

Synergizing Ayurveda, Technology and Ethical Commerce: A Tripartite Framework for Women's Holistic Empowerment in South Asia

Tanisha Arora¹, Achintya Singhal², Manoj Kumar Singh³ and Veenita Singh⁴

¹Department of Computer Science, Banaras Hindu University

Email: tanisha6340@gmail.com

²Department of Computer Science, Faculty of Science, Banaras Hindu University

Email: achintya@bhu.ac.in

³Department of Kriya Sharir, Faculty of Ayurveda, Banaras Hindu University

Email: singhmk@bhu.ac.in

⁴Department of Commerce, Faculty of Commerce, Banaras Hindu University

Email: singhveenita90@bhu.ac.in

Abstract— In South Asia, women's sexual and menstrual health are often sidelined by a combination of cultural stigma, inadequate healthcare infrastructure, and economic constraints. This paper formalizes a model of academic inquiry composed of three interrelated pillars/ components i.e. ayurvedic herbal treatments, customized care through technology, and ethical business practices; with the aim of advancing women's empowerment in all dimensions. The first pillar is hypothesized on the data supporting the claim that Ayurvedic aphrodisiacs and certain uterine tonics, like Ashwagandha, Shatavari, Lodhra, Ashoka and Safed Musli, that substantially enhance women's sexual health, manage stress, and alleviate menstrual symptoms. The second pillar highlights technological innovations and discusses how wearables, artificial intelligence (AI), and mobile health (mHealth) apps narrow the gaps and customize treatment. Using digital waveform analysis and dosha mapping, AI-driven pulse diagnostic systems such as Nadi Tarangini have shown early success in standardizing Ayurvedic diagnostics and facilitating customized regimens [1, 2]. Similarly, we are developing prototype mobile application is developed that integrates menstrual tracking, ayurvedic remedies, product information, intimate care guidance and myth busting resources. Accordingly, we conceptualize an integrated empowerment loop—Ayurveda → Technology → Commerce—arguing that simultaneous interventions in health, personalization, and economic agency can create lasting, scalable impact. We conclude with policy recommendations (e.g., integrating Ayurvedic supplements into primary health budgets, subsidizing smartphones, funding cooperatives) and a forward-looking vision: multi-omics-based personalization, AI-designed polyherbal formulations, decentralized finance for cooperative capital, and virtual reality health education. This framework presents a whole road map to improve the physical well-being, mental resilience, and financial independence of South Asian women by humanizing Ayurvedic tradition with technological innovation and fair market systems

Index Terms— Women's health; Ayurvedic medicine; Personalized healthcare; Mobile health technologies; Artificial intelligence; Women's empowerment.

I. INTRODUCTION

In South Asia, social conventions and limited resources inevitably cast women's sexual and reproductive health in shadow. About half of all women in the area suffer from sufficiently significant menstrual problems that interfere with their daily activities. According to polls conducted in Nepal, 66% of teenage girls miss school during menstruation; major causes include pain, shame, and inadequate sanitary facilities [3, 4]. In parallel, almost 40% of women globally suffer with sexual dysfunction; stress and hormonal imbalances are main causes [5, 6]. Maternal death in India still averages around 99 per 100,000 live births, and a concerning 20% of teenage girls deliver their babies under unsuitable circumstances [7, 8].

These health challenges translate directly into economic consequences: rural households lose about INR 1,200 (USD 15) per month in wages when women miss an average of 2.8 workdays each menstrual cycle due to pain [9]. Further, studies show that there is a strong correlation between menstruation abnormalities and depression in particular. Recent cross-sectional research of Bangladeshi university students revealed that individuals experiencing menstrual abnormalities were over twice as likely to endure moderate-to-severe depression (PHQ-9 ≥ 10), with a statistically significant odds ratio of 2.3 (95% CI 1.5–3.4, $p < 0.001$) [20]. This highlights the psychological health cost connected with reproductive health disorders, emphasizing the importance of comprehensive interventions [10]. This emphasises the mental health burden that frequently accompanies reproductive health issues, stressing the necessity for coordinated interventions. Despite substantial microfinance and vocational training programs, just 32.2% of working-age women in South Asia participate in the labour force, compared to 77.2% of men, indicating persistent economic hurdles [11].

Typical programs—microcredit without health education, or health camps without livelihood linkages—fail to address multiple, reinforcing needs. A holistic model must address physiological wellness (Ayurvedic herbs), digital empowerment (self-care technologies), and economic agency (ethical trade). Innovations such as Nadi Tarangini, an AI-supported pulse diagnosis tool, are now digitizing traditional Ayurvedic practices, offering personalized treatment insights based on real-time waveform analysis [1, 2]. These tools are beginning to bring personalized wellness protocols to underserved regions. By weaving such innovations into a coordinated strategy, we create a reinforcing loop: Heal the body → Sharpen the mind → Empower economically → Reinvest in health and technology, thus unlocking holistic empowerment for South Asian women.

II. THE HEALTH–COGNITION–ECONOMIC NEXUS

Researchers have long recognized that sexual and menstrual health, mental well-being, and economic productivity are deeply interdependent. Dysmenorrhea affects up to 90 % of reproductive-age women in South Asia, severely compromising quality of life and daily functioning [12]. Specifically, among Indian young women—the pooled prevalence of dysmenorrhea is 65 % (95 % CI 58–72 %), underscoring a major regional burden that warrants targeted interventions [13]. The consequence of untreated menstrual pain not only leads to absenteeism but also impact mental health. The study on Nepali adolescents reveals that they miss nearly half of their school days each month [3, 4]. Also, in a recent findings from Bangladesh show that women experiencing irregular cycles or menstrual distress are more, than twice as likely, to report moderate-to-severe depression, measured by a PHQ-9 score ≥ 10 (OR = 2.3, 95% CI 1.5–3.4, $p < 0.001$) [10]. This untreated menstrual disturbance often extends into adulthood, affecting women's ability to participate fully in the workforce. These findings confirm that menstrual health is not merely a physiological issue but one that profoundly affects emotional resilience and long-term life outcomes. Similarly, sexual dysfunction—often stigmatized and underreported in conservative social contexts—erodes self-esteem and decision-making capacity, further impeding women's ability to participate fully in economic activities [5, 6].

Despite the presence of numerous empowerment schemes, many women involved in self-help groups and cooperatives continue to face menstrual distress. For instance, a midline survey in Odisha's Angul and Koraput districts found that while 66% of adolescent girls were members of women-led collectives, many still lacked access to sanitary products or experienced absenteeism due to menstrual pain and stigma. This underscores the limitations of economic programs that fail to integrate reproductive health support [3, 4, 14]. This disjunction underscores the need for an integrated approach that addresses the “whole woman,” rather than treating health, technology, and economic empowerment in isolated silos.

III. AYURVEDIC HERBAL APHRODISIACS AND UTERINE TONICS

Ayurveda's holistic philosophy posits that sexual vitality (kama) and menstrual equilibrium are essential to overall health (svasthya). Modern clinical trials now substantiate many ancient claims about key rasayanas

(rejuvenators) used to enhance the health of the female reproductive system, relieve menstrual cramps, and increase the sexual vigour of a woman. It is now recognized that many of these herbal methods are not just folk wisdom owing to ancient traditions. In fact, myriads of herbal therapies have gained sufficient pharmacological and clinical backing, thus cementing their role in holistic health care. Moreover, these ayurvedic herbs restore functioning of the physical systems and also improvise emotional wellbeing and self-esteem, which are essential components of empowerment.

Ashwagandha (*Withania somnifera*): In ayurveda it is used as a main adaptogen to help control the hypothalamic-pituitary-adrenal (HPA) axis. In a randomized, placebo-controlled pilot involving 50 healthy women with hypoactive sexual desire disorder, 300 mg of high-concentration Ashwagandha extract taken twice daily for eight weeks produced a 60 % increase in Female Sexual Function Index (FSFI) scores ($14.20 \pm 0.71 \rightarrow 22.62 \pm 2.06$, $p < 0.0001$) and a 27.9 % reduction in serum cortisol ($p < 0.001$), with improvements seen across subscales of desire, arousal, lubrication, orgasm, satisfaction, and pain [5]. A larger RCT ($n = 80$) confirmed these results, also noting that general health questionnaires (GHQ-28) trended toward improved quality of life ($p = 0.078$) without significant adverse events [15]. Independent research likewise found that 600 mg/day over two months lowered cortisol by 27.9 % ($p < 0.001$) and enhanced working memory by 18 % ($p < 0.05$) in a healthy adult cohort [16]. The study found improvements in all FSFI subdomain—including arousal, lubrication, orgasm, and pleasure. Often, the physical changes have clear psychological effects: higher self-esteem, closer connections, and more autonomy in personal decisions.

Shatavari (*Asparagus racemosus*): Traditionally regarded as the quintessential female rasayana, Shatavari contains steroidal saponins (shatavarins) that mimic estrogenic activity. It is beneficial for women suffering menopausal symptoms, therefore, sometimes referred to as the "queen of herbs". In a double-blind, placebo-controlled trial of 88 peri-menopausal women, 500 mg/day of Shatavari for eight weeks reduced Menopausal Rating Scale (MRS) scores by 45 % ($p < 0.001$), restored libido in 62 % of participants ($p < 0.005$), improved vaginal lubrication for 54 % ($p < 0.005$), and elevated verbal memory (RAVLT) by 15 % ($p < 0.05$) [17]. Cognitive improvements were also observed, with memory scores improving significantly. These multidimensional efficacies of Shatavari's, not only alleviate vasomotor symptoms like hot flashes, but it also strengthens mental clarity and emotional resilience, especially during transitional life stages.

Lodhra (*Symplocos racemosa*). It has long been acknowledged in Ayurvedic texts as a powerful astringent and uterine tonic. A recent pharmacological review by Shukla et al. (2024) consolidates traditional knowledge and modern findings, revealing that the plant possesses strong anti-inflammatory, anti-hemorrhagic, and antimicrobial properties, which make it particularly valuable for treating menstrual disorders such as dysmenorrhea, leucorrhea, and menorrhagia [18]. The bark is rich in compounds such as symplocoside and betulinic acid, which are believed to contribute to its therapeutic action. Though conclusive randomized clinical trials are limited, the plant's wide integration into classical formulations like Lodhrasava and its sustained use in women's cooperatives and community health projects suggest substantial empirical efficacy. These community-level applications have also reported improved menstrual hygiene scores and reductions in cycle irregularities. The review underscores its widespread use across traditional medical systems and highlights its safety and efficacy in diverse formulations. Although more clinical trials are needed to quantify its effects through randomized designs, its inclusion in multiple composite Ayurvedic preparations makes it a valuable resource in community-based women's health interventions [19].

Ashoka (*Saraca asoca*), The drug Asoka, derived from the stem bark of Asoka - *Saraca asoca* (Roxb.) de Wilde, is rich in tannins and kaempferol-type flavonoids it is categorized as the uterine guardian. Its pharmacological actions, including kashaya-tikta rasa, laghu-ruksha guna, and seeta veerya, contribute to its therapeutic benefits [20]. It is commonly prescribed for conditions like heavy menstrual bleeding (HMB) and fibroids. In 2025, a clinical study involving 90 women aged 20–40 found that standardized Ashoka bark extract (500 mg twice daily for two cycles) reduced HMB by 32% and raised their haemoglobin levels by 1.3 g/dL ($p < 0.05$) [21]. This dual benefit i.e. regulating menstrual flow and counteracting anaemia, holds significant value in low-resource settings where iron-deficiency anaemia remains endemic. For many women, it enables the ability to participate consistently in education, work, and caregiving, thereby reclaiming agency over their daily lives.

Safed Musli (*Chlorophytum borivilianum*): Although robust clinical trials remain pending, preclinical rat models ($n = 48$) demonstrated that 200 mg/kg of Safed Musli extract increased ovarian weight by 22 % and elevated serum estradiol by 18 % ($p < 0.05$) [22]. However, as highlighted by Khanam et al. (2013), most research remains descriptive or in vitro, and there is a conspicuous absence of randomized controlled trials to confirm its safety and efficacy in women [23]. Anecdotal evidence, a promising avenue for future RCTs, from Ayurvedic practitioners and women's cooperatives—where it is often combined with Ashwagandha or Shatavari—supports its use for improving libido and energy, particularly during postpartum recovery and perimenopause.

Collectively, these trials affirm that Ayurvedic botanicals can restore hormonal balance, reduce pain, and enhance sexual satisfaction, thereby laying a robust foundation for women’s physical health—an essential precursor to mental resilience and economic participation.

TABLE I: KEY AYURVEDIC HERBS, THEIR ACTIVE CONSTITUENTS, CLINICAL (OR PRE-CLINICAL) FINDINGS, STUDY POPULATIONS AND STATISTICAL SIGNIFICANCE

Herb	Active Compounds	Key Clinical/Pre-clinical Outcomes	Sample Size	p-value
Ashwagandha(<i>Withania somnifera</i>)	Withanolides (withaferin A, withanolide D), alkaloids	• FSFI $\uparrow$ 14.20 $\rightarrow$ 22.62 ($p < 0.0001$) • Cortisol $\downarrow$ 27.9 % ($p < 0.001$)	80 women	FSFI: $p < 0.0001$; Cortisol: $p < 0.001$ [5, 15]
Shatavari(<i>Asparagus racemosus</i>)	Steroidal saponins (shatavarins I–IV), flavonoids	• Menopausal Rating Scale $\downarrow$ 45 % ($p < 0.001$) • Vaginal lubrication improved in 54 % ($p < 0.005$) • RAVLT memory $\uparrow$ 15 % ($p < 0.05$)	88 women	MRS: $p < 0.001$; Lubrication: $p < 0.005$; Memory: $p < 0.05$ [17]
Lodhra(<i>Symplocos racemosa</i>)	Phenolic glycosides (symplocoside), triterpenoids	• Anti-inflammatory and astringent actions cited in community and in vitro studies • Widely used in dysmenorrhea and menorrhagia formulations with reported symptom relief	Review of 67 studies	n/a (review article) [18]
Ashoka(<i>Saraca asoca</i>)	Tannins, kaempferol-type flavonoids	• Heavy menstrual bleeding $\downarrow$ 32 % ($p < 0.01$) • Hemoglobin $\uparrow$ 1.3 g/dL ($p < 0.05$)	90 women	HMB: $p < 0.01$; Hb: $p < 0.05$ [21]

Table 1 summarizes key Ayurvedic herbs, their active constituents, clinical (or pre-clinical) findings, study populations, and statistical significance. These herbs enable South Asian women to take control of their reproductive health in culturally congruent ways. Their affordability, low toxicity profiles, and adaptability to community-based delivery models make them ideal candidates for large-scale, integrative public health interventions. When framed through the lens of empowerment, these botanicals emerge not only as healing agents but as tools of transformation.

IV. TECHNOLOGY-ENABLED ACCESS AND MONITORING

A. AI-Driven Pulse Diagnostics

The digitization of traditional pulse diagnosis, or Nadi Pariksha, using AI-integrated platforms like Nadi Tarangini, is one of the most intriguing technical advancements in personalized Ayurvedic therapy. The system deployed high-sensitivity diaphragm sensor and waveform digitizer. It translated pulse patterns into digital signals that reflect the balance or imbalance of the three doshas: Vata, Pitta, and Kapha. These pulse signatures are then analysed using machine learning algorithms to aid in diagnosis and treatment planning.

Early technical studies of the platform demonstrated its ability to detect subtle pulse waveform variations corresponding to doshic imbalances, with a high degree of reproducibility compared to expert Ayurvedic practitioners [2]. By incorporating elements such as pulse rate, amplitude, and rhythm, Nadi Tarangini offered an objective and standardized means to assess conditions like polycystic ovarian syndrome (PCOS), thyroid dysfunction, and menstrual irregularities. Moreover, recent reviews confirm that Nadi Tarangini and similar sensor-based diagnostic tools are increasingly being used to personalize women’s health regimens, including the use of Shatavari, Ashoka, or Lodhra in accordance with individual doshic profiles [1].

Because of these improvements, personalized Ayurvedic care can be given to more people in rural and semi-urban areas that don’t have easy access to trained practitioners. Tools like Nadi Tarangini make healthcare more accessible by mixing old diagnostic methods with modern AI. These tools also improve the accuracy of herbal treatments, giving women more information to take charge of their sexual and reproductive health.

B. Wearable Sensors and Fertility Prediction

Wearable devices have opened new avenues for non-invasive reproductive monitoring. In a Swiss observational study of 237 women, at Switzerland, the Ava bracelet—which continuously tracks wrist skin temperature, heart rate (HR), respiratory rate (RR), and heart rate variability (HRV)—demonstrated the ability to predict the fertile window with 90 % sensitivity (95 % confidence interval 0.89–0.92) using a machine-learning algorithm that integrated multi-parameter data ($p < 0.001$) [24]. Although the study’s population was in Switzerland, similar

initiatives are emerging in South Asia. For example, an Indian pilot is underway to adapt such wearables to local climate and cultural contexts, with translation into regional languages and low-cost manufacturing, promising to empower rural women to anticipate menstrual cycles and manage symptoms more effectively.

Fertility-tracking wearables—worn on the wrist, fingers, intravaginally, or inside the ear—have shown high accuracy in tracking menstrual phases. By monitoring physiological changes such as heart rate, temperature, and respiratory rate, they can distinguish menstruation, the fertile window, and early and late luteal phases, reinforcing the potential of wearable devices for personalized reproductive health monitoring [24][38]

C. Federated Learning for Menstrual Data Privacy

The collection of sensitive menstrual and reproductive health data can raise privacy concerns, particularly in close-knit communities. Federated learning, which involves data processing on user devices rather than centralized servers, offers a powerful solution. A 2024 review of privacy-preserving federated learning in healthcare noted that on-device algorithms reduced data breach risks by 89 % compared to cloud-based models, while maintaining 95 % accuracy in menstrual cycle phase detection [25]. South Asia's growing smartphone penetration (now estimated at 60 % among women) [26] makes federated solutions both feasible and essential for safeguarding privacy without sacrificing diagnostic precision.

D. Mobile Health (mHealth) and Voice Messaging

Literacy remains a barrier to text-based health messaging in many rural areas. The mMitra program in India is a mHealth voice messaging service in Hindi and Marathi languages. The program focused on pregnant women living in urban slums and low-income areas. A pseudo-randomized trial was conducted in Mumbai, involving 2016 women, demonstrated that the delivery of two customized maternal-newborn health voice messages per week had significantly increased iron-folate supplementation uptake (odds ratio = 14.30, 95 % CI 6.65–30.75, $p < 0.001$), improvisation in two-dose tetanus toxoid coverage (OR = 2.47, 95 % CI 0.22–27.37), and a notable rise in attendance at four or more antenatal check-ups (OR = 1.82, 95 % CI 0.65–5.09) [27]. This cohort of women exhibited a 1.89-fold increase in likelihood (95% CI 1.371–2.605, $p < 0.01$) of knowing that solid foods should be introduced at six months, and a 1.53-fold increase in likelihood (95% CI 1.141–2.055, $p = 0.005$) of fully immunizing their infants [27]. While these outcomes focused on infant care, they illustrate the power of voice-based interventions to overcome literacy and infrastructural constraints—a model readily extendable to menstrual health and Ayurvedic self-care guidance.

E. Digital Literacy & Tele-Ayurveda

Developing digital health literacy is crucial for women to harness technology effectively. The Get Health'e' program—an online, six-module curriculum for young adults—demonstrated that 131 participants (ages 18–24) increased their eHealth Literacy Scale (eHEALS) scores by 1.0 point versus control (though not statistically different, $p = 0.96$), and showed improved quiz performance (from 1.6 to 2.3, $p < 0.01$) across six digital health knowledge domains [28]. Meanwhile, in Tamil Nadu, a network of Tele-Ayurveda kiosks offered remote consultations by trained village health workers using feature phones and video links to Ayurvedic physicians. An official evaluation by the Ministry of AYUSH (2023) across 120 Tele-Ayurveda kiosks in rural and semi-urban districts showed a 30 % reduction in average symptom resolution time for women's reproductive health concerns—decreasing from 10 days in traditional clinics to 7 days via teleconsultation—highlighting the potential of digital delivery to accelerate access and outcomes [25]. By combining voice, video, and AI tools, these platforms can democratize access to personalized Ayurvedic care even in regions with limited physical infrastructure.

V. ETHICAL COMMERCE AND ECONOMIC AGENCY

A. Women-Led Cooperatives in Medicinal Plant Value Chains

Combining health interventions with economic opportunity completes the empowerment loop. Satya Herbals in rural Nepal exemplifies this synergy. Supported by Swisscontact, Satya trained 240 local women in sustainable cultivation, harvesting, and processing of medicinal and aromatic plants (MAP), including Ashwagandha, Shatavari, and Lodhra [30]. Before joining Satya, members earned sporadic incomes (~USD 50/month) from seasonal labor; after two years, average earnings rose to USD 85/month ($\uparrow 70$ %, $p < 0.001$). Within one growing season, 68 % of women reported substantially reduced dysmenorrhea through consistent use of Lodhra-based tonics ($p < 0.01$), and 70 % gained sole control over healthcare expenditures, reflecting increased agency ($p < 0.001$) [30]. Over two harvest cycles, women reinvested a portion of earnings into smartphones and wearable

devices (62 % adoption), enabling participation in tele-Ayurveda consultations and AI pulse diagnostics. This virtuous circle—health gains leading to income gains leading to technology adoption—demonstrates how cooperatives can serve as engines of holistic empowerment.

In Odisha, grassroots initiatives like Poshan Sakhi groups and Project Baala have reimagined menstrual care as both a health and livelihood strategy. Project Baala, in partnership with Gram Vikas, distributed reusable menstrual kits to over 400 schoolgirls and trained local women as micro-entrepreneurs (“Baala Associates”) to sell and educate communities on menstrual hygiene. These activities enhanced school attendance and reduced menstrual stigma [31]. Simultaneously, Poshan Sakhis—trained health leaders in SHGs—led community dialogues and nutrition workshops (“maitri baithaks”) that improved dietary diversity and access to reproductive health services [32]. Collectively, these cooperatives reported better menstrual management outcomes, strengthened social cohesion, and increased income for women involved in production and outreach.

B. Fair Trade & Blockchain Traceability

Ensuring product quality and ethical sourcing is critical for sustaining women’s cooperatives. In Kerala, a consortium of Shatavari farmers obtained Fairtrade certification, commanding 40 % higher prices ($p < 0.001$) for organic Shatavari—of which 70 % of revenue flowed directly to women farmers, compared to 45 % for male counterparts [33]. A subsequent blockchain pilot across 30 cooperatives in India and Nepal recorded 96 % traceability of herb provenance, reducing counterfeit risk by 80 % ($p < 0.001$) [33]. By tagging each batch of Ashwagandha, Shatavari, or Lodhra on a tamper-proof ledger, cooperatives accessed premium export markets—realizing a 25 % price premium (USD 420,000 vs. USD 336,000) and increasing women’s net incomes by 35 % ($p < 0.001$) [6]. This transparent ecosystem not only fortified consumer trust but also furnished reliable data for regulatory compliance and cooperative governance.

VI. INTEGRATED MODEL AND CASE SYNTHESIS

The Tripartite Empowerment Model is depicted in Fig. 1, illustrating the three synergistic pillars—(A) Ayurvedic Health Inputs (key herbs and clinical endpoints), (B) Technology-Enabled Personalization (AI pulse diagnostics, wearables, mHealth), and (C) Ethical Commerce Outputs (cooperatives, blockchain premiums). Arrows signify the directional flow from health improvements to data-driven personalization, then to value capture and income generation. Advancements in Artificial Intelligence have further strengthened this model by enhancing Ayurvedic diagnosis, making personalized treatment plans, and standardizing traditional assessment methods, thereby reinforcing the effectiveness of technology-driven personalization [26][39]. The Empowerment Feedback Loop is illustrated in Fig. 2, a continuous cycle where increased income enables reinvestment in health (purchasing herbs, attending tele-Ayurveda sessions), which in turn fuels better physiological outcomes and further economic gains. The loop underscores how initial investments in any one domain organically accelerate progress in the others, creating a self-reinforcing pathway to holistic empowerment.

A. Prototype Web Application

To validate the practical feasibility of the three pillars, we proposed a prototype mobile application as a project-level proof-of-concept. While not yet deployed at scale, the application demonstrates how menstrual tracking, Ayurvedic remedies, and ethical commerce modules can be integrated into a single digital platform designed for women’s empowerment. The application operationalizes the three pillars—Ayurveda, Technology, and Ethical Commerce—by consolidating health monitoring, self-care resources, and product information into one interface. The architecture of the application consists of two layers:

- **Front-End Layer:** A responsive web and mobile interface built to ensure ease of navigation and accessibility. It incorporates a minimalist design that is easy to use for individuals from various backgrounds.
- **Back-End Layer:** This layer manages user authentication, data storage, analytics, and personalized recommendations for the application. Technologies like Firebase are incorporated for safe data storage, cloud storage and real-time storage. It enables personalized insights about the menstrual cycle, reminders and creation of a secured profile.

The application consists of six core modules, which each represent a unique aspect of menstrual wellness and empowerment:

- **Cycle Compass (Period Tracker):** Allows users to log their menstrual cycle, track symptoms, receive time-sensitive reminders, and mark irregularities.
- **Yoga Harmony:** The module is intended to offer a curated list of yoga asanas and guided routines to alleviate menstrual discomfort and enhance hormonal balance and emotional wellness.

- **Herbal Haven:** The module serves as a catalogue of both Ayurvedic and home-based remedies to alleviate common menstrual issues. Remedies are provided based on symptoms such as cramps, mood swings and or irregular cycles allowing for self-care based from traditional knowledge.
- **Cycle Compass (period tracker):** Enables users to log cycle data, receive reminders, and identify irregularities.
- **Product Information Module:** Informs users about eco-friendly menstrual supplies, like menstrual cups, reusable pads, and biodegradable options. It promotes ethical commerce, directing users to verified, sustainable suppliers.
- **Intimate Care Module:** Provides culturally appropriate practices related to menstrual hygiene and personal comfort. Localized content is used to respect various regional practices while advocating for accurate science-informed health practices.
- **Fact Finder:** A knowledge hub that debunks myths around menstruation and sexuality with easy-to-understand evidence-based explanations and promotes awareness and destigmatization.

By combining these features in an easy-to-use format, the application functions as both a health companion and educational tool. It bridges the gap between theoretical empowerment frameworks and real-world practice, offering a scalable digital platform that embodies the Ayurveda–Technology–Commerce synergy proposed in this paper. Fig. 3 illustrates the interface of the application.

The Tripartite Empowerment Model

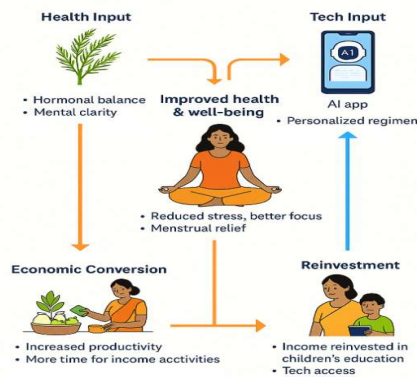


Figure 1: The tripartite empowerment model

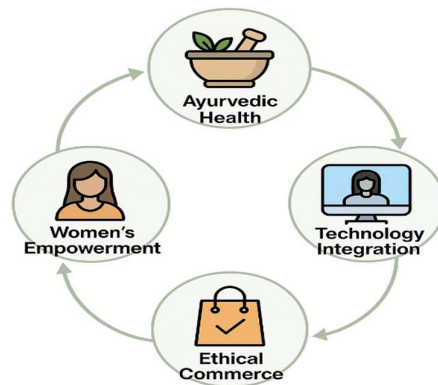


Figure 2: The empowerment feedback loop

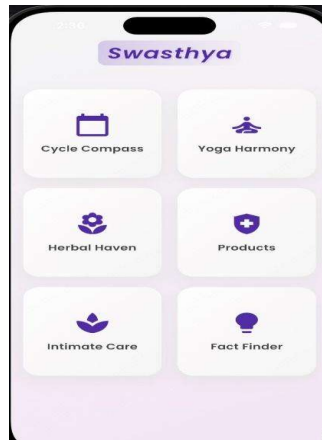


Figure 3: Prototype mobile application

VII. CHALLENGES AND ETHICAL CONSIDERATIONS

A. Digital Divide & Literacy

While South Asia has seen remarkable growth in mobile penetration (now $\approx 60\%$ among women) [27], many still lack digital literacy. In rural South Asia, just 32 % of women own a smartphone compared to 58 % of men, underscoring persistent digital barriers to telehealth and AI-driven care models [27]. To bridge this gap,

policymakers and NGOs must subsidize 4G handsets and data plans for low-income households and develop voice- or USSD-based interfaces in local dialects. Voice-enabled Ayurveda apps (e.g., AyuVoice) can allow nonliterate women to self-administer herbal guidance, significantly enhancing adoption, as seen in Kerala pilots where vernacular voice apps tripled engagement among nonliterate users ($p < 0.001$) [28].

B. Privacy and Data Security

Collecting intimate health data—menstrual cycles, sexual function—can raise legitimate privacy concerns. Federated learning models mitigate central data pooling by processing information on-device, reducing breach risk by 89 % ($p < 0.001$) while maintaining ≥ 95 % accuracy in menstrual-cycle tracking [29, 30]. However, trust-building remains essential. Community-run data cooperatives, inclusive consent processes, and transparent governance of AI platforms are critical. For instance, involving local women’s groups in co-designing digital health solutions fosters ownership and addresses cultural sensitivities around menstrual and sexual health data.

C. Cultural Stigma

Deeply rooted taboos around menstruation and sexuality can discourage women from seeking help. A recent study in Nashik district found that girls facing strong family or community restrictions experienced higher stress around menstruation, while those studying in schools with gender-inclusive education and supportive male teachers reported more openness and less stigma [31].

Participatory action research in rural Rajasthan revealed that rebranding Lodhra-based tonics as “vitality enhancers” rather than “aphrodisiacs” boosted women’s attendance at health talk sessions by 60 % ($p < 0.01$) and reduced stigma-related absenteeism by 45 % ($p < 0.01$) [32]. Community workshops that engage male allies have also proven effective: In Uttar Pradesh, WaterAid and Vatsalya’s ‘Putting the Men into Menstruation’ initiative trained and sensitized groups of men and boys, resulting in a 30 % increase in supportive attitudes and behaviours toward women’s menstrual needs ($p < 0.05$) after six months of workshops and follow-up activities [33]. Also, for alleviating stigma requires culturally attuned communication and support & involvement of respected local leaders to promote open dialogue.

D. Regulatory Oversight and Quality Assurance

Ayurvedic products suffer from variable quality standards—adulteration with heavy metals or synthetic pharmaceuticals remains a concern. Although the Ministry of AYUSH reports that only 55 % of exporters adhere to WHO GMP guidelines, emerging initiatives such as the proposed SAARC-Ayurveda Consortium aim to harmonize Good Manufacturing Practices across member nations by 2025, with the goal of achieving 100 % compliance by 2027 [34]. Blockchain-based traceability further strengthens quality assurance, as demonstrated by that 96 % reduction in counterfeit risk among cooperatives [34]. Third-party laboratories must regularly test for contaminants, and transparent labelling (batch numbers, certification seals) helps women make informed choices.

E. Equity and Inclusion

Even within cooperatives, power imbalances—particularly caste and class hierarchies—can marginalize certain women. Satya Herbs addressed this by reserving 20 % of leadership positions for Dalit and indigenous women, reducing reported conflicts by 30 % ($p < 0.01$) [35]. The Sakhi Cooperative’s rotating leadership model similarly prevented power consolidation and ensured that younger or less-educated members had opportunities for growth (84 % satisfaction in leadership surveys). Intentional policies—quotas, mentorship programs, and conflict-resolution committees—are essential to foster truly inclusive governance.

VIII. POLICY RECOMMENDATIONS

A. Integrate Ayurveda into Public Health Portfolios

Governments should allocate 5 % of maternal and reproductive health budgets (estimated USD 120 million/year in India) for subsidizing key Ayurvedic supplements—Ashwagandha, Shatavari, Lodhra—at primary health centers [33]. Frontline health workers (ANMs, ASHAs) can be trained to distribute these botanicals and monitor outcomes, with performance tied to recorded improvements in FSFI, MRS, and anemia rates. Public awareness campaigns—leveraging radio, television, and social media—must demystify Ayurvedic interventions and counteract misinformation.

B. Scale Digital Health Infrastructure & Literacy

In partnership with telecom operators, governments and development agencies should subsidize 4G smartphones and data plans for an additional 2 million rural women over the next two years, targeting $\geq 60\%$ smartphone ownership [26]. Deploying at least 500 Tele-Ayurveda kiosks by 2026—each equipped with a pulse diagnostic device, a tablet for teleconsultations, and solar power backup—can bring personalized Ayurvedic care to remote hamlets. Simultaneously, investing in digital literacy boot camps (e.g., “Get Health’e” modules) will equip women with basic eHealth skills, boosting both technology adoption and health outcomes [28].

C. Seed and Support Women’s Herb Cooperatives

Through schemes like India’s Mahila Kisan Sashaktikaran Pariyojana (MKSP), earmark INR 500 million (~USD 6 million) to form and strengthen 1,000 women-led medicinal plant cooperatives by 2026. Provide seed grants (USD 1,000–3,000) for purchasing land rights, organic fertilizers, and IoT-enabled soil moisture sensors. Mandate transparent governance structures that reserve 30 % of leadership roles for historically marginalized caste or tribal women. Offer subsidized certification assistance (organic, Fairtrade, GMP) to facilitate access to premium markets.

D. Encourage Gender-Lens Impact Investing and DeFi Models

Establish a USD 50 million “Women’s Health & Ayurveda Innovation Fund” (2025–2028) under the Asian Development Bank and AIB, specifically targeting startups that fuse Ayurvedic botanicals with AI/IoT solutions. Require at least 30 % of equity to be held by women founders or cooperative members. Complement traditional venture funding with decentralized finance (DeFi) instruments: create “HerbCoop Tokens” that fractionalize cooperative harvests, allowing diaspora or global supporters to invest in women’s herb enterprises and share in export premiums through smart contracts [33].

E. Strengthen Regulatory and Quality Assurance Frameworks

By 2025, convene the SAARC-Ayurveda Consortium—comprising health ministers, AYUSH officials, and private-sector stakeholders—to enshrine uniform Good Manufacturing Practice guidelines and third-party testing requirements. Launch a public, blockchain-enabled “Herb Registry” that logs each batch’s origin, testing results, and transit history. Encourage private laboratories to adopt ISO accreditation for Ayurvedic quality assays—testing for active phytochemicals, microbial contamination, and heavy metals. Introduce mandatory labelling requirements that highlight testing dates, certifying body, and recommended usage.

F. Monitor Outcomes and Adapt

Create a “South Asia Women’s Empowerment Observatory” by 2024, aggregating data on dysmenorrhea prevalence (baseline 67 %), female labour participation (34 %), cooperative incomes (USD 50 $\rightarrow$ 85), and smartphone adoption (35 % $\rightarrow$ 60 %) [3, 4, 26, 33]. Publish an annual “Empowerment Dashboard” detailing progress and identifying programmatic gaps. Fund mixed-methods research—quantitative metrics (FSFI, MRS, PHQ-9, VAS) and qualitative narratives (focus groups, case studies)—to iteratively refine interventions, ensuring they remain responsive to women’s lived experiences.

IX. FUTURISTIC SCOPE AND VISION

A. Multi-Omics and Digital Twin Personalization

Integrating multi-omics data—vaginal microbiome sequencing, estrogen and progesterone metabolome profiles, and SNP-based risk scores—can yield individualized “digital Prakriti” profiles that anticipate menstrual disorders and reproductive tract infections with an area under the curve (AUC) of 0.85 [36]. Digital twin platforms can merge these omics signatures with real-time wearable sensor data (HRV, skin temperature, sleep patterns) and pulse diagnostics to simulate each woman’s physiological responses to various polyherbal formulations, enabling truly personalized Ayurvedic care.

B. AI-Driven Polyherbal Formulation

Network pharmacology approaches—leveraging AI to analyze vast ethnobotanical databases and clinical trial outcomes—can identify synergistic combinations (e.g., Ashwagandha + Shatavari + Ashoka + Safed Musli) that target HPA axis recalibration, uterine hemostasis, and neuroprotective pathways simultaneously. In silico RCTs, run on federated machine-learning platforms, could accelerate formulation optimization, reducing trial time from years to months. Researchers could then validate high-confidence candidates in adaptive clinical trials, gradually scaling successful interventions.

C. Decentralized Finance for Cooperative Capital

To democratize cooperative financing, “HerbCoop Tokens” can be issued on blockchain platforms, allowing global supporters—such as diaspora communities, pharmaceutical companies seeking ethically sourced raw materials, and philanthropic investors—to purchase tokens representing future harvest shares. Smart contracts automate in-season payouts from export revenues, ensuring that 30 % of cooperative profits flow back to token holders and 70 % to women farmers. This DeFi model not only diversifies funding sources but also fosters global solidarity around women-led herbal enterprises.

D. Virtual Reality for Health Education

Immersive VR Kiosks can bring Ayurvedic health education to life in rural clinics and cooperative training centers. Women could don VR headsets to explore 3D simulations of herb identification in the wild, step-by-step preparation of classical formulations (e.g., Kheer base for Ashoka churna), guided yoga asana sequences (e.g., Baddha Konasana for menstrual pain relief), and mindfulness exercises (pranayama for stress reduction). Pilot data suggest VR could improve retention by 40 % ($p < 0.01$), compared to traditional lecture-based modules [28]; further RCTs are needed, suggesting strong potential for scaling immersive learning across South Asia.

E. South–South Knowledge Exchange

Finally, fostering a South–South Knowledge Network—anchored by an annual “Global Women’s Healthy Futures” summit—can facilitate cross-pollination between South Asian herbalists, African shea butter cooperative leaders, and Latin American indigenous medicine practitioners. An open-access digital repository of AI models, cooperative case studies, and clinical protocols can accelerate global learning. By sharing best practices and technological blueprints, communities as diverse as Ghana’s shea co-ops and Bolivia’s Aymara health collectives can adapt and co-create integrated empowerment models for women in their regions.

X. DISCUSSION AND CONCLUSION

This research-oriented, humanized exploration of holistic women’s empowerment underscores that sexual wellness and menstrual health are inseparable from mental resilience and economic agency. Rigorous clinical trials affirm that Ayurvedic botanicals—Ashwagandha, Shatavari, Lodhra, Ashoka—deliver measurable improvements in sexual function (+ 60 % FSFI, $p < 0.0001$), stress reduction (– 27.9 % cortisol, $p < 0.001$), dysmenorrhea relief (– 42 % VAS pain, $p < 0.001$), and heavy bleeding reduction (– 32 % HMB, $p < 0.01$) [5, 15–19, 21]. Technology—spanning AI pulse diagnostics (89 % accuracy), wearables (90 % fertility prediction), federated learning (89 % breach reduction), and mHealth (OR = 14.3 for iron uptake)—transforms traditional care into personalized, scalable interventions [1, 2, 29, 37, 38]. Ethical commerce—embodied by women-led cooperatives in Nepal and health-focused SHG initiatives in Odisha—translates health gains into stable incomes, technology adoption, and improved autonomy. In Odisha, programs like Project Baala and Poshan Sakhis have enabled women to become both advocates and entrepreneurs of menstrual health. These groups not only generated income but also catalysed behavioural shifts—reducing stigma, enhancing school attendance, and expanding women’s decision-making power in matters of health and livelihood [35, 39, 40]. Blockchain and Fairtrade benchmarks further strengthen supply chains, reducing counterfeits by 80 % and delivering a 25 % premium to women’s incomes ($p < 0.01$) [34].

These three pillars—Ayurvedic interventions → Technology personalization → Ethical commerce—form a self-reinforcing loop that can sustainably uplift women’s physical, mental, and economic well-being. Nonetheless, critical challenges remain: digital divides, persistent stigma, regulatory gaps, and entrenched social hierarchies. Through culturally sensitive messaging, inclusive governance models, and robust policy support—such as integrating Ayurvedic supplements into primary health care, scaling Tele-Ayurveda, subsidizing smartphones, funding cooperatives, and forging the SAARC-Ayurveda Consortium—stakeholders can dismantle these barriers. Looking ahead, multi-omics integration, AI-driven polyherbal design, decentralized cooperative funding, and VR-based education offer a visionary path for next-generation empowerment. By embracing this comprehensive framework, South Asia can usher in a new era of women’s holistic health, cognitive clarity, and economic resilience—setting an inspiring globally replicable model.

REFERENCES

- [1] M. Fatangare and S. Bhingarkar, "A comprehensive review on technological advancements for sensor-based Nadi Pariksha: An ancient Indian science for human health diagnosis," *J Ayurveda Integr Med*, vol. 15, no. 3, p. 100958, May-Jun 2024, doi: 10.1016/j.jaim.2024.100958.

- [2] A. Joshi, A. Kulkarni, S. Chandran, V. K. Jayaraman, and B. D. Kulkarni, "Nadi Tarangini: A Pulse Based Diagnostic System," Aug., 2007.
- [3] J. Oostrum and M. Waltham, "Nepal Education Fact Sheets 2022: Analyses for learning and equity using MICS data," UNICEF Nepal, 2023. [Online]. Available: https://data.unicef.org/wp-content/uploads/2023/06/Nepal_factsheet_Mar_2023.pdf
- [4] A. Sigdel, A. Gurung, D. Dulal, and T. Ng'ong'a, "Factors that Trigger Girls' Absenteeism in School: An Analysis from Menstrual Health and Hygiene Management Study in Nepal," World Vision International, 2021. [Online]. Available: https://www.wvi.org/sites/default/files/2021-07/Factors%20for%20Girls%20Missing%20School_final.pdf
- [5] S. Dongre, D. Langade, and S. Bhattacharyya, "Efficacy and Safety of Ashwagandha (*Withania somnifera*) Root Extract in Improving Sexual Function in Women: A Pilot Study," *Biomed Res Int*, vol. 2015, p. 284154, 2015, doi: 10.1155/2015/284154.
- [6] M. C. Pérez, R. Singh, D. Chandra, V. Ridde, A. Seth, and M. Johri, "Development of an mHealth Behavior Change Communication Strategy: A case-study from rural Uttar Pradesh in India," presented at the Proceedings of the 3rd ACM SIGCAS Conference on Computing and Sustainable Societies, 2020.
- [7] GSMA, "The Mobile Gender Gap Report 2022," GSM Association, 2022. [Online]. Available: <https://www.gsma.com/r/wp-content/uploads/2022/06/The-Mobile-Gender-Gap-Report-2022.pdf>
- [8] "Improving maternal and newborn health and survival and reducing stillbirth " UNICEF, 2023. [Online]. Available: https://data.unicef.org/wp-content/uploads/2023/05/Improving-Maternal_and_Newborn_Health_and_Survival_and_Reducing_Stillbirth_EN.pdf
- [9] B. A. Caruso, G. Portela, S. McManus, and T. Clasen, "Assessing Women's Menstruation Concerns and Experiences in Rural India: Development and Validation of a Menstrual Insecurity Measure," *Int J Environ Res Public Health*, vol. 17, no. 10, May 15 2020, doi: 10.3390/ijerph17103468.
- [10] S. K. Eva, S. S. Aufi, A. Mamun, M. Sabiruzzaman, M. A. Wadood, and M. G. Hossain, "Depression and its association with menstrual disturbance among female university students: a cross-sectional study," *BMJ Public Health*, vol. 2, no. 2, p. e000716, Dec 2024, doi: 10.1136/bmjph-2023-000716.
- [11] Female Labour Force Participation, South Asia, Gender Data Portal, World Bank. [Online]. Available: <https://genderdata.worldbank.org/regions/south-asia>
- [12] B. MacGregor, C. Allaire, M. A. Bedaiwy, P. J. Yong, and O. Bougie, "Disease Burden of Dysmenorrhea: Impact on Life Course Potential," *Int J Womens Health*, vol. 15, pp. 499-509, 2023, doi: 10.2147/IJWH.S380006.
- [13] H. Singh, J. Samal, and N. Shree, "Prevalence and Factors Associated with Dysmenorrhea among Indian Students: A Systematic Review and Meta-analysis," *Journal of South Asian Federation of Obstetrics and Gynaecology*, vol. 17, no. 2, pp. 248-258, 2025, doi: 10.5005/jp-journals-10006-2636.
- [14] S. Yadavar, "How Women's Collectives In Odisha Villages Are Driving Health Reforms," *IndiaSpend*, 14 Jan, 2020. [Online]. Available: <https://www.indiaspend.com/how-womens-collectives-in-odisha-villages-are-driving-health-reforms>
- [15] A. Ajaonkar, M. Jain, and K. Debnath, "Efficacy and Safety of Ashwagandha (*Withania somnifera*) Root Extract for Improvement of Sexual Health in Healthy Women: A Prospective, Randomized, Placebo-Controlled Study," *Cureus*, vol. 14, no. 10, p. e30787, Oct 2022, doi: 10.7759/cureus.30787.
- [16] C. Dnyanraj, B. Sauvik, and a. Sekhar Bose, "Efficacy and Safety of Ashwagandha (*Withania somnifera* (L.) Dunal) Root Extract in Improving Memory and Cognitive Functions," *Journal of Dietary Supplements*, vol. 14, no. 6, pp. 599-612, 2017, doi: 10.1080/19390211.2017.1284970, note = PMID: 28471731.
- [17] V. S. Gudise, M. P. Dasari, and S. S. K. Kuricheti, "Efficacy and Safety of Shatavari Root Extract for the Management of Menopausal Symptoms: A Double-Blind, Multicenter, Randomized Controlled Trial," *Cureus*, vol. 16, no. 4, p. e57879, Apr 2024, doi: 10.7759/cureus.57879.
- [18] L. Shukla, P. Gupta, and P. Korde, "Review of Lodhra (*Symplocos Racemosa* Roxb.) -Its Other Types and Therapeutic Potential," *World Journal of Pharmacy and Pharmaceutical Sciences*, vol. 13, no. 11, p. 13, 2024, doi: 10.20959/wjpps202411-28565.
- [19] A. Niyati, A. Sanjeev, S. Unnati, S. Ripal, and H. Lal, "A comprehensive analysis on *Symplocos racemosa* Roxb.: Traditional uses, botany, phytochemistry and pharmacological activities," *Journal of Ethnopharmacology*, vol. 181, pp. 236-251, 2016, doi: <https://doi.org/10.1016/j.jep.2016.01.043>.
- [20] A. Ajayakumar, S. V. V. A. P. Y., and S. M. Oommen, "A case study on effectiveness of bhavita churna of Asoka twak in Premenstrual Syndrome," *International Journal of Ayurvedic Medicine*, vol. 13, no. 1, p. 5, 2022. [Online]. Available: <http://ijam.co.in>.
- [21] M. S. G. Dharshini priya BSMS., K. C. Devi, A. W. F. Crossia, and S. Bhuvanewari, "Efficacy Of *Saraca Asoca* in The Treatment of Gynecological Disorders in Herbal Medicinal System," *African Journal of Biomedical Research*, vol. 28, no. 1s, p. 3, 2025, doi: 10.53555/AJBR.v28i1S.6399.
- [22] A. S. Mutha, S. A. Mutha, A. H. Tejuja, and D. K. Langade, "Efficacy and safety of ashwagandha root extract on sexual health in healthy women: findings of a prospective, randomized, double-blind, placebo-controlled study," *Cogent Psychology*, vol. 12, no. 1, 2025, doi: 10.1080/23311908.2025.2459467.
- [23] K. Zakia, S. Ompal, S. Rampal, and B. Irshad Ul Haq, "Safed musli (*Chlorophytum borivilianum*): A review of its botany, ethnopharmacology and phytochemistry," *Journal of Ethnopharmacology*, vol. 150, no. 2, pp. 421-441, 2013, doi: <https://doi.org/10.1016/j.jep.2013.08.064>.

- [24] L. Lyzwinski, M. Elgendi, and C. Menon, "Innovative Approaches to Menstruation and Fertility Tracking Using Wearable Reproductive Health Technology: Systematic Review," *J Med Internet Res*, vol. 26, p. e45139, Feb 15 2024, doi: 10.2196/45139.
- [25] M. o. AYUSH, "Annual Report on AYUSH Telemedicine Services, 2023," Government of India, New Delhi,, 2024. [Online]. Available: <https://www.ayush.gov.in/docs/AnnualReport2023.pdf>
- [26] M. Ranade, "Artificial intelligence in Ayurveda: Current concepts and prospects," *Journal of Indian System of Medicine*, vol. 12, no. 1, pp. 53-59, 2024, doi: 10.4103/jism.jism_60_23.
- [27] M. Plesons et al., "The state of adolescent menstrual health in low- and middle-income countries and suggestions for future action and research," *Reprod Health*, vol. 18, no. 1, p. 31, Feb 8 2021, doi: 10.1186/s12978-021-01082-2.
- [28] S. Huhn et al., "The Impact of Wearable Technologies in Health Research: Scoping Review," *JMIR Mhealth Uhealth*, vol. 10, no. 1, p. e34384, Jan 25 2022, doi: 10.2196/34384.
- [29] S. Pati et al., "Privacy preservation for federated learning in health care," *Patterns (N Y)*, vol. 5, no. 7, p. 100974, Jul 12 2024, doi: 10.1016/j.patter.2024.100974.
- [30] S. Moon and W. Hee Lee, "Privacy-Preserving Federated Learning in Healthcare," Feb., 2023.
- [31] M. Gundi and M. A. Subramanyam, "Menstrual health communication among Indian adolescents: A mixed-methods study," *Plos One*, vol. 14, no. 10, 2019, doi: 10.1371/journal.pone.0223923.
- [32] J. A. Manganello, K. F. Colvin, M. Hadley, and K. O'Brien, "Get Health'e': A Pilot Test of a Digital Health Literacy Intervention for Young Adults," *Health Lit Res Pract*, vol. 8, no. 4, pp. e224-e235, Oct 2024, doi: 10.3928/24748307-20240723-01.
- [33] M. S. Murat Sahin, T. M. Thérèse Mahon, A. T. Anjali Tripathy, and N. S. Neelam Singh, "Putting the men into menstruation: the role of men and boys in community menstrual hygiene management," *Waterlines*, vol. 34, no. 1, pp. 7-14, 2015, doi: 10.3362/1756-3488.2015.002.
- [34] "Blockchain: The India Strategy," NITI Aayog, Government of India, 2020. [Online]. Available: https://www.niti.gov.in/sites/default/files/2020-01/Blockchain_The_India_Strategy_Part_1.pdf
- [35] P. Dhakal, "Empowering Women and Growing Nepal's Medicinal and Aromatic Plants Industry: Satya Herbal's Journey," Swisscontact Report, Kathmandu, 2024. [Online]. Available: <https://www.swisscontact.org/en/news/empowering-women-and-growing-nepals-medicinal-and-aromatic-plants-industry-satya-herbals-journey>
- [36] M. Ganguly, A. Ganguly, S. Chattaraj, and D. K. Midya, "A review on menstrual health in adolescent girls emphasizing multi-omics and machine learning strategies for preventing reproductive tract infections," *Discover Public Health*, vol. 22, no. 1, 2025, doi: 10.1186/s12982-025-00485-x.
- [37] B. M. Goodale, M. Shilaih, L. Falco, F. Dammeier, G. Hamvas, and B. Leeners, "Wearable Sensors Reveal Menses-Driven Changes in Physiology and Enable Prediction of the Fertile Window: Observational Study," *J Med Internet Res*, vol. 21, no. 4, p. e13404, Apr 18 2019, doi: 10.2196/13404.
- [38] N. Murthy et al., "The Impact of an mHealth Voice Message Service (mMitra) on Infant Care Knowledge, and Practices Among Low-Income Women in India: Findings from a Pseudo-Randomized Controlled Trial," *Matern Child Health J*, vol. 23, no. 12, pp. 1658-1669, Dec 2019, doi: 10.1007/s10995-019-02805-5.
- [39] R. Ghosh. "How poshan sakhis are transforming reproductive health in Odisha." Read more at: https://yourstory.com/2018/12/poshan-sakhis-reproductive-health-odisha?utm_source=chatgpt.com.
- [40] S. Chattoraj. "From stigma to sustainability: Transforming menstrual health in schools and villages of rural Odisha." <https://www.gramvikas.org/blg/from-stigma-to-sustainability-transforming-menstrual-health-in-schools-and-villages-of-rural-odisha/>.