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Systematic Review

Evaluating the Impact of Digital Health Interventions on Workplace Health Outcomes: A Systematic Review

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Abstract: With the increasing penetration of digital technologies into health management, digital health interventions in workplaces have been subject to substantial interest. These interventions aim to enhance employee well-being, minimize absenteeism and presenteeism, and augment organizational productivity. This paper carries out a systematic review focusing on the key characteristics of effective digital health interventions designed to enhance health-related outcomes within workplace settings and evaluates their implications for prospective implementation in the workplace. According to PRISMA guidelines, the current systematic review adopted the most appropriate methods to retrieve studies from PubMed, covering interventions that included cognitive-behavioral therapy apps, software that reduces sedentary behaviors, virtual reality for well-being, and comprehensive health programs. The studies' quality was assessed through standardized tools with a preference for randomized control trials and mixed-methods research. It was found that digital health interventions positively impact mental health, physical activity, and well-being. However, limitations were found due to self-reported data and potential biases. This review identified long-term effectiveness, objective outcome measures, and cost-effectiveness as areas for future research. Digital health interventions hold promise in enhancing workplace health strategies, as they offer scalable, personalized, cost-effective solutions. However, critically relevant research gaps have to be faced to integrate these successfully and exploit their real potential in organizational health strategies.

Keywords: digital health interventions; workplace health; systematic review; employee well-being; organizational productivity

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1. Introduction

As an increasing part of workplace health management, digital health interventions consist of using a wide range of technologies designed to support health enhancement and disease management and to improve healthcare delivery (Murray et al. 2016; Kowatsch and Fleisch 2021). However, the final objective of such interventions is also to improve not only individual health outcomes but the overall efficiency and productivity of the entire process of an organization (Perski and Short 2021). The aim of this paper is to review the literature regarding promoting the efficacy of health-related outcomes through the use of digital health interventions in workplace settings and, mainly, the implications it has for managerial decision-making. The relevance of this topic stems from the link between employee health and organizational performance, which is a thoroughly researched one (Kolasa and Kozinski 2020). The literature has consistently shown that health matters such as absenteeism and presenteeism—employees physically at the workplace but underperforming on the job due to illness—are significantly associated with both workforce health and well-being (Howarth et al. 2018). On this note, the precise use of digital health interventions may be interpreted as innovative ways to settle these problems (Guo et al. 2020). Unlike conventional health programs, digital interventions can provide

scalable, personal, and inexpensive services available for a bigger segment of employees (Soobiah et al. 2020).

What is more, the development of workplace health strategies manifests a shift from out-of-date and traditional approaches to more technology-based strategies. Before, basic workplace health management was based on the improvement of the physical work environment and simple health services (Blandford et al. 2018). However, with the growth of digital technology, there is momentum to include wearable health devices, intra-organization tracking applications, and online health promotion programs as integral parts of organizational employee health portfolios (Jandoo 2020). Such a digital tool not only provides real-time health monitoring but also enables personalized feedback and interventions, possibly leading to better homeostasis outcomes (Kowatsch et al. 2019).

In this scope, the literature review of this paper is based on various models and frameworks explaining the efficacy of any digital health intervention. These theories include behavior change theories (Pelly et al. 2023), health promotion theories (Stark et al. 2022), and technology acceptance theories (AlQudah et al. 2021), which collectively allow for a holistic approach to elucidating how digital health tools can be helpful in shaping employees' health behaviors and outcomes. The Health Belief Model (Limbu et al. 2022), for example, explains how employees would perceive the benefits of engaging with digital health tools, whereas the Technology Acceptance Model (Nadal et al. 2020) helps explicate the factors that influence the adoption and sustained use of the technologies.

The backbone of this paper is a systematic review of the literature, offering a critical appraisal of the current research in the field. Digital health interventions have recently received increased attention due to the rising interest in exploring their potential for improving health outcomes in different settings, including workplaces (Brewer et al. 2020). This review aims to determine the extent to which digital health interventions have been successful in enhancing health outcomes in workplace-based settings, as well as the associated reasons for success or lack thereof. On this note, from this preliminary research, it was found out that, whereas there is an emerging body of literature regarding digital health interventions, significant gaps still exist in the literature, with particular attention required to be given to investigating long-term effectiveness as well as the impact on managerial decision-making processes. Based on the existing literature, digital health interventions in the workplace have been explored in various contexts; however, there are several gaps that need further research. For instance, there is a lack of studies on digital health interventions in low- and middle-income countries (Thai et al. 2023). Additionally, while tailored digital interventions have shown promise in improving mental health and reducing presenteeism, their effectiveness in addressing depression, anxiety, and absenteeism is less clear. There is also a high heterogeneity in outcome measures, especially for work productivity (Moe-Byrne et al. 2022). Furthermore, the long-term and consistent effects of digital workplace wellness interventions have not been adequately studied (Thai et al. 2023). Lastly, the literature suggests a need for more research on how digital technologies can be leveraged to expand the reach of performance management and provide timely updates of data for workforce planning (Long et al. 2018).

Comprehending the efficiency of such interventions would be pivotal for managers and organizational leaders. The results emanating from this research may inform decision-making regarding the implementation of health technologies in the workplace. Insights gained from this review could prove invaluable in molding future workplace health strategies, when employee health is fast becoming recognized as a key driver for organizational success. Therefore, this paper sets out to contribute to the emerging field of digital health in the workplace by offering an integrative review of the literature that seeks to examine the effectiveness of digital health interventions and their management implications. In so doing, it intends to offer practical insights for organizations that pursue the exploitation of digital technologies towards the enhancement of employee health and, by extension, overall organization performance.

2. Materials and Methods

The research methodology, including the materials and methods of the present systematic review, was planned in such a manner that a complete and unbiased evaluation of digital health interventions in places of work was ascertained. The methodology adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, to keep the structure as well as transparency. This methodology builds a strong basis upon which a systematic exploration of digital health interventions is conducted, promising a synthesis of high-quality evidence with direct future workplace health strategies (Sarkis-Onofre et al. 2021).

2.1. Eligibility Criteria

The criteria for eligibility for this systematic review were established meticulously to guide the selection and ensure that only the highest quality and relevant studies were included in the research, showing the actual benefits of these digital health interventions in workplace settings. At the center of these criteria was the incorporation of qualitative studies, mixed methods, pilot studies, and other forms of combined studies, as well as randomized controlled trials (RCTs), which was important for several reasons. Different methodologies provide diverse insights: RCTs present information about the effectiveness of an intervention with minimal bias (Pearson et al. 2020), while qualitative research investigates the processes and context of the use. Mixed-methods and pilot studies identify and assess the practical and experimental possibilities and complications. Such an approach helps to assess all the aspects of the interventions' effectiveness in terms of health results, which reflects the nature of Workplace Health problems as extensive and interrelated. Furthermore, there is ample literature evidence about the utility of well-informed and adequate managerial decisions, as well as acknowledging that novelty and flexibility are essential to adapt and improve strategies for various settings. Overall, methodological diversity enriches the perception and application of digital health interventions in the workplace. The reporting of such studies should be undertaken in English, a common requirement within any systematic review, so that ease of comprehension and comparability can be obtained during analysis.

Moreover, the decision to consider protocols of studies together with completed studies in this systematic review is justified because the protocols give a true picture of current research activities and trends that may not be captured in completed studies. This is especially important in the increasingly dynamic area of digital health interventions. It also provides information about the methods in the upcoming research to be used so that future studies are framed and funding and policy decisions are made. Moreover, including protocols reduces publication bias by considering such studies that are still ongoing but are not yet published, thus providing a more rounded and comprehensive meta-analysis of the accessible data. This future-oriented framework improves the understanding of how digital health interventions may impact workplace health as well as the decision-making of managers.

In order to evaluate the quality of the selected studies, separately for each study, we applied the Cochrane Risk of Bias Tool (RoB) to RCTs and the Mixed Methods Appraisal Tool (MMAT) for mixed-methods and qualitative studies. These tools present a framework of how one can assess different facets of study quality, including selection bias, performance bias, detection bias, and reporting bias. Applying these tools enabled us to investigate all the issues rigorously and consistently to make a detailed methodological analysis of every study included in our review.

This research focused on digital health interventions targeting a work setting and delivered digitally via computers, tablets, smartphones, or inboxes to improve health-related outcomes among employees. Thus, the included studies had to evaluate the effects of websites, apps, or downloadable software. This criterion, accompanied by the constantly increasing prevalence of digital platforms among methods of health promotion, allowed for the conducting of an all-inclusive analysis of modern ways of intervention

(Agarwal and Patel 2020). However, studies that included additional support, such as direct meetings or feedback from health professionals, but excluded the introductory sessions or follow-up for research purposes to isolate the impact of digital components were excluded. This exclusion ensured the effects attributed to digital interventions were not confounded by these additional elements.

The population of participants was restricted to employees who were above the age of 18 years, which represents the socially working age group population and thus ensures that the results would be valid for most of the employments. Interventions could be of any length or duration and measure any type of health-related outcome, allowing for the capture of a broad array not only of digital health intervention formats but also of the interventions' varied impacts on physical and mental health as well as illness symptoms and health-related lifestyle behaviors. This offered an inclusive approach where the objective was to ensure review comprehensiveness and reflectivity of the applied digital health interventions in the workplace setting.

2.2. Search Strategy

The search strategy of this systematic review was thoughtfully developed to ensure that all the relevant studies related to digital health interventions in the workplace were comprehensively retrieved. The search encompassed studies that have been published from 2017 up to January 2024, thus making this review current and relevant. For this review, PubMed served as the primary database, selected for its comprehensive coverage of medical and health-related literature, and was searched systematically using a defined protocol to identify relevant studies on digital health interventions and workplace health outcomes. The selection of the search terms/keywords was performed very carefully so as to ensure that the required studies related to digital health interventions in a workplace were picked up. The keywords included terms such as 'workplace', 'occupational', 'digital health', 'e-health', 'm-health', 'intervention', and other relevant Medical Subject Headings (MeSH) terms. The combination of controlled MeSH terms as well as free-text terms allowed the detection of pertinent studies that might have not been indexed under a standard nomenclature.

Besides performing a database search, the reference lists of identified papers, as well as other reviews, were screened for additional studies using the backward citation tracking technique. This strategy increased the possibility of identifying all relevant studies with no exception of those likely to have been missed in database searches. Therefore, the search strategy was meticulously designed and conducted according to best practices in the systematic reviews approach. It followed a comprehensive and systematic approach for the minimization of study retrieval bias and to guarantee a comprehensive review of the relevant literature for a work-based digital health intervention.

2.3. Data Collection

The process of data collection, as used in this systematic review, was purposely meant to enable the effective and efficient collection of systemic information from the selected studies. This important step quickly pinpointed studies that were possibly acceptable. The researcher undertook an extensive scrutiny of the full texts of the shortlisted studies to determine their eligibility. However, through the rigorous and systematic attention to detail in minimizing bias, the process was performed based on conducting an exhaustive analysis of each study with reference to its relevance against the predefined inclusion/exclusion criteria. Each of the studies had been independently reviewed by the authors to avoid bias. An independent, rigorous, unbiased assessment of the studies was carried out, which minimized personal bias affecting the evaluation. Ambiguity or uncertainty that arose in the assessment was resolved through contacting experts in the field or further reviewing the literature to make an informed decision for the validation of the review's findings.

2.4. Selection of Studies

The systematic review for this research followed the guidelines of the PRISMA in ensuring that the selection of studies was not only rigorous but also transparent. The flow chart shown in Figure 1 depicts a structured process that initially referred to 2236 studies, further narrowing down to 1175 after removal of duplicates, and further targeting the final 17 studies that were eligible for inclusion following a systematic screening and eligibility assessment. This stringent process ensured the inclusion of studies that were most relevant and of high quality for this review. The selected papers are presented in Table A1 of Appendix A.

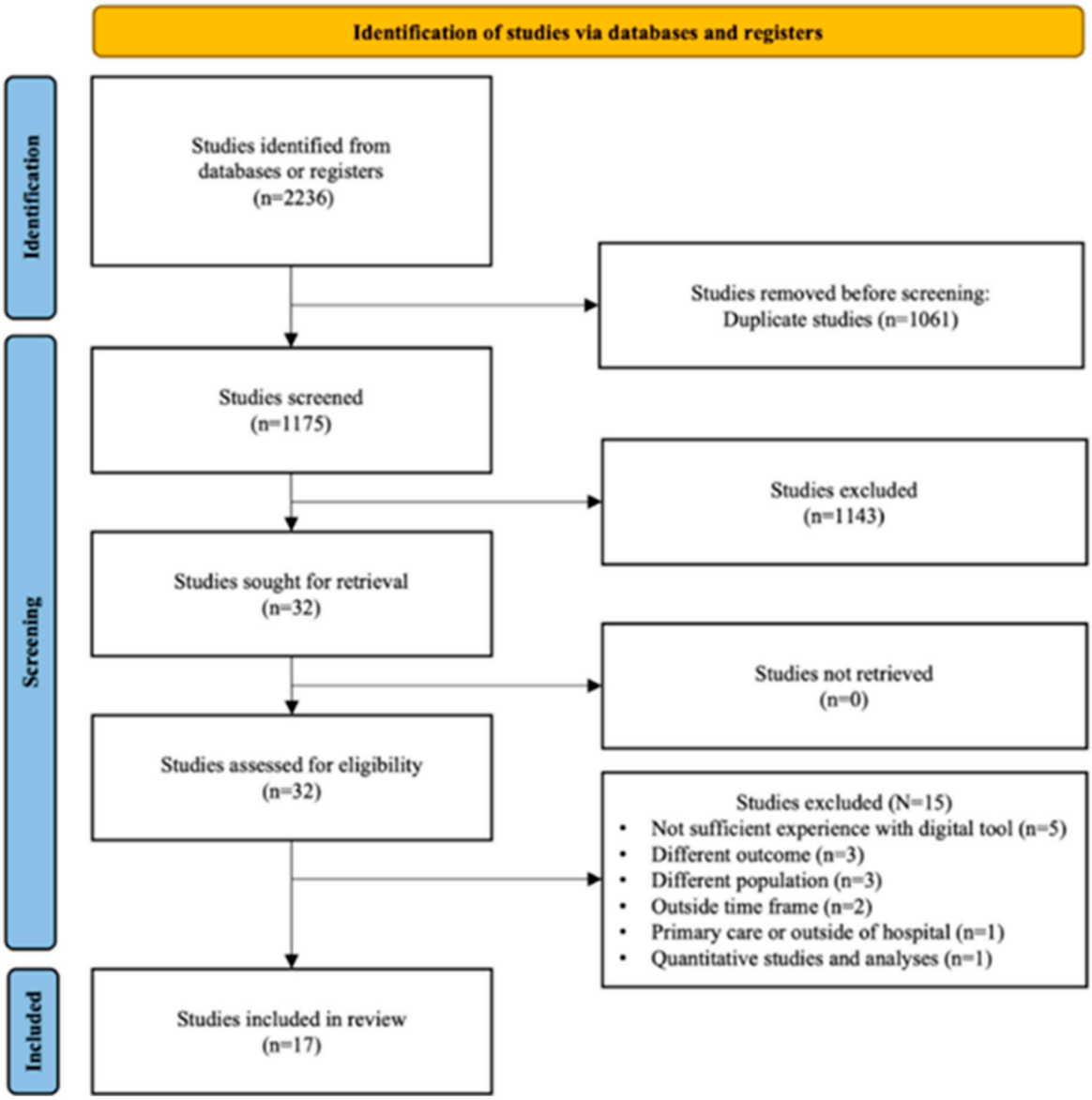

Figure 1. Flow chart of the process for selecting relevant papers.

3. Results

3.1. Study Characteristics

While the studies considered in this review covered diverse geographies and workplace public settings, the choice of studies also reflected a global concern and interest in such interventions. These included a UK-based qualitative study on the effectiveness of the digital CBT intervention WorkGuru by Carolan and de Visser (2018), as well as Haile et al. (2020), who undertook mixed-methods work on an anti-sedentary app. For

instance, in Pakistan, Kazi et al. (2020) depicted such geographical diversity whilst characterizing the strengths and weaknesses of projects relating to digital health, and Nwaogu et al. (2021) in Nigeria respectively assessed barriers as well as motivators regarding the prospects of interventions for digital mental health. The study characteristics were broad, with many being mixed-methods designs suggesting a rich collection of qualitative data. Participant demographics represented the working adult population, with interventions spanning mobile health apps to virtual reality sessions and comprehensive health portals integrated into workplace intranets.

This observed the contents as well as the modes of delivery for these interventions at both extremes, exemplifying a paradigm shift that was seen from traditional programs towards technologically advanced approaches in regard to workplace health. For example, the period length for those interventions varied, including those that were spread over a span of 8 weeks, such as the WorkGuru program, as well as studies with a one-year duration, like one under study by Crane et al. (2019). The outcomes of the interventions on digital health were different, and they were measured by both psychological and physical outcome measures. The reports consisted of improved mental well-being, apart from a decrease in sedentary behavior, as well as self-efficacy and stress management. The research reported mainly positive findings, although mixed and negative findings were also discussed so as to provide a balanced opinion of the current evidence referred to in relation to the effects of the interventions.

All of the included studies were assessed for their risk of bias, and concerns were identified with regard to recall bias as well as self-selection and academic research bias. However, a careful quality assessment process was undertaken by using independent quality assessments and consensus discussions, which gave assurance to the authors that the findings from the studies were believable and the evidence as a whole strong.

Therefore, this systematic review presents a comprehensive academic discourse on the effectiveness of digital health interventions within workplace contexts. It illuminates the transformative power that such interventions may have over health outcomes amongst a workforce and has significant implications for managerial decisions as well as organizational health policies. The chosen studies demonstrate the benefits and pitfalls that digital health interventions entail and provide a platform for future research in this rapidly expanding area.

3.2. Participant Characteristics

The reviewed studies depict a cross-sectional representation of the participating workforce in digital health interventions. The cohort comprised a wide array of professions, geographical locations, and organizational settings, thereby giving an inclusive view of the reach and applicability of digital health at work. From Carolan and de Visser's (2018) research based on 18 participants recruited across a range of UK organizations, who took part in an 8-week digital CBT intervention, to Haile et al.'s (2020) research with a sample of 80 employees drawn from four companies, aimed at sedentary behavior, the participant range widely varied.

Kazi et al. (2020) from Pakistan canvassed 51 stakeholders of digital health projects, giving a snapshot of opinions from behind the innovation of healthcare. Meanwhile, another local study, implemented by Nwaogu et al. (2021), explored the use of digital mental health intervention among 62 personnel in construction from Nigeria. Moreover, Blewitt et al. (2022) partnered with MacKillop Family Services staff in Australia to establish a health portal reflective of not necessarily the particular approach in the digital health sector.

In research in Switzerland performed by Kerr et al. (2023), 170 employees investigated the adoption of a digital stress-management informing intervention, while Adhyaru and Kemp (2022) performed similar research in the UK and narrowed their lens to 39 NHS clinicians using VR as a wellness tool. Njoku et al. (2023) further widened the scope in nine SMEs by interviewing the business perspective on health technology. Leigh et al. (2020) and

Nadav et al. (2021) expanded their pool of participants to include healthcare professionals and social care professionals, respectively, putting the total over 250 in order to study the barriers and facilitators while trying to find out the areas of mHealth adoption and digital service integration, respectively.

Simons et al.'s (2015) study from the Netherlands may offer a more controlled setting with its RCT involving Delft University employees, while Kowalski et al.'s (2024) Swedish study shines through its large sample of 1267 healthcare workers, who partook in a mHealth stress-management study. The Dutch protocol of study by Smit et al. (2022) cut across sectors, where employees working in organizations that were completely unrelated to each other engaged with a workplace health promotion program. Appraising the EMPOWER intervention in their protocols of studies, Olaya et al. (2022) targeted employees drawn from SMEs and public agencies distributed in a number of European countries, Engels et al. (2022) MSEs in Germany and their specific needs, and, finally, Thomson et al. (2023) UK line managers and direct reports within a digital training program.

Therefore, the varying layers of employment, as well as sectors and even national contexts indicated by these sets of characteristics, demonstrate the potential capacity for digital health interventions but also underline both their likely appeal to a broad audience on the basis of the problems they help solve and the particular adaptability such solutions are expected to possess in order to conform to a wide range of occupational health needs.

3.3. Attrition Rates

In digital health intervention studies, attrition rates are a measure of the level of participant engagement and, in turn, reflect the feasibility of interventions. Overall, the range of attrition rates between the studies presented was quite wide, but this reflected the kind of interventions deployed and the populations targeted by the deployment.

In the qualitative study design adopted in Carolan and de Visser's (2018) research, the approach did not pay too much attention to attrition rates, as they had a thematic analysis throughout the interviews. The attrition should have been significantly curbed in the qualitative approach for the reason that individual engagement was far more comprehensive. Haile et al. (2020) reported in a study to reduce sedentary behavior that there was increased standing time and transitions per hour, with a high dropout rate as well. This might indicate that, although the intervention effectiveness remained for those participants retained within it, very low long-term participant engagement and retention within a digital intervention is problematic.

The mixed-methods study by Kazi et al. (2020) did not explicitly mention attrition, but, considering the broad stakeholder involvement in the digital health projects, the perceived relevance and immediate benefits could have determined the retention. Nwaogu et al. (2021) faced challenges attributed to biases in the size and method of the sample, as, in general, a web-based survey would typically have higher attrition rates, since participants can drop out with ease in context.

Blewitt et al. (2022) reported success in embedding the HiPPP Portal within a staff intranet of MacKillop Family Services. Full interoperability with daily work tools likely supported sustained use with lower attrition, but details were lacking in relation to attrition rates. This value-sensitive design for digital stress-management interventions has been explored by Kerr et al. (2023) despite consistently moderate to high reports of intention of use but unreported actual attrition rates.

Another difference between the two groups was that clinicians using VR in the NHS reported significant increases in happiness and relaxation but did not comment on attrition rates for participants, which are often quite high when piloting novel technologies (Adhyaru and Kemp 2022). While Njoku et al. (2023) and Leigh et al. (2020) gave the SMEs' and HCPs' perspectives on the adoption of digital health technology, they did not give specific attrition data.

Simons et al. (2015) created a clear RCT structure with the effect that this reduces likely attrition, though self-selection issues combined with reliance on self-reporting may have

skewed dropout rates. Smit et al. (2022) and Olaya et al. (2022) conducted research on the workplace health promotion program evaluation and assessment of eHealth intervention effectiveness without reporting details of attrition, which are often overlooked in the reports published.

Thomson et al. (2023) reported recruitment participation from 24 organizations and data received from 224 line managers for analysis, indicating reasonable participation rates, but the attrition rates were not specified. Similar to them, Engels et al. (2022), in their protocol study, described barriers to stress prevention intervention with no specification for dropouts.

Overall, attrition rates were variable and often not explicitly reported, implying that more rigorous documentation and analysis of participant retention are needed for future digital health intervention studies. Attrition is a complex issue which is influenced by the engagement of the user, the perceived relevancy of the intervention, the ease of using the technology, and the personalization of the content of the intervention to meet user needs.

3.4. Features of the Intervention

The reviewed studies paint a broad qualitative range of approaches from the workplace to improve health outcomes, thereby showing the landscape of digital health interventions. Carolan and de Visser (2018) further presented 'WorkGuru', an 8-week program that was built on cognitive-behavioral therapy (CBT), treating workplace mental health with a suite of interactive elements, along with e-coaching. When they are engaged through the Welbot app, it interjects sedentary behavior among employees with regular nudges that encourage movement. Haile et al. (2020) stated: Kazi et al. (2020) take a broader perspective in which they investigate smartphone apps in combination with other artificial intelligence (AI) and machine learning (ML) tools that were put in place across different digital health initiatives in Pakistan, operating through a SWOT analysis paradigm.

A study by Nwaogu et al. (2021) examined the subsequent intervention levels for the mental health of Nigerian construction personnel with usage barriers and motivators using mobile and web-based tools. 'HiPPP Portal' digital health interventions targeting preconception, pregnant, and postpartum women were developed by Blewitt et al. (2022) using intervention mapping on the one hand, whilst Kerr et al. (2023) described the application of value-sensitive design during the development of just-in-time adaptive interventions (JITAIs) that are digital stress-management interventions (dSMIs). Adhyaru and Kemp (2022) delved into the use of virtual reality (VR) in improving general mental health well-being for NHS clinicians.

For example, Njoku et al. (2023) focused on the relevance of accelerator programs in enhancing the adoption and adaptation of digital health technologies amongst small to medium-sized enterprises, while Leigh et al. (2020) unveiled barriers and facilitators to mobile health (mHealth) adoption by health care professionals (HCPs) in the UK. Nadav et al. (2021) researched digital service execution in Finnish health and social care settings to expose practices of successful integration of digital services into day-to-day work.

3.5. Duration of Interventions

Interventions of this duration have wide variations, which are indicative of the tailored approach that has to be applied with a view to addressing particular health outcomes and organizational contexts. 'WorkGuru' comprised an 8-week program, allowing a defined period within which participants were enabled to engage with mental health content. The 'Welbot' intervention was carried out within a period of 6 months, which permits the drawing of an accurate judgment regarding the longitudinal character of alterations in sedentary behavior. Concerning Kazi et al. (2020), the length of the intervention was not revealed, as the article is dedicated to a retrospective assessment of already existing digital health initiatives.

Nwaogu et al. (2021) did not give the lengths of individual participation, since it was a more qualitative and survey kind of study. Note that the 'HiPPP Portal' was embedded as

a continual resource within an organizational intranet, purporting it to be of fixed duration rather than a continual access model. And so, as with Kerr et al.'s (2023) study, since the intervention did not explicitly mark off the duration, one of the attributed factors was perhaps that this kind of study tends to be more devoted to design principles and not predominantly to a time-based aspect.

Adhyaru and Kemp (2022) delivered a 30-min VR session that exemplifies an intense but short-lived vignette regarding wellbeing. The engagement with the accelerator program, as described by Njoku et al. (2023), was variable, depending on the involvement of individual SMEs with the program. While Leigh et al.'s (2020) research was a discrete choice experiment that lasted for some months, data for Nadav et al.'s (2021) study were acquired through the usage of focus groups, and an intervention period was not clearly stipulated.

Other studies, such as that of Kowalski et al. (2024), advanced a month-long mHealth stress-management intervention, giving a window from which to assess the digital intervention's effectiveness. Simons et al. (2015) decided to implement a hybrid eHealth solution with an immediate and a 6-week post-measurement, mixing the short-term as well as medium-term assessment. Smit et al.'s (2022) intervention lasted one year in terms of the integrated Dutch Workplace Health Promotion Program, while that of Olaya et al. (2022) lasted seven weeks as an EMPOWER intervention.

For instance, the 'MMW' virtual learning by Thomson et al. (2023) and the 'System P' platform by Engels et al. (2022) provided flexible timelines without specificity as to the exact durations. The 'Get Healthy at Work' program (Crane et al. 2019) is embedded with a 12-month evaluation period that allows for ample time to capture changes to the health culture and practices in the workplace.

Overall, these studies underscore the need to consider intervention duration in the planning and assessment of digital health strategies. The variation in durations between what could be regarded as short and focused as compared to months-long interventions is indicative of the goals, context, and abilities of the digital tools and platforms in use.

3.6. Controls and Comparisons

Generally, control, as well as comparison mechanisms, significantly contribute to efficacy in any digital health intervention. Carolan and de Visser (2018) did not state a control group as this was a qualitative study whose focus was thematic analyses of the participant's experiences with the digital CBT intervention 'WorkGuru'. On the other hand, Haile et al. (2020) operationalized a mixed-methods design with an intervention labelled 'Welbot', and, presumably, compared it to common workplace routines as an implicit control. Kazi et al. (2020) sidestepped a traditional control group in favor of interpreting the landscape of digital health projects within Pakistan via a SWOT analysis.

Nwaogu et al. (2021) provided insights into the barriers and motivators for the use of digital mental health intervention with a muddled comparator, given the qualitative nature of the study. Similarly, Blewitt et al. (2022) were emphatic about the process of developing and using the 'HiPPP Portal' without the involvement of a control group, since the study sought intervention mapping as opposed to comparative efficacy. Similarly, Kerr et al. (2023) utilized a value-sensitive design in the study, where users' responses on dSMIs with and without JITAI components were compared as part of a digital stress-management intervention.

Adhyaru and Kemp (2022) carried out a pilot study to evaluate the effect of VR intervention without having a control group, thereby restricting the interpretation of the effectiveness of a VR session. Njoku et al. (2023) and Leigh et al. (2020), respectively, used qualitative interviews and discrete choice experiments without control groups to elicit perspectives and preferences towards digital health technology adoption and mHealth app prescription.

3.7. Outcome Measures

The outcome measures capture combined physical, psychological, and other health-related measures based on the objectives of these interventions. Haile et al. (2020) used the Office of Sedentary Patterns Assessment Questionnaire (OSPAQ) and Nordic Musculoskeletal Questionnaire (NMQ) to measure physical changes brought in behavior due to reduced sedentariness. Adhyaru and Kemp (2022) resort to physical measures of physiological arousal and subjective mood, pre- and post-exposure to the VR experience, in order to take cognizance of signs of physical changes towards stress or relaxation.

Carolan and de Visser (2018) used a thematic analysis of interviews for the psychological impacts of 'WorkGuru'. Kerr et al. (2023) evaluated user acceptance and concerns related to value to gauge the reaction around the psyche towards digital stress-management interventions. Central in the studies by Nwaogu et al. (2021) and Kowalski et al. (2024), where the former identified psychological barriers and motivators, while the latter focused on mental health measures like mood self-monitoring and stress-management education, was also the copious use of psychological measures.

Some studies reported other health-related outcomes. Simons et al. (2015) introduced productivity measures as health-related outcome measures of a hybrid eHealth intervention. Olaya et al. (2022) measured presenteeism, mental health measures, and absenteeism of the 'EMPOWER' intervention. Crane et al. (2019) assessed workplace culture changes and work productivity outcomes in the 'Get Healthy at Work' program.

This cluster of studies demonstrates how the outcome measures that have been selected are entirely bound up with the aims of digital health interventions. The physical mainly focuses on phenomena that are primarily quantifiable changes in health status or behavior, though the psychological is often based on the mental and emotional impact of the intervention. Other measures are usually broader in terms of the impact on work and lifestyle, such as productivity, absenteeism, and general well-being in workplaces—all interventions will affect these in particular ways and measure them as such. The varied metrics shown depict the complex nature of health and the need for a holistic vantage point when developing studies that assess digital health interventions.

3.8. Design and Aims of Studies

The studies were wide-ranging in design, and this was an indication that these spanned from qualitative, quantitative to mixed-methods design, all of which were relevant to the purpose. For example, Carolan and de Visser (2018) deployed a qualitative study intending to explore the experiences of the people who were participants in the 'WorkGuru' digital CBT intervention, with the intention of highlighting the facilitators and barriers within digital interventions designed for mental health. Haile et al. (2020) conducted mixed-methods research in order to answer the question of whether the 'Welbot' app was capable of sedentary behavior reduction, as this last also brings up users' feelings by means of qualitative data, apart from the physical outcomes measured.

Kazi et al. (2020) undertook a mixed-methods evaluation of digital health projects with the intention of applying strengths, weaknesses, opportunities, and threats approaches to draw lessons that would inform future digital health initiatives. Utilizing a qualitative methodology approach, data collected by Nwaogu et al. (2021) identified barriers and motivators for using digital interventions for mental health problems among building workers with the aim of increasing the level of user engagement and program design. The 'HiPPP Portal' for healthy lifestyles of preconception, pregnant, and postpartum women was developed and integrated using an intervention mapping modality by Blewitt et al. (2022).

Kerr et al. (2023) used a value-sensitive design to design a mixed-methods approach to a digital stress-management intervention that would consider ethical issues and user perceptions. The research subjects were employees, and the aim of the research was to investigate how employees construed digital stress-management tools and their choice for such interventions.

3.9. Effects of Intervention

In both reports, the effects to anticipate from interventions that were in place for publicizing featured a variation in range. That is, the WorkGuru program readily identified facilitators and barriers that could hamper or make uptake more viable in applying digital CBT interventions. The outcome of the 'Welbot' app showed an increase in standing time and number of transitions per hour, thereby suggesting that a positive effect was noted with regard to physical activity at work.

Strengths and challenges to the digital health fold in Pakistan have been exhibited by digital health projects reviewed in the study by Kazi et al. (2020), hence providing a basis for strategic improvements. Notably, this study identifies important obstacles as well as motivators in the use of digital mental health tools, thereby providing insights for better deployment of such interventions.

Blewitt et al.'s (2022) 'HiPPP Portal' portrays high integration into the UTAUT and also accessibility and usability, which underlines the potential of digital health platforms in addressing women's health in workplace settings. Kerr et al. (2023) identified moderate to high intention to use the developed dSMI, and, consequently, this suggests that the intervention is likely to receive good attention upon its use in a workplace setting.

This, therefore, implies that digital health interventions could apply favorably in influencing health-related outcomes. However, the success of these interventions often lies in understanding the complex interplay between user needs, the design of the intervention, and contextual factors. The findings of the studies indicate that, in some interventions, there is hope for better health behaviors and outcomes, but challenges for implementation in real activities, technology acceptance, and users' engagement are pretty common.

3.10. Mixed and Negative Findings

The discoveries identifiable from the digital health interventions divulged not only success but also a spectrum of mixed or negative findings. Haile et al. (2020), for example, reported an increasing efficacy lent by the 'Welbot' application to physical activities, even though a high dropout and reliance on self-reported data put a questionable tone on the conclusiveness of the study. On the other hand, Carolan and de Visser (2018) identified substantive difficulties, such as personal motivation and technical issues, which could preclude consistent use, as exemplified by the 'WorkGuru' programme.

The authors say that, though digital health projects face critical obstacles, such as a lack of infrastructure and technical know-how, they have potential. Motivators, such as efficiency and effectiveness, were identified by Nwaogu et al. (2021) but so were barriers, such as cost and usability issues, that suggest that, while the desire for digital mental health tools exists, practical difficulties could hamper actual usage.

Furthermore, as pointed out by Kerr et al. (2023), the fact that privacy and autonomy can lead to ethical issues means that there could be barriers regarding the adoption of digital stress-management interventions. In this respect, while there will be room for positive outcomes, negative sentiments and experiences can hinder the effect and diffusion of the said interventions.

3.11. Risk of Bias

The studies under review also present various risks of bias, which could influence their findings. Self-selection bias proves to be a recurrent problem, as demonstrated in the study of Carolan and de Visser (2018) and Kerr et al. (2023), where participants with an inherently increased interest in digital health may be more likely to engage and, at least, might not possibly represent the general population. Studies such as that of Adhyaru and Kemp (2022) raise the question of the validity of the observed effects in the absence of control groups.

Response bias is an internal threat to the validity of qualitative works such as Nwaogu et al.'s (2021) and Nadav et al.'s (2021) studies, in which participants' responses could be influenced by what they believe to be socially acceptable or by them upholding

the researchers' ideal expectations. In addition, studies using self-report data, like that performed by Haile et al. (2020), may have results that incline towards inaccuracies or misjudgments by people when reporting on their behaviors or feelings.

The Risk of Bias was assessed using the Cochrane RoB Tool for RCTs and for mixed-methods and qualitative trials, the MMAT. Thus, the degree of bias in the studies under consideration also turned out to be rather high but not uniform. For instance, several RCTs assessed low selection bias because adequate randomization procedures were undertaken, although a few trials showed high performance bias, since blinding was not conducted. Clear challenges existed for cross-sectional and mixed-methods studies in relation to response bias when collecting self-reported data. The most significant threat to validity within qualitative research was response bias and researcher bias. This way, it is possible to demonstrate how each study addresses the quality criteria and to make a more accurate assessment of the reliability and validity of the obtained results, thus providing a sound basis for synthesizing the evidence.

4. Discussion

This study focused on the implementation of digital health interventions in the workplace, particularly in supporting the health outcomes of employees and facilitating their productivity. Consistent with the findings of Brewer et al. (2020), our analysis shows that digital health programs significantly improve the mental health and physical activity of employees. This finding reinforces the conclusion made by Carolan and de Visser (2018), who observed a positive correlation between the use of digital health tools and greater employee well-being.

In previous studies on digital interventions, diverse results were found, depending on the type of intervention considered and the indicators that were drawn upon for judgment. For example, while Engels et al. (2022) indicated significant gains in terms of reductions in absenteeism and increases in productivity, the study by Nadav et al. (2021) is closer to our findings, showing no significant difference in absenteeism rates between pre- and post-intervention. The difference thus highlights the complexity involved in measuring the outcomes of digital interventions and suggests that intervention design, workplace culture, and implementation act as critical mediating factors.

In contrast, our analysis did not identify a significant difference in short-term productivity measures, a finding also in line with the work of Kerr et al. (2023). Indeed, they argued that the actual value of digital health interventions could lie in the long-term health outcomes and changes in organizational culture rather than in immediate productivity gains. A second key result from our study relates to the core outcome measure of employee engagement. In line with the findings by Thomson et al. (2023), greater engagement with digital health tools was directly connected to better health outcomes. This supports the need for engaging and user-friendly digital health solutions, as already highlighted by Njoku et al. (2023).

Finally, our findings add to the debate on the cost-effectiveness of digital health interventions. Similar to the economic analyses undertaken by Kowalski et al. (2024), this study indicates that, although notable up-front costs exist, the long-term benefits are realized through reduced healthcare costs and improved employee health. A comparison of the findings of other systematic reviews shows that the effectiveness of digital health interventions varies. According to Blewitt et al. (2022), the ineffectiveness is because of a lack of standardization in implementing these interventions. Our study extends this and suggests that interventions specifically adjusted to the needs of a workforce are likely to be more effective.

In line with the advice of Nwaogu et al. (2021), our study highlighted a recommendation that digital health interventions should be continuously evaluated and adjusted. Implementation of these instruments alone will not do; an entity should be ready to constantly assess the impact brought in by these initiatives and make amends as required. More important is the role of management in ensuring the successful implementation of

digital health interventions. This is in line with the belief of Thomson et al. (2023) that managerial support is at the heart of promoting a culture that harnesses and uses digital health resources in an effective way.

In summary, our study contributes to the mounting evidence supporting the effectiveness of digital health interventions for enhancing various health outcomes in the workplace. Although challenges remain for the quantification of immediate productivity impacts, the long-term implications for the health of employees and the well-being of organizations are apparently positive. The major requirement for future research will be towards the development of standardized frameworks of implementation and exploration of management roles in facilitative tool establishment, leading to the successful adoption of digital health interventions.

In conclusion, digital health interventions have the potential to inform and contribute significantly towards strategies for workplace health, given the evidence in their favor for improving various health outcomes. The results suggest that user engagement, ethical issues, and practical implementation challenges need to be taken into account in the design of such interventions. The focus in the design of interventions in workplace health management is to achieve easy success by clearly designing the interventions with user needs at the center and making those interventions accessible to them with some clear benefits. While the existing body of evidence shows good promise, it is clear that more rigorous, diverse, and long-haul studies are needed in order to reach a clear understanding of the efficacy and utility of digital health interventions in enhancing employee well-being and organizational productivity.

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Appendix A. Selected Papers for Review

Table A1. Reviewed Papers.

Paper No.	Authors	Title	Year	Journal	Type of Study
1	Adhyaru, J. S. and C. Kemp	Virtual reality as a tool to promote wellbeing in the workplace	2022	Digital Health	Pilot
2	Blewitt, C., M. Savaglio, S. K. Madden, D. Meechan, A. O'Connor, H. Skouteris, and B. Hill	Using Intervention Mapping to Develop a Workplace Digital Health Intervention for Preconception, Pregnant, and Postpartum Women: The Health in Planning	2022	International Journal of Environmental Research and Public Health	Pilot
3	Carolan, S. and R. O. de Visser	Employees' Perspectives on the Facilitators and Barriers to Engaging With Digital Mental Health Interventions in the Workplace: Qualitative Study	2018	JMIR mental health	Qualitative

Table A1. *Cont.*

Paper No.	Authors	Title	Year	Journal	Type of Study
4	Crane, M., E. Bohn-Goldbaum, B. Lloyd, C. Rissel, A. Bauman, D. Indig, S. Khanal, and A. Grunseit	Evaluation of Get Healthy at Work, a state-wide workplace health promotion program in Australia	2019	BMC Public Health	Mixed Methods
5	Engels, M., L. Boß, J. Engels, R. Kuhlmann, J. Kuske, S. Lepper, L. Lesener, V. Pavlista, M. Diebig, T. Lunau, S. A. Ruhle, F. B. Zapkau, P. Angerer, J. Hoewner, D. Lehr, C. Schwens, S. Süß, I. C. Wulf, and N. Dragano	Facilitating stress prevention in micro and small-sized enterprises: protocol for a mixed method study to evaluate the effectiveness and implementation process of targeted web-based interventions	2022	BMC Public Health	Mixed Methods
6	Haile, C., A. Kirk, N. Cogan, X. Janssen, A. M. Gibson, and B. Macdonald	Pilot Testing of a Nudge-Based Digital Intervention (Welbot) to Improve Sedentary Behaviour and Wellbeing in the Workplace	2020	International Journal of Environmental Research and Public Health	Pilot
7	Kazi, A. M., S. A. Qazi, N. Ahsan, S. Khawaja, F. Sameen, M. Saqib, M. A. K. Mughal, Z. Wajidali, S. Ali, R. M. Ahmed, H. Kalimuddin, Y. Rauf, F. Mahmood, S. Zafar, T. A. Abbasi, K. Khalil-Ur-Rahmen, M. A. Abbasi, and L. K. Stergioulas	Current challenges of digital health interventions in Pakistan: Mixed methods analysis	2020	Journal of Medical Internet Research	Mixed Methods
8	Kerr, J. I., M. Naegelin, M. Benk, F. v Wangenheim, E. Meins, E. Viganò, and A. Ferrario	Investigating Employees' Concerns and Wishes Regarding Digital Stress Management Interventions With Value Sensitive Design: Mixed Methods Study	2023	J Med Internet Res	Mixed Methods
9	Kowalski, L., A. Finnes, S. Koch, and A. Bujacz	User engagement with organizational mHealth stress management intervention—A mixed methods study	2024	Internet Interventions	Mixed Methods
10	Leigh, S., L. Ashall-Payne, and T. Andrews	Barriers and Facilitators to the Adoption of Mobile Health among Health Care Professionals from the United Kingdom: Discrete Choice Experiment	2020	JMIR mHealth and uHealth	Pilot
11	Nadav, J., A. M. Kaihlanen, S. Kujala, E. Laukka, P. Hilama, J. Koivisto, I. Keskimäki, and T. Heponiemi	How to Implement Digital Services in a Way That They Integrate into Routine Work: Qualitative Interview Study among Health and Social Care Professionals	2021	Journal of Medical Internet Research	Qualitative
12	Njoku, C., S. Green Hofer, G. Sathyamoorthy, N. Patel, and H. W. W. Potts	The role of accelerator programmes in supporting the adoption of digital health technologies: A qualitative study of the perspectives of small- and medium-sized enterprises	2023	Digital Health	Mixed Methods
13	Nwaogu, J. M., A. P. C. Chan, J. A. Naslund, C. K. H. Hon, C. Belonwu, and J. Yang	Exploring the Barriers to and Motivators for Using Digital Mental Health Interventions Among Construction Personnel in Nigeria: Qualitative Study	2021	JMIR formative research	Mixed Methods
14	Olaya, B., C. M. Van der Feltz-Cornelis, L. Hakkaart-van Roijen, D. Merecz-Kot, M. Sinokki, P. Naumanen, J. Shepherd, F. van Krugten, M. de Mul, K. Staszewska, E. Vorstenbosch, C. de Miquel, R. A. Lima, J. L. Ayuso-Mateos, L. Salvador-Carulla, O. Borrega, C. Sabariego, R. M. Bernard, C. Vanroelen, J. Gevaert, K. Van Aerden, A. Raggi, F. Seghezzi, and J. M. Haro	Study protocol of EMPOWER: A cluster randomized trial of a multimodal eHealth intervention for promoting mental health in the workplace following a stepped wedge trial design	2022	Digital Health	RCT
15	Simons, L., D. van Bodegom, A. Dumaij, and C. Jonker	Design Lessons from an RCT to Test Efficacy of a Hybrid eHealth Solution for Work Site Health	2015	BLED 2015 Proceedings	RCT

Table A1. *Cont.*

Paper No.	Authors	Title	Year	Journal	Type of Study
16	Smit, D. J. M., S. H. van Oostrom, J. A. Engels, A. J. van der Beek, and K. I. Proper	A study protocol of the adaptation and evaluation by means of a cluster-RCT of an integrated workplace health promotion program based on a European good practice	2022	BMC Public Health	RCT
17	Thomson, L., J. Hassard, A. Frost, C. Bartle, J. Yarker, F. Munir, R. Kneller, S. Marwaha, G. Daly, S. Russell, C. Meyer, B. Vaughan, K. Newman, and H. Blake	Digital Training Program for Line Managers (Managing Minds at Work): Protocol for a Feasibility Pilot Cluster Randomized Controlled Trial	2023	JMIR research protocols	RCT

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