistics and generate reports.



The main objectives of the proposed system are:

1. To maintain digital vaccination records for children.
2. To automatically identify upcoming vaccination dates.
3. To send reminders to parents or caregivers.
4. To identify missed and overdue vaccinations.
5. To support healthcare workers in follow-up activities.
6. To provide reports for vaccination monitoring.
7. To improve the accessibility and reliability of vaccination information.

II. PROPOSED CHILD VACCINATION TRACKING SYSTEM

The proposed CVTS is a digital system that maintains a centralized record of childhood vaccination information. The system can be implemented as a web-based or mobile-based application connected to a secure database. The system consists of several major modules.

A. Child Registration

The child registration module stores basic information such as child name, date of birth, gender, parent or caregiver information, contact number, address, and unique identification number. The date of birth is particularly important because vaccination schedules are generally associated with the child's age.

B. Vaccination Record Management

The vaccination record module maintains information about vaccines already administered to the child. Each record can include vaccine name, dose number, date of administration, healthcare center, and authorized healthcare-worker information. This module provides a chronological vaccination history and helps prevent unnecessary duplication of vaccination records.

C. Vaccination Schedule Management

The schedule module determines which vaccines are due based on the child's date of birth and the applicable immunization schedule. When a vaccination is recorded, the system updates the child's vaccination status and calculates the next relevant due date. The schedule should be configurable so that an authorized health program can update vaccine schedules when official recommendations change.

D. Reminder and Notification Module

The notification module sends reminders to parents or caregivers before a scheduled vaccination. Notifications may be provided through SMS, mobile applications, email, or other approved communication channels. Research has shown that SMS and mobile-phone reminders can improve childhood immunization outcomes [2]–[6]. Therefore, the proposed system uses reminders as an important mechanism for reducing missed vaccination appointments.

E. Missed Vaccination Alert

If a vaccination is not recorded within the expected period, the system can mark the dose as overdue. The system can then generate an alert for the caregiver and, where permitted, a follow-up task for the healthcare worker. This feature helps healthcare workers prioritize children who require additional follow-up.

F. QR-Based Child Identification

A unique QR code can be generated for each registered child. At an authorized vaccination center, the QR code can be scanned to retrieve the child's digital record. The QR code should contain only a non-sensitive unique identifier rather than directly exposing personal or medical information. This approach can reduce manual searching and data-entry time.

G. Administrator Dashboard

The administrator dashboard provides summarized information such as:

- Total registered children
- Completed vaccinations
- Upcoming vaccinations
- Overdue vaccinations
- Missed-dose statistics
- Vaccination-center performance
- Monthly vaccination trends

The dashboard can help administrators identify areas requiring additional attention.



III. LITERATURE SURVEY

Recent research demonstrates increasing use of mobile technologies and electronic immunization registries for improving vaccination services. Atkinson et al. presented a patient-centric digital immunization system designed around interoperability and individual vaccination records [1]. Their work emphasized that future immunization systems should provide accessible and connected vaccination information rather than relying exclusively on isolated records. Yunusa et al. conducted a systematic review and meta-analysis of mobile-phone reminders for childhood immunization in low- and middle-income countries [2]. Their findings indicated that mobile reminders can support vaccine uptake, completeness, and timeliness. Eze et al. examined SMS reminders for childhood immunization and reported positive effects on vaccination outcomes [3]. The study demonstrates that SMS can be a practical communication method, particularly in settings where smartphone applications may not be universally available. Eze et al. also investigated the acceptability of mobile-phone reminders among caregivers in Nigeria [4]. Their findings indicated substantial acceptance of mobile reminders, supporting the inclusion of caregiver notification features in digital vaccination systems. Dithiine et al. studied parental reminder strategies and their cost implications [5]. Their findings indicate that reminder interventions can contribute to improved immunization outcomes while potentially providing a relatively economical approach to follow-up. MacDonald et al. evaluated an SMS reminder intervention in Alberta, Canada [6]. The study found that text-message reminders were associated with improved appointment attendance in the participating setting. Dang et al. investigated the transition from paper-based immunization reporting to a digital immunization system in Vietnam [7]. The research demonstrated that digital transformation can influence data quality, data use, outcomes, and operational costs. However, successful implementation requires training, workflow changes, and appropriate infrastructure. Michael et al. evaluated the Zindagi Mehfooz electronic immunization registry in Sindh, Pakistan [8]. The system incorporated several digital-health components, including a vaccinator application, dashboards, caregiver SMS, QR-based identification, offline capability, and decision support. This study provides strong evidence for combining multiple digital functions within an immunization ecosystem. Hirani and Wüst investigated reminder design and childhood vaccination coverage [9]. Their findings emphasize that the timing and design of vaccination reminders are important. Therefore, CVTS should use schedule-specific rather than generic reminders. Patel et al. evaluated the Lao Electronic Immunization Registry [10]. The study reported improvements in immunization reporting and identification of under-immunized children while also identifying challenges such as data gaps, training requirements, staffing limitations, and the need for stronger governance. Together, these studies indicate that digital vaccination systems can provide benefits at both individual and program levels. However, successful implementation depends on data quality, usability, training, privacy, connectivity, and integration with existing healthcare systems.

TABLE I SUMMARY OF RECENT LITERATURE

Ref.	Author and Year	Method/Technology	Major Finding	Relevance to CVTS
[1]	Atkinson et al., 2020	Digital immunization information system	Proposed patient-centric and interoperable vaccination records	Digital child record
[2]	Yunusa et al., 2021	Mobile reminders	Improved uptake, completeness and timeliness	Reminder module
[3]	Eze et al., 2021	SMS reminders	Positive effect on childhood immunization	SMS notification
[4]	Eze et al., 2021	Mobile reminder acceptability	High caregiver acceptance	Parent communication
[5]	Dathini et al., 2022	Reminder strategies	Reminders can improve immunization outcomes	Cost-effective reminders
[6]	MacDonald et al., 2022	SMS appointment reminders	Reduced missed appointments in study setting	Appointment tracking
[7]	Dang et al., 2024	Digital immunization reporting	Improved digital data management with implementation challenges	Digital database
[8]	Michael et al., 2024	EIR, QR, SMS, dashboards	Supported coverage and timeliness monitoring	Integrated CVTS
[9]	Hirani & Wüst, 2024	Reminder design	Timing of reminders affects vaccination	Schedule-aware alerts
[10]	Patel et al., 2026	Electronic immunization registry	Improved reporting and identification of under-immunized children	Defaulter tracking



IV. RESEARCH GAP

Although existing studies demonstrate the usefulness of mobile reminders and electronic immunization registries, several research gaps remain.

1. many studies concentrate on individual reminder interventions rather than providing an integrated child-centered system. A complete vaccination tracking platform should combine registration, vaccination history, schedule calculation, reminders, missed-dose identification, and reporting.
2. some electronic registry systems primarily focus on healthcare workers or administrative reporting. Parents and caregivers also require a simple interface through which they can understand the child's vaccination status and upcoming doses.
3. interoperability remains a challenge. A standalone vaccination application may create a separate data repository that cannot communicate with authorized healthcare systems. Interoperability should therefore be considered during system design.
4. internet connectivity and digital literacy may limit the use of mobile applications in some communities. Offline functionality and SMS-based communication can improve accessibility.
5. privacy and security require greater attention because vaccination records contain health-related information. Secure authentication, authorization, encryption, audit logs, and data minimization should be incorporated into the system.
6. more long-term real-world evaluations are required to determine whether integrated digital tracking systems improve vaccination completion rates, reduce dropout, decrease administrative workload, and remain sustainable.

V. MOTIVATION

The main motivation for developing CVTS is the need to reduce missed and delayed childhood vaccinations.

A paper vaccination card mainly provides a historical record. It does not automatically remind parents about future vaccinations or identify children who have failed to attend an appointment. In contrast, a digital tracking system can actively monitor vaccination status and generate appropriate notifications.

Another motivation is the difficulty faced by healthcare workers when managing large numbers of children. Manually checking registers to identify children with overdue vaccinations can consume considerable time. A digital dashboard can automatically generate due and defaulter lists.

The proposed system is also motivated by the need for continuous access to vaccination information. Digital records can reduce dependence on physical cards that may be damaged or misplaced. With appropriate authorization, healthcare workers can retrieve the child's record when required.

Therefore, CVTS aims to convert vaccination record management from a passive process into an active monitoring and follow-up system.

VI. APPLICATIONS OF THE CHILD VACCINATION TRACKING SYSTEM

A. Parent and Caregiver Application

Parents can register children, view vaccination history, receive reminders, and check upcoming vaccinations. The application can also provide basic educational information about immunization.

B. Healthcare-Centre Application

Healthcare workers can search for children, scan QR codes, update vaccination records, and view upcoming and overdue vaccinations.

C. Defaulter Tracking

The system can automatically identify children who have missed scheduled vaccinations. Healthcare workers can use the generated list for follow-up.

D. Vaccination Monitoring

Administrators can monitor vaccination activity using dashboards and reports. This can help identify areas with low vaccination coverage.

E. SMS Notification

SMS notifications can be used for caregivers who do not have smartphones or reliable internet access. This makes the system more inclusive.

*F. QR-Based Record Retrieval*

QR codes can provide quick identification of a child's authorized record at participating healthcare centres.

G. Public-Health Planning

Aggregated and appropriately de-identified information can support vaccine-demand planning, outreach activities, and evaluation of immunization programs.

VII. FUNCTIONAL WORKFLOW

The proposed system follows the workflow:

Child Registration → Vaccination History Entry → Schedule Calculation → Reminder → Vaccination Visit → Dose Confirmation → Record Update → Next-Dose Calculation

When a child is registered, the system records the date of birth and previous vaccination information. The schedule engine then determines upcoming doses.

Before the due date, the notification module sends a reminder to the caregiver. When the child receives the vaccine, the healthcare worker records the dose in the system.

The system then updates the vaccination history and calculates the next required dose. If the vaccination is not recorded within the expected period, the system changes the status to Overdue and generates a follow-up alert.

VIII. SECURITY AND PRIVACY

Security is an important requirement for CVTS because the system stores personal and health-related information. The following security measures should be considered:

1. User Authentication: Only registered users should access the system.
2. Role-Based Access: Parents, healthcare workers, and administrators should have different access privileges.
3. Data Encryption: Sensitive information should be protected during transmission and storage.
4. Audit Logs: Important record modifications should be logged.
5. Secure Backup: Regular backups should be maintained to prevent data loss.
6. Data Minimization: Only necessary information should be collected.
7. QR Security: QR codes should contain an identifier rather than sensitive health information.
8. Privacy Controls: Access to child records should be limited to authorized personnel.

The system should also provide simple interfaces and multilingual communication to improve usability.

IX. EXPECTED CONTRIBUTION

The proposed Child Vaccination Tracking System contributes an integrated framework for managing childhood vaccination information.

The system combines:

- Digital child registration
- Vaccination-history management
- Schedule calculation
- Automated reminders
- Missed-dose detection
- QR-based identification
- Healthcare-worker dashboards
- Administrative reports

Unlike a simple reminder application, CVTS creates a continuous tracking cycle from child registration to vaccination completion and follow-up.

The proposed framework can serve as the foundation for developing a working prototype and evaluating its effectiveness in real-world healthcare environments.

X. CONCLUSION AND FUTURE DIRECTIONS

The Child Vaccination Tracking System provides a digital approach for improving childhood vaccination record management, reminders, follow-up, and monitoring. The literature reviewed in this paper indicates that mobile reminders and electronic immunization registries can improve vaccination timeliness, data availability, and identification of children requiring additional follow-up [1]– [10].



The proposed system integrates these concepts into a child-centered platform. Parents can receive vaccination reminders, healthcare workers can update records and identify overdue children, and administrators can monitor vaccination activities through dashboards and reports.

Future development can focus on integration with national or regional immunization information systems, offline-first functionality, multilingual SMS and voice notifications, improved interoperability, and privacy-preserving analytics. Predictive analytics and artificial intelligence could also be investigated to identify children who may be at higher risk of missing future vaccinations. However, such technologies should support rather than replace healthcare-worker and public-health decision-making.

Future research should evaluate the proposed system using measurable indicators such as vaccination completion rate, on-time vaccination rate, number of missed doses recovered, reminder delivery rate, data completeness, user satisfaction, system usability, and implementation cost.

In conclusion, a secure, user-friendly, and interoperable Child Vaccination Tracking System can support caregivers and healthcare workers while improving the efficiency of immunization monitoring.

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