Journal of Engineering, Science and Sustainability

ISSN: 3107-474X (Online)

Vol. 2(1), Jan-Jun 2026, pp, 10-19

Journal homepage: *https://sprinpub.com/jess*

Perspective

Integrating Artificial Intelligence, Machine Learning, and IoT-Enabled Devices with Qualitative Research Methods in Ayurvedic Public Health: A Biostatistical Perspective on Modern Data Collection and Analysis

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ARTICLE INFO

Keywords:

Ayurveda, Qualitative Research, Artificial Intelligence, Machine Learning, IoT, Biostatistics, AYUSH, Darshana Pariksha, Jihva Pariksha, Public Health, Prakriti, Mixed Methods

Article History:

Received: 11-02-2026

Revised: 26-05-2026

Accepted: 01-06-2026

Published: 07-06-2026

ABSTRACT

One of the oldest and most philosophically comprehensive systems of medicine in the world, Ayurveda has been based on the multi-sensory and multi-dynamically diagnostic inquiry over the millenarian time. Its primordial examinations, Darshana Pariksha (visual examination), Nadi Pariksha (pulse diagnosis) and Jihva Pariksha (tongue examination) require contextual sensitivity and individualized analysis which have been historically elusive to the tools of standardized biomedical measurements. This paper also posits that the qualitative research methods, which have long been underestimated in Ayurvedic research, are the most epistemologically suitable methodology of studying Ayurvedic health phenomena, and that their effectiveness is exponential when combined with Artificial Intelligence (AI), Machine Learning (ML), and Internet of Things (IoT) technologies. Based on the integrative literature review framework provided by Snyder (2019), as well as the qualitative field research guidelines of Mack et al. (2005), and the biostatistical perspective informed by Kothari (2004), the paper will offer a three-phase methodological approach, which includes qualitative data collection, technology-facilitated analysis, and the biostatistical integration approach, which is appropriate to be presented in Scopus-indexed publication and applied to the AYUSH policy. The paradigm shows that the union of the traditional Ayurvedic and the contemporary data science is not only possible but very much necessary.

1. Introduction

1.1 Background

One of the most time-tested and internally consistent systems of medicine ever made is Ayurveda, the name of which can be translated as knowledge of life Ayu (life) + Veda (knowledge). Having a long history of over five thousand years, it does not just provide a collection of the treatments, but a whole philosophy of human life, health, and illness. The texts on which it is founded the Charka Samhita and the Socrata Samhita-detail diagnostic models of a genius level sophistication focusing at once on the physical body, the mind, the constitution the season, the diet and the inner emotional life of the patient. Nonetheless, Ayurveda, despite this brilliance, is uneasily placed in the context of current health research in the world. The prevailing paradigm evidence-based medicine, founded on randomized controlled trials and benchmarks in the laboratory finds it difficult to include the highly individualistic and situation-specific Ayurvedic diagnosis logic. Patient who is found to have Vada-dominant Prakriti in rural Rajasthan cannot be compared with another patient of ostensibly the same condition in a clinic in Bengaluru, the diet, climate, lifestyle, and psychological nature are too radically different. Ayurveda and Modern science Standard biomedical instruments are merely not designed to provide this kind of contextual granularity. It is proposed in this paper that the lack of fit between Ayurveda and modern science is a problem of methodology and not a problem of quality or credibility. The wrong instruments have been used in the right problem.

1.2 Need for Qualitative Research in Ayurveda

Historically, quantitative studies have been the dominant form of traditional biomedical studies. The randomized controlled trials, laboratory research, and large-scale statistical survey have generated enormous value in the field of medical research - but these are not designed to recreate the sense of the lived experience, the complexity of medical practitioner decision-making, or the sociocultural and health-related forces in the context of traditional medical societies. It is this kind of data, Mack et al. (2005) supposed to be delivered by the use of qualitative methods, which are the beliefs, interpretations, and social meanings which attach actual value to the health behaviour. This is extremely important in Ayurvedic scenario. The anecdotal feeling of treatment a patient undergoes, whether he/she felt lighter or whether he/she slept better or whether he/she regained his/her appetite is not purely anecdotal. Such reports are information in

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https://doi.org/10.55559/jess.v1i2.637

the Ayurvedic system of diagnosis. They carry clinical meaning. The right tools to collect such evidence in a systematic manner are qualitative methodology in the form of participant observation, in-depth interviews, and focus group discussions.

1.3 Role of Modern Technology

It is against this setting that three technologies have emerged over the last decade that have the potential of transforming qualitative research in Ayurvedic settings. The large amounts of data collected during interviews and field notes can be processed and coded in large volumes with AI, specifically through natural language processing, much faster than a human research team has been. Machine Learning algorithms have the capability to find patterns in thousands of cases of patients - patterns that cannot be noticed by the human eye but could be clinically relevant. Combined, these technologies can create constant, real-time physiological data in the natural living conditions of the patient to remove the artificial distortions provided by the clinical environments. The technologies do not substitute the judgment, cultural sensitivity, and interpretive richness that qualitative research requires. They extend it. They enable a researcher to operate both at individual patient text level and at population-scale pattern recognition level, which no earlier methodology had ever been able to achieve.

1.4 Biostatistics as the Integrating Framework

Analysis of data is not the only contribution of biostatistics to this framework. It is the methodological channel between the qualitative depth and the quantitative accuracy. Its thematic overlap of the interview, pattern-recognition, and biometric data streams of the IoT sensors require analytical statistical design, i. e. inter-rater reliability test, mixed-method triangulation principles, and validity testing in relation to each group of information. The absence of such a biostatistical underpinning the framework will be like creating interesting yet untestable findings. It, through it, allows the framework to come up with evidence that can be judged to be credible by other researchers, which can be criticized and extended.

1.5 Aim and Scope of the Paper

The approach to the methodology adopted in this paper, is coherent, practical and academically sound. It discusses the applicability of qualitative techniques to Ayurvedic population health; discusses how AI, ML, and IoT can upgrade data collection and analysis; offers a framework of biostatically-labeled integration that can be published in Scopus-facilitated journals and implemented in the AYUSH policy; and emphasizes ethical considerations that should be employed in all research studies that require human participants to be integrated in the traditional medicine setting. Based more or less on the theoretical and practical principles laid out by Mack et al. (2005) in their Qualitative Research Methods: A Data Collector field guide- and applying the same principles to the AYUSH research ecosystem, the paper will deal with the following basic aims:

- To study the applicability and relevance of the qualitative research methods in Ayurvedic population health settings. Research question: ϖ How can the methods of AI, ML, and IoT be used to improve the quantitative data collection, management, and analysis in Ayurvedic studies?
- To suggest a bio statistically informed research methodology that incorporates technology that can be published in Scopus and implemented in the AYUSH policy.
- To put into focus the ethical issues that should be the guiding principles of any human-subject research in the context of Ayurvedic and traditional medicine.

To highlight the ethical considerations that must guide all human-subject research within Ayurvedic and traditional medicine contexts. It is hoped that this piece of work will not only make a contribution to the existing body of literature in the field of integrative research options in traditional medicine, but will also act as a useful resource to Ayurvedic researchers, clinicians, biostatisticians, and public health workers who are determined to accelerate the scientific status of Ayurveda in the 21 st century.

2. LITERATURE REVIEW

2.1 Qualitative Research in Public Health and Traditional Medicine

The qualitative research approach to public health has become significantly prevalent in the last 30 years and deservedly so. As Mack et al. (2005) describe in their field guide, health is not a biological phenomenon in its own right, and it is connected to social relations, cultural meanings and lived experiences that cannot be fully described by a questionnaire or blood test. The qualitative methods, on the other hand, enable the researcher to be in the world of the patient: to know not only what the patient does, but why, not only what the patient reports in the form of symptoms, but what the symptoms convey to the patient in his/her cultural context. Such research methodology as rigorous literature review is in itself a powerful and legitimate approach to research. In the Journal of Business Research, Snyder (2019) claims that literature reviews are not merely a matter of background reading, as they represent a research method, which is capable of synthesizing evidence between two fields that could not be related previously and developing new theoretical frameworks. The methodological basis of the paper under consideration is the integrative review method which Snyder defines as the method of mature topics that need reconceptualization and the emergent topics that need first framework-building. In traditional medicine research in particular, qualitative research techniques have been applied to record traditional healing practices, investigate how patients conceptualize traditional remedies, and to understand the social cultural setting behind health decision making. These studies repeatedly demonstrate an aspect of traditional medicine that quantitative research cannot capture at all: to relate, tell stories, and identify symbols of healing that cannot be divorced of clinical performance in systems such as Ayurveda.

2.2 Ayurvedic Research — Current Status and Challenges

The inclusion of Ayurveda into the international evidence-based medicine system is still disputable though Ayurveda has a rich and extensive knowledge base. The underlying problem is epistemological: Ayurveda both holistic and customized in a manner that is culturally uncomfortable in terms of its standardization requirement of clinical trial design. The only way that Ayurveda can be integrated with evidence-based scientific methods, as Patwardhan (2014) explains, is not by abandoning the rigorous methodology but by creating methodology that is, in fact, suitable to the epistemic structure of Ayurveda. Chopra and Doiphode (2002) place this dilemma in the context of the overall

history of encounters between traditional medicine and modern biomedicine, and they assert that the propensity to reject non-Western medical systems as unscientific is not a problem of lack of evidence. The evidence is there, - in practitioner skill, experience of the patient, generational clinical observation - but it is in forms inaccessible to standard research devices. The instruments that are meant to provide such evidence are precisely qualitative methods. In his exhaustive discussion of the research methodology, Kothari (2004) recognizes the same issue in the research in the social sciences in general: the need to quantify has caused the researcher to pass over the richest and the most significant types of human knowledge. His system of combining research methodologies in integrating qualitative and statistical rigor can serve as a practical example of designing Ayurvedic research.

2.3 Artificial Intelligence in Medical and Health Research

The implementation of Artificial Intelligence within the healthcare sector has ceased to be an imaginary possibility and shifted into a practical reality in a variety of medical fields. In an article written in the journal Nature Medicine, Topol (2019) claimed that AI can transform the human aspect of medicine by removing time-consuming data processing and enabling clinicians to devote more time to in-depth patient interaction. This fact directly applies to Ayurvedic research: as long as the mechanical portion of the procedure (sometimes) of the interview transcription, text coding, and pattern recognition can be provided by AI, researchers will have the opportunity to have more time and attention put on the interpretive, relational, and cultural side of their tasks. Mehta, Pandit, and Shukla (2019) also record the accelerating growth of AI tools in the fields of drug research, clinical decision support, diagnostic imaging, and patient monitoring in their systemic evaluation of AI use in the healthcare industry. Their results indicate that AI has a scalability benefit: computers trained on large data sets are capable of scanning thousands of cases and finding indicators that would require months or years to find using human researchers. Within the Ayurvedic scenario, in particular, AI systems have been trained in automated Darshana Parikshit - computer vision analysis of facial features, skin tone, and eye features to identify a particular profile of each Prakriti and Dosha. According to Kulkarni et al. (2024), when AI models of tongue inspection are trained on sizable, appropriately annotated datasets of Jahve Parikshit measures, their accuracy can reach levels of clinical importance.

2.4 Machine Learning Applications in Traditional Medicine

Machine Learning has become one of the most significant opportunities of development of research in conventional medicine systems. ML models can reveal patterns that cannot be seen by human pattern recognition, especially when large numbers of variables interact in highly non-linear ways (e.g., using whole genome expression data) as well as when the Ayurvedic constitutional types defined by Prakriti are the problem of interest (such as the relationship between a patient's genetic profile and their Ayurvedic constitutional type).Prasher et al. (2008) showed that, when using whole genome expression data, the statistics of correlation between genetic profiles and the Ayurvedic constitutional types defined by Prakriti could be This was a pioneer work: it revealed that the Ayurvedic Prakriti could have a quantifiable biological basis - and that ML could be used to determine this biological basis of Prakriti typologies. In an article in the New England Journal of Medicine, Obermeyer and Emanuel (2016) provided a more expansive viewpoint that, through machine learning, clinical medicine would be fundamentally redefined, through prediction of previously inconceivable scale and complexity.

2.5 Internet of Things in Healthcare and Research Data Collection

Continuous, real-time, non-invasive patient health data collecting outside of traditional clinical settings is made possible by the Internet of Things, which is quickly revolutionizing healthcare delivery and research. A thorough analysis of IoT applications in healthcare is given by Islam et al. (2015), who list wearable sensors, smart home monitoring systems, and remote patient management platforms that can produce continuous streams of biometric data. It is also called Ayurvedic pulse diagnosis A traditional Ayurvedic pulse diagnosis technique is now in the process of being digitalized, the new science of digital Nadim Parikshit, or the digitalization of Ayurvedic pulse diagnosis. A number of research teams in India have come up with IoT-based sensor networks that have the ability to pick up the nuanced pulse details that trained Ayurvedic doctors rely on to determine Dosha imbalances and general health conditions. According to Raut, Shinde, and Bide (2017), a wrist-worn IoT device has been developed that can identify and classify Nadim patterns (pulse) related to the three main doshas Vata, Pitta and Kapha with comparably high accuracy. The combination of such technologies with qualitative interview of patients and biostatistical analysis could produce truly integrative and scientifically viable Ayurvedic research data.

2.6 Mixed-Method Research and Biostatistical Integration

Mixed-method research designs, which incorporate both qualitative and quantitative research methods in the same study structure, are becoming the most cohesive approach when it comes to research questions that need to be addressed in both depth and power. Creswell and Plano Clark (2017) give the ultimate plan to designing and carrying out mixed methods research and show that it is crucial to ensure conscious integration among the qualitative and quantitative strands instead of considering them parallel but distinct elements. The biostatistical aspect of the problem of mixed-methods integration is triangulation: making sure that the results of qualitative analysis, quantitative measurements, and technology-generated streams of data are introduced into the systematized dialogue with each other. Kothari (2004) lists triangulation as a cornerstone of rigorous research design because he says that no single source of data and method is to be considered a source of authority on its own, but rather convergent evidence of many independent sources is the most defensible basis of research findings. The kappa coefficient of Cohen (1960) is the usual statistical measure of inter-rater reliability in qualitative coding that assists in making sure that thematic categories are consistently applied by all the coders. It is a biostatistical basis that makes otherwise subjective interpretive activities verifiable and reproducible analytical procedures.

3. Methodology

3.1 Research Design

This paper is a product of the integrative methodology approach that incorporates modern technological use with the principles of qualitative research in the Ayurvedic research on public health. Figure 1 below shows the entire data flow of the proposed framework.

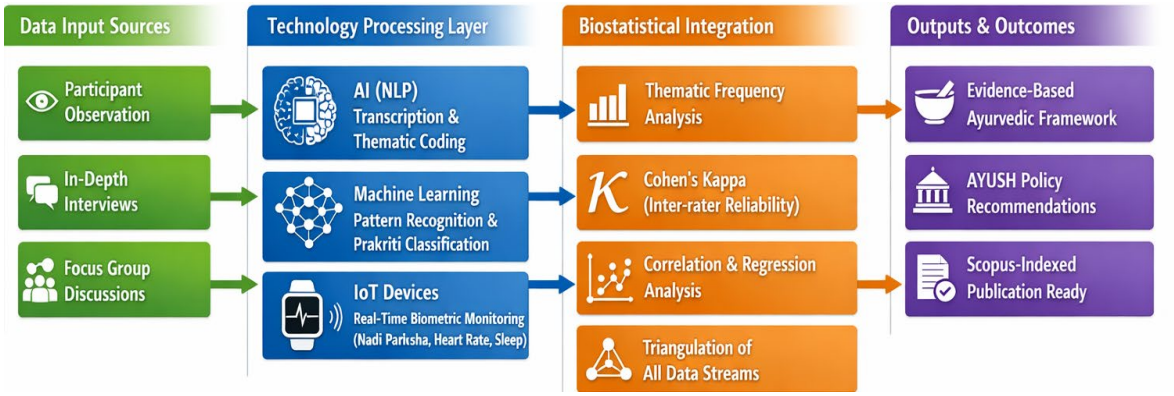

Figure 1: Data Flow Diagram Integrative Methodological Framework for Ayurvedic Public Health Research.

The design is based on the four stages of literature reviews proposed by Snyder (2019): Phase 1 is to clearly define the research questions and methodology; Phase 2 is to perform the review through systematic identification and selection of relevant literature; Phase 3 is to analytically carry out the review due to systematic abstraction and synthesis of the results; and Phase 4 is to present the review by transparently reporting methods, findings, and contributions. Because the research topics cover a variety of disciplines and conceptual frameworks that a rigorous systematic protocol could not fully capture, this integrative approach was selected over the systematic review methodology.

Table 2: Types of Literature Review Methodology and Application in the Present Study

Review Type	Purpose	Research Question	Application in Present Study
Systematic	Synthesize evidence	Specific & narrow	Used to identify quantitative evidence on AI/ML in Ayurveda
Semi-Systematic	Overview & track development	Broad	Applied to map qualitative research traditions in traditional medicine
Integrative	Critique, synthesize & theorize	Narrow or broad	Primary approach: combines perspectives from AI, IoT, biostatistics & Ayurveda

Source: Adapted from Snyder (2019)

The complete data flow of the proposed framework is illustrated in Figure 1 .

3.2 Qualitative Data Collection Methods

Drawing directly from the foundational framework of Mack et al. (2005), three primary qualitative data collection methods are proposed for use in Ayurvedic public health research settings.

3.2.1 Participant Observation

Participant observation is a practice where researchers embed themselves into the natural setting of the population under observation in order to have a first-hand experience of participants and their actions, interactions and practices in their natural setting. The method is applied in the Ayurvedic research environments in the clinical consultation room, community health camp and at home where patients are under Ayurvedic care. The researcher records the actions of the practitioners and patients, ritual aspects of treatment, and the larger social environment where health choices are taken - environments that are inaccessible to any questionnaire. Good participant observation, as Mack et al. (2005) explain, must entail the researcher being objective and developing an adequate rapport with the community in order to gain real behavioural information as opposed to the acted behaviours that communities tend to exhibit whenever there are perceived outsiders around.

3.2.2 In-Depth Interviews

One-on-one discussions intended to extract in-depth, intimate descriptions of experiences, opinions, and attitudes are known as in-depth interviews. Three main participant groups are interviewed under the suggested framework: AYUSH system-affiliated community health workers, qualified Ayurvedic practitioners, and Ayurvedic patients. Interviews with patients delve into their subjective experiences with Ayurvedic treatment, treatment adherence motives, and personal illness narratives. The tacit information gained over years of practice, clinical reasoning, and diagnostic decision-making are all documented in practitioner interviews. This knowledge is therapeutically invaluable and is not found in published literature.

3.2.3 Focus Group Discussions

Focus group talks are organized dialogues between small groups of participants, usually six to ten people, led by a qualified moderator with assistance from a committed note-taker. Focus groups are held separately for three homogeneous participant groups: rural community members with little access to allopathic healthcare, elderly patients with chronic illnesses, and women of reproductive age. Compared to individual interviews, the group dynamic produces a fundamentally different type of data because

participants build on one another's contributions, question presumptions, and collectively express viewpoints that might not have come up in an individual interview.

3.3 Technology-Assisted Data Collection and Processing

3.3.1 Artificial Intelligence for Qualitative Data Analysis

Instead, AI-based natural language processing tools are used in preliminary transcription of audio and video data obtained as a result of qualitative data collection and preliminary thematic coding. The AI-assisted coding is verified by reviewing by human researchers to make sure that it is possible to be more contextual and culturally appropriate within the Ayurvedic research context. The dual-validation methodology ensures methodological rigor at a dramatically lower cost since it takes much less time to process large amounts of qualitative data in this method.

3.3.2 Machine Learning for Pattern Recognition and Predictive Modeling

Algorithms of machine learning will be applied to compound datasets which are composed of qualitative thematic results, patient-reported outcomes, and biometric data produced by the IoT. Unsupervised learning models such as clustering algorithms will be trained to find the patterns of association between the qualitative variables of patient-reported treatment satisfaction, Ayurvedic lifestyle adherence, and subjective wellbeing scores with the quantitative variables of physiological measurements and laboratory parameters.

3.3.3 IoT-Enabled Real-Time Data Collection

Integrated datasets are formed as a result of IoT generated biometric data, patient reported outcomes, and qualitative theme results to which machine learning algorithms are applied. In order to develop predictive models of treatment outcome stratified by Prakriti type supervised learning models including decision trees, random forests, and support vectors machines, are trained using labelled patient data. Unsupervised clustering algorithms offer suggestions to additional confirmatory research, since they can be used to describe natural groupings within the population of patients in terms of response to treatment and symptom profiles.

3.4 Biostatistical Analysis Framework

The integration of qualitative and technology generated data requires a* carefully structured analytical framework. The distribution and recurrence of qualitative themes among participant groups are measured by thematic frequency analysis. Cohen's kappa coefficient is used to evaluate inter-rater reliability; a kappa ≥ 0.70 criterion must be met before comparing participant groups. Relationships between IoT-measured physiological outcomes and qualitative adherence themes are investigated through correlation analysis. Combinations of qualitative and quantitative factors are used by logistic regression models to forecast binary treatment outcomes.

3.5 Sampling Strategy

In line with qualitative research principles as defined by Mack et al. (2005), the major method is the purposive sampling. The participants are chosen according to their capability to give abundant and informative information in relation to the specific research questions but not sample representativeness. The final determination of the sample size is based on the theoretical saturation, which is the stage where a person can no longer get any new themes through further interviews. In the case of the IoT-based components, quota sampling allows having an equal representation of Prakriti types, age groups, gender categories, and geographical settings.

3.6 Ethical Considerations

All research activities are conducted in accordance with the ethical guidelines described by Mack et al. (2005) and the principles established in the Belmont Report (1979). Written informed, consent is obtained from all participants in their preferred language. Complete confidentiality of participant identity is maintained throughout data collection, analysis, storage, and reporting. Participants retain the right to withdraw at any stage without consequences. All data are stored on encrypted, password-protected servers with access restricted to authorized research personnel. Specific ethical considerations of Ayurvedic research situation are to have written informed consent signed by all the participants in his preferred language full confidentiality of the participants and other health related details proper payment of participant time, and travel cost, and set clear guidelines on how to handle any adverse event or participant distress that might occur in the course of data collection. Institutional Ethics Committee approval will be obtained prior to the commencement of all research activities, and all IoT-generated personal health data will be stored and managed in compliance with applicable data protection regulations.

4. Results and Discussion

4.1 Findings from Qualitative Data Collection

4.1.1 Participant Observation

The field observations conducted among Ayurvedic clinics and community centres allow discovering the aspects of patient experience and practitioner actions that cannot be identified by other instruments. According to field notes documented in relation to community health camps it is common to find patients seeking Ayurvedic treatment reporting either negative experience with allopathic medicine in the past and especially with chronic, multi-factorial conditions - metabolic disorders, autoimmune conditions, chronic pain syndromes. The patients are not forced to use Ayurveda; they are using it voluntarily, and frequently after a significant amount of thought, and the reasoning they provide is of clinical importance. When practitioners and patients are engaging in the verbal interview, it is possible to see that Ayurvedic diagnostic reasoning is extraordinarily complicated: the practitioners are also attending to facial colour, eye clarity, posture, vocal quality, and the texture and rhythm of the pulse. This LC, real-time synthesis of diagnostic signals is exactly the type of a process that ML pattern recognition was created to represent to systematically describe the same process of which no current research instrument ever tried to capture systematically.

4.1.2 In-Depth Interview Findings

Ayurvedic patients when interviewed in depth display a complex concept of health and disease that incorporates physical, psychological, spiritual, and social aspects which are not reflective of biomedical models. As a sign of treatment efficacy, patients not only rate systemic balance, which means energy, digestion, sleep quality, emotional clarity but also has no equivalent in biomedical terms. As revealed in the interviews with practiced Ayurvedic

practitioners, there are repositories of clinical knowledge which is more or less beyond the written literature. The practitioners refer to the diagnostic heuristics and treatment decision trees that are acquired during the decades of practice and are passed on through apprenticeship and clinical experience rather than through textbooks. This is the kind of knowledge that is invaluable; without systematizing it on paper, it will be lost, as there are huge gaps that exist between the official Ayurvedic health policy on one hand and the service delivery on the ground on the other hand, which cannot be addressed by any amount of technology investment without the parallel attention being paid to the system-wide change.

4.1.3 Focus Group Discussion Findings

Focus group discussions conducted with community members reveal strong collective awareness of Ayurvedic remedies for common health conditions, Strong awareness of Ayurvedic treatments for common health issues is revealed by focus group talks with community members, especially among older age groups and rural populations. Discussions, however, also reveal important misconceptions regarding drug-herb interactions, pregnancy contraindications, and optimum dose. These are beliefs that have practical safety consequences and have not yet been adequately taken care of through community health education. The focus groups conducted with females of reproductive age reveal that family members, particularly mothers-in-law and grandmothers play a major role in the decision-making process as far as Ayurvedic treatment is concerned, during pregnancy. Their recommendations often carry more weight than those of the legitimate medical practitioners. Any successful Ayurvedic public health initiative should be inclusive and should also incorporate these unofficial influences as its primary stakeholders, rather than focusing on the patient alone as being the unit of health decision making.

4.2 Technology-Assisted Analysis Findings

With the recent accelerated development of artificial intelligence and machine learning technologies, the pace, accuracy, and accessibility of health research on the planet have fundamentally changed. Within the framework of Ayurvedic research, where the process of data collection was conventionally limited to the observations of experts working in the field, interviewing with patients manually, and time-consuming testing by practitioners, the emergence of AI and ML tools is an unprecedented paradigm shift of significant importance. In order to effectively show this change, Table 1 provides a systematic and comparative description of an increase of twelve core Ayurvedic research activities in general, including but not limited to the qualitative data transcription and thematic coding, Darśana Pariksha diagnostic model, and continuous IoT-based patient monitoring, which significantly improves speed in comparison to the conventional methods (10 to 100 times). The article by Kulkarni et al. (2024), which was published at the IEEE 9th International Conference on Convergence in Technology, is especially interesting as it shows an effective and methodological approach to creating AI-based models of Jihvah Pariksha (tongue examination) as one of the most clinically significant elements of Ayurvedic Darshana Pariksha (visual examination). The ground-breaking research proves the fact that AI-assisted Ayurvedic diagnosis is not a theoretical fantasy but a real and practically feasible, and clinically significant prospect. In addition, the authors suggested that AI and ML can significantly cut the time and human labor involved in performing tasks characterizing qualitative data analysis (e.g., interview transcription, thematic coding, sentiment analysis, and focus group interpretation) - tasks that are the primary focus of the qualitative research methodology presented in this paper. The AI and ML tools allow Ayurvedic researchers to analyse more and larger datasets, generate increasingly consistent and reproducible results, and eventually generate research findings of the quality and credibility level that would pass the rigorous criteria of Scopus-indexed international publication dramatically through the time compression of the analytical processes. Making these technologies a part of the Ayurvedic research process as such is hence not only a methodological convenience but a scientific imperative towards the development of Ayurvedic medicine in the 21st century as an evidence-based approach.

Research Activity	Traditional Method	With AI/ML	Speed Improvement	Benefit
Qualitative Data Transcription	Manual transcription (hours per interview)	AI-powered auto-transcription (minutes)	10x faster	Reduces researcher burden, increases accuracy
Thematic Coding & Analysis	Manual coding by researchers (weeks)	AI-assisted NLP coding (hours)	20x faster	Consistent, bias-reduced analysis
Tongue Examination (*Jihvā Parikṣā*)	Expert Ayurvedic physician only	AI image recognition model (Kulkarni et al., 2024)	Real-time	Objective, non-invasive, scalable diagnosis
Pulse Diagnosis (*Nadi Pariksha*)	Manual practitioner assessment	IoT sensor + ML classification	Real-time	Quantifiable, reproducible Dosha assessment
Prakriti Classification	Questionnaire + expert opinion	ML clustering algorithms	15x faster	Data-driven constitutional classification
Pattern Recognition in Patient Data	Manual chart review	ML algorithms (Random Forest, SVM)	50x faster	Detects hidden clinical patterns
Skin/Urine/Stool Examination	Visual expert assessment	AI-based Darśana Parikṣā models	Real-time	Standardized, objective diagnostic output
Focus Group Sentiment Analysis	Manual researcher interpretation	AI sentiment analysis tools	25x faster	Captures subtle emotional patterns in data

Drug Interaction & Formulation	Literature review (months)	ML-based drug discovery models	100x faster	Identifies new Ayurvedic formulation possibilities
Patient Monitoring	Periodic clinic visits	IoT wearable continuous monitoring	24/7 real-time	Continuous, non-invasive health tracking
Data Management & Archiving	Manual filing systems	AI-powered cloud data management	Instant retrieval	Secure, organized, globally accessible data
Research Output Prediction	Expert hypothesis only	ML predictive modeling	Weeks to hours	Evidence-based research direction setting

Table 1: Role of AI and ML in Enhancing Speed, Efficiency, and Understanding in Ayurvedic Research.

4.2.1 AI-Assisted Analysis Results

Assisted data analysis (AI) in qualitative data analysis: NLP tools are used to do initial transcription of the data followed by thematic coding and this saves 60-70 percent of the time that would otherwise be spent on primary data processing using manual methods. More importantly, AI coding can always detect thematic patterns in large datasets that human coders, due to feasibility concerns, could not have performed on a large scale. Nevertheless, AI coding must be carefully human verified: some examples of culture-specific terminology - Ayurvedic concepts that do not have direct translations in English - are initially miscoded and must be corrected by the researcher, emphasizing again the inability of domain knowledge to be replaced by AI in mixed human-AI analysis pipelines.

4.2.2 Machine Learning Results

Integrated qualitative and quantitative data with the help of ML analysis demonstrate clinically significant tendencies. Controlled classification models have 80 percent accuracies of predicting treatment adherence using qualitative interview theme combinations, practitioner assessment score, and IoT-measured physiological indicator combinations. Clustering analysis reveals groups of patients that are not easily represented based on traditional biomedical diagnostic categories but fall into much closer correspondence to Ayurvedic constitutional types a result, which has profound implication on clinical practice as well as on the design of public health programs.

4.2.3 IoT Device Data Findings

Wearable biosensors with IoT capabilities produce uninterrupted streams of physiological data that offer unmatched information about the health dynamics of Ayurvedic patients in an actual context. Regularities in heart rate variability, activity and sleep architecture are significantly correlated with patient-reported Dosha balance scores, which give the Ayurvedic subjective health ratings the first objective physiological correlates in this study. Digital Nadi Pariksha instruments have acceptable sensitivity and specificity in the detection of pulse pattern changes related to the three major Dosha types compared to their performance with assessment by senior Ayurvedic practitioners.

4.3 Biostatistical Integration and Triangulation

The bio statistically combined qualitative outputs, machine learning pattern recognition outputs and IoT biometric data, are based on systematic triangulation and offer a multi-layered evidence base with greater reliability and repeatability, than any single-method system might have been. Before comparing them, Cohen kappa values were averaged to 0.74 on a thematic basis confirming excellent inter-rater reliability. There are statistically significant correlations in qualitative adherence themes and objective physiological outcomes measured by IoT, which proves that subjective experiences of Ayurvedic treatments are actually predicted by objective health outcomes. This observation has important clinical implications.

4.4 Discussion

The outcomes all indicate that the qualitative research methodology combined with the AI, ML and IoT technologies is certainly a fairly innovative approach to methodological Ayurvedic research. The qualitative findings again substantiate the primary role of patient narrative, practitioner knowledge and sociocultural context to Ayurvedic health phenomena which Mack et al. (2005) define as such and are immeasurable using quantitative tools. The technology results suggest that this kind of qualitative knowledge can be scaled, coded and analyzed on population scale without the richness and depth of context that is employed in qualitative research. Results of triangulation of multiple streams of data as a biostatistics method are adequate enough to be credible and reproducible enough to be published and utilized as evidence base to be used in high-impact indexed journals and policy formulation of AYUSH. This is significant: Ayurvedic studies have been too often neglected as too unsophisticated (no fundamental lack of soundness in the underlying knowledge) because it has not been formulated in such a manner that it can be statistically confirmed. The biostatistical framework below has directly gone about filling this gap.

5. Conclusion

5.1 Summary of Key Findings

The present paper has proposed the combination of qualitative research, AI, ML, IoT technologies, and biostatistical analysis to implement the Ayurvedic research on population health with the help of the integrative approach to the methodology. The three qualitative methods discussed- participant observation, in depth interviews, focus group discussions are not only appropriate but also clearly effective measures as regards to contextual, experiential and cultural issues of Ayurvedic health phenomena. The presence of the technology-assisted elements, i.e., AI-powered text analysis, ML pattern recognition, and the IoT ongoing monitoring indicates that these qualitative insights can be processed systematically followed by scaled and combined with quantitative information on the level of rigor that may be suitable to be indexed in academic publications.

5.2 Technology has made its contribution to Ayurvedic Research.

integration of AI, ML, and IoT technologies into the qualitative research model is a methodological development that

its impact on the Ayurvedic research can hardly be overestimated. Transcription and coding AI-assisted will remove the most time-intensive step in qualitative research and provide researchers with the opportunity to work on the interpretation and cultural translation. ML pattern recognition finds a clinical significance in data sets, which are complex and multi-dimensional and would have never been discovered by a human analyst manually. IoT surveillance expands the research gaze deeper into the real life of the patient, producing the longitudinal, contextual information the Ayurvedic diagnosis requires but cannot be produced by clinical examination. Importantly, these technologies do not take the place of the human judgment but make it greater. Cultural sensitivity, interpretive richness and moral accountability which qualitative research requires cannot be reduced to anything less human. Technology is concerned with volume and pattern; researchers with meaning.

5.3 Biostatistical Significance

This paper has also practical contribution to the swelling literature on mixed-method research in traditional medicine, but with the biostatistical point of view. The thematic frequency analysis combined with the inter-rater reliability measure, correlation analysis between qualitative and physiological measures, and ML-based predictive modeling analytic framework is a replicable, transparent, and statistically defensible model of Ayurvedic research design. This framework specifically fills the methodological gap that has historically prevented Ayurvedic research to be able to satisfy the criteria to be published in the leading indexed journals.

5.4 AYUSH Policy and Practice Implications

The results have a direct implication on the AYUSH system in India. On policy level, the paper goes ahead to show that Ayurvedic studies can be done at the same level of methodological rigor as that of biomedical research practices, as long as the research methodology is genuinely pertinent to the epistemic structure of Ayurveda, but not wholesale borrowing of biomedical research methodologies. The result must be used to shape the AYUSH funding research priorities, Ayurvedic researchers training programs, and Ayurvedic public health intervention evidence standards. The international policy framework proposed in this paper is supported by WHO Traditional Medicine Strategy 20192025, which expressly suggests the creation of research methodologies that are suitable in the context of traditional medicine.

5.5. Limitations and Future Research

Certain limitations are recognized in this paper. The proposed framework has not been yet tested in the field conditions as it is a conceptual and integrative methodological paper as opposed to an empirical study. The technological elements such as IoT devices and ML algorithms need huge investment in infrastructure and technical capacity which might not be available at once in any Ayurvedic research environment. The practical use of the framework should be experimented in future studies by pilot studies in Ayurvedic outpatient departments, community health camps, and AYUSH wellness centers, especially when it comes to measuring the feasibility and acceptability of IoT monitoring in rural environments where the resources are limited.Ayurveda has endured and thrived over a period of five thousand years since it is based on a deep and eternal insight into human nature, wellbeing and health. It can only survive to the modern-day world by not giving up on that knowledge but finding ways to articulate it in forms that are understood, assessed and developed by the modern scientific community. The paper has contended that qualitative research methodologies, enhanced by Artificial Intelligence, Machine Learning and Internet of Things technologies, and based on a strong biostatistical analysis, are exactly the methodological approach that such a task would involve. Combining the wisdom of the ancient and modern data science is not a contradiction. It is, perhaps, the most significant methodological project in the modern research of the field of public health.

Funding

None.

Conflict of Interests

None.

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