Saudi J. Med. Pub. Health **Vol. 1,** No. 2, pp 1535-1542 (2024)

Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202412440

Bridging the Gap: AI-Powered Digital Health Assistants in Men's Preventive Care—A Narrative Review of Integration with Nursing, Laboratory Systems, and Public Health Surveillance

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Abstract

Background: Men experience significant health disparities, including higher mortality from preventable causes, later diagnosis of chronic conditions, and lower engagement with preventive services. This "men's health gap" is exacerbated by barriers to healthcare access, health literacy, and help-seeking behaviors. Concurrently, artificial intelligence (AI) has catalyzed the development of sophisticated digital health assistants (DHAs)—chatbots, virtual agents, and mobile apps—capable of delivering personalized, scalable health promotion. **Aim:** This narrative review synthesizes current evidence on the role of AI-powered DHAs in advancing men's preventive care, with a specific focus on their integration with nursing practices, medical laboratory data systems, and public health surveillance infrastructures. **Methods:** A comprehensive search of PubMed, IEEE Xplore, CINAHL, Scopus, and ACM Digital Library was conducted. **Results:** AI-DHAs show promise in improving men's engagement with preventive screenings, mental health support, and chronic disease management through 24/7 accessibility and personalized dialogue. Effective integration hinges on secure, bidirectional data flow: DHAs can collect patient-reported outcomes, trigger nursing follow-up for high-risk cases, ingest and interpret lab results (e.g., PSA, lipid panels) to provide contextualized feedback, and contribute anonymized aggregate data to public health dashboards for monitoring men's health trends and disparities. **Conclusion:** AI-DHAs represent a transformative tool for men's preventive health but function optimally as a node within a connected care ecosystem. Success requires robust technical integration, ensuring security and interoperability, alongside a redefined nursing role that blends virtual triage with human empathy.

Keywords: Digital Health Assistant; Men's Health; Preventive Care; Nursing Informatics; Public Health Surveillance; Artificial Intelligence

Introduction

Globally, men experience a disproportionate burden of morbidity and mortality from preventable conditions. They have higher age-standardized death rates for cardiovascular disease, suicide, and many cancers, and are more likely to be diagnosed with chronic diseases at a later, less treatable stage (Baker, 2016; WHO, 2011). This "men's health gap" is driven by a complex interplay of biological, behavioral, and socio-cultural factors, including traditional masculinity norms that discourage help-seeking, risk-taking behaviors, and lower utilization

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Receive Date: 17 December 2024, Revise Date: 30 December 2024, Accept Date: 31 December 2024

of primary and preventive care services (Marcos-Marcos et al., 2021; Robertson & Baker, 2021). Consequently, public health strategies reliant on traditional clinic-based outreach often fail to engage a significant portion of the male population.

The digital revolution, accelerated by the COVID-19 pandemic, has created new avenues for health engagement. Among the most promising are AI-powered Digital Health Assistants (DHAs) (Agarwal et al., 2020). These are software systems—ranging from rule-based chatbots to advanced large language model (LLM)-driven virtual agents—that interact with users via natural language to provide health information, conduct symptom assessments, offer behavioral coaching, and promote adherence to clinical guidelines (Moshe et al., 2021; Laranjo et al., 2018). By offering anonymity, convenience, and a non-judgmental interface, DHAs have the potential to circumvent some of the key barriers to men's engagement with health systems.

However, to move beyond isolated wellness applications and realize their full clinical and public health potential, DHAs must be integrated into the broader healthcare ecosystem (Shan et al., 2022). An AI chatbot that reminds a man to check his blood pressure is useful; an AI system that can also retrieve his recent lipid panel results from the laboratory information system (LIS), interpret them in the context of his family history, flag concerning trends to a telehealth nurse for follow-up, and contribute de-identified, aggregated data on hypertension control rates to a regional public health observatory is transformative (Dabla et al., 2021). This integration is a multifaceted challenge spanning technical interoperability, data security, clinical workflow redesign, and ethical governance (Yang et al., 2022).

This narrative review synthesizes contemporary evidence on the development, application, and integration of AI-powered DHAs specifically for men's preventive care. It examines their core functionalities in addressing key men's health priorities, critically analyzes the requirements and challenges for seamless integration with three critical pillars: nursing (for human-in-the-loop triage and empathy), medical laboratories (for data-driven personalization), and public health surveillance (for population-level insight). By mapping this interdisciplinary landscape, the review argues that AI-DHAs should not be conceived as standalone apps, but as intelligent nodes within a Learning Health System, capable of closing feedback loops between individual men, frontline clinicians, diagnosticians, and public health planners to systematically reduce the men's health gap.

Methodology

This narrative review employed a systematic search and thematic synthesis methodology to map the interdisciplinary literature on AI-DHAs in men's health and their integration with clinical and public health systems.

Search Strategy and Information Sources

A comprehensive electronic literature search was conducted across five databases chosen for their complementary disciplinary coverage: PubMed/MEDLINE (biomedical and clinical), IEEE Xplore (technical and engineering, with a focus on AI and security), CINAHL (nursing and allied health), Scopus (broad multidisciplinary), and ACM Digital Library (computing and human-computer interaction). To focus on the modern era of machine learning-based AI and mobile health, the search was limited to publications from January 2015 through December 2024. The search strategy employed Boolean operators to combine terms across four conceptual domains: (1) Technology & Intervention (e.g., "digital health assistant," "chatbot," "mHealth," "AI"); (2) Population & Focus (e.g., "men's health," "male," "preventive care"); (3) Health Domain (e.g., "cardiovascular disease," "prostate cancer," "mental health"); and (4) Integration Concepts (e.g., "nursing," "telehealth," "EHR integration," "public health surveillance"). To ensure thoroughness, the reference lists of key review articles and seminal studies were also hand-searched for additional relevant sources.

Eligibility Criteria and Study Selection

Studies were included if they: (1) focused on an AI or algorithm-driven digital intervention targeting men's preventive health; (2) discussed at least one aspect of integration with clinical care (nursing, laboratory) or public health systems; or (3) presented evaluative data on engagement, efficacy, or implementation challenges. All study designs were considered, including randomized controlled trials (RCTs), cohort studies, feasibility studies, qualitative research, system descriptions, and review articles. Exclusions were: articles not in English, studies on pediatric populations, interventions without an AI/automation component (e.g., simple SMS reminders), and articles focusing solely on acute care or treatment without a preventive component. After deduplication, titles and abstracts were screened, followed by full-text review.

Data Extraction and Thematic Synthesis

Data from included studies were extracted using a standardized template capturing: citation, study design, sample characteristics (if applicable), DHA description, integration features, key findings, and limitations. Given the heterogeneity in study designs and outcomes, a meta-analysis was not performed. Instead, an inductive thematic analysis was conducted. Extracted data were coded and grouped into emerging themes related to DHA functionalities for men, integration challenges and models, evidence of effectiveness, and ethical/implementation considerations. These themes were synthesized to construct a coherent narrative addressing the review's aims.

The Men's Health Imperative and the DHA Opportunity

Men's health disparities remain well-documented yet stubbornly persistent. Compared to women, men are less likely to visit a physician for preventive services, have higher rates of being uninsured in some regions, and are often socialized to avoid appearing vulnerable, framing health concerns as threats to autonomy or productivity (Smith et al., 2022). This dynamic creates a significant "prevention paradox," where the group with the greatest need for early intervention is frequently the least likely to seek it. Key priority areas include cardiovascular disease and metabolic syndrome, the leading cause of male mortality and modifiable through lifestyle and risk factor management; cancer screening, where adherence for colorectal, prostate, and lung cancers remains low despite higher incidence and mortality rates; mental health and suicide, with men three to four times more likely to die by suicide globally while being less likely to report depression or seek psychological help (Bennett et al., 2023); and health behaviors, characterized by a higher prevalence of smoking, excessive alcohol consumption, and poor dietary habits.

AI-powered digital health assistants (DHAs) offer a unique set of advantages to address these challenges. First, they provide anonymity and reduced stigma, as text-based interactions can feel less confrontational than face-to-face consultations, encouraging disclosure about sensitive topics like mental distress or substance use (Gaffney et al., 2019; He et al., 2023). Second, their asynchronicity and 24/7 convenience fit into irregular work schedules, allowing engagement at the user's moment of readiness and breaking down temporal access barriers (Jabir et al., 2023). Furthermore, DHAs enable personalization at scale; using machine learning algorithms, they can tailor content based on user input, demographics, and connected device data, moving beyond generic messages to personalized risk communication and goal setting (Nahum-Shani et al., 2016). Finally, they facilitate proactive engagement by initiating contact based on time, such as reminders for check-ups, or triggered data like a new lab result, thereby shifting the model of care from a passive to a proactive one.

Core Functions of AI-DHAs in Men's Preventive Care

AI-DHAs for men's health are being deployed across a continuum of prevention, from primary health promotion to tertiary management of established disease. Their core functions can be categorized as follows:

Risk Assessment and Triage

Using structured dialogues or natural language processing (NLP), DHAs can administer validated screening tools (PHQ-9 for depression, IPSS for prostate symptoms, ASCVD risk estimator). Based on the score and user-reported symptoms, they can provide immediate feedback, education, and a tiered recommendation—from self-management resources to a prompt to connect with a live healthcare provider (Milne-Ives et al., 2020). For example, a DHA for construction workers might assess occupational risk factors for hearing loss, skin cancer, and musculoskeletal injury.

Behavioral Coaching and Habit Formation

Leveraging techniques from behavioral economics and cognitive behavioral therapy (CBT), DHAs support lifestyle modification. They can set goals for physical activity, nutrition, smoking cessation, or sleep, send reminders, track progress, and provide motivational reinforcement. Conversational agents have shown efficacy in promoting weight loss and increasing physical activity in male-dominant cohorts (Luger et al., 2016).

Medication and Screening Adherence Support

DHAs can send reminders for medication intake, schedule and prepare users for upcoming screening tests (explaining the colonoscopy prep process), and follow up afterwards. They can also address specific barriers to adherence through psychoeducation and problem-solving dialogues (Mahmud et al., 2021).

Mental Health First Aid and Crisis Intervention

This is a critical area for men. DHAs can offer low-intensity psychological interventions, such as CBT-based exercises for anxiety or insomnia, and mindfulness training. For acute crises, they must be programmed to recognize high-risk language (e.g., suicidal ideation) and immediately escalate by providing crisis hotline numbers, initiating contact with an emergency contact, or, in integrated systems, alerting a telehealth nurse (Torous et al., 2021).

Patient Education and Health Literacy Building

DHAs can demystify medical jargon, explain conditions and treatments in plain language, and direct users to credible resources. This is particularly important for conditions like prostate cancer, where men face complex decisions about PSA screening and treatment options.

The Integration Imperative: Connecting DHAs to the Care Continuum

The standalone utility of a DHA is limited. Its true value is unlocked when it acts as a bridge, connecting the individual user to human expertise and institutional data systems. Table 1 outlines a vision for this integrated ecosystem. Figure 1 illustrates the central role of AI-powered Digital Health Assistants (DHAs) within an integrated men's preventive care ecosystem.

Table 1: The Integrated DHA Ecosystem for Men's Preventive Care

System Component	Data Flow *to* DHA	DHA Function	Data Flow *from* DHA / Action Triggered
Electronic Health Record (EHR)	Demographics, medical history, medication list, and upcoming appointments.	Personalizes conversations; knows the user's conditions and care plan.	Logs of interactions (with user consent); patient-reported outcome measures (PROMs); updated goals.
Medical Laboratory (LIS)	Recent lab results (e.g., HbA1c, LDL, PSA, testosterone).	Interprets results in lay terms; flags abnormal/trending values; provides context (e.g., "Your LDL improved but is still above goal").	Alerts for critical results sent to nursing dashboard; prompts DHA to initiate a follow-up conversation with user.
Nursing Telehealth Platform	Care plans, scheduled follow-ups, and nurse availability.	Seamlessly transfers user to live nurse via chat or video for complex issues, emotional support, or clinical assessment.	**Escalation Alert:** Automatically notifies nurse of high-risk screening scores (e.g., severe depression, chest pain symptoms). **Task Generation:** Creates a nursing task for medication reconciliation or lifestyle coaching.
Public Health Registry	(Optional) De-identified, aggregated data on population health metrics.	Can deliver localized public health messages (e.g., flu shot campaigns, local STI outbreak alert).	**Anonymized Data Export:** Provides aggregates on screening completion rates, prevalent risk factors, and health behavior trends for men in specific geographies/demographics.
Wearable/IoT Devices	Step count, heart rate, sleep data, and blood pressure readings.	Correlates behavioral data with health goals; provides feedback (e.g., "Your resting heart rate dropped this month").	May trigger health inquiries (e.g., "I noticed a spike in your blood pressure readings this week. How are you feeling?").

Note: LIS = Laboratory Information System; IoT = Internet of Things.

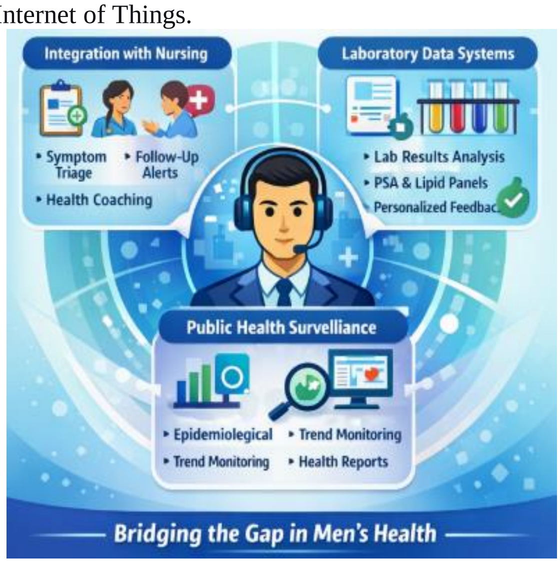

Figure 1. Integrated Role of AI-Powered Digital Health Assistants in Men's Preventive Care

Integration with Nursing

The integration of digital health assistants (DHAs) within the healthcare system is operationalized through a collaborative, human-in-the-loop model centered on the nursing profession. Nurses provide the essential human judgment, empathy, and clinical expertise that AI cannot replicate, leading to a model of role augmentation rather than replacement (Robert, 2019). In an integrated system, the DHA handles initial virtual triage for routine queries, while escalating complex, emergent, or emotionally charged issues directly to a telehealth nurse for appropriate intervention. This ensures both patient safety and efficient use of human resources (Ergin et al., 2023). Furthermore, nurses are empowered to conduct proactive outreach through dashboards populated by DHA-generated alerts—such as a patient reporting persistent low mood—enabling targeted follow-up and transforming nursing into a proactive care management role. For adherence support and counseling, nurses can leverage the rich interaction history from the DHA to understand a patient's struggles and provide tailored guidance that reinforces digital coaching with a human connection (Verma & Domingo, 2023).

Integration with medical laboratories focuses on closing the diagnostic loop through bidirectional data exchange. With proper security and patient consent, DHAs can be granted read-access to lab results via APIs connected to the Laboratory Information System (LIS) or patient portal. Using clinical logic or advanced AI, the DHA can then generate a personalized explanation of results, such as interpreting a lipid panel for a user. The system is also configured to flag critical results or concerning trends—like a rising PSA velocity—and automatically alert a nurse or physician to ensure timely clinical intervention.

Beyond individual care, integration with public health surveillance enables a shift from individual to population health insights. While protecting individual privacy is paramount, the anonymized and aggregated data from thousands of DHA interactions can provide unprecedented real-time understanding of men's health behaviors and needs (Abernethy et al., 2022). For instance, public health departments could monitor trends in self-reported mental health scores among young men in specific regions following economic downturns, evaluate engagement with smoking cessation modules across demographic groups to target outreach campaigns, or analyze anonymized data on barriers to colon cancer screening—extracted via natural language processing from user dialogues—to design more effective public health messaging. This effectively transforms the DHA network into a distributed sentinel system dedicated to advancing men's health at a population level.

Critical Challenges and Enablers for Implementation

The envisioned integration of digital health assistants (DHAs) faces significant hurdles that must be addressed for safe, effective, and equitable implementation (Taber et al., 2021). Technical and security challenges are fundamental, as seamless interoperability between DHAs, EHRs, laboratory systems, and nursing platforms requires robust APIs and strict adherence to data standards like HL7 FHIR (Mandel et al., 2016). Furthermore, health data security is non-negotiable; DHAs must incorporate end-to-end encryption, secure authentication, and full compliance with regulations such as HIPAA and GDPR to prevent unauthorized access and ensure data integrity (Wesley et al., 2021).

Clinical validation and liability present another critical layer of complexity. Any DHA providing clinical recommendations must be rigorously validated for accuracy and safety to prevent missed diagnoses or harmful advice (Wang et al., 2022). Establishing clear lines of liability—such as determining responsibility if a DHA fails to escalate a user in crisis—is essential. While regulatory bodies like the FDA are developing frameworks for Software as a Medical Device (SaMD), this landscape remains in flux (Meszaros et al., 2022). Ethical considerations and algorithmic bias further complicate implementation, as AI models trained on non-representative data can perpetuate and amplify existing health inequities. A DHA developed primarily with data from white, educated men may be less effective or even harmful for minority or low-income populations (Obermeyer et al., 2019). Mitigating this requires diverse training datasets, algorithmic fairness audits, inclusive design processes, and transparent, easily understood informed consent for data use.

Successful integration also hinges on effective workflow integration and the thoughtful evolution of nursing roles. Clinicians, especially nurses, must embrace the technology, which necessitates involving them in the design process, providing comprehensive training, and clearly demonstrating how the DHA reduces administrative burdens and enhances patient care. Resistance is likely if the technology is perceived as an added task or a threat to professional autonomy (Pepito & Locsin, 2019). Finally, the digital divide and health equity cannot be overlooked. Despite high smartphone penetration, disparities in digital literacy, reliable broadband access, and technological comfort persist. An over-reliance on DHAs risks exacerbating health inequalities for older, less tech-savvy, or socioeconomically disadvantaged men (Pepito et al., 2020). Implementation strategies must therefore include alternative care pathways and support for digital skill-building to ensure equitable access (Table 2). Figure 2 summarizes the key benefits of AI-powered Digital Health Assistants in advancing men's preventive healthcare.

Table 2: Strategic Framework for Implementing Integrated AI-DHAs in Men's Health

Strategic Domain	**Key Objectives**	**Specific Actions & Enablers**
Technology & Interoperability	Ensure secure, seamless data exchange across systems.	1. Adopt HL7 FHIR standards for all health IT systems. 2. Develop and use open, well-documented APIs for DHA-EHR-LIS integration. 3. Implement strong cybersecurity protocols: encryption, regular penetration testing, access controls.
Clinical Governance & Safety	Validate DHA performance and establish clear accountability.	1. Conduct rigorous RCTs and real-world evidence studies for each DHA clinical module. 2. Define clear escalation protocols and liability frameworks involving developers, healthcare institutions, and clinicians. 3. Implement continuous monitoring of DHA interactions for safety signals.

Ethics & Equity	Prevent algorithmic bias and ensure equitable access.	1. Audit algorithms for fairness across race, age, and socioeconomic status. 2. Co-design DHAs with diverse male user groups. 3. Offer low-tech alternatives (e.g., phone-based interactive voice response) and in-person support for digital onboarding.
Workflow & Change Management	Integrate DHAs into clinical practice and support nursing staff.	1. Involve nurses and physicians in the design and implementation process from the start. 2. Redesign nursing workflows to incorporate DHA alerts and virtual triage tasks. 3. Provide comprehensive training and ongoing technical support for clinical staff.
Public Health Integration	Leverage data for population health insight while protecting privacy.	1. Develop clear, tiered consent models for data aggregation (opt-in with clear benefits). 2. Build secure, cloud-based public health analytics platforms that can ingest anonymized DHA data. 3. Foster partnerships between healthcare systems, DHA developers, and public health agencies.

Figure 2. Benefits of AI-Powered Digital Health Assistants for Men's Preventive Health Outcomes

Conclusion

The men's health gap represents a persistent and costly failure of traditional healthcare delivery models. AI-powered Digital Health Assistants offer a promising, scalable tool to engage men in their health earlier and more consistently, leveraging the very technologies that permeate modern life. However, as this review has detailed, their potential is not as isolated applications, but as integrated components of a smarter health ecosystem.

The path forward requires a concerted, interdisciplinary effort. Technologists must build secure, interoperable platforms. Clinicians, led by a reconfigured nursing workforce adept in digital triage and human compassion, must guide and validate these tools. Laboratory medicine must extend its reach into the digital sphere to provide real-time, interpretable data. Public health must innovate in its use of aggregated digital data for surveillance and intervention. Finally, policymakers and ethicists must create the regulatory and ethical guardrails to ensure these systems are safe, effective, equitable, and trustworthy.

By weaving together AI-driven personalization, nursing expertise, laboratory diagnostics, and public health intelligence, we can construct a proactive, responsive, and truly preventive care continuum for men. This integrated approach does not just aim to treat disease in men more efficiently; it seeks to redefine the very relationship between men and the healthcare system, fostering a culture of proactive health stewardship and ultimately narrowing the pervasive gap in men's health outcomes.

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