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PROMOTING MENTAL WELL-BEING THROUGH DIGITAL INTERVENTIONS: A META-ANALYSIS

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ABSTRACT

Growing importance of enhancing mental well-being across the general population has fueled a significant rise in the market for digital mental well-being tools. However, there is a lack of comprehensive evidence regarding their effectiveness. This meta-analysis seeks to evaluate the evidence on the effectiveness of digital interventions in improving mental well-being among general population. Following the PRISMA guidelines, searches were carried out in databases i.e. Association of Computing Machinery, ScienceDirect, Elsevier, Journal of Medical Internet Research, Mental Health, Journal of Theoretical and Applied Economics Research, Public Library Of Science ONE (PLOS), Frontiers in Psychiatry, BioMed Central, Medical Education, Sustainability, Geriatrics, Australian Journal of Information Systems, and Nordic Journal of Working Life Studies. After evaluating 20 digital mental well-being intervention studies, and 6 of these quanitative studies were included in the random effect model. The pooled effect size suggest moderate significant effect of these digital well-being interventions on mental well-being. Some researches claim that these digital interventions are not effective enough to change technology-use behavior. Therefore, it is important to investigate whether personalization is necessary to increase the efficacy of such technologies. Ethical concerns should be taken care when designing and developing these digital interventions.

Keywords: *Mental, Well-being, Digital, Interventions, Wellness*

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INTRODUCTION

The discussion around the negative aspects of technology overuse has grown in recent years, with mainstream media and researchers from various fields such as addictive behaviors, psychology, and human-computer interaction (HCI) leading the conversation (Andreassen, 2017). While much of this discourse can be speculative, especially when it frames everyday behaviors like smartphone use as addictive, there is substantial evidence indicating that excessive use of technology such as mobile devices, social media, and the Internet can negatively impact daily activities and tasks, including studying, driving, and sleeping (Lanette et al., 2018). These issues can further extend to mental health and social interactions.

Many individuals now feel conflicted about their screen time, particularly with passive use of technology. This concerned has led researchers to study this dimension of psychological well-being termed "digital well-being" (Nansen et al., 2011). According to Burr et al. (2020) digital well-being involves understanding the influence of digital technologies on living a good life in an information society. Cecchinato et al. (2019) suggest that digital well-being can be examined from medical, user, and design-oriented insights. Major tech companies including Google and Apple have recently adopted design philosophies aimed at providing users with tools to enhance their digital well-being (Burr et al., 2020; Cecchinato et al., 2019).

To promote digital well-being, fully automated digital interventions have emerged both in academic research and as commercial products (Google Design, 2019). These tools are to help users improve their relationship with technology and can be viewed as technologies for behavior change and sustainment, or more specifically, as digital interventions for behavior change (Cecchinato et al., 2019; Linardon et al., 2024; Roffarello & De Russis, 2023). A thorough analysis of the evidences about the effectiveness of completely automated digital therapies targeted at enhancing mental health, including psychological and subjective well-being, in the general population is urgently needed (Wang et al., 2018). Hence, this meta-analysis intends to evaluate the effectiveness of fully automated digital interventions in enhancing mental well-being in the general population.

METHOD

Study Protocol

The PRISMA protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was followed for reporting the meta-analysis.

Eligibility Criteria

Those studies were included that used fully automated digital interventions that were designed for the promotion of mental well-being in the general population based on the following preestablished inclusion and exclusion criteria:

- Those studies were included which included adults with age 18years and above as a study population.
- Studies using general population but not clinical populations were part of the meta analysis.
- Digital interventions were defined in line with the National Institute for Health and Care Excellence as interventions delivered via hardware and electronic devices (e.g., smartwatches and smartphones), software (e.g., computer programs and apps), and websites.
- The digital intervention intended to promote individual mental well-being were included in the study.
- Highly cited and published researches were included.
- Studies conducted with clinical population were excluded.
- Articles written in languages other than English were excluded.
- Studies with vague study design were excluded.
- Studies whose focus was not on mental well-being were excluded.
- Unpublished researches were excluded.

Information Sources and Search Strategy

The search was conducted in May 2024. The databases searched included Association of Computing Machinery (ACM), ScienceDirect, Elsevier, Journal of Medical Internet Research Mental Health (JMIR Mental Health), Journal of Theoretical and Applied Electronic Commerce Research (JTAER), Public Library of Science ONE (PLoS ONE), Frontiers in Psychiatry, BioMed Central (BMC) Medical Education, Sustainability, Geriatrics, Australian Journal of Information Systems, and Nordic Journal of Working Life Studies. The following key search

terms were used “digital well-being” “digital wellness” “digital self-control tools” “digital interventions” “mental well-being” “digital well-being applications” “smartphone overuse” “digital well-being tools”.

Study Selection

Titles and abstracts from all research studies were reviewed. Out of 62 studies, only 20 fulfilled the inclusion criteria as mentioned above.

Data Analysis

Full-text screening was conducted for the selected studies. The authors, year of publication, study population, specifics of the intervention and control conditions (including duration, frequency, timing, and activities), study methodology, study results, study limitations, and study implications were all included in the data extraction.

Meta analysis was performed using random effect model. The *Q* statistics was used to assess the study heterogeneity. The I^2 statistic is also computed to estimate the percentage of variance in the observed effects.

RESULTS

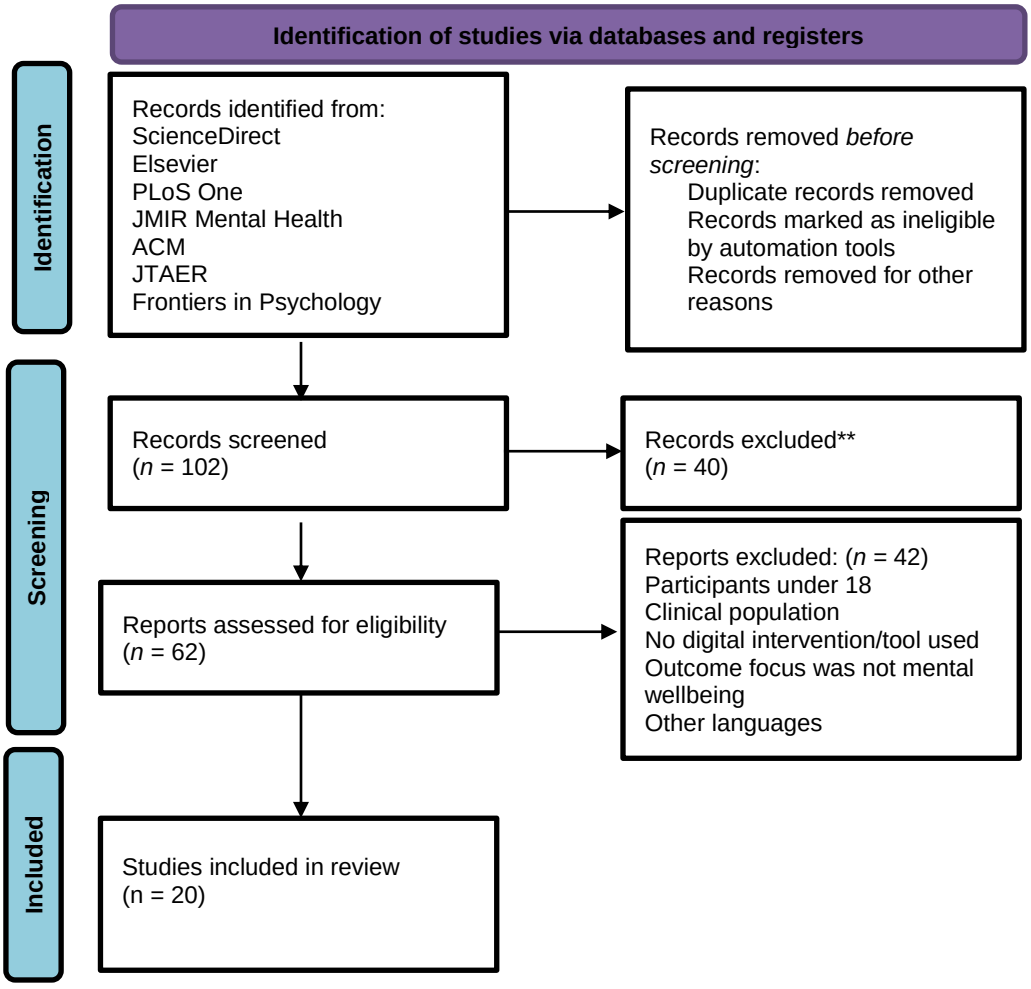


Figure 1. PRISMA 2020 Flow Diagram

Table 1
Characteristics of the Studies included in the Meta-Analysis

Study	Population	Intervention	Study Type	Outcome	Effect Size
Abreu & Campos (2022)	University students (*n* = 16)	Digital well-being chatbots	Field study	High effectiveness of self-tracking in facilitating behavior change	81% users reduced their smartphone usage
Almourad et al. (2021)	Users of SPACE and GDW app (*n* = 14)	SPACE GDW	Qualitative	Acceptance of wellbeing applications is positively influenced by the implementations of usage awareness functionalities	No statistical value reported
An et al. (2023)	Employees	Working in Remote Environment	Qualitative	Digital wellbeing literacy increased	No statistical value reported
Bhattacharjee et al. (2023)	Participants between 18 to 25 years of age (*n* = 42)	Text messaging tool	Qualitative	Supports psychological well-being	No statistical value reported
Bordi et al. (2018)	Employees (n = 36)	Digital workshop	Mix-method action research	Flexibility in digital communication supports employee wellbeing	23% of working time was spent on communication-related activities

Table 1
Continued

Study	Population	Intervention	Study Type	Outcome	Effect Size
Boucher et al. (2021)	Participants with little or no social anxiety (*n*=20)	+Connect	Randomized Control Trial	Reduces loneliness and improves subjective wellbeing	*d* = .94
Boucher et al. (2021)	Participants between 18-64 years of age (n=11)	Happify	Qualitative Focus Group	Reduced loneliness, increased coping skills, gratitude, and mindfulness	No statistical value reported
Carlsson & Walden (2016)	Young elderly (*n* = 101)	Digital Wellness Program	Semi-structured workshops and interviews	Supports digital wellness and helps in building and maintaining wellness routines in young elderly	Partial Eta Squared = .84
Ko et al. (2016)	Students (*n* = 976)	Lock n' LoL	Field Study	Reduced smartphone overused by limiting group behavior	R^2 = .20
Lukoff et al. (2023)	Young adults (n = 64)	SwitchTube	Qualitative	Greater sense of agency, satisfaction, and goal alignment	45% participants maintained their changed behavior

Table 1
Continued

Study	Population	Intervention	Study Type	Outcome	Effect Size
Lyngs et al. (2024)	Students (n= 280)	DSCTs	Field Study	Helps in regulating digital device use	95% participants still using one of the DSCTs *d* = .84
Parry et al. (2023)	Digital wellbeing app users (*n* = 20)	Forest, Stay Focused, Huawei Digital Balance, and Android Digital wellbeing	Qualitative	Supports digital mental wellbeing	*d* = .04
Porter et al. (2024)	164 school students	Digital Health Contact	Field study	Helps to raise awareness of the mental health and wellbeing support in schools	Effect of model 0.26 - 0.36
Rich et al. (2020)	Doctors (n = 22)	Digital wellness focused workshops	Mixed-method study	Digital intervention reduced burnout and increased wellbeing in doctors	Pre-workshop scores on burnout (M=2.78, SD=.43) Post workshop scores on burnout (M=2.58, SD=.43)

Table 1
Continued

Study	Population	Intervention	Study Type	Outcome	Effect Size
Roffarello & De Russis (2019)	App users (n = 38)	42 Digital wellbeing apps	Qualitative	Digital wellbeing apps are appreciated but not effective enough to bring change in smartphone usage	No statistical value reported
Roffarello & De Russis (2021)	DSCTs users (*n* = 20)	313 DSCTs	Qualitative and sketching exercise	Multi device use can both positively and negatively impact mental wellbeing	Intervention impact range from 39% to 91%
Roffarello & De Russis (2023)	Users of Facebook and YouTube (*n* = 14)	inControl	Field Study	Decreased time spent and passive scrolling	Reduced time spent on Facebook and YouTube (-57%)
Tam et al. (2021)	Older adults (*n* = 140)	Focused Digital Wellness Program	Retrospective analysis	Participants were highly satisfied with the program	NPS score = 43

Table 1
Continued

Study	Population	Intervention	Study Type	Outcome	Effect Size
Tam et al. (2021)	Older adults (*n* = 140)	Focused Digital Wellness Program	Retrospective analysis	Participants were highly satisfied with the program	NPS score = 43
Tkáčová et al. (2021)	High school students (*n* = 20)	Social media platforms	Qualitative	Positively impacted the well-being of students by supporting their personal interests, motivation, communication, education, and entertainment needs	No statistical value reported
Wohn & Lampe (2018)	Users of Everything2.com (*n* = 30)	Everything 2.com	Qualitative	Improved wellbeing and relatedness in the community	No statistical value reported

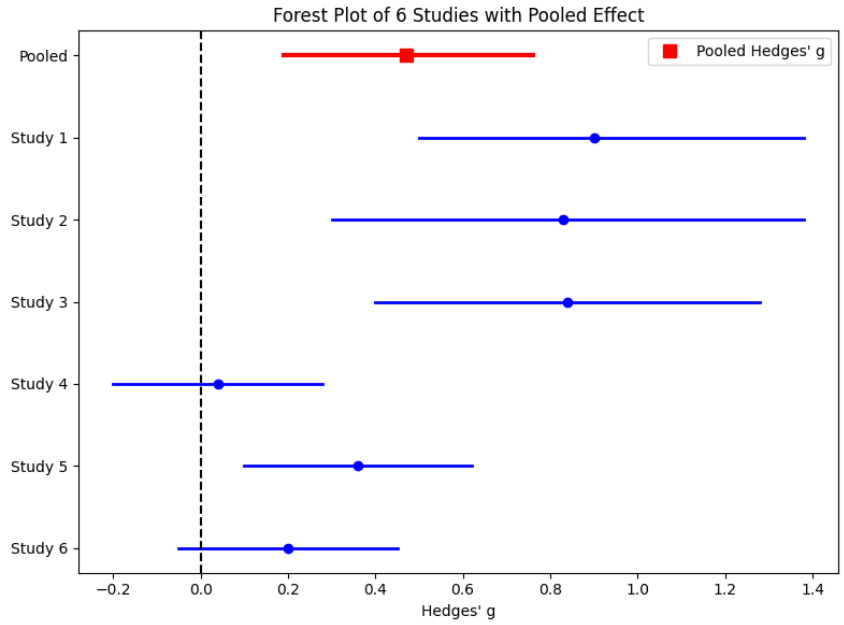
Intervention Effectiveness

Six quantitative studies were included in the meta-analysis. Individual study effect sizes ranged from negligible to large, indicating variability in intervention effectiveness across studies. Three studies reported large effects favoring the intervention, one study demonstrated a moderate effect, and two studies showed small or non-significant effects.

Using a random-effects model, the pooled effect size demonstrated a moderate and statistically significant overall effect of the interventions on the outcome of interest (Hedges' g = 0.47, 95% CI [0.19, 0.76]). This finding suggests that, on average, participants receiving the intervention experienced greater improvements compared with those in control conditions.

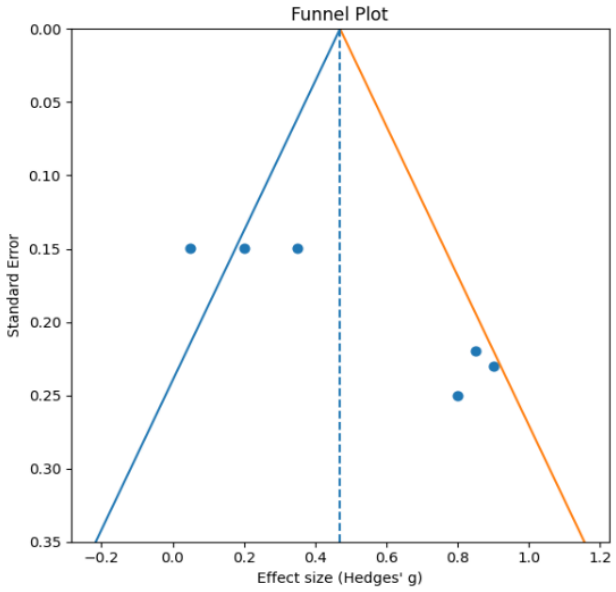
Statistical tests revealed substantial heterogeneity among the included studies (Q = 22.4, df = 5, p < .001; I^2 = 77.7%). The high I^2 value suggests that true differences between studies, rather than just sampling error, account for a large proportion of the observed variance in effect sizes. This heterogeneity may reflect differences in intervention content, duration, delivery mode, or participant characteristics. Consequently, the use of a random-effects model was considered appropriate.

The forest plot displays individual study effect sizes with corresponding 95% confidence intervals alongside the pooled estimate. Several studies show effects favoring the intervention, while others report non-significant findings. The pooled effect, represented by the diamond, lies entirely to the right of the null line, indicating a statistically significant overall effect despite variability across studies.



Publication Bias

Potential publication bias was examined using the funnel plot by plotting effect sizes against their standard errors. Visual inspection suggests approximate symmetry around the pooled effect size. Although minor asymmetry is present, this is likely attributable to the small number of included studies rather than systematic publication *bias.*



DISCUSSION

The purpose of this meta-analysis was to evaluate how effective fully automated digital interventions are in enhancing mental well-being in the general public. Twenty totally automated digital interventions for mental well-being were evaluated, findings suggest moderate to high significant effect of these digital well-being interventions on mental well-being in the general population. Some of the significant results extracted from study analysis reveal that these apps can reduce smartphone use up to 81% and can increase personal interests and motivation of students. Some study findings showed 20% variance in subjective well-being of the individuals caused by these digital apps. Some of these studies indicated

significant impacts on mental health with effect sizes ranging from .49 to .94. These digital app played an important role during the COVID-19 by enhancing the mental well-being of the individuals. Digital interventions can also reduce loneliness, burnout, and can be used as screening apps for mental well-being. Some researches claim that these digital interventions are not effective enough to change technology use behavior. However, majority of the studies promote the mental well-being through the use of different apps and interventions. It was also seen that smartphone use had the most significant improvement than other devices. It was also highlighted that individuals who use iPhone were more inclined towards using these apps than Android users. Recent studies highlights the need for online mental health strategies for young adults. It was also evident that digital interventions are as effective as face to face therapeutic approaches for mental health related issues (King et al., 2022). It was further discussed in the research that digital literacy related to health raised during COVID-19. According to a study conducted in Germany, even though college students showed high levels of digital health literacy during the COVID-19 pandemic, using digital tools for health problems—particularly stress management—is uncommon. However, mindfulness related interventions through digital platforms show significant reduction in stress among students (Dadaczynski et al., 2021). Harrer et al. (2018) further emphasized that Digital based CBT is effective intervention and produce effective outcomes in elevation of stress and benefits in mental health related problems especially in people less likely to pursue traditional therapies. The use of digital interventions can help the general population (students, employees, or older adults) maintain their mental well-being by overcoming their technology overuse. However, the effectiveness of these apps and interventions can be improved.

In conclusion, digital well-being is a burgeoning field with constantly emerging research. Therefore, this meta-analysis cannot cover all relevant studies. The review focused primarily on adults, indicating a need for further research on technology overuse and related interventions in children. Additionally, the scope of the findings is limited by the search methodology, which concentrated on articles discussing digital interventions only. Due to the varied measures in the analyzed articles and incomplete statistical data, the study could only examine the effects of few researches in which statistical data was reported.

The findings from the meta-analysis suggest several directions for future research. Firstly, future studies should focus on understanding what constitutes effective engagement and determining the optimal level of engagement needed for bringing change in individual's use of smart devices. Secondly, research should

explore how to tailor digital interventions to deliver relevant content according to user preferences. It is important to investigate whether personalization is necessary for effectiveness or not. Ethical concerns should be taken care when designing and developing these digital interventions.

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