

Review Article

From Paper to Pixels: An In-Depth Review of Health Information Systems in India

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Abstract - Due to an increase in demand, healthcare organisations are under pressure for enhanced health services. The primary component and an alternative remedy for this stress has been proven to be the application of information technology in the healthcare industry. The reliability and timeliness of information creation, analysis, transmission, and utilisation are crucial for the Health Management Information System (HMIS) to be effective. Several organisational, structural, technological, and human support, led to the creation of the national web-based HMIS portal. This review paper offers a thorough evaluation of the Indian Health Information System, stressing its contributions to the transformation of health information exchange, technological infrastructure, data collection and management, and healthcare delivery. It also addresses issues and promotes the idea of a digitally connected, data-driven healthcare ecosystem.

Keywords - Data, Health, Health care, Health management, Health system.

1. Background

The state of Odisha on the eastern coast of India has made significant progress in the aspect of information technology to improve healthcare and ensure better access to healthcare services for all citizens predominantly the rural population comprising 83.3% of its residents. [1]. The establishment of a functional and integrated health information system is the primary necessity as nations work to achieve Universal Health Coverage (UHC) as a component of the Sustainable Development Goal (SDG). [2] The information communication technology-based Health Information Systems (HISs) was developed and implemented by all the states prioritising district-level electronic routine health information databases. Before 2008, there was no uniform portal to supply the need for the Ministry of Health and Family Welfare. The National Rural Health Mission (NRHM), known as the National Health Mission under the Ministry, is now focused on developing and utilising an efficient HIS system to improve the health care of rural populations, particularly poor and marginalised groups, aimed at swift dissemination of data, starting at the individual level facility and reaching up to the upper levels. [3,4]

2. Introduction

The landscape of healthcare is undergoing a transformative shift in the digital age, with HIS playing a pivotal role in this evolution. The efficient management of health-related data and records has become essential for providing quality healthcare services and informed decision-

making as the existing surveys, such as National Family Health Surveys (NFHS), do not capture the relevant health data required for routine planning and monitoring. Previously, the Government of India collected data using a paper-based system specific at the state and district level, however, it was not sufficient to meet the needs of the country. For regular tracking and planning, it is necessary to set up a complete system to gather data on health services performance at the lowest levels (such as the facility, block, and district levels). [5] However, evidence suggests that India lacks in both data quality and quantity. For example, in terms of the Vital Statistics Performance Index (VSPI), which starts with the timely generation of mortality and birth data, it has been observed that India performs very poorly (0.25). [6] In research by the National Health Systems Resource Centre (NHSRC) with a sample of 35 districts of India, gaps were found in data collection. Also, duplication of work was found at the same center due to the existence of both old and new reporting systems.[7] According to a survey, India was among the 39 lowest-performing nations out of 148. [8] Despite the critical role these systems play, there is a lack of updates on recent health information management systems related to Odisha, thus, this review article aims to bridge the research gap of the state.

Also, it assesses comprehensive data on the health information system in the country, highlighting the areas of improvement, along with discussing aspects of the system at the state level.



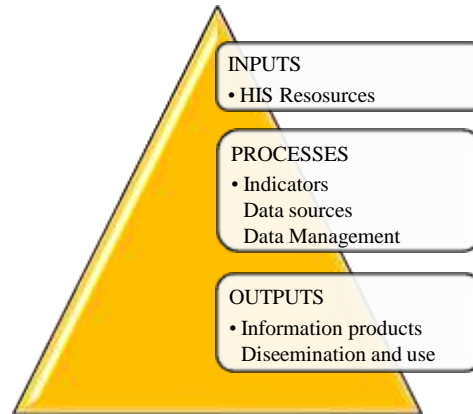


Fig. 1 Overview of health information system

3. Aspect of a Health Information System

The health information system was created to cater the information requirements of the healthcare sector serving as the backbone for data management and information, facilitating critical functions related to planning, managing, and evaluating public health efforts. [9,10] Refer Figure 1.

3.1. Health Information System Resources

Health programs such as the National Rural Health Mission (NRHM), Ayushman Bharat-Pradhan Mantri Jan Arogya Yojna (PM-JAY), Rashtriya Swasthya Bima Yojana (RSBY) run by the Ministry and primarily funded by internal resources. However, the Global Health Observatory Data Repository by WHO observes that the majority of funds come from private rather than public sources.

The Indian government initiated a noteworthy program in 2005 to improve the standard and accessibility of healthcare services in rural regions, focusing especially on 18 states including Odisha, with low public health indicators and infrastructure. The Health Management Information System (HMIS) web portal was launched in 2008 to facilitate the implementation of the NRHM. [11] Due to this advancement, computer access and internet connectivity have spread even to Sub-Centers, allowing healthcare facilities to enter electronic data directly.[12]

3.2. Indicators

The NRHM initiated a comprehensive reform of the system, streamlining and consolidating standard reporting forms. At the outset, the Ministry of Health and Family Welfare (MoHFW) faced challenges of managing more than 3,000 data elements associated with various maternity, child, and reproductive health programs, which was further trimmed down to 134 for community health centres, sub-district hospitals, and district hospitals, 76 for primary health centers, and 76 for sub-centers. [13] Furthermore, to introduce the RMNCH+A (Reproductive, Maternal, Newborn, Child, and Adolescent Health) program in 2013,

NRHM worked with a group of technical resource partners that included foreign organisations and regional non-governmental organisations.[14]

3.3. Data Sources

India has a vast data source for information regarding various health programs across the state and nation, including routine, non-routine, and institution-based along with population-based ones, which have been divided into two groups reported by Health Metrics Network, in the following tables (Table I and Table II) consisting of indirect sources and direct sources. [15]

3.4. Data Management

Tremendous progress has been seen in the country since the time digital objective was taken up by the NRHM in 2005. The establishment of the national HMIS web portal beginning in 2008 drove the proliferation of computers and internet access down to the Sub-Center level in the majority of districts throughout India. It encompasses a systematic approach to collecting, storing, organising, and ensuring the security and integrity of health-related information. Once collected, this data is meticulously checked for accuracy, relevance, and timeliness to maintain its quality. Following this, HIS employs standardised coding and classification systems to organise the data, making it accessible for healthcare professionals and decision-makers.

3.5. Data Dissemination and Use

At the district and health facility levels, there is minimal proof that the data produced by NRHM programs is actively utilised; however, there is documentation suggesting it is used at the state level. In India, many public websites with databases for health programs include the most recent program-related health statistics. The MoHFW, the Office of the Registrar General, and the Office of Business Health Intelligence are in charge of the majority of these websites. Given that a sizeable portion of Indians have internet access, this practically guarantees that health information is accessible and free for state-level program planning purposes.[16]

Table 1. Indirect source of health information system

Type of source	Description	Strengths	Limitations
Census	<p>Once in every ten years, the Indian Census is conducted.</p> <p>A thorough source of factual data on the local populace and area.</p> <p>It is under the control of the Union Ministry of Home Affairs, and the Registrar General is designated as the Census Commissioner.</p>	<p>Includes all people along with varied geographic locations</p> <p>Data on mortality and fertility for various levels of geographic areas are also supplied.</p>	<p>By the time the information is available and disseminated, a decade has passed.</p> <p>It does not include all the information necessary for analysing the population's health, such as morbidity, etc.</p>
Civil Registration System	<p>It is a mechanism for continuously documenting life-changing occurrences like births, deaths, weddings, etc.</p> <p>Since 1969, the Registrar General of India has been in charge of the system.</p>	<p>Annual statistics on death causes are broken down by age, sex, and type of residence.</p>	<p>The reporting of the cause of death has inadequate coverage and compliance.</p> <p>Mortality statistics do not account for non-fatal outcomes like the length of an illness or lost productivity due to disease.</p>
Sample Registration System	<p>Estimates the state's and the nation's vital statistics launched by Indian Registrar General's in 1969-70</p> <p>Estimates are given for major states of the nation, including both rural and urban areas.</p>	<p>A dual recording method that records both births and deaths in a sample of villages and urban areas that is nationally representative.</p>	<p>It tends to underestimate fertility rates in the age group of 15 and 19.</p> <p>It does not provide any information on spontaneous, induced, or stillbirths, which is a crucial data set that policymakers need.</p>

Table 2. Direct sources of health information system

Type of source	Description	Strengths	Limitations
Surveys	<p>National samples of households and respondents constitute the foundation for national population-based surveys.</p>	<p>Covers a wide range of health concerns for the entire population.</p> <p>Both biological and clinical information about the respondents is provided.</p> <p>Data disaggregation and analysis are primarily possible at the state and district levels.</p>	<p>Bias in reporting for certain medical conditions.</p> <p>Extensive research is needed for rare or low-prevalence conditions, and high resources are needed to ensure high data quality.</p>
Health infrastructure	<p>The subcenter operates under the oversight of a parent Primary Health Center (PHC) and submits monthly reports. In addition to these routine data transmissions, health program data is often directly sent to the state health program offices, bypassing the District Headquarters. Furthermore, the PHC acts as an intermediate point, collecting reports from subcenters and transmitting them to the District Headquarters.</p>	<p>Information was collected from the primary level, i.e. grassroots level.</p>	<p>They struggle with long periodicity in information compilation and lack information on the private sector's health infrastructure.</p> <p>At the district level, there are limitations in terms of data availability for assessing healthcare quality, inadequate updates regarding personnel resources, and shortages of hospital beds.</p>

Health status	Several health indicators are used to assess a country's health- such as the birth rate, nutritional status, age-sex-specific death rates, infant, maternal, and perinatal mortality rates, and the Human Development Index.	Includes a variety of health indicators	Because of administrative, legal, social, and ethical issues, the data available from various sources are frequently insufficient.
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4. Generations of Health Information System

4.1. First Generation

While Health Information Systems exhibit significant variation across the developing world, they commonly share several key characteristics

- Since they operate in the public sector, they frequently only record information relating to encounters with the public health system.
- The lack of incentives for governments, funders, and implementing partners to collaborate on data collecting, data sharing, or usage of shared infrastructure results in extremely fragmented and repeated data collection.
- Local healthcare providers and managers do not use the health information system since it is frequently assumed that they do not require this kind of health information.
- The information in these systems often does not travel horizontally (or downwards) to the healthcare provider but instead upward to the Central Ministry of Health (MoH) and funders. [17]

4.2. Second Generation

These systems have evolved to be more sophisticated, interoperable, and patient-centric than their predecessors. They not only encompass the basic functionalities of data collection, storage, and retrieval but also focus on the seamless exchange of health information between various healthcare entities, improving care coordination and decision-making. They place a stronger emphasis on patient engagement and empowerment, enabling individuals to access and manage their health records and play a more active role in their healthcare journey. The trends of the system include-

- Data gathering from routine company processes
- Selection of the bare minimal data sets required.
- Creation of cutting-edge technologies
- Mobile technology has emerged as a key HIS enabler. [17]

5. Categories Of Health Information Systems

Electronic Medical/Health Records (EMR) and Clinical Decision Support Systems (CDSS) are the two main categories into which HIS can be divided. [18,19]

5.1. Electronic Medical/Health Record (EMR)

It is a specialised type of health information systems that electronically gather, processes, and stores patient medical records or data and makes it available to authorised people. This information includes the patient's medical

history, diagnosis, prescriptions, radiology images, treatment plans, visits, allergies, and the results of lab and test results. [19,20]

5.2. Clinical Decision Support System (CDSS)

Clinical data are organised using CDSS, which makes data sharing easier and helps doctors make better clinical judgments. It provides frequent advice and reminders to medical professionals to improve the quality of care and timely information to assist medical professionals in making decisions regarding patients' healthcare.

Examples of such CDSS are Laboratory Information Systems (LISs) that emphasise the values of critical health care or Pharmacy Information Systems (PISs) that display a warning when a new medication is ordered and suggest a possible drug-drug interaction. [21]

6. Features of a Health Information System

6.1. National Health Mission Health Management System (NHM-HIMS)

The nationwide reform initiative includes the launch of the HMIS portal that receives reports from over 1,80,000 healthcare establishments across the nation. It was initially intended to serve as a repository for integrated aggregate data at the district level, but it has subsequently been scaled down to the sub-district level. [22]

6.2. District Health Information System (DHIS)

For developing HISs in low- and middle-income nations, the free and open-source DHIS platform has become the de facto global standard. The states enter all facility-based data into the system, and from there, the reports are sent in the proper format to the national HMIS portal. [23]

6.3. Mother and Child Tracking System (MCTS)

The Union Ministry of Health and Family Welfare introduced the MCTS system in 2009, principally motivated by the rationale of enhancing the reliability of data. It ensures delivery of a full spectrum of healthcare and immunisation services to pregnant women and children up to 5 years of age including modules for enrolling expectant moms, tracking the antenatal care, the appointments, and enrolling kids throughout the vaccination cycle. An Auxiliary Nurse Midwife (ANM) at the sub-center, a data entry operator at the primary health center/block level, enters the required data into the system. [24]

6.4. NIKSHAY: Tuberculosis Case Tracking and Surveillance

In May 2012, India commenced NIKSHAY, a new online platform for tracking tuberculosis cases, in response to the adoption of a law requiring obligatory notification of these patients. The purpose of this program was to track patients, including those who were extensively and/or multi-drug resistant (MDR/XDR). By incorporating systems for alerts and reminders for the patient as well as the Directly Observed Treatments (DOTS) provider. [25]

6.5. Integrated Disease Surveillance Program (IDSP)

In November 2004, the IDSP portal was established as a public health initiative implemented by the government of India to strengthen disease surveillance and response activities across the country. The portal provides resources for disease monitoring, training modules, viewing reports, reporting outbreaks, analysing data, and entering data. Three sets of forms, S, P, L, i.e. Syndromic, Presumptive, and Laboratory, are completed and manually delivered to the sub divisions of districts where health care professionals enter

information electronically into the current information flow. [25]

6.6. Strategic Information Management (SIM)

It refers to the systematic and deliberate process of collecting, storing, processing, and using information to support an organisation’s strategic objectives and decision-making processes to gain a competitive advantage, make informed choices, and achieve long-term goals. The National AIDS Control Organisation (NACO) used a Computerised Management Information System (CMIS) before SIMs were created to unify all the program elements into a single framework. Even though most of the data are collective, case-based data are still needed, especially for HIV+ cases, to support the follow-up. [26]

7. Organisational Arrangements in India

India, which has a growing population of over one billion people scattered throughout 600,000 villages and megacities, has healthcare difficulties that are unparalleled in the developing world in terms of scope and variety. [27] (Refer Figure 2)

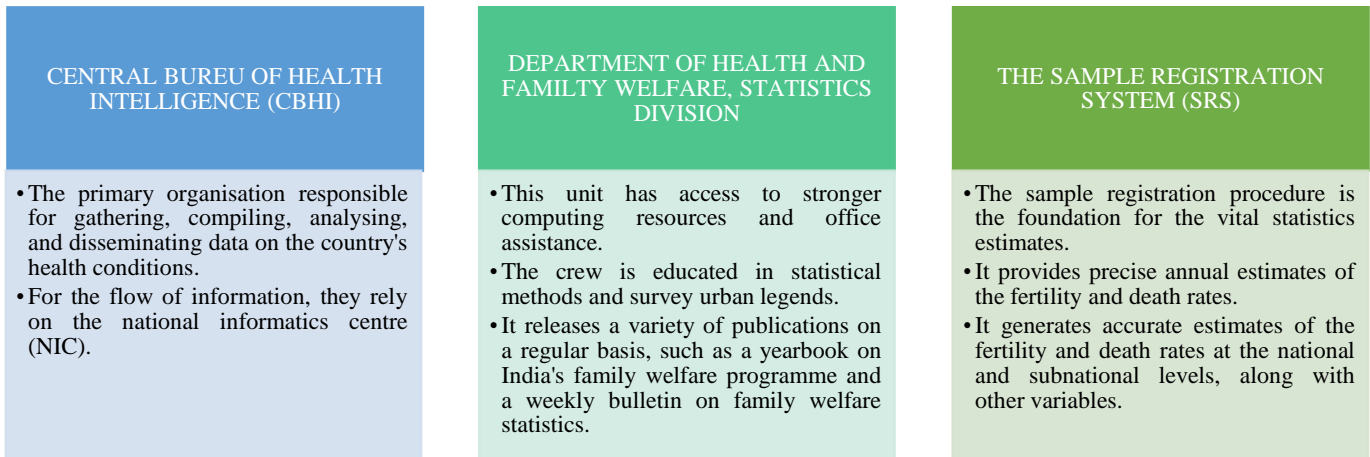


Fig. 2 Organisational arrangements at central level

7.1. State Level

Every state frequently has directorates for primary care, secondary care, and medical education, each with its bodies. Usually, Family Welfare and Reproductive and Child Health are two different directorates. Each of these directorates has a statistics section under the direction of a deputy director, joint director, etc., and computing units to assist with data. The joint director is in charge of a separate section that maintains vital statistics. The collection of data from the civil registration system is the main emphasis of the vital statistics departments.

7.2. District Level

The typical district health system is managed by the district medical and health officer, also known as the chief

medical officer. He is in charge of overseeing family and public health in the district. Two statisticians back the assistant district medical officer. The most important individuals in the entire HMIS chain are these statistical officers who are trained and chosen through state-level service recruiting.

8. Challenges for Health Information Management Systems in India

The identification of a significant gap between data sources and reporting systems in the context of health data is a common challenge in healthcare systems. Issues regarding data collection, definition, analysis, and distribution are further investigated on a national, sub-national, and institutional level. [27]

<p>Differing Figures From Various Sources</p> <ul style="list-style-type: none"> In India, many data sources have produced dissimilar population demographic figures, making analysis challenging Sample Registration System (SRS), 2016 estimates the sex ratio at birth for India as 898, whilst National Family Health Survey-4, 2015 gives the same statistics as 923. [28,29] 	<p>Non-Standardised Decentralised Procurement Of Human Resource Information System (Hris)</p> <ul style="list-style-type: none"> It is determined that a web-based information system is the most efficient way to compile such data due to the standards for data quality covering a broad range, from simple checks to quite complex ones but there is absence of a standardised mechanism for state-level acquisition of such sophisticated software. [30] 	<p>Absence Of A Centralised System For Connecting Data From Various Sources</p> <ul style="list-style-type: none"> Several ministries, including the MoHFW and Ministry of Road Transport, publish different data sets The system cannot enable informed planning, create linkages between data sources, or assess the degree to which various social and environmental factors influence people's health in the absence of a central data resource center or data stewardship. [31] 	<p>Data Dissemination</p> <ul style="list-style-type: none"> At the national level, there is a gap in the timely provision of data and its usage Statistics of NFHS-4 2015–16, was released on December 2017 due to shortage of processed information from various states, which was an example of how the gathering and synthesizing of data is delayed. [26]
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Fig. 3 Issues regarding the health management system at the national level

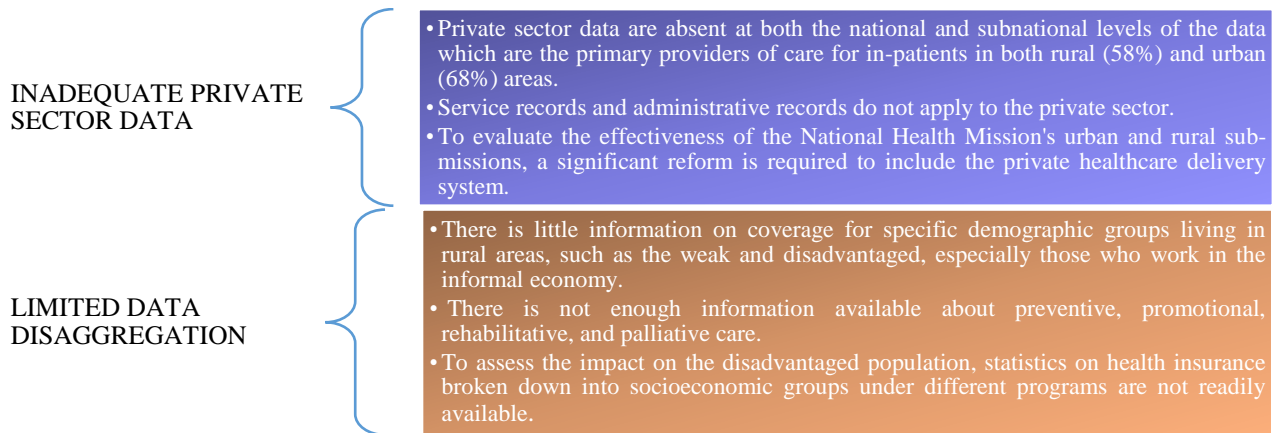


Fig. 4 Issues regarding health management information system at the sub-national level

<p>LACK OF GUIDANCE IN PROBING TECHNIQUES</p> <p>--Even though both the Central Statistical Office (CSO) and the National Sample Survey Office (NSSO) have training divisions for their personnel, there are still several areas where they fall short.</p> <p>-The Consumer Expenditure Survey and the Morbidity and Health Care Surveys, which both collect information on healthcare costs, are conducted by the National Sample Survey Office (NSSO), yet the differences in results are still apparent.[31,32]</p>	<p>SHORTAGE OF STAFF</p> <p>-Lack of qualified professionals, especially in the fields of nursing, and data entry, who are in charge of data inputs, is the main cause of poor data quality.</p> <p>-In rural hospitals, just 30% of nurse positions are filled</p> <p>-The Data Entry Operator at the PHC is in charge of entering data for District-HIS. for instance, is another health information system.</p>
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Fig. 5 Problems with data collection and analysis

9. Healthcare Reporting and Information Management in Odisha

Despite the existing health information systems as discussed above, the state also reported a household sample survey in 12 villages of Khurdha district in Odisha with in-depth interviews with medical officers, vital statistics clerks of PHCs and CHCs, and district-level medical officers. Though the reporting of vital events and general problems was tackled efficiently at the grassroots level, significant challenges were faced in terms of incomplete maintenance of household registers and the absence of recording mechanisms for prevalent diseases like filariasis and leprosy at the community level. This was because insufficient training for healthcare workers to identify certain diseases and document their incidences existed. The numbers make this evident, and records examined and reporting procedures are not occurring as planned. [33] (Refer Figure 6).

In 2018, the Government of Odisha also launched the web portal of Odisha e-Hospital Management Information System (OeHMIS) to provide a computerised platform for the online recording of clinical parameters with a digitalised form for patients and reporting performance criteria of

hospitals where patients can download their health records. [34]

The Government of Odisha and the Health Systems Transformation Platform (HSTP) worked together to improve health systems through the development of user-friendly reporting methods and analytical tools. These tools will make it easy to create dashboards that are accessible, guaranteeing availability at all implementation and policymaking levels.

To improve the delivery of public health services, the Department of Health and Family Welfare has developed an IT with e-governance innovations covering areas under e-Blood Bank, Health workforce, Human resources, Mother and Child tracking system, First referral unit monitoring system, Routine immunisation, Vaccine Logistics, Contraceptive Logistics, Drug Testing, e-Swasthya Nirman, e- Sanjog, e-Attendance, and State Malaria Information System. This portal has increased access to accurate information, resulting in improved planning and decision-making, more streamlined systems, and increased transparency. [36]

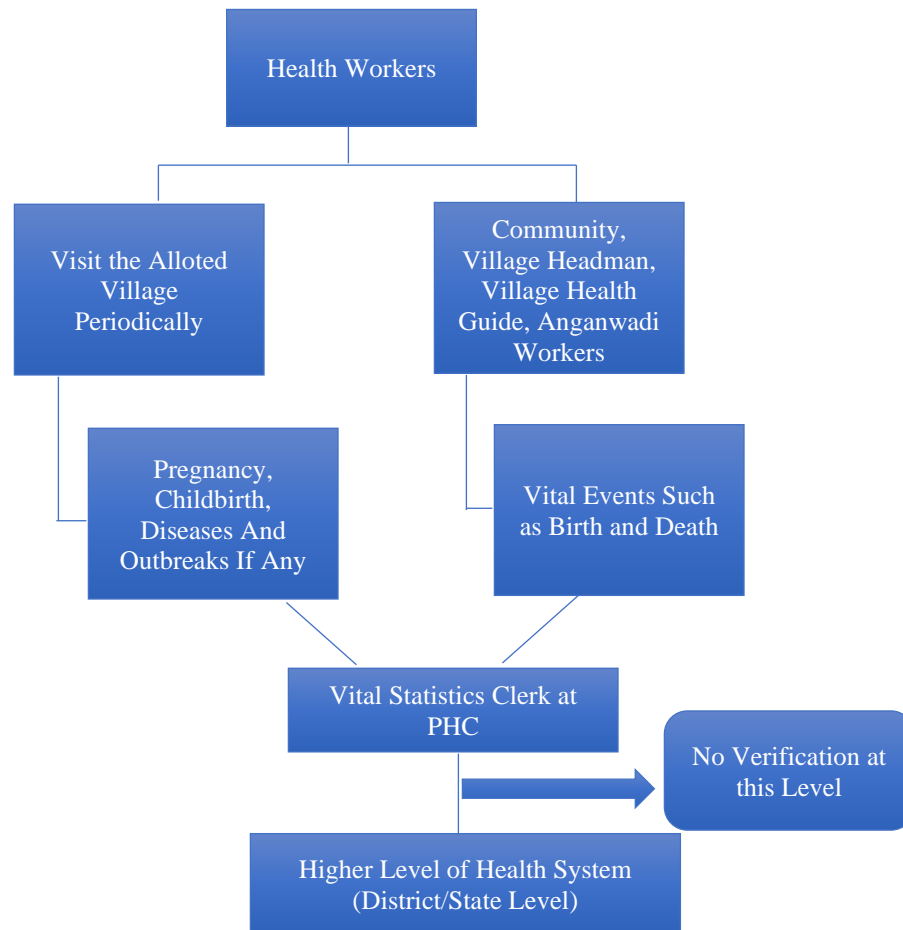


Fig. 6 Flow of health information at the village level

The Ministry also developed an Integrated Human Resource Information System to capture data sets, including Antenatal Care, Delivery Services, Post Natal Care Services, Family Planning, Immunization, Childhood diseases, and Blindness Control Programmes and to strengthen the online transmission of data/reports. [37]

10. Conclusion

In conclusion, the evolution of Health Information Systems (HISs) stands as a crucial element in the global pursuit of Universal Health Coverage (UHC) and aligning with the Sustainable Development Goals (SDGs). The transformative shift from paper-based systems to the current digital age, exemplified by the National Rural Health Mission (NRHM) in India, highlights the role of HIS in managing health-related data for quality healthcare services and informed decision-making. Despite commendable efforts and implementation of web-based monitoring systems like the Health Management Information System

(HMIS) in India, challenges persist. The evaluation of healthcare data management reveals deficiencies in data size, quality, and availability, particularly in addressing primary healthcare needs, community-based care, and people-centred services. In the broader context, the review highlights the need for continuous improvement, addressing existing challenges, and fostering the effective utilisation of healthcare data. As the digital landscape advances, the focus should extend beyond data collection to meaningful data dissemination and utilisation at all levels. The findings of this evaluation contribute to the ongoing discourse on strengthening health information systems, ultimately paving the way for a more inclusive, efficient, and responsive healthcare delivery system in India and beyond.

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