

Digital Libraries and Knowledge Access in Ayurveda Education: A Review of Services, Challenges, and Opportunities

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Abstract

Digital transformation has fundamentally reshaped how academic knowledge is created, organized, accessed, disseminated, and preserved. In Ayurveda education, digital libraries hold particular significance because students, educators, practitioners, and researchers require simultaneous access to classical Ayurvedic literature and contemporary scientific evidence. Digital resources including e-books, e-journals, bibliographic databases, institutional repositories, online catalogues, research portals, digitized manuscripts, and specialized Ayurveda databases can substantially reduce geographical and temporal barriers to knowledge access. India has developed an expanding digital ecosystem for AYUSH education and research, encompassing the Traditional Knowledge Digital Library (TKDL), AYUSH Research Portal, Digital Helpline for Ayurveda Research Articles (DHARA), e-Grantha samuccaya /Ayurveda granthi samuccaya, and other initiatives. Nevertheless, prior research has identified persistent weaknesses in infrastructure, user awareness, information literacy, training, resource availability, internet connectivity, and institutional library development. A notable North Karnataka study involving 23 Ayurvedic medical colleges reported substantial interest in electronic resources but highlighted inadequate awareness and the need for user training among library professionals and users. More recent regulatory and institutional developments indicate increasing recognition of digital libraries and electronic resources as integral components of medical and Ayurveda education. This review examines the role, services, current ecosystem, challenges, and future opportunities associated with digital libraries in Ayurveda education. The review argues that successful digital transformation requires more than providing computers and electronic resources; it necessitates integrated digital collection development, information-literacy programmes, remote access, preservation of classical knowledge, multilingual interfaces, interoperability, research support, usage analytics, and continuous professional development of library personnel. A strategic hybrid model combining classical knowledge resources with contemporary scientific databases is proposed for strengthening knowledge access and evidence-informed Ayurveda education.pib.gov+3.

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KEYWORDS: Digital Libraries; Ayurveda Education; Electronic Resources; Ayush; Knowledge Access; Ayurveda Libraries; Information Literacy; Digital Preservation; E-Resources; Library Services

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1. INTRODUCTION

Libraries have traditionally functioned as organized centres for collecting, preserving, and providing access to knowledge. The emergence of information and communication technologies (ICT) has transformed this conventional role. Academic libraries increasingly operate as digital learning environments in which users can discover, access, evaluate, retrieve, and disseminate information irrespective of physical location.

This transformation is especially significant in health sciences education. Medical and healthcare students require rapid access to current research literature, clinical evidence, databases, electronic journals, textbooks, guidelines, and multimedia learning materials. Digital resources have consequently become an essential component of academic learning, research, and professional development.

Ayurveda presents a distinctive knowledge environment. Its educational system demands simultaneous engagement with classical Sanskrit texts, commentaries, lexicons, contemporary research literature, pharmacological information, clinical studies, and interdisciplinary biomedical literature. Consequently, an effective Ayurveda digital library cannot simply replicate a conventional medical library. It must connect traditional knowledge with contemporary scholarly communication while preserving the textual, linguistic, historical, and contextual characteristics of Ayurveda.

India has developed a substantial digital ecosystem for AYUSH information and research. A review of AYUSH digital initiatives identified 19 major initiatives and categorized them into health information systems, research databases/libraries, academic initiatives, and information, education and communication resources. The research database/library category included TKDL, the AYUSH Research Portal, DHARA, e-CHLAS, Research Management Information System (RMIS), and e-Granthasamuccaya.pib.gov+1

The Government of India describes TKDL as a digital repository of traditional knowledge derived from public-domain literature concerning Ayurveda, Unani, and Siddha, digitized in multiple international languages. The AYUSH Research Portal provides access to research publications and evidence-based information across AYUSH systems.pib.gov+4

Despite these developments, the availability of digital resources does not automatically guarantee effective use. Earlier investigations of Ayurveda institutional libraries have identified serious deficiencies in infrastructure, electronic access, library services, and integration of libraries into education and research.

Therefore, there is a need to examine digital libraries in Ayurveda education not merely from the perspective of technology, but from the broader perspectives of knowledge organization, accessibility, user behaviour, information literacy, preservation, scholarly communication, and educational outcomes.

2. OBJECTIVES OF THE REVIEW

The principal objectives of this review are:

1. To examine the concept and role of digital libraries in Ayurveda education.
2. To identify major digital resources and services relevant to Ayurveda students, teachers, and researchers.
3. To review the development of digital knowledge initiatives in the AYUSH sector.
4. To identify major challenges affecting access to and use of digital resources in Ayurveda institutions.
5. To examine opportunities for improving digital library services in Ayurveda education.
6. To propose a strategic framework for strengthening digital knowledge access in Ayurveda institutions.

3. METHODOLOGY

3.1 Research Design

The study adopts a narrative review with structured literature identification. The review focuses on research and authoritative institutional information concerning digital librarie, electronic resources, Ayurveda education, AYUSH digital initiatives, medical library services, and information literacy.

3.2 SOURCES OF INFORMATION

Literature and information were identified from:

- PubMed and PubMed Central
- Google Scholar-indexed scholarly literature
- Institutional and government websites
- Ministry of AYUSH resources
- National Commission for Indian System of Medicine (NCISM) documents
- Central Council for Research in Ayurvedic Sciences (CCRAS) resources
- Rajiv Gandhi University of Health Sciences (RGUHS) library resources
- Research literature concerning medical and Ayurveda libraries

The review particularly considered literature published from approximately 2020 to 2026, while older studies were retained where they provided important background evidence.

3.3 Selection Approach

Priority was given to literature addressing:

- Digital libraries
- Electronic information resources
- Ayurveda libraries
- AYUSH digital initiatives
- Information literacy
- E-resource utilization
- Digital preservation of classical Ayurveda literature
- Library infrastructure
- Remote access and digital services

Government and institutional sources were used to verify current information concerning digital platforms and regulatory developments.pib.gov+2

4. Concept of Digital Libraries in Ayurveda Education

A digital library may be understood as an organized collection of digital information resources supported by technological

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infrastructure, metadata, retrieval systems, authentication mechanisms, preservation systems, and user-oriented services.
In Ayurveda education, a digital library should ideally provide access to five broad categories of knowledge:

4.1 Classical Ayurvedic Knowledge
This includes:
- Samhitas
- Commentaries
- Nighantus
- Classical formularies
- Lexicons
- Historical works
- Manuscripts
- Translations and critical editions

4.2 Contemporary Ayurveda Research
This includes:
- Research articles
- Clinical studies
- Systematic reviews
- Dissertations
- Theses
- Conference proceedings
- Pharmacological studies
- Pharmacovigilance literature

4.3 Modern Medical Literature
Ayurveda students and researchers also require access to:
- Anatomy
- Physiology
- Pathology
- Pharmacology
- Microbiology
- Medicine
- Surgery
- Public health
- Evidence-based medicine

4.4 Educational Resources
Digital libraries can provide:
- E-textbooks
- Recorded lectures
- Educational videos
- Question banks
- Online courses
- Interactive learning materials
- Examination resources

4.5 Research and Scholarly Communication Services
These may include:
- Literature-search assistance
- Reference management
- Plagiarism detection
- Research databases
- Citation management
- Institutional repositories
- Research impact services

5. Major Digital Resources Relevant to Ayurveda
5.1 Traditional Knowledge Digital Library (TKDL)
The Traditional Knowledge Digital Library is one of India's most important digital initiatives for preserving and protecting traditional medical knowledge. It documents knowledge from traditional literature in a structured digital format and supports the protection of traditional knowledge against inappropriate patent claims. The Government of India reports that TKDL includes public-domain knowledge related to Ayurveda, Unani, and Siddha in five international languages.pib.gov+5
TKDL demonstrates how digital knowledge organization can serve purposes extending beyond education, including intellectual-property protection and international knowledge governance. Access to this prior art database is provided to 18 patent offices worldwide that have signed non-disclosure Access Agreements with the CSIR, for the purposes of search and examination in the context of patent applications filed.pib.gov+4
An important limitation, however, is that TKDL should not be treated simply as an open-access student e-library. Full database access is governed through access arrangements with patent offices.

5.2 AYUSH Research Portal
The AYUSH Research Portal provides a centralized environment for dissemination of research information relating to AYUSH systems. The portal supports searching by categories including disease and system-related information and is intended for academic and research purposes.pib.gov+1
Such centralized research discovery services are important because Ayurveda literature is dispersed across journals, institutional publications, dissertations, conference proceedings, and specialized databases.

5.3 DHARA
The Digital Helpline for Ayurveda Research Articles (DHARA) was developed as an indexing service for Ayurveda research literature. It represents an important step toward improving the discoverability of Ayurveda research articles. ajprui+1
The AYUSH digital-initiative review identifies DHARA as a research database/library initiative intended to provide online indexing of Ayurveda research articles.
For students undertaking literature reviews, the importance of such specialized indexing services lies in improving subject-specific discovery rather than requiring researchers to depend exclusively on general search engines.

5.4 Ayurvedagranthasamuccaya / APTA Digital Library
One of the most significant recent developments is the Ayurvedagranthasamuccaya (APTA Digital Library) developed by CCRAS.pib.gov+2

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The platform brings together searchable classical Ayurveda texts in a web-based environment. A recent publication describes the platform as a searchable digital collection developed for Ayurveda students, teachers, practitioners, and researchers.

The portal reportedly contains 35 books and more than 68,000 slokas, including major works such as Charaka Samhita, Sushruta Samhita, Ashtangahridaya, Ashtangasangraha, Madhavanidana and several Nighantus and commentaries.

This development is particularly important because digital search can substantially reduce the time required to locate terminology or passages across large classical collections.

5.5 HELINET and Consortium-Based Access

For Ayurveda institutions affiliated with RGUHS, consortium-based access has particular significance. RGUHS states that its HELINET consortium serves affiliated institutions across health sciences, including Ayurveda and other AYUSH disciplines. The consortium provides access to e-books, e-journals, multimedia learning resources, point-of-care tools, drug databases, question banks, and theses/dissertations. It also supports remote access and user training.

Consortium models can therefore reduce duplication of subscriptions and extend access to scholarly resources beyond the financial capacity of individual colleges.

6. Digital Library Services for Ayurveda Students

Digital libraries can provide a broad range of services.

Digital Library Service	Application in Ayurveda Education
Web OPAC	Discovery of print and electronic collections
E-books	Access to classical and modern textbooks
E-journals	Current research and scholarly communication
Research databases	Literature searching
Institutional repository	Preservation of theses and institutional publications
Remote access	Off-campus learning and research
Reference service	Assistance in information discovery
SDI	Current-awareness information
CAS	Alerts about newly published literature
Citation services	Research writing and referencing
Anti-plagiarism service	Academic integrity
Digital preservation	Long-term preservation of classical resources
User education	Training in information searching
Research support	Literature reviews and database searching

CCRAS itself currently identifies digital library services including WebOPAC, electronic resources, research-writing support, and anti-plagiarism software.

7. Evidence from Ayurveda and Medical Library Studies

A particularly important study for the present topic is the investigation of e-resource use among users of Ayurvedic Medical College libraries in North Karnataka.

Devi and Keshava studied 23 Ayurvedic Medical Colleges of North Karnataka affiliated with RGUHS. The study distributed 1,150 questionnaires among undergraduate students, postgraduate students, and faculty members and received 1,101 responses, representing a response rate of 97.3%. The study examined awareness, utilization, satisfaction, infrastructure, and training needs relating to electronic resources.

The study is especially relevant because its geographical and institutional context closely corresponds to the North Karnataka Ayurveda education environment. It also employed statistical analysis including frequency, percentage analysis, ANOVA, and Tukey post-hoc tests.

The study reported concerns regarding awareness of available e-resources and highlighted the need for training to improve utilization. These findings demonstrate that availability and utilization are separate dimensions of digital library development. Research in medical education more broadly has also shown that information literacy affects the ability of students to locate relevant information. A study of 120 medical students in India found difficulties in locating desired information, irrelevant information retrieval, inadequate resources, and lack of awareness, emphasizing the importance of information-literacy interventions.

Similarly, a Karnataka study of medical college libraries examined e-resource availability, ICT infrastructure, collection development, user education, and barriers to e-resource development, illustrating the wider importance of infrastructure and staff competency.

8. Challenges of Digital Libraries in Ayurveda Education

8.1 Inadequate ICT Infrastructure

Reliable computers, high-speed internet, Wi-Fi, servers, scanners, backup systems, and adequate digital-library workstations are essential.

Infrastructure disparities between institutions can create unequal access to knowledge.

The earlier case study of an Ayurveda institutional library in North India reported an extremely weak digital and physical infrastructure, including absence of computers, internet, printers, photocopying facilities, and access to research journals.

Although individual institutions have improved considerably since then, the case illustrates the structural problem that digital transformation must address.

8.2 Limited Awareness

A digital resource has little educational value if users do not know that it exists.

Students may be familiar with Google and general search engines but may not know how to use:

- Specialized Ayurveda databases
- Scholarly databases
- Institutional repositories
- Citation databases
- Controlled vocabulary
- Advanced search techniques

Therefore, library orientation should evolve into continuous information-literacy education.

8.3 Information Literacy Deficiencies

Information literacy includes the ability to:

1. Identify an information need
2. Select an appropriate database

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3. Formulate search strategies
4. Evaluate information quality
5. Identify scholarly evidence
6. Use information ethically
7. Cite sources appropriately

For Ayurveda students, information literacy should additionally include the ability to distinguish between classical textual authority, traditional knowledge, clinical evidence, modern biomedical evidence, and unreliable internet information.

8.4 Language and Script Barriers

Language represents a distinctive challenge for Ayurveda.

Many foundational texts are written in Sanskrit, while modern research is predominantly available in English. Students may therefore encounter difficulties in:

- Searching Sanskrit terminology
- Transliteration
- Spelling variations
- Synonyms
- Devanagari versus Roman script
- Locating equivalent modern medical terminology

Future digital libraries should incorporate multilingual and transliteration-aware search systems.

8.5 Limited Access to Full Text

Indexing a document is not equivalent to providing access to its full text.

A high-quality digital library should clearly distinguish:

- Bibliographic discovery
- Abstract access
- Full-text access
- Institutional subscription access
- Open-access resources

This distinction is particularly important when students conduct systematic reviews or dissertation research.

8.6 Subscription Costs

Commercial databases, e-journals, reference works, and specialized clinical information systems can be expensive for individual institutions.

Consortium-based acquisition, open educational resources, institutional repositories, and government-supported platforms can reduce financial barriers.

8.7 Digital Divide

Students may have different levels of:

- Device ownership
- Internet connectivity
- Digital literacy
- Language proficiency
- Access to quiet study environments

Consequently, a digital-first library strategy should not eliminate essential print resources. A hybrid library model remains appropriate for Ayurveda education.

8.8 Preservation and Copyright

Digitization of classical literature involves challenges related to:

- Copyright
- Ownership
- Authenticity
- Metadata
- File formats
- Long-term preservation
- Manuscript provenance
- Version control

Digital preservation must therefore follow recognized metadata and archival principles.

9. Opportunities for Digital Libraries in Ayurveda

9.1 Artificial Intelligence and Semantic Search

Artificial intelligence can enhance Ayurveda digital libraries through:

- Semantic search
- Natural-language queries
- Automatic subject indexing
- Entity recognition
- Terminology mapping
- Recommendation systems
- Multilingual translation
- OCR correction
- Knowledge graphs

For example, a student could search for an Ayurvedic concept using Sanskrit, Kannada, Hindi, or English terminology and retrieve related classical passages and contemporary research literature.

9.2 Digital Preservation of Classical Texts

Digitization provides an opportunity to preserve rare books, manuscripts, palm-leaf records, commentaries, and out-of-print texts.

Digital preservation should include:

- High-resolution scanning
- OCR where technically appropriate
- Metadata creation
- Authority control
- Provenance information
- Persistent identifiers
- Redundant storage

9.3 Integrated Ayurveda Knowledge Portal

A future Ayurveda digital library could integrate:

Classical Texts → Research Articles → Clinical Evidence → Pharmacopoeial Information → Theses → Educational Resources → Institutional Repositories

Such integration could substantially improve literature discovery.

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9.4 Remote Access

Remote access enables students and researchers to use library resources beyond campus hours.

RGUHS HELINET provides an example of a consortium-based remote-access model in which affiliated users can access subscribed resources using internet-connected devices.

9.5 Institutional Repositories

Every Ayurveda medical college should consider establishing an institutional repository containing:

- PG dissertations
- PhD theses
- Faculty publications
- Conference papers
- Institutional reports
- Teaching materials
- Rare digital documents
- Research datasets where appropriate

Institutional repositories can reduce the loss of locally generated scholarly knowledge.

9.6 Research Support Services

The role of the Ayurveda librarian should expand from circulation and reference services to research support.

Potential services include:

- Systematic literature searching
- Reference management
- Bibliometric analysis
- Plagiarism checking
- Journal selection
- Research-data management
- ORCID support
- Citation analysis
- Research visibility services

10. Regulatory and Institutional Developments

Digital library development is increasingly reflected in standards for health sciences education.

The NCISM assessment framework for Ayurveda colleges includes indicators relating to electronic journals and the creation of an e-library. It recognizes library automation/digitization and access to electronic resources as components of institutional library development.

This indicates a transition from viewing the library merely as a physical collection toward recognizing it as a digital academic infrastructure.

The broader regulatory direction is therefore favourable to digital library development, although implementation at individual institutional level remains important.

11. Proposed Framework for Digital Knowledge Access in Ayurveda Education

A sustainable digital Ayurveda library can be conceptualized through six interconnected layers:

Layer 1: Infrastructure

- Computers
- Broadband
- Wi-Fi
- Servers
- Scanners
- Backup systems

Layer 2: Digital Collections

- E-books
- E-journals
- Databases
- Classical texts
- Theses
- Institutional publications

Layer 3: Discovery

- OPAC
- Federated search
- Full-text search
- Semantic search
- Multilingual search

Layer 4: User Services

- Remote access
- Reference services
- CAS/SDI
- Research assistance
- Document delivery

Layer 5: Digital Literacy

- Induction programmes
- Database training
- Research methodology workshops
- Citation management
- Plagiarism awareness

Layer 6: Evaluation

- Usage statistics
- User satisfaction
- Resource cost-effectiveness
- Database downloads
- Search behaviour
- Research output
- Learning outcomes

This framework suggests that technology, resources, people, services, and evaluation must operate together.

12. DISCUSSION

The literature demonstrates that digital libraries have moved from being supplementary facilities to becoming important components of contemporary health sciences education. In Ayurveda, however, the transformation has an additional dimension: digital libraries must preserve and make discoverable a traditional knowledge system while simultaneously connecting it with modern scientific literature.

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The development of AYUSH digital initiatives represents a major institutional response to this requirement. The AYUSH digital ecosystem encompasses research databases, digital libraries, academic platforms, and information services.pib.gov+2

The development of Ayurvedagranthasamuccaya is particularly significant because it addresses one of the central problems in Ayurveda education: efficient retrieval across large bodies of classical literature. Its searchable collection illustrates how digital technologies can improve access to traditional knowledge without eliminating the importance of textual study.

At the institutional level, however, availability remains uneven. Earlier Ayurveda library research demonstrated that some institutions treated libraries largely as compliance-oriented facilities rather than as active centres of academic knowledge.

The North Karnataka e-resource study provides particularly relevant evidence. It demonstrates that even where electronic resources exist, awareness, utilization, satisfaction, infrastructure, and training require separate assessment.

Therefore, the central issue is not simply "Does an Ayurveda college have a digital library?" The more meaningful questions are:

- Can students find the resources?
- Can they access them remotely?
- Can they evaluate their quality?
- Can they search classical and modern literature effectively?
- Can faculty members integrate digital resources into teaching?
- Can researchers use databases systematically?
- Can librarians provide advanced research support?
- Are resources evaluated according to actual usage?

The future of Ayurveda digital libraries should therefore be based on a user-centred, research-oriented, multilingual, interoperable and evidence-based service model.

13. RECOMMENDATIONS

Based on the reviewed literature, the following recommendations are proposed:

1. Develop institutional digital-library policies specifically addressing Ayurveda education and research.
2. Strengthen ICT infrastructure and provide reliable high-speed internet.
3. Expand e-book and e-journal collections covering both Ayurveda and modern medical sciences.
4. Promote access to AYUSH digital initiatives, including appropriate research databases and digital classical-text resources.pib.gov+2
5. Conduct regular information-literacy programmes for students, teachers, and researchers.
6. Provide remote access to subscribed resources wherever licensing permits.
7. Develop institutional repositories for theses, dissertations, faculty publications, and institutional research.
8. Digitize rare and historically significant Ayurveda collections using appropriate preservation standards.
9. Introduce multilingual and transliteration-enabled search systems.
10. Use AI-assisted discovery carefully, with human oversight and source verification.
11. Train librarians in advanced digital-library and research-support skills.
12. Monitor usage statistics and user satisfaction to guide collection development.
13. Promote inter-library cooperation and consortium purchasing to reduce subscription costs.
14. Integrate library instruction into the Ayurveda curriculum rather than limiting it to one-time orientation.
15. Develop a national interoperability framework connecting Ayurveda digital repositories and research databases.

14. FUTURE RESEARCH DIRECTIONS

Future studies should move beyond simple awareness and frequency-of-use surveys.

Important areas for investigation include:

14.1 User Behaviour

Studies should examine how BAMS and postgraduate students actually search, evaluate, and use digital information.

14.2 Comparative Institutional Studies

Comparisons may be undertaken between:

- Government and private Ayurveda colleges
- Urban and rural institutions
- Undergraduate and postgraduate users
- North and South Indian institutions

14.3 Digital Literacy Measurement

Validated information-literacy instruments could be developed specifically for Ayurveda students.

14.4 Usage Analytics

Libraries can study:

- Database logins
- Downloads
- Search queries
- Full-text usage
- Remote-access activity
- Most-used resources

14.5 AI and Ayurveda Information Retrieval

Research should investigate whether AI-assisted retrieval can accurately connect:

Sanskrit terminology ↔ transliteration ↔ English terminology ↔ Ayurvedic concepts ↔ biomedical concepts

14.6 Impact on Academic Performance

Future empirical studies could investigate whether digital-library use is associated with:

- Examination performance
- Dissertation quality
- Publication productivity
- Research competence

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- Evidence-based clinical decision-making

15. CONCLUSION

Digital libraries have considerable potential to transform knowledge access in Ayurveda education. Their significance extends beyond providing electronic copies of books and journals. A mature digital Ayurveda library should function as an integrated knowledge environment connecting classical texts, contemporary research, modern medical literature, educational materials, institutional scholarship, and research-support services.

India's AYUSH digital ecosystem has created important foundations through initiatives such as TKDL, the AYUSH Research Portal, DHARA, and Ayurveda granthasamuccaya. Consortium arrangements such as RGUHS HELINET further demonstrate how collaborative acquisition and remote access can expand scholarly resource availability.pib.gov+5

Nevertheless, infrastructure alone cannot guarantee effective knowledge access. Awareness, information literacy, language, training, resource quality, remote access, preservation, affordability, and professional library services remain critical.

The future Ayurveda library should therefore evolve from a book-centred facility into an intelligent, interconnected and user-centred knowledge hub. Such transformation can strengthen Ayurveda education, facilitate research, preserve traditional knowledge, improve scholarly communication, and support the integration of classical Ayurvedic wisdom with contemporary evidence.

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