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Sustaining Digital Health Interventions for Long-Term Cardiovascular Disease Prevention in the Energy Industry

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Abstract

Cardiovascular disease (CVD) is a major health concern for energy industry workers due to occupational risks. Digital health interventions (DHIs) offer innovative strategies for CVD prevention in this high-risk group. This study aimed to explore the effectiveness and sustainability of DHI by incorporating behavior change theories, behavior change techniques, and principles of persuasive system design. A literature review was performed using PubMed, Scopus, Web of Science, and CINAHL databases to collect relevant information on interventions for CVD prevention among energy sector workers. The results indicated that while DHI could improve physical activity, dietary habits, and medication adherence in the short term, sustaining these changes remained challenging due to intervention fatigue, lack of ongoing support, and changing user engagement. To maintain long-term effectiveness, strategies including adaptive interventions, gamification, social support, and iterative refinement based on user feedback are essential. Furthermore, employing a user-centered design approach and integrating DHIs with existing health programs can further enhance sustained behavior change. In conclusion, DHI holds significant potential for CVD prevention in the energy industry. However, its long-term success requires structured approaches, personalized strategies, and ongoing evaluation tailored to this unique occupational setting.

Keywords: cardiovascular disease, digital health interventions, effectiveness, energy industry

Introduction

Cardiovascular diseases (CVDs) are a leading cause of global morbidity, especially in high-risk occupations like energy.¹ Compared to others, workers in the energy sector face elevated risks due to occupational factors such as high stress, physical demands, and hazardous substance exposure.² These factors, along with hypertension, high cholesterol, obesity, smoking, and inactivity, elevate CVD risks among workers.³ Research shows that offshore workers experienced a 121.2% increase in major adverse cardiovascular events (MACE) risk over ten years, with their risk of suffering CVDs rising from 9.2% to 20.4%, exceeding the high-risk threshold measured by the Framingham Risk Score (FRS).⁴ A survey conducted among oil and gas workers revealed a significant health issue, with 62.4% being overweight, 35.5% having hypertension, 24.3% showing dyslipidaemia, and 3% with diabetes.⁵

The energy industry presents unique challenges for CVD prevention, including shift work,⁶ disrupting circadian rhythms, and limited healthcare access.³ The combination of hazardous substance exposure and intense physical demands necessitates specialized preventive measures, with customized health promotion strategies to improve workers' health.⁷ Digital Health Interventions (DHIs) offer promising solutions to reduce the risk and prevent CVD in this sector through remote, personalized support via mobile apps, wearable devices, and online platforms.⁸ The integration of artificial intelligence and machine learning using the method is expected to enhance personalization and adaptation to workforce needs.⁹ For instance, the CV-PREVITAL study demonstrated significant improvements in cardiovascular risk scores through mHealth applications over 12 months.¹⁰

However, despite much research supporting the positive outcomes of the approach, a previous study indicated challenges in maintaining long-term DHI effectiveness in high-risk sectors.¹¹ Moreover, even though DHIs have shown success in reducing cardiovascular risk factors,⁸ their impacts are often diminished due to user attrition, intervention

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fatigue, and declining engagement.¹² Among the available DHIs is the INTERCEPT program, which incorporates wearables and telemedicine and has demonstrated feasibility in managing coronary heart disease risk.¹³ Nonetheless, its application to the energy sector's unique challenges remains unexplored. The need for innovative approaches tailored to the energy industry's distinct occupational settings, characterized by remote work locations, high-stress environments, irregular shifts, hazard exposure, limited healthcare access, and workforce diversity. These challenges stem from the complexity of integrating DHIs into existing systems, the need for continuous stakeholder engagement, and the technical intricacies involved in their design and implementation. It is surmised that continuous innovation, adaptive interventions, and sustained engagement strategies are essential for successfully implementing DHI programs in this sector.

Method

A literature search was conducted from April to June 2024 using PubMed, Scopus, Web of Science, and CINAHL with keywords like 'digital health interventions,' 'cardiovascular disease prevention,' and 'energy industry.' Reference lists were manually reviewed for additional relevant studies. The term "reviewed manually" refers to the process in which the authors carefully examined the reference lists of selected articles to identify additional relevant studies, ensuring a broad and inclusive literature review. This manual review process was essential to ensure the inclusion of relevant resources beyond the databases, including books, systematic reviews, and meta-analyses, which are often overlooked in standard database searches.

This study followed a narrative literature review approach. Studies were selected based on relevance, peer-reviewed publication, and alignment with the study objectives, focusing on diverse sources, including books, systematic reviews, and meta-analyses, for comprehensive insight. A targeted search was conducted using relevant keywords in major databases, and studies that provided significant insights into the effectiveness of DHIs in CVD prevention among energy industry workers were included. This study targeted energy industry workers (oil and gas, renewable resources, and utilities) and focused on DHIs for CVD prevention, including mobile apps, wearable devices, and online platforms. Although no direct comparison group was used (the interventions were assessed without a separate, equivalent group that received standard care or no intervention for comparison), this review considered studies that compared different DHI approaches and varying levels of personalization. Instead, the outcomes of the interventions were evaluated based on pre- and post-intervention measurements within the same group of participants.

Primary outcomes included both short-term and long-term effectiveness of DHIs in reducing CVD risk factors and sustaining behavior change. This review included studies published since 2014 in peer-reviewed English journals, prioritizing those that incorporate behavior change theories and implementation strategies in high-risk occupational settings. Exclusions comprised narrative reviews, editorials, non-digital interventions, and studies lacking theoretical foundations. A narrative synthesis was conducted to analyze theoretical underpinnings, identify literature gaps, and provide recommendations for future research in DHI implementation for CVD prevention in the energy industry.

Results

Most of the selected literature did not specify the sex distribution; however, in studies that did, males slightly outnumbered females, with approximately 48%-54% of participants being male. However, it is essential to note that such demographic data can impact the applicability and generalizability of the findings, particularly in diverse workforce environments like the energy sector. The age range of participants varied, with older adults (50+) potentially influencing the implementation and effectiveness of DHI, particularly in high-risk sectors such as energy.

The framework for DHIs in CVD prevention was based on behavioral change theories, including the Transtheoretical Model (TTM), Theory of Planned Behavior (TPB), and Social Cognitive Theory (SCT). These theories provide a framework for understanding how behavioral change occurs and guide the design of interventions. TTM, also known as the Stages of Change model, proposes that behavior change happens in a series of five stages: pre-contemplation, contemplation, preparation, action, and maintenance. TTM has been applied to various health behavior interventions, including internet-based exercise behavior changes by DiClemente *et al.* in 2020.¹⁴

In examining the effectiveness of DHIs for CVD prevention, various studies explored diverse aspects of intervention design and user characteristics. Yardley *et al.* (2015) applied the Person-Based Approach (PBA) to understand user needs, emphasizing principles that improve engagement and adherence, which are crucial for sustained behavior change.¹² Similarly, DiClemente *et al.* (2020) based their interventions on TTM, focusing on the stages and processes of change,

motivational readiness, and tailored interventions. Although specific sex and age information was not provided, the study's approach highlights the importance of tailoring interventions to the individual's stage of change.¹⁴

Morren *et al.* (2021) conducted eHealth interventions in environmental behavior studies, noting that cultural variations significantly influence the effectiveness of the TPB factors. The study did not specify sex or age data. However, it highlighted how these factors can shape intervention outcomes, suggesting that cultural context plays a critical role in the success of DHIs.¹⁵ Warner *et al.* (2020) focused on self-efficacy-based behavioral interventions, emphasizing mastery experience, vicarious experience, verbal persuasion, and affective and somatic states. Similar to other studies, this study did not specify sex or age, but these factors were identified as key to motivating participants and maintaining long-term engagement.¹⁶ Mair *et al.* (2023) examined DHI targeting non-communicable diseases (NCDs) and emphasized the importance of credible sources, social support, prompts, graded tasks, goal setting, and human coaching in improving intervention effectiveness. The study included adult participants aged 18 years and older, but did not provide specific sex distribution.¹⁷

Wang *et al.* (2019) proposed a holistic framework for theory-based DHIs, integrating behavioral theories, behavior change techniques (BCTs), and persuasive system design (PSD), offering a flexible approach that can be tailored to the unique challenges of the energy sector, such as shift work and high physical demands. Like other studies, no sex or age data were provided, but the authors discussed how these frameworks can enhance the scalability and effectiveness of DHIs.¹⁸ Van Gemert-Pijnen *et al.* (2018) focused on persuasive health technology interventions, with an emphasis on PSD principles, including primary task support, dialogue support, system credibility, and social support. This study did not provide specific details on sex or age, yet its findings suggest that these principles are vital for improving user engagement and adherence to interventions.¹⁹ Xue *et al.* (2024) applied the Unified Theory of Acceptance and Use of Technology (UTAUT) model to assess performance expectancy, effort expectancy, social influence, and facilitating conditions in DHIs. The study involved participants with varied characteristics, but sex and age data were not specified, and it focused on the acceptance of technology in health behavior change.²⁰ Higgins *et al.* (2016) evaluated smartphone apps for health and fitness in adults aged 50 and above, with a focus on goal-setting, rapid intention formation, self-monitoring, and feedback. The study, which targeted older adults, offers valuable insights into how DHIs can effectively cater to this specific demographic.²¹

Sequi-Dominguez *et al.* (2020) investigated mobile health interventions for promoting physical activity and lifestyle changes, with a study population consisting of 52% females. This study found that mobile-based interventions were effective in significantly reducing BMI, blood pressure, and fasting glucose levels, highlighting the importance of tailored interventions for diverse populations.²² Tong *et al.* (2024) also explored mobile apps, fitness trackers, and text message interventions, with a study population comprising 46% females. This study emphasized the cultural fit, user engagement, goal setting, and self-monitoring elements as key to promoting sustained health behavior change.²³ Perski *et al.* (2017) examined Digital Behavior Change Interventions (DBCIs) and found that the content, context, and behavioral target of the intervention influenced engagement. This study included adults aged 18 years and older, but did not provide specific data on sex distribution.²⁴ Finally, Murray *et al.* (2016) assessed evaluation strategies for DHIs, focusing on scalability, usability, engagement, cost-effectiveness, and sustainable implementation. This study did not provide specific sex or age data, yet it underscored the importance of these factors in determining the long-term success of DHIs.²⁵

The TPB, developed by extending the Theory of Reasoned Action, posits that behavioral intention is influenced by factors like attitude toward the behavior and perceived social pressure (subjective norms) to perform or not perform a behavior. This theory incorporates perceived behavioral control, which refers to the belief in one's ability to perform the behavior that can influence both intention and actual behavior.¹⁵ Meanwhile, according to the SCT, an individual's behavior results from the interplay of cognitive, environmental, and behavioral factors. A fundamental SCT construct is self-efficacy, the belief in one's ability to organize and execute actions to manage prospective situations. The theory suggests that by enhancing self-efficacy, one can facilitate behavior change.¹⁶ Mair *et al.* (2023) observed that using these theories in internet-based behavior change interventions had a greater effect size, with TPB, TTM, and SCT being the most commonly used theories.¹⁷ There are 82 behavioral theories that were classified into continuum and stage theories by Wang *et al.* (2019).¹⁸

One of the prevalent issues with behavioral theories is that they often provide abstract guidance that cannot be directly translated into concrete intervention techniques. This gap can be addressed using two common taxonomies (Behavior Change Techniques (BCT) Taxonomy and Persuasive Systems Design (PSD) principles) frequently used in DHI research. The BCT Taxonomy is a hierarchical list of 93 concrete BCTs, such as self-monitoring, goal setting, and action

planning, which serve as an intervention strategy. In contrast, the PSD principles comprise 28 principles organized into four categories (supporting task, dialogue, credibility, and social support) for designing persuasive digital technologies.¹⁹ Wang *et al.* developed the "DHI Taxonomy" by integrating techniques from the BCT Taxonomy and overlapping principles from the PSD model into intervention strategy categories. They also proposed the TUDER framework (Targeting, Understanding, Designing, Evaluating, and Refining) to enhance comparability and evidence synthesis in DHI studies. TUDER incorporates behavioral theories, established BCT taxonomies, and persuasive design principles, comprising four key steps and two toolboxes: Behavioral Theories and the DHI Taxonomy for comprehensive DHI development.¹⁸

How individuals adopt new ways of doing things and use technology is critical to a successful DHI. The Unified Theory of Acceptance and Use of Technology (UTAUT) serves as a comprehensive model in this domain. This model identifies important determinants for technology acceptance and usage, such as performance expectancy, effort expectancy, social influence, and facilitating conditions. These factors influence users' intentions to use technology and their actual usage behavior. The DHIs can be developed to enhance these determinants so that the interventions seem helpful, easy to use, and supported by peers and the organization.²⁰

Digital Health Intervention for CVD Prevention: Short-Term Effectiveness

To date, DHIs have shown promising short-term outcomes in the prevention of CVD through lifestyle modifications, medication adherence, and risk factor control. Recent studies indicate that DHIs effectively promote physical activity, improve dietary habits, and enhance adherence to medications among users.²¹⁻²³ One study has demonstrated that wearable technology, mobile apps, and online tools can lead to positive changes in physical activity levels, promote weight loss, reduce blood pressure, and lower cholesterol levels.²¹

Despite the considerable improvements in the short term, sustaining these positive changes in the long term remains a challenge. Evidence from systematic reviews and meta-analyses highlights that DHIs, particularly those delivered through mobile technologies, can effectively reduce key risk factors such as body mass index (BMI), waist circumference, and blood pressure, as well as promote faster plasma glucose production in individuals with metabolic syndrome. These technologies provide scalable, cost-effective, and accessible solutions by enabling personalized health support and reducing reliance on traditional in-person care models.²²

Several factors contribute to the short-term success of DHIs, such as the novelty effect, where users are initially motivated and highly engaged due to the intervention's newness. Early engagement is also influenced by user perceptions of relevance and ease of use, as well as the integration of BCTs like goal setting and self-monitoring. A systematic review in 2024 emphasized that interventions through mobile apps and text messages with features such as tailored feedback, reminders, and culturally adapted content effectively improve user satisfaction and adherence in the short term. Additionally, the intuitive design and real-time feedback of these technologies enhance user experience and foster initial success in promoting health behaviors.²³

Digital Health Intervention for CVD Prevention: Challenges in Sustaining Long-Term Effectiveness and Behavior Change

The application of DHIs to combat CVD faces several obstacles in terms of sustainability concerning user engagement and long-term behavior change. The most critical obstruction is intervention fatigue, where, over time, users become less motivated and engaged. Monotonous content and a lack of variety in engagement methods can further exacerbate this fatigue.²⁴ Another significant barrier is the absence of ongoing support. Consistent reinforcement is necessary for continued engagement, yet most DHIs lack long-term support mechanisms. This includes limited follow-up sessions, impersonal feedback, and insufficient access to health professionals.²³

Personalization enhances engagement by addressing the specific needs and preferences of workers in the energy sector, while intuitive, user-friendly interfaces ensure ease of use, which is crucial in high-risk occupational settings where workers may have limited time or expertise to navigate complex systems. Conversely, poor design can cause frustration and dropout.¹² Social support boosts DHI adherence through peer, family, or professional involvement, fostering motivation and accountability. However, DHIs face limitations, including short engagement duration, poor integration with health systems, and insufficient real-time data analysis for personalized feedback, hindering long-term behavior change.²⁵

Discussion

To achieve long-term behavior change, DHIs must be adaptive and dynamic, as well as able to evolve in response to user interactions and progress. A personalized feedback loop plays a central role in this approach by providing tailored recommendations and adjustments as users progress.²⁶ This necessitates the development of DHIs that can adapt over time to align with the users' changing needs and circumstances. By continuously providing relevant and engaging content, interventions are expected to become an integral part of users' daily routines, fostering sustained behavior change.²⁷

Gamification enhances engagement, particularly in high-stress environments like the energy industry, by utilizing both intrinsic and extrinsic motivators, such as points, badges, and leaderboards. Gamification also provides motivation by setting achievable goals, providing instant feedback, and acknowledging user achievements. These approaches enhance user commitment, reduce attrition rates, and foster a sense of accomplishment as users track their progress and earn rewards. This, in turn, will alter their perception, making them consider healthy behaviors not just necessary but also enjoyable and sustainable.²⁸

Gamification requires a structured approach for sustainable engagement, with the LIVE IT wellness program in Canada as a successful mode. This program utilized a web-based platform to integrate gamified elements, including team challenges, goal setting, leaderboards, and badges, alongside educational modules and biometric health assessments. The initiative was rolled out gradually, beginning with an 8-week physical activity challenge (MOVE IT), followed by nutrition-focused challenges (FUEL IT) and mental health activities (BALANCE IT). Employees were encouraged to participate through a combination of intrinsic motivators, such as social connections, and extrinsic rewards, including branded items and healthy competition. Key principles for workplace gamification include goal setting and feedback, where clearly defined health goals and real-time feedback keep participants engaged and aware of their progress. For example, tracking physical activity through pedometers or wearable devices was used in the LIVE IT program to enable participants to monitor daily steps and compete against peers. The LIVE IT program reported that 76% of participants tracked their activity on at least half of the days during challenges, illustrating the role of consistent tracking in maintaining engagement.²⁹

Social support through teamwork and colleague interaction is crucial in the energy sector, as it fosters shared responsibility for health outcomes, reduces isolation, and helps workers adhere to behavior change goals, especially in remote and high-stress work environments. The implementation of online forums, group challenges, and peer mentoring may create community engagement and shared purpose. These social elements, including family and colleague involvement, are expected to foster sustainable behavior change by providing emotional support and reducing isolation while making the whole process enjoyable. According to a previous study on the topic, the integration of DHI with occupational health programs can be inferred to have the potential to enhance employees' well-being. Additionally, collaboration with healthcare providers offers professional oversight and personalized care plans, which boosts the credibility of interventions and supports long-term health outcomes.²⁸

Continuous user engagement is critical for the sustained success of DHIs. Regular feedback mechanisms, including surveys, focus groups, and user analytics, provide valuable insights into user experiences and preferences.³⁰ By collecting and acting on this feedback, DHIs can be iteratively refined to better meet the needs and expectations of energy sector workers. Moreover, incorporating both quantitative and qualitative user input may enhance satisfaction and promote long-term adherence to the intervention. Besides, addressing context-specific determinants is crucial to achieving effective behavior change in this sector. Since factors such as shift work, activity levels, job demands, and the work environment affect the feasibility and sustainability of health behaviors, DHIs tailored to these unique contexts are necessary. Last but not least, organizational support, including leadership commitment, resource allocation, and structural changes, plays a pivotal role in the successful implementation and sustainability of DHIs.^{7,31}

The design and development of sustainable DHIs for workers in the energy industry must be guided by user-centered design (UCD) principles. UCD focuses on meeting the needs, preferences, and specific contexts of users to create interventions that are both effective and easy to use.³² For energy industry workers, this includes addressing unique challenges such as shift work, high-stress environments, and physical demands. Involving workers in the design process through participatory methods ensures that DHIs are tailored to their specific challenges and preferences, thereby enhancing usability and promoting long-term engagement.

The incorporation of evidence-based content and BCTs using techniques such as goal setting, self-monitoring, and feedback are systematically proven to influence behavior change and are critical for the effective implementation of DHIs.¹⁴ For workers in high-demand settings like the energy industry, it is essential to select BCTs that can adapt to their

specific work conditions to enhance the intervention's relevance and promote sustained behavior change over time.

Systematic frameworks and metrics relevant to a robust evaluation are crucial for assessing the long-term effectiveness of DHIs. Frameworks such as RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) and PRECEDE-PROCEED (Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation - Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development) offer comprehensive methodologies for evaluating public health interventions.³³ These frameworks aid in assessing immediate outcomes as well as the sustainability and scalability of interventions, which is particularly important for the dynamic and diverse environments found in the energy industry.

Additionally, pragmatic approaches can be employed to evaluate and develop DHIs that are relevant to the evolving global health discussions. Combining hybrid research designs with pragmatic trials provides valuable insights into the real-world effectiveness of DHIs. Hybrid designs blend elements of both effectiveness and implementation research, providing data on not only intervention outcomes but also the delivery process. Pragmatic trials, which evaluate interventions under real-world conditions, are especially applicable to the energy industry, where DHIs must adapt to various work environments and operational demands.³⁴

Data privacy, security, and ethical considerations must be prioritized during the design and implementation of DHIs. Given the sensitivity of health data and the potential risks of misuse, strict measures are essential to protect user information. Furthermore, compliance with regulations, such as the General Data Protection Regulation (GDPR), and adherence to ethical guidelines for digital health research are essential.³⁵ Key strategies to safeguard user data include ensuring transparency, obtaining informed consent, and implementing appropriate data encryption protocols. By upholding data privacy and ethical standards, DHIs will be able to build trust among participants and encourage sustained user engagement.

Organizational readiness and stakeholder engagement are crucial for the successful implementation of DHIs in the energy industry. Preparing an organization for change requires an understanding of its current capabilities, resources, and the willingness of its members to embrace new interventions.³⁶ Strategies such as forming an advisory committee, conducting workshops, and facilitating regular dialogues to align the goals and expectations across all stakeholders can foster a shared vision for the intervention. Bringing DHIs into the energy sector's workplace culture is important for long-term success. To make this happen, it is necessary to follow a clear process that includes careful planning, implementing the plan, and regularly monitoring its effectiveness. It is also essential to address any resistance and create an environment that supports health programs.³⁷ This process includes developing a clear vision, effectively communicating the benefits of DHIs, and empowering employees to actively participate in the change process. By fostering a culture of health and wellness, organizations create a supportive framework that makes DHIs more acceptable and sustainable over time.

Meanwhile, adequate training and support systems for healthcare providers and facilitators must be implemented in parallel with other approaches to ensure the effective implementation of DHIs. On top of that, ongoing support through continuous education, peer support networks, and access to necessary resources ensures that healthcare providers remain competent and confident in delivering interventions.³⁸ This continuous support system is expected to maintain the integrity and effectiveness of the DHI implementation for an extended period.

Many researchers believe that incorporating DHIs into current health promotion programs improves their effectiveness and ensures long-term sustainability. This approach maintains consistency and aligns with broader health promotion efforts within the energy industry. Working alongside occupational health services, wellness programs, and external health agencies helps create a supportive environment that encourages behavior change and amplifies the reach and impact of DHIs. This method builds on existing structures to strengthen DHI strategies and supports a more holistic health promotion effort.

Compliance with regulatory and policy standards is a crucial consideration in implementing DHIs in the energy industry. Ensuring data privacy, security, and adherence to legal requirements is crucial for maintaining trust among employees and protecting their health information. Additionally, workplace policies that support the adoption and sustainability of DHIs, such as participation incentives and clear data protection provisions, further facilitate the successful implementation of these interventions. In brief, by adhering to guidelines like the GDPR and other ethical standards, a secure and trustworthy framework for digital health research and interventions can be established between an organization and its employees.³⁵

While DHIs hold significant promise for the energy sector, several limitations persist. First, there was a lack of empirical studies that examined DHIs in the energy industry. Based on the literature review, most research focused on the general population or other occupational settings, with no specific focus on addressing the unique challenges and needs of the energy sector. This gap underscored the need for more industry-specific research to inform the development of effective interventions. Second, there was a selection bias in current studies, where participants are typically more computer-savvy, which limits the generalizability of findings. Additionally, there was an insufficient amount of longitudinal data on the effectiveness of DHIs, which is crucial, as CVD is a chronic condition requiring sustained intervention.

Furthermore, the diversity of cultures and organizational structures across the global energy industry presents an additional challenge. The unique, high-stress, and high-risk nature of work in this sector, combined with frequently remote and irregular working conditions, means that DHIs must be carefully developed to meet these specific needs. It must be pointed out that although the principles and strategies discussed here have broader applicability in other high-risk occupational settings, such as manufacturing, construction, or mining, the successful implementation of DHIs requires consideration of industry-specific factors. To date, DHI implementation has encountered numerous challenges. For example, platforms like District Health Information System version 2 (DHIS2) struggle to support collaborative work environments, with failure resulting in configuration errors, delays, and inefficiencies in health data management. Therefore, integration complexities with existing systems demand substantial resources and expertise.³⁹

Conclusion

DHIs show great potential for preventing CVD in the energy sector by leveraging user-centered designs, behavior change techniques, and continuous engagement. Successful implementation requires organizational readiness, stakeholder involvement, and integration with existing health programs while addressing industry-specific challenges such as high-stress environments and irregular shifts. Future research should tailor DHIs for the energy sector, incorporating wearables and AI, and conduct longitudinal studies on their long-term impact on CVD prevention. Ethical considerations, cost-effectiveness, and scalability must also be prioritized to ensure sustainable impact. A comprehensive, user-centered approach will enhance worker health and well-being in this demanding industry.

Abbreviations

CVD: Cardiovascular Disease; DHI: Digital Health Intervention; TTM: Transtheoretical Model; TPB: Theory of Planned Behavior; SCT: Social Cognitive Theory; BCT: Behavior Change Techniques; PSD: Persuasive System Design; TUDER: Targeting, Understanding, Designing, Evaluating and Refining; BIT: Behavioral Intervention Techniques; UCD: user-centered design; GDPR: General Data Protection Regulation.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

The author(s) have no conflict of interest in the research.

Availability of Data and Materials

The data and materials used in this research, including the Supplementary File, are available to the public for further review of the datasets and research findings.

Authors' Contribution

YI conceptualized the study and interpreted the data. LMK supported content development and review. DHR assisted with the title and manuscript structure. All authors approved the final manuscript.

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