International Journal of Community Medicine and Public Health
Harshitha N et al. Int J Community Med Public Health. 2026 Jun;13(6):3239-3246
https://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20261823

Review Article

Standardizing non-communicable diseases surveillance: a review of variables, tools, digital platforms and a proposed integrated HMIS framework

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Received: 19 April 2026
Accepted: 15 May 2026

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ABSTRACT

Non-communicable diseases (NCDs) account for a significant share of preventable morbidity and mortality, yet data collection on NCDs is carried out in separate, disconnected and often inconsistent ways. This review showcases the variables, tools and digital platforms used for NCD data collection, monitoring and implementation by collecting the data elements such as behavioural risks, physical measurements, biochemical markers, clinical diagnostic and treatment variables, outcomes and system performance indicators and to classify the tools used to capture and manage them. This work also proposes a baseline NCD dataset and a unified framework for integrating survey and routine care data within a single ecosystem-wide Health Management Information System (HMIS), enabling consistent measurement, programme monitoring and actionable decision support.

Keywords: Noncommunicable diseases, Public health surveillance, Health information systems, Health information interoperability, Speech recognition software

INTRODUCTION

World Health Organisation highlights that non-communicable diseases (NCDs) contribute 74% of global deaths worldwide, which is a big health concern.[1] The results also report that lifestyle and behavioural factors like tobacco use, physical inactivity, unhealthy diet and the harmful use of alcohol are the major risk factors.[1] To control these, we need to spot these habits early, track them across populations for effective prevention and management.[2] Therefore, the Global Action Plan for the Prevention and Control of NCDs was initiated, and Sustainable Development Goal also aims to reduce premature mortality from NCDs by one-third by 2030.[3,4] Hence, many countries start NCD prevention programmes across the world, which lead to the need for continuous monitoring of the data, taking decisions on it and integration with HMIS systems to track the progress of programme implementation.[5] Therefore, countries start including risk factor prediction, screening and identification of diseases and revisit for further screening in their implementation programmes.[6] To achieve these, continuous data collection plays an important role.[7]

So many countries start implementing structured approaches; the most implemented approach is using the WHO STEPS framework, which helps identify what data variables need to be collected. The framework includes NCD risk factors such as tobacco use, diet, obesity, physical activity, blood pressure and glucose etc.[8] These structured survey methods help countries systematically collect the right kind of required data at population level for NCD risk factor evaluation and help to compare between countries in a standard way.[9] Although the structured framework like STEPS helps identify what data to collect for NCD surveillance, the challenge lies in its implementation. All these approaches require a lot of human resources, planning and logistics as data collection requires manual entry.[10] These traditional methods of data collection result in various limitations because the data which is collected is periodic, which cannot be used for continuous monitoring and as it is collected by manual process, it often results in delay in availability of the data.

So, these problems result in the development of digital systems which help for further diagnosis and follow-up.[11] It also helps to maintain health records longitudinally, track patients over time and integrate different data sources. These developments represent a shift from periodic survey-based surveillance towards more integrated system-based data management.[12] Even though digital health systems improve the way NCD data is managed, several challenges still exist in practice. In many settings, data entry still depends on health workers manually entering information into the platforms, which increases workload and may lead to in-complete or delayed records. Different systems may also work separately, making it difficult to combine information from multiple sources.[13]

These limitations show that while digital platforms help in organising information, there is still a need for smarter approaches that can assist in processing and understanding NCD-related data more efficiently.[14] Given the evolution from survey-based methods to integrated digital platforms, there is a need to understand how different variables, instruments and systems con-tribute to NCD data collection.[15]

Many studies focus either on surveys or on digital health technologies separately, but a clear overview of how these approaches work together is still limited. Therefore, this review aims to focus on the variables required for NCD surveillance, tools used to capture the data and the platforms which manage the data across various health systems.

This study helps us to understand the data required for NCD management and mainly it brings to the point the importance of effective monitoring for better decision-making systems, because even though there is an evolution in how NCD data is collected, there is still a need for better systems.

This study initially focused on the operational implementation of NCD programmes across various countries to study the structure of implementation programmes. It then examined what variables are required for NCD data collection, because operational implementation influences the type of variables collected, followed by tools required for data collection, digital platforms, challenges and future directions. In this context, it proposes a baseline dataset and a unified framework which uses current technologies like OpenAI's Whisper model and Large Language Models such as Gemini, Med Gemma to overcome existing operational barriers.

METHODS

The methodology for this review paper is used PUBMED and Google scholar for the data collection. Along with the research papers, articles and official websites which provide the implementation details for NCD were also studied. The study mainly focused on the papers which are aligned with the core part of the topic like NCD surveillance, data collection methods and digital platforms used. Conversely, the papers which mainly focused on the clinical part instead of data collections methods were excluded. the search was executed using the keys words along with combinations such as Noncommunicable Diseases, Public Health Surveillance, Health Information Systems and Health Information Interoperability.

Operational implementation of national NCD programmes

The operational implementation of NCD programme varies across the countries because of the structural differences in its implementation programme.[5] Based on the place where screening happens, the way NCD programmes are implemented is conceptually divided into three categories: Community-based, Facility-based and Routine Care Surveillance model.

In the Community-based approach, frontline workers visit houses, conducts the initial risk scoring and direct them to the hospitals like Brazil's family Health Strategy, India's National Programme for Non-Communicable Diseases (NP-NCD) and Samoa's Package of Essential Noncommunicable (PEN) Fa'a Samoa.[17-19] In the facility-based approach, the individuals directly visit primary health center to get screened like Sri Lanka's Healthy Lifestyle Centers and China's National Basic Public Health Service.[20-22] Finally, in the routine care surveillance approach, when an individual visits the hospital for a regular health checkup or for any other reason, they get screened for NCD as well like United Kingdom's Making Every Contact Count (MECC).[23,24] This categorization indicates the presence of these facilities in the country, rather than implying it is the only approach followed.

Variables collected in national NCD programmes

The way National NCD programme is implemented in different operational settings influences the type of variables collected.[25] Community based models mainly prioritize behavioural and basic measurement variables as they are used for early disease risk identification. The facility-based screening models further add clinical assessment and diagnostic information. Thereafter routine care models include long term surveillance variables which are collected during their regular visits. Table 1 showcases the variables collected in different operational settings.

Tools used for NCD data collection

Several tools used across national NCD programmes to capture behavioural, clinical and biochemical data during screening and diagnosis. Behavioural risk factors are commonly collected using structured questionnaires and screening instruments.

Physical and anthropometric measurements are collected using clinical devices. Biochemical markers use glucometers and laboratory diagnostic equipment. Clinical diagnosis, treatment details and patient outcomes are documented using electronic clinical forms used in healthcare.

Table 1: Variables by operational setting.

Operational setting	Variables collected	Reason	Examples
Community-based	Tobacco use, alcohol use, physical activity, BP, BMI	No laboratory equipment available	India NP-NCD.[26]
Facility-based	Tobacco, alcohol, PA, BP, BMI, glucose, cholesterol, CVD risk score	Requires laboratory cholesterol testing	Sri Lanka HLC.[27]
Routine care surveillance	Tobacco, alcohol, PA, BP, BMI, glucose, cholesterol + patient tracking	Requires cholesterol + BP recording	Australia MBS 699.[28]

Note. BP=Blood Pressure; BMI=Body Mass Index; PA=Physical Activity; CVD=cardiovascular disease; NP-NCD=National Programme for Prevention and Control of NCDs; HLC=Healthy Lifestyle Centers; MBS=Medicare Benefits Schedule.

Table 2: Classification of NCD variables and data collection tools.

Data category	Variable type	Key variables	Tools used for data collection
Behavioural	Questionnaire-based	Tobacco use (current/former), alcohol consumption, physical activity (met-minutes), fruit/vegetable intake, diet quality scores, sedentary behaviour.[29]	WHO stepwise survey instruments (steps); community-based assessment checklist (CBAC).[30,31]
Physical	Anthropometric	Systolic/diastolic BP (≥140/90 mm Hg), BMI (≥25 kg/m^2), waist circumference, waist-hip ratio, height/weight raw values.[29]	Digital blood pressure monitors; weighing scales; stadiometers.[32]
Biochemical	Laboratory	Raised fasting glucose, raised total cholesterol, HbA1c, LDL/HDL ratio, triglycerides.[29]	Glucometers.[31,32]
Clinical	Diagnostic	Hypertension diagnosis, diabetes diagnosis, CVD 10-year risk score, CKD staging.[33]	Outpatient registers; patient case sheets; electronic medical records.[34]
System and outcomes	Operational	Referral status, follow-up visits.[18]	Follow-up registers; treatment monitoring forms; programme monitoring forms; reporting templates; digital dashboards.[34,35]

Note: NCD=Non-Communicable Disease; MET=Metabolic Equivalent of Task. BP=Blood Pressure; BMI=Body Mass Index; HbA1c=Haemoglobin A1c; LDL=Low-Density Lipoprotein; HDL=High-Density Lipoprotein; CVD=cardiovascular disease; CKD=chronic kidney disease.

Programme monitoring data are captured using reporting formats and monitoring tools to assess system performance and service coverage. To understand better how these data elements are captured in practice, the commonly used tools can be grouped based on the type of data they collect, as shown in Table 2.

Digital platforms in NCD surveillance

Digital platforms represent the evolution from periodic survey-based NCD data collection to integrated, real-time health management systems that enable continuous monitoring, referral tracking and programme evaluation across health system levels.[36] Table 3 demonstrates the digital platforms used in different countries and its functioning.

DISCUSSION

Challenges in NCD data capture and integration

Several challenges exist in the implementation of NCD programs across national level. Al though there is an evolution in the way data is collected, managed and used for clinical purposes, many challenges still affect the effective implementation of these programs. The key challenges include While using digital tools there were regular application crashes, inconsistent internet and server downtime. These issues lead to reliance on pen and paper methods and take extra time to re-enter the data into the portal.[41] There are workload issues because of inadequate staff across the health system. Data entry into the portal during busy clinical hours 7 is often difficult. Managing multiple portals is time-consuming.[13] The challenges further include the constrained integration across systems, Data interoperability, Fragmentation and lack of common terminologies.[42]

Overall, these challenges highlight gaps between data collection, clinical workflows and system-level analytics, emphasizing the need for stronger integration across the NCD data life cycle.

Proposed baseline NCD dataset

A baseline dataset is to be designed with minimum required variables required for risk scoring, early detection, and continuous surveillance of NCDs. The dataset consists of demographic, behavioural, anthropometric measurements, key biochemical markers, disease history, and environmental exposures.

Additionally selective genetic variables and air quality index can also be included. Based on STEPS and NPNCD questionnaires this Table 4 is developed.[43]

Table 3: Digital platforms for NCD screening and surveillance.

Country	Platform	Functioning
India	National NCD portal	(clinical management) a cloud-based platform accessed via a mobile app. Health workers input multi-NCD screening data directly from the field, which is integrated with a unified health ID (ABHA). A backend clinical decision support system (CDSS) auto-generates risk scores for physician referrals.[37]
Brazil	E-SUS APS	(clinical management) the national primary care digital platform. Community health agents use its integrated mobile application (e-SUS território) during household visits to directly collect multi-NCD screening data (e.g., hypertension, diabetes), which syncs directly to the national health database.[38]
Singapore	NEHR via smart CMS gateway	(clinical management) a centralized national clinical platform. Primary care providers utilize the smart CMS gateway to digitally input and longitudinally track screening data for multiple NCDs under the national chronic disease management programme (CDMP), seamlessly contributing to national electronic health record (NEHR) for care continuity.[39]
Zambia, Philippines, Morocco, Malawi, Sri Lanka	Surveda platform	(population surveillance) an open-source, multi-modal platform backed by the CDC. It operates autonomously by sending automated SMS, IVR, and mobile web surveys directly to citizens to collect NCD behavioural risk factors without clinical intervention.[40]

Note: NCD=Non-Communicable Disease; ABHA=Ayushman Bharat Health Account; CDSS=Clinical Decision Support System; NEHR=National Electronic Health Record; CDMP=Chronic Disease Management Programme; CDC=Centers for Disease Control and Prevention; SMS=Short Message Service; IVR=Interactive Voice Response.

Table 4: Baseline NCD dataset variables.

Section	Variables
Identification	Unique ID, age, sex
Socio-demographic	Education level, occupation
Behavioural risk factors	Tobacco use, alcohol use, fruit and vegetable intake indicator, physical activity level
Anthropometry	Height, weight, waist circumference
Blood pressure	Systolic BP, diastolic BP, on BP medication (yes/no)
Biochemical markers	Fasting blood glucose, total cholesterol
Known disease status	Hypertension (yes/no), diabetes (yes/no)
Family history	Family history of hypertension/diabetes/heart disease (yes/no)
Early detection symptoms	Chronic cough (more than 2 weeks), unexplained weight loss, breast lump (women), oral ulcer non-healing
Environmental exposure	Type of cooking fuel, occupational exposure, air quality index (AQI), PM2.5 concentration, PM10 concentration
Genetic information	Genetic test performed (yes/no), genes evaluated, genetic variant identified, variant classification, genetic risk interpretation
Insurance	Insurance coverage (yes/no)

Note: ID=Identification; BP=Blood Pressure; AQI=Air Quality Index; PM2.5=Particulate Matter 2.5 micrometers or less in diameter; PM10=Particulate Matter 10 micrometers or less in diameter.

Proposed integrated framework

This framework proposes a singular voice-based HMIS architecture which can be used across primary, secondary and tertiary care for NCD data capture, structuring and clinical decision-making. It addresses the limitations of the existing digital health ecosystem where data capture, clinical documentation and health data management function as isolated systems which lead to fragmented information and duplicated effort. Supported by present-day technologies which combine multilingual speech recognition and translation tools, the framework enables unstructured conversations between patients and frontline workers. Voice samples also can be used to extract mental health aspects, generate structured electronic health records, and integrate with a unified HMIS. The framework shown in figure 1 presents a continuous lifecycle of NCD data management from capture to clinical decision.

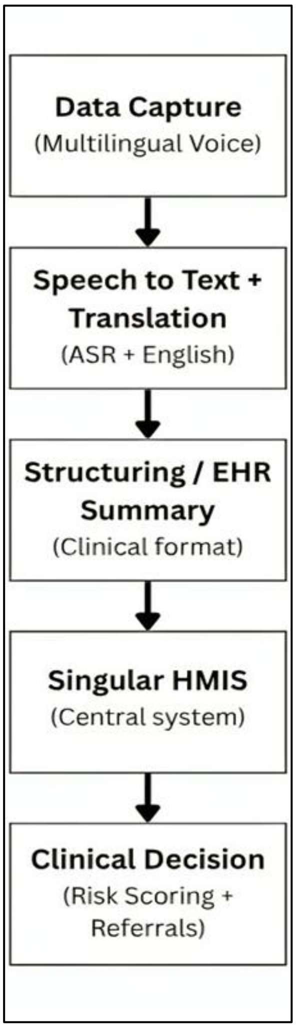

Figure 1: Proposed voice-enabled integrated HMIS framework for NCD data capture and clinical decision support.

The first stage involves multilingual voice data capture where the data of the recipient and the data collector is collected during the conversation in local languages. It mitigates the dual data entry problem and reduces the frontline workers' burden. Automatic Speech Recognition (ASR) engines like Sarvam AI and Whisper-based transcription systems demonstrate practicality of converting real-time spoken data into machine-readable text in healthcare environments.[44,45] Captured voice data undergoes speech-to-text conversion and language standardization where ASR converts spoken responses into digital text. Neural translation systems like Indic Trans or comparable multilingual frameworks then standardize output into English. This maintains a common format across the system without losing multilingual input flexibility during data entry. After transcription and translation, a structured Electronic Health Record (EHR) summary is generated which aligns with predefined NCD data elements. Standards such as Health Level Seven Fast Healthcare Interoperability Resources (HL7 FHIR) ensure consistency and interoperability of the produced electronic records. The structured EHR summary is stored in a singular HMIS system as a central repository for patient-level and program-level data. This eliminates duplication across screening and clinical platforms and supports system-wide continuity. In the final stage, the framework includes a clinical decision layer which operates on EHR records stored in the central HMIS. An algorithm can be developed and trained using collected EHR records to aid risk scoring. Based on the computed risk score, the system generates referral recommendations. As the HMIS gathers longitudinal data over time, the model is refined which improves prediction accuracy and forward-looking risk management.

CONCLUSION

Non-communicable diseases remain a serious global health problem. Solving this requires more than just awareness it needs smarter, practical approaches. Since prevention depends on catching diseases early, a reliable surveillance system becomes essential. Without it, early identification is simply not possible. This review looks at how NCD programmes are implemented across different countries. A key finding is that programme structure directly shapes what variables get collected. Countries with more resources tend to have more comprehensive systems, while others collect only what their infrastructure can support. The existence of these differences is not random; it actually represents the reality in current health systems. This study examined three major components, those are variables, tools, and platforms which are used for NCD data management. Frameworks such as STEPS tell what variables to collect, but there is a difference between knowing what to collect and actually collecting it. The usage of the type of variable depends on the implementation model. The evolution to digital systems has improved the availability of data, patient tracking, and monitoring, but the problems still persist with regard to fragmented systems, poor interoperability, and the workload on frontline workers, which weakens the usage of NCD data for decision-making. To tackle these gaps, this review proposes a conceptual framework using present technologies and designs a unified HMIS system combined with voice-based data capture and generates a structured EMR by using AI-assisted clinical decision support within one single ecosystem. The framework supports multilingual speech recognition and encourages conversations to be in an unstructured way; the framework automatically collects the data, which reduces the burden on frontline workers from the dual data entry problem. The voice samples which are collected can also be used to extract mental health aspects. The baseline dataset which is proposed uses the most essential parameters to predict the risk for NCDs. The dataset uniquely includes the AQUA index, as it is the second major reason for the cause of NCDs and also includes important genetic variables. Future research should focus on the integration of these using current AI capabilities and making it a reality. Routine data, when properly collected and connected, can become actionable insight for clinicians, for programme managers, and ultimately for patients.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Harshitha N, Chidambar B, Nanjundaswamy DL. Standardizing non-communicable diseases surveillance: a review of variables, tools, digital platforms and a proposed integrated HMIS framework. Int J Community Med Public Health 2026;13:3239-46.