

Effectiveness of Digital Interventions for Deficit-oriented and Asset-oriented Psychological Outcomes in the Workplace: A Systematic Review and Narrative Synthesis

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Abstract: Background: Digital psychological interventions can target deficit-oriented and asset-oriented psychological outcomes in the workplace. This review examined: a) the effectiveness of digital interventions for psychological well-being at work, b) associations with workplace outcomes, and c) associations between interventions' effectiveness and their theory-base. Methods: six electronic databases were searched for randomised-controlled trials (RCT) and quasi-experimental studies. The methodological quality of studies that used randomisation was conducted with the "Cochrane Collaboration's Risk of Bias" tool, while the "JBI Critical Appraisal Checklist" was used for non-randomised studies. Studies' theory-base was evaluated using an adaptation of the "theory coding scheme" (TSC). Due to heterogeneity narrative synthesis was performed. Results: 51 studies were included in a synthesis describing four clusters of digital interventions: a) cognitive behavioural therapy, b) stress management interventions and workplace wellbeing promotion, c) meditation training and mindfulness-based interventions, and d) self-help interventions. Studies demonstrated a high risk of contamination effects and high attrition bias. Theory-informed interventions demonstrated greater effectiveness. Cognitive behavioural therapy demonstrated the most robust evidence for reducing depression symptoms among healthy employees. With the exception of the Headspace application there was weak evidence for meditation training apps, while relaxation training was a key component of effective stress management interventions.

Keywords: systematic review; digital interventions; workplace

1. Introduction

There has been a growing need for workplace interventions as occupational outcomes associated with poor mental wellbeing have been on the increase in recent years. In particular, absenteeism, presenteeism and turnover have increased in recent years costing UK employers between £42- £45bn a year, representing a 16% rise since 2016 [1]. Furthermore, UK Labour Force Survey results show that mental ill-health has risen to account for 51% of all work-related ill health, compared to 2018/19 when it accounted for 44% of all work-related ill-health, [2,3]. A similar trend is manifested by the annual NHS staff survey results that show that in 2020 44% of their participants reported that they felt unwell due to stress at work, whereas the same metric the year before was 40.3%, and in 2016 it was 36.8% [4-6].

Workplace interventions frequently tend to incorporate individual level-psychological interventions. There is evidence supporting the effectiveness of in-person psychological interventions but there is considerable variation in their approaches and their intended outcomes [7-13]. What, often distinguishes interventions, and their intended

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outcomes, is their approach towards psychological wellbeing at work. This in turn shapes intervention components and mechanisms. For example, improvement of psychological wellbeing can be defined both as reducing poor mental health indicators (deficit-oriented outcomes) and as increasing positive mental health (asset-oriented outcomes). A separatist, though, approach on psychological wellbeing can create further challenges for wellbeing promotion in organisations. For example, stress prevention interventions focus on modifying risk factors for poor mental well-being at work, whereas stress management tends to target individuals' coping and stress management skills before symptoms' initiation [9,14]. However, this distinction can become even less clear at times with secondary prevention becoming over the years increasingly integrated within organisations' employee wellbeing programmes [15,16]. An holistic approach to psychological wellbeing promotion is also reflected in guidelines for mental health prevention at work [12,17,18]. In particular, LaMontagne et al. [12] argued that workplace interventions targeting mental health problems need to adopt an integrated approach focusing on 1) reducing work-related risk factors; 2) promoting the development of positive aspects including worker strengths and positive capacities, and 3) addressing mental health problems.

As a concept psychological wellbeing not only addresses deficit-oriented psychological outcomes indicating poor mental health but also encompasses asset-oriented psychological parameters (e.g. subjective wellbeing, autonomy, positive relationships etc) [19-25]. For example, previous research also shows that positive cognitive/affective states may play a critical role in the creation of resilient workplaces and employee engagement [26-31]. Based on the conservation of resources theory, a generic definition of resources is 'anything perceived by the individual to help attain his or her goals' [32]. In recent years, psychological wellbeing promotion has been associated with the development and interplay of psychosocial resources at multiple levels of analysis within organisations [33-35]. Similarly, Schaufeli's [36] online assessment tool ('Energy Compass') balances a negative and positive approach to work-related wellbeing allowing organisations to assess psychological and social resources at work and understand their impact on employee wellbeing.

It is evident that theoretical underpinnings of psychological well-being promotion shape intervention focus, effectiveness measures and intervention delivery parameters [11,13,37]. With many organisations, though, adopting for the first time remote or hybrid models of work over the pandemic [38] and digital tools being increasingly used for the delivery of workplace interventions due to their cost-effectiveness, scalability and promise for anonymity and stigma reduction [39-41] it is essential to highlight determinants of their effectiveness.

Recent reviews show that digital interventions can reduce common mental health concerns at work and may improve work performance [23,42]. However, there are numerous issues about digital interventions' theoretical base, intended outcomes and methods that may obscure the systematic evaluation of their findings. Common problematic areas involve the incompatibility of evidence elicited at the group level to the context of digital interventions, an often weak theoretical base, along with challenges associated with diverse delivery modalities and difficulties with setting up robust controlled studies [43,44]. A characteristic example of the theoretical disparity of the field is the variations among digitally delivered interventions for perceived stress among nurses that are ranging from large eMental health programmes to standalone stress management interventions and eHealth training modules [20,45-48]. Furthermore, there is significantly less rigorous research on secondary outcomes of digital psychological interventions at work addressing occupational outcomes [13,49]. For this reason, this systematic review will report on the effectiveness of digital psychological interventions at work and assess its association with the interventions' theoretical underpinnings and explore their associations with occupational outcomes. The review objectives as reported in the review's protocol [50] were:

(1) To describe the effectiveness of digital interventions for psychological wellbeing including: (i) improvement of asset-oriented psychological outcomes at work; (ii) the prevention/management of poor mental well-being in the workplace.

(2) To explore the relationship between interventions' effectiveness and their theoretical base.

(3) To explore the effects of digital interventions on occupational outcomes as secondary intervention outcomes.

2. Materials and Methods

2.1. Study design

The review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines. The study protocol was prospectively registered with PROSPERO (CRD42019142428) and published [50].

2.2. Eligibility criteria

2.2.1. Inclusion criteria

The study's search strategy was based on PICO-elements (Interventions, Comparators, Outcomes) that reflect the screening criteria against which studies were screened.

a) Participants

Included studies' participants needed to be current 'employees' including working-age adults and those over 65 years that were still in a contracted role within their organisations.

b) Interventions

For studies to be included they needed to report the results of workplace interventions. Interventions could be delivered via any digital method and there were no restrictions regarding the timing, duration, or modality of the interventions.

d) Comparator(s)/control:

The types of the studies that were included in this review were experimental (randomised controlled trials) or quasi-experimental studies (without randomised allocation). Both controlled and uncontrolled studies) were considered for inclusion.

e) Outcomes

Interventions' primary outcome could be either asset-oriented or deficit-oriented psychological outcomes in the workplace. For this reason, included studies needed to report on at least one instrument that claimed to measure psychological well-being and/or mental well-being outcome(s). As described in our study's protocol (50) "The effectiveness of digital interventions for psychological well-being in the workplace: a systematic review protocol" interventions' primary outcomes could include any aspect of psychological or mental wellbeing of healthy adults in a work-setting, while secondary outcomes could include any other individual-level assessment.

f) Type of studies: Included studies needed to report empirical research (i) written in English and (i) published in peer-reviewed journals or conference proceedings accompanied by full-length peer-reviewed papers. A restriction was posed to include only English-language papers due to financial and language constraints to identify and process papers in languages other than English.

2.2.2. Exclusion criteria

a) Participants

Studies were excluded if they did not focus on working adults.

b) Interventions

Studies were excluded if they reported interventions delivered in settings other than the participants' workplace and if they did not report a psychological intervention.

d) Comparator(s)/control

Studies were excluded if they reported digital interventions delivered simultaneously with other interventions without a comparison between them. Furthermore, studies were excluded if they reported case studies and cross-sectional research designs.

e) Outcomes

Studies were also excluded if (i) they did not include relevant outcome measures, (ii) they focused primarily on the clinical treatment of mental health disorders, and/or (iii) their primary outcomes did not measure a deficit-oriented or asset-oriented psychological outcome.

g) Type of studies

Studies were **excluded** if they (i) were not published in a peer-reviewed journal, (ii) were not written in the English language, (iii) reported conference abstracts (without a corresponding full-length peer-reviewed paper) and unpublished research.

2.2.3. Information sources

A comprehensive literature search was conducted in July 2019 in five electronic databases (MEDLINE, Web of Science, CINAHL, PsycINFO, Cochrane Register of Controlled Trials (CENTRAL) and EMBASE) for studies published from January 1990 to July 2019.

2.2.4. Search strategy

The search strategy was pilot tested in PsychInfo and was refined and appropriately modified for each database (Appendix 1: complete search strategy). Terms were searched in titles, abstracts, and keywords. Related systematic reviews were checked for the purpose of identifying other potentially eligible studies.

2.2.5. Selection process

All references were stored at the Mendeley desktop (v1.19.8) and subsequently duplicates were removed. One reviewer (MA) screened all titles and abstracts, and full texts were sought for those that remained unclear. Then, two reviewers (MA, EA) screened independently abstracts and full texts of potentially eligible studies against the studies' eligibility criteria. A third reviewer (HB) advised on studies eligibility in a few cases that remained unclear after reviewers' assessment.

2.2.6. Data collection process

Data collection involved the data extracted independently by two reviewers (MA, EA) using the JBI data extraction form [51] in order to extract all relevant information from the studies (see Appendix). NVivo (Version 11) was used to consolidate all extracted information.

2.2.7. Quality appraisal

Two reviewers independently (MA, SD) conducted the quality appraisal of the retrieved papers using the Cochrane Collaboration's Risk of Bias [52] and the JBI Critical Appraisal Checklist for Quasi-Experimental Studies [51]. Agreement was reached through discussion and any disagreements were resolved after a second round of review.

2.2.8. Synthesis

Due to the heterogeneity in the data and outcomes reported, statistical pooling of the data was not used. A narrative synthesis was performed that explored relationships between studies' characteristics and findings as outlined by Popay et al. [53]. Moreover, evidence from RCT's was separately reviewed to assess relationships between interventions' effectiveness and their theoretical base.

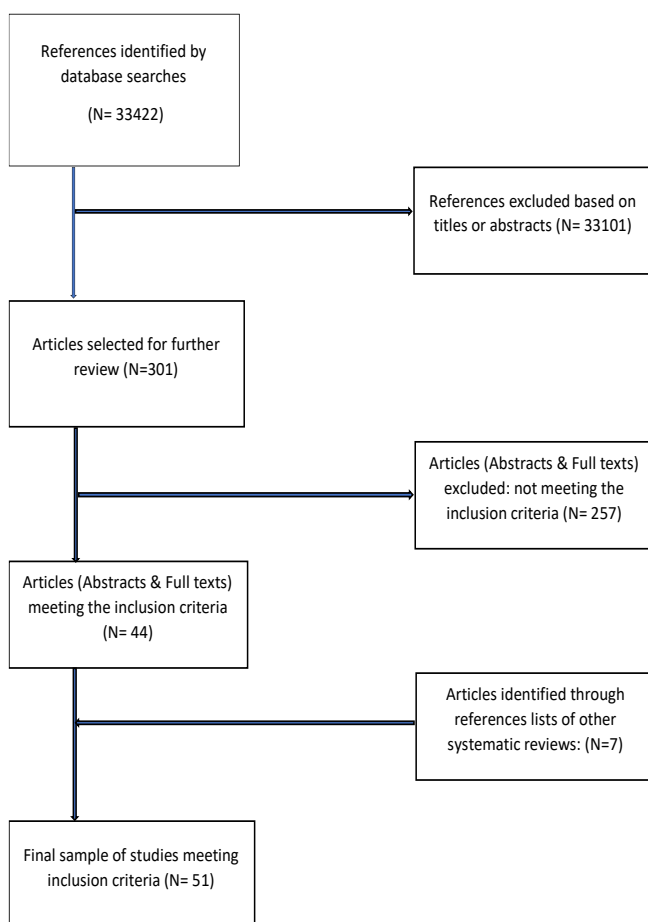
3. Results

3.1. Study selection

The initial search identified 48,177 hits, including duplicates. In total, 33,422 articles were screened following the removal of duplicates. 33,121 papers were excluded after the screening, 301 full papers were reviewed, and 51 articles met the reviews' inclusion criteria, including 7 papers identified through references lists of other reviews (Figure 1). We excluded 257 articles for not meeting the inclusion criteria due to the following reasons: 1) not reporting relevant primary outcomes, 2) not testing a digital intervention, 3) no specific workplace settings, 4) reporting organisational intervention, 5) simultaneous delivery of a digital intervention with other types of interventions without any comparisons, 6) not a psychological intervention, 7) not employees (e.g. university students), 8) not an RCT or quasi-experimental study, 9) paper published not in English, 10) full paper unavailable and 11) not a preliminary study.

Figure 1: Flow diagram of studies' selection

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Appendix 2 presents the studies by their study ID number and author name, settings, intervention, population, method, measures and main findings.

3.2. Studies' characteristics

Thirty intervention studies adopted a randomised controlled trial (RCT) research design and twenty-one quasi-experimental intervention studies. Intervention studies that used randomisation and controlled conditions involved twenty-four standard RCT's, four cluster RCT's, two pilot RCT's, and one RCT with cross-over design. Quasi-experimental intervention studies involved thirteen studies with single group pre-post designs, three pilot studies with single group pre-post designs, three non-randomised controlled trials, and two randomised trials without a control group. RCT's had an average of two hundred forty-nine participants (min=30, max= 762) working across

different sectors, including technology/information technology companies (5 RCT's), ~~Healthcare~~healthcare (8 RCT'S), manufacturing (3 RCT's), emergency services (2 RCT's), media (1 RCT), insurance (1 RCT), education (1 RCT), civil service (1 RCT) and various companies/organisations/associations (8 RCT's). With regards to their control conditions, nineteen RCT's included control-comparison conditions. Among those one RCT compared two different forms of a digital intervention with a control condition of not receiving an intervention, while three RCTs compared digital and in-person versions of an intervention with control conditions of not receiving an intervention or not receiving one of those. Quasi-experimental studies had an average of ninety-nine participants (min=15, max=379) employed as health professionals (11/21), university employees (2/21), firefighters (1/21), employees in governmental or public enterprises (3/21), white-collar employees (1/21), engineers (1/21), construction machinery employees (1/21) and naval active duty members (1/21). Control conditions involved a waiting list (n=2), and not receiving previously the intervention (n=1).

3.3. Process of Narrative Synthesis

We first coded the studies on NVivo in terms of their characteristics, including study designs, settings and populations. Then we proceeded to code them by the type of interventions, the measures they used and the outcomes they reported. Finally, we completed our narrative synthesis by tabulating intervention outcomes per intervention type.

3.4. Objective 1: Description of psychological wellbeing measures of digital psychological interventions at work

Due to the vast differences in study design and populations, the outcomes measured varied considerably. For this reason, as discussed in the study's protocol [50] there were formed three clusters of primary outcomes and one cluster of secondary outcomes:

i. Primary Outcomes

- a) Common mental wellbeing outcomes at work (referred to for the rest of this review as 'Mental health concerns') (e.g. measures of anxiety, depression).
- b) Work-related wellbeing (e.g. measures of perceived stress, stress indicators, burnout etc).
- c) Psychological indicators for mental wellbeing at work (referred to for the rest of this review as 'Psychological wellness indicators') (e.g. measures of psychological resources, subjective wellbeing etc).

ii. Secondary Outcomes

- d) Workplace outcomes (e.g. measures of absenteeism, job attitudes etc)

A key difference across the three clusters of primary outcomes is the approach they adapt towards psychological wellbeing improvement. For those focusing on mental health concerns improvement is equated with the reduction of negative (deficit-oriented) mental health outcomes. For those targeting work-related wellbeing, improvement included both deficit-oriented (e.g. distress, burnout) and asset-oriented outcomes (e.g. work-engagement). Finally, those focusing on psychological wellness indicators improvement is equated with higher levels of different psychological and psychosocial resources, subjective well-being and positive mental health.

3.4.1. Description of psychological wellbeing measures

- a) Primary outcomes

Mental health concerns were assessed using well-established previously validated instruments measuring depression, anxiety and dysfunctional attitudes. Most frequently used instruments included different versions of the centre for epidemiologic studies depression scale: the 20-item (CES-D) scale (58, 95, 61, 62, 100) and the CESD-R-20 (64); the Depression, Anxiety, and Stress Scale (DASS-21) (63, 42); the Japanese version of Dysfunctional Attitude Scale 24 (DAS24-J) (55), the Attributional Style Questionnaire (ASQ) (54), the Hospital Anxiety and Depression Scale (HADS) (54, 95, 61), the Beck Anxiety Inventory (BAI) (64, 25) and the Spielberger State-trait Anxiety Index (STAI) (73, 57).

Assessments of work-related wellbeing included instruments measuring perceived stress most frequently with the 10-item PSS (73, 60, 68, 69, 100) and the Stress Questionnaire- (10, 65, 87, 62); instruments measuring stress outcomes, psychological distress and job strain often with Job Stress Questionnaire (BJSQ) (94, 71), the Symptoms of distress scale (64, 71, 95), and the Job Stress Questionnaire (BJSQ) (94, 71); and instruments measuring burnout, work-engagement and compassion-fatigue with the Maslach Burnout Inventory (62, 75, 87), (62), the Professional Quality of Life-Revision IV (ProQOL) (74, 82), and the Utrecht Work Engagement Scale ((10, 71, 83, 91, 102)

Finally, assessment of psychological wellness indicators included instruments measuring general mental well-being/positive mental health such as the WHO-5 well-being scale (83, 99, 80, 69) and the Mental Health Continuum (83, 91); as well as instruments measuring happiness and satisfaction in life most frequently using the Positive and Negative affect schedule (64, 87, 88), the 8-item Flourishing scale (87, 88, 80), and the satisfaction with Life Scale (SWLS, (79, 88). Other studies included instruments measuring mindfulness such as Freiburg Mindfulness Inventory (86, 59, 73, 80) and the Five Facet Mindfulness Questionnaire (FFMQ) (77, 76) as well as instruments measuring psychological and psychosocial resources such as resilience with the Connor-Davidson Resilience Scale (CDRISC) (86, 98, 82), and various scales measuring self-efficacy (73, 89, 94), coping (56, 89, 95) and gratitude (92, 93).

b) Secondary Outcomes

Studies' secondary outcomes involved measures of workplace outcomes. These included measures of job attitudes such as the Nurse Satisfaction Scale (95), and the Maastricht Job Satisfaction Scale for healthcare (MAS-GZ) (91), as well as measures of job performance such as the World Health Organization (WHO) Health and Work Performance Questionnaire (HPQ) (71, 102, 95, 61), and the Work Limitations Questionnaire (64, 95, 100). Other frequent assessment of workplace outcomes included measures of job attendance such as the short form World Health Organization Health and Work Performance Questionnaire (56), and self-reported sick leave days (102, 85, 92, 62).

3.4.2. Effectiveness of digital psychological interventions

i. Primary Outcomes

a) Mental health concerns

Ten studies reported positive effects on mental health concerns at work. Three CBT interventions showed significant effects on depression and anxiety over time [54-56] and especially among those with high psychological distress at baseline [55]. Stress inoculation training [57] and relaxation training [58] showed positive effects in reducing anxiety and depression ($p < .05$), while two meditation training/mindfulness-based interventions [59,60] showed positive effects in reducing anxiety and depression symptoms ($p < .05$).

Finally, one self-help intervention that delivered problem-solving therapy had small effects in anxiety [61], another that delivered problem-solving therapy had had sustainable positive effects on depressive symptom severity ($p < 0.01$) [62]; and finally another that included CBT-informed modules reported significant sustainable reduction in depression scores [63].

Seven studies reported no effects on mental health concerns at work including one CBT intervention [38], four stress management/wellbeing promotions interventions [1, 11, 21, 46], and two self-help interventions that delivered problem solving therapy and cognitive therapy [47, 48]

b) Work-related wellbeing

Twenty-eight studies reported positive effects on work-related wellbeing measures. Two RCTs of an internet-based CBT programme had marginally significant effects on distress ($p = 0.09$) and indirect effects on work-engagement but only through changes in depression ($p < 0.1$) [55]. Ten studies (7 RCTs and 2 quasi-experimental studies) reported positive effects of stress management and wellbeing programs on work related wellbeing measures including perceived stress [64-69], subjective symptoms of stress wellbeing [69], distress [68], job stress [47], work-related fatigue ($p < 0.05$) and psychosocial demands (mental workload, emotional labour) [58,70]. However, three RCT's [65, 70-72] reported minimal effects on improving work-related wellbeing. Moreover, there were greater effects for an instructor-led workshop ($F = 4.45$, $p < 0.05$), while participants in both conditions were especially benefited from mini-relaxation exercises, especially after the second session ($F = 8.44$, $p < 0.01$) [72]. Similarly, a videoconferencing-based telepsychology intervention [65] showed greater effects for the in-person condition than the digital one. Nine studies (3 RCTs and 6 quasi-experimental studies) reported positive effects of meditation training or mindfulness-based interventions on work-related wellbeing measures [59,60,66,68,73-77]. Those included significant effects on job control ($F = 5.71$, $p < 0.05$), that was sustained for 2 months post-intervention [59]; a lower risk for compassion fatigue ($p < 0.05$) for nurses below the clinical cut-off point for PTSD [77]; a significant improvement for compassion fatigue and burnout ($p < 0.05$) [74]; a significant decrease in perceived stress ($p < 0.05$) [73]; small to moderate effects on stress levels post-intervention (Cohen's $d = 0.34$; $p < 0.001$) that continued three months later (Cohen's $d = 0.22$; $p < 0.05$) [66], and improvements in fatigue scores ($p < 0.05$) [60,73] as well as in chronic and acute fatigue scores post-intervention ($p < 0.05$) [76]. Finally, seven studies (3 RCTs, 1 pilot RCT and 3 quasi-experimental studies) reported positive effects of self-help interventions on work-related wellbeing measures ($p < 0.05$). Those included significant effects on perceived stress [62,78] and worrying over time [62], stress levels over time [79-81], work-engagement [78] burnout and compassion fatigue [82], and small effects on emotional exhaustion [61].

c) Psychological wellness indicators

Nineteen studies reported positive effects on psychological indicators for mental wellbeing at work. Two studies, one RCT and a quasi-experimental study, reported positive effects of computerised CBT [55,56] on efficacy variables over time ($p < 0.05$) [55], as well as on self-esteem ($F = 31.5$; $p < 0.05$) and coping flexibility ($F = 14.2$; $P < 0.001$) post-intervention [56]. Four studies, three RCTs and one quasi-experimental study showed positive effects of stress management and wellbeing promotion programmes [57,67,83,84] on psychological wellbeing ($p < 0.01$) [83,84], mental energy and active coping ($p < 0.05$) [57,85]. Seven studies, three RCTs and four quasi-experimental studies, showed significant positive effects of meditation training/mindfulness on psychological wellness indicators. Those include significant effects on psychological resources, positive emotions, and flourishing ($p < 0.05$) [59,73,74,76,86,87] and moderate to large effects on global mental well-being over time [59]. Finally, five self-help ~~intervention~~ interventions, one RCT and four quasi-experimental studies had significant positive effects ($p < 0.05$) on positive affectivity, life satisfaction, happiness, flourishing, quality of life and self-efficacy [79,80,88,89]. However, three mobile-based resilience training interventions [79,82,90] did not have significant

effects on resilience measures, while two RCTs and two quasi-experimental studies that tested three online positive psychology interventions [91-93] had no significant effects on any indicators of psychological wellness.

ii) Types of interventions

We grouped the interventions based on the authors' explicit descriptions of their intervention approach and, secondarily, on key components of the interventions (i.e. mode of delivery, intervention content, and engagement with users). We identified four clusters of interventions:

a) Self-help interventions

Self-help interventions was the most frequently tested cluster of interventions (n=18). They involved educational interventions [81,89,90,94], multicomponent interventions featuring cognitive and behavioural interventions [61,62,63,78,79,88,95], positive psychology exercises [80,91-93,96] and resilience training [82,97].

b) Stress management and workplace wellbeing promotion programs:

Another cluster of studies (n=14) were ten RCTs and four quasi-experimental studies that were identified by their authors either as stress management interventions or workplace health and mental health promotion programmes. Ten out of fourteen interventions were delivered through self-paced online sessions, five of which combined psychoeducation with training in cognitive techniques [45,64,71,72,84].

c) Meditation training and mindfulness-based interventions:

Fourteen studies (six RCTs and eight quasi-experimental studies) reported on the effectiveness of meditation training and mindfulness-based interventions. Interventions were delivered via online platforms as educational programmes [66,73,75,76,86,87,98-100] and via mobile applications [59,60,74,77,101]. Mobile-based interventions delivered guided meditation practices. Other web-based interventions combined psychoeducation with training in meditation practices [75,87,99] or included online evidence-based psychological skills training sessions based on mindfulness-based stress reduction, acceptance and commitment therapy and mindfulness-based cognitive therapy [66,73,76,86,98].

d) Cognitive Behavioural Therapy (CBT): Five studies, four RCT's and one quasi-experimental study, reported computerised, internet-based or digitally enhanced CBTs. Four interventions were delivered through self-paced computer programmes [54,55,85,102] and 4/5 included trained clinicians in some capacity.

We constructed an auxiliary evidence map [Appendix 3: Evidence maps] to retain an overview of effects observed across the three clusters of primary outcomes for this review.

²Table 1: Evidence Maps

Psychological Wellbeing Promotion Evidence Maps							
Evidence Group A: Mental Health Concerns							
Evidence: n=10				No evidence: n=7			
CBT (n=3)	Stress management (relaxation training) (n=2)	Meditation/mindfulness-based interventions (n=2)	Self-help (problem solving therapy, CBT-informed modules) (n=2)	CBT (n=1)	Stress management/Wellbeing promotion (n=4)	Meditation/mindfulness-based interventions	Self-help (problem solving cognitive

								therapy)- (n=2)
RCT interactive cCBT programmes- (40, 45) depression symptoms,- dysfunctional attitudes, anxiety-	RCT (34) 4-week mobile- stress inoculation- training: eight video- clips accompanied- with a narrative- among nurses: sig- nificant decrease in- anxiety	(22) mindfulness ap- plication app (Head- space): anxiety and- depression symptoms	RCT (48) Web-based- guided self-help- course: anxiety- (secondary out- come) small ef- fects	RCT (38) 5-week computer- ised CBT in- tervention- among em- ployees- with ele- vated- scores in- Patient- Health- Question- naire- (online- course)	RCT (1) 3-month web- based multimedia- stress and mood- programme that in- cluded self-paced- cognitive behav- ioural techniques:- no other significant- differences in- other mental well- being outcomes (de- pression, anxiety,- mood management) (11) 3-month web- based stress man- agement: no signifi- cant effect on dis- tress symptoms,- coping with stress	0	6-week- guided- self-help- course- web- based in- terven- tion for- employ- ees with- depres- sive- symp- toms- (prob- lem-solv- ing treat- ment,- cognitive- therapy)- (47, 48):- no effect- on de- pression	
Quasi: (15) cCBT: 6-week webinar, six- sessions: depression, anxiety	Quasi (27) fully automated smartphone-based- 4-week stress man- agement applica- tion-reduction in- depression symp- toms only for the- second version that- included relaxation- training	Quasi (29) 2-week mindful- ness practice a weara- ble neurofeedback- system managed via- smartphone state anx- iety	(49) internet- based problem- solving: depres- sion RCT pilot: (18)- 24-week web- based & mo- bile-based cCBT- modules for de- pression and- anxiety and- other empiri- cally validated- tools-signifi- cant reduction-	0	(21) 4-week stress- management inter- vention: educational sessions on stress,- coping and the di- mensions of psycho- logical wellbeing- and the use of cog- nitive restructuring- techniques-no ef- fect on depression- symptoms (46) a 70-minutes- web-based asser- tion training stress- management-	0	0	

			in depression— score		programme: no effect		
Evidence Group B: Work-related wellbeing							
Evidence: n=27				No evidence: n=8			
CBT (n=2)	Stress management/Wellbeing promotion (n=10)	Meditation/mindfulness-based interventions (n=8)	Self-help (n=7)	CBT	Stress management/Wellbeing promotion (n=2)	Meditation/mindfulness-based interventions (n=2)	Self-help (n=2)
RCTs (10) interactive eCBT programme marginally significant effect on distress (6) marginally significant indirect effects on work engagement through changes in depression (p's<0.1)	RCTs (1) 3-month web-based multimedia health promotion programme that included self-paced cognitive-behavioural techniques tailored to individuals based on their earlier screening assessment. Only marginally significant reduction in stress (2) self-help e-mental health approach: five online interventions tailored to participants' earlier screening work-functioning results. Significant improvement in work-related fatigue & work functioning but not significant effects on stress (11) 3-month web-based stress	RCTs (22) mindfulness application app (Head-space): job strain & workplace support (33) 7-week mindfulness training adaptation of mindfulness-based stress reduction (a moderated discussion board) significant small to medium effect & at 3-month follow-up but no effects on mindfulness. (40) 4-week instructor-led (through online instructional videos) mindfulness training that combined elements of mindfulness-based stress reduction & mindfulness-based cognitive therapy: large effect on chronic and acute fatigue.	RCTs (10,49): 3-6-weeks evidence-based web-based cognitive & behavioural training (self-regulation, problem-solving); feedback, internet-based: overall stress, perceived stress, work engagement (48) Web-based guided self-help course (problem solving & cognitive therapy): emotional exhaustion (secondary outcome) small effects RCT (pilot) (28) online happiness training: stress warning, and particularly	-	RCTs (12) videoconferencing-based telepsychology: no perceived stress (23) 7-week psychoeducation & 2-phased approach (skill acquisition & practice): job stress & work engagement (32) cognitive-behavioral (4 modules, 2 sessions) no long-term effect in stress & in-person group better	RCT (8) 3-week mindfulness meditation practices via an app: no effect on perceived stress (51) 12-week real-time long-hour virtual classes: no effect on perceived stress	(9) micro-tasks: no effect on burnout/work engagement

	<p>management created (12) videoconferencing-based telepsychology: emotional labour (23) 7 weeks psychoeducation & 2-phased approach (skill-acquisition & practice): marginally coping skills</p> <p>(43) 6-week smartphone-administered stress intervention (based on ACT): significant medium effect-size for distress, significant medium effect-size for perceived stress</p> <p>(32) cognitive-behavioral (4 modules, 2 sessions) perceived stress (short-term)</p> <p>(37) 6-month web-based stress management and health promotion tool: perceived ability to manage stress, perceived social support</p> <p>(50) 8-week app developed to promote stress management and well-being: significant decreases in perceived stress, general stress.</p>		emotional stress				
	<p>Quasi: (27) two versions of a fully automated</p>	<p>Quasi: (24) 8-week online MBSR significant</p>	<p>Quasi: (7) one's month-use mobile</p>	-	-	-	(6) psychoeducation no

	<p>smartphone-based 4-week stress management (46) 70 minutes web-based assertion training stress management: improved significantly mental workload</p>	<p>improvement for state anxiety (35) Headspace app once a week for 4 weeks marginally improved burnout and compassion satisfaction (and improved compassion fatigue for those with low levels of PTSD symptoms (4, 29) 2-week mindfulness practice a wearable neurofeedback system managed via smartphone (29) & 6-week yoga therapy meditation program delivered and tracked by a smartphone app (4) significant improvement for burnout (4), mindfulness (4) (perceived stress (29), fatigue scores (29) and compassion fatigue (4) (3) online classes through six 50-minute interactive facilitated sessions of mantra repetition: beneficial effects in the frequency of Stressful Events, troubled conscience about stressful events & a significant decline in feelings of exhaustion);</p>	<p>mental wellness (20) one's month use of a resilience mobile application (Provider Resilience app): significant improvement in burnout and compassion fatigue, no significant effect on compassion satisfaction, symptom distress, interpersonal relations and social role (36) feasibility study a web-based version of a previously standardised group intervention behavioral intervention: perceived stress</p>			<p>effects on job stress (20) one's month use of a resilience mobile application (Provider Resilience app): no significant effect on compassion satisfaction</p>
<p>Evidence Group C: Psychological wellness indicators</p>						
<p>Evidence: n=20</p>			<p>No evidence: n=10</p>			

CBT (n=2)	Stress management/Wellbeing promotion (n=5)	Meditation/mindfulness-based interventions (n=7)	Self-help interventions (n=6)	CBT	Stress management/Wellbeing promotion n=1)	Meditation/mindfulness-based interventions (n=3)	Self-help interventions (n=6)
<p>RCT (10) interactive cCBT programme—significant effect on all efficacy variables except problem-solving—</p>	<p>RCT's (14) online workplace mental health promotion—five self-help online courses—with a duration from 6 to 8 weeks—significant (medium-sized effects at three-month follow-up and six-month follow-ups for positive mental health—and especially its psychological well-being subscale (34) 4-week mobile stress inoculation training: decrease in denial along with an increase in active coping (37) 6-month web-based stress management and health promotion tool:—mental energy, concentration ability.</p>	<p>RCT:— (5) six online sessions (mindfulness training, psycho-education and training in skills and strategies drawn from third-wave CBT); resilience, optimism and coping (22) 8 weeks mindfulness application app (Headspace): significant effect on mental well-being, daily positive emotions (40) 4-week instructor-led elements of MBSR & mindfulness-based cognitive therapy—significant medium effect on affective rumination and problem-solving pondering. Effects almost completely mediated from—effect on acting with awareness.</p>	<p>RCT: (15) 5-week self-help goal-based intervention: positive affect, life satisfaction</p>	<p>-</p>	<p>-</p>	<p>RCT:— (33) 7-week mindfulness training program—no effects on—mindfulness (51) 12-week real-time—long-hour virtual classes:—no effect on—mindfulness</p>	<p>RCT (16), (42) positive psychology interventions—psychoeducation—no significant effects</p>
<p>Quasi: (15) cCBT: 6-week webinar, six sessions: coping flexibility, self-esteem</p>	<p>Quasi: (21) 4-week web-based stress management intervention: improvement in psychological well-being (50) app developed to promote stress—</p>	<p>Quasi: (24) 8-week online MBSR—significant improvement—Mindfulness and Optimism (4) 6-week yoga therapy meditation program delivered and tracked by a smartphone app:—</p>	<p>Quasi: (28) happiness training: happiness, satisfaction, quality of life, mindfulness, recovery—experience,—and flourishing</p>	<p>-</p>	<p>Quasi: (27) fully automated smartphone-based 4-week stress management application: no effect in resilience</p>	<p>Quasi:— (17) of a—mindfulness-based resilience program (mindfulness & psychoeducation non-significant—moderate—</p>	<p>Quasi (7) one's—month—use of—mobile—mental—wellness—training—app (ACT—</p>

management and well-being 8-week	significant improvement (12) elective educational program in mind-body skills— three clusters of 1-hour modules: significant improvement for both Positive and Negative Affect) and Significant improvement on Flourishing. (19) 3 (1-hour-long each) meditation— meditation training— modules: gratitude, well-being, self-compassion, and confidence in providing compassionate care	intervention:— subjective well-being (31) e-learning— module resilience training:— perceived workplace resilience (7) one's month use of mobile— mental wellness training— app (ACT processes): life satisfaction (44) computer-assisted resilience training— course— on-pandemic self-efficacy and stress responses: improved self-efficacy, medium-length course— was sufficient for significant improvements— in pandemic self-efficacy, and interpersonal problems		effect size of re-	processes): (29, 41)— positive psychology interventions— psychoeducation— no significant effects (31) e-learning— module— resilience training:— no effect in dispositional— resilience
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3.5. Objective 2: Relationship between interventions' theoretical base and their effectiveness

We evaluated RCTs' theoretical base in order to understand the relationship between digital interventions' effectiveness and their theoretical underpinnings. This was also in line with this review's protocol that required the production of a separate analysis for the included RCT's. For this evaluation, we used the most relevant items from the 'theory coding scheme' (TSC) [103], combining them in two categories: a) Theory constructs (Are specific models/theories explicitly mentioned and their relationship with targeted

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psychological constructs?), and b) Intervention components (Are intervention techniques explicitly linked to theory relevant constructs?). This analysis allowed the tabulation of interventions' reported effects for "some effects" (only post-intervention) and "multiple effects over time" (post-intervention & follow-up) against the theoretical mechanisms described in those interventions. For those interventions that no explicit theory-base was described the "theoretical mechanism" column was also left **blackblank** while the rest were distinguished between (i) those targeted theory-based constructs OR described theory-based intervention components, and ii) those targeted theory-based constructs AND described theory-based intervention components (Table 2: Intervention types, theory mechanisms and effectiveness, Appendix: Full theory assessment).

Table 2: Intervention types, theory mechanisms and effectiveness.

	No effects	Some effects	Theory mechanisms	Multiple effects over time (T3 follow-up)	Theory mechanisms
No theory-base	5 RCTs: (85)cBT (95) self-help (96) self-help (91) self-help	6 RCTs: (86) Mindfulness-based (66) mindfulness-based (64) Stress management (47) stress management (65) stress management (72) stress management (37) stress management/health promotion	-	1 pilot RCT: (63) self-help: multi-component intervention	-
Theory-based constructs & theory-based intervention components	0 RCTs	2 RCTs (54)cBT (57) Stress management	(45) attributional style & cognitive and behavioural skills to improve it & reduce depression symptoms (34) Karasek's stress model & stress inoculation training (relaxation effect)	2 RCTs (55) cBT (59) Mindfulness-based	(55) cognitive restructuring & dysfunctional attitudes (59) Karasek's stress model-mindfulness components & social support
Theory-based constructs or theory-based interventions	4 RCT (101) Mindfulness-based (100) Mindfulness-based (71) Stress management (social learning theory) (97) self-help: positive psychology interventions	6 RCTs (83) Mental health promotion (62) self-help: problem-solving (102) cBT (78)self-help: self-regulation (68) Stress management (61) self-help: problem-solving (76) Meditation and mindfulness-based	(83) psychological wellbeing measures (positive mental health, subjective well-being measures), & positive psychology interventions choice (autonomy-self-termination theory) (62) Problem-solving therapy (102) cBT (cognitive restructuring) (78)self-regulation training	3 RCTs (88) Self-help: positive psychology (80) Self-help: positive psychology (69) Stress management	(88) psychological wellbeing measure (flourishing measure) & goal setting-happiness (80) Lubomirsky's happiness approach & positive psychology interventions for cultivating positive feelings, positive behaviours, or positive cognitions (69) mechanisms actions of mindfulness, relaxation response & positive mental health

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(68) ACT mechanisms
 (61) Problem-solving therapy
 (76) Mindfulness mechanisms of change, affective rumination & problem solving
 pondering & measures

The most effective cluster of interventions appeared to be theory-informed digital interventions that delivered evidence-based cognitive or behavioural training for the improvement of mental health concerns at work and other measures of work-related well-being [54,55,61,62,78,102]. Those interventions included computerised or digitally enhanced CBT targeting dysfunctional attributional styles through cognitive restructuring and self-regulation [54,55,102]; problem-solving therapy [61], and multi-component cognitive-behavioural training [62,63]. Stress management and [workplace wellbeing](#) programmes were often atheoretical as only 5/10 were partially explicitly based on a specific theory. Only one study [57] demonstrated a strong theoretical base as it was explicitly informed by Karasek's job strain model [104] measuring psychosocial outcomes and showed positive effects on improving state anxiety and active coping [57]. Four in five atheoretical interventions showed some positive effects on work-related wellbeing measures [47,64,67,72]. Finally, three in four partially theory-informed interventions [68,69,83] showed positive effects on work-related wellbeing and measures of psychological wellness based on acceptance and commitment therapy [68] and broad or dynamic conceptualisations of health and positive mental health [69,83]. For example, one intervention [69] that offered a tailored choice of online positive psychology interventions, viewing them as part of the preventive role of workers' health surveillance system that can improve subjective well-being [105], psychological wellbeing [106] and positive mental health [107] showed significant improvement in positive mental health but not significant differences for work-engagement, subjective well-being and mental [health](#) concerns (anxiety and depression). Mindfulness-based interventions were, in their majority, at least partially theory-based (4/6) but the impact of their theoretical assumptions was less clear. Two partially theory-informed interventions justifying meditation training on relaxation mechanisms showed no effects on stress [100,101]. In comparison, two mindfulness-based interventions that adopted Karasek's job strain model demonstrated significant effects on different aspects of psychological wellbeing at work. One study [59] adopted Karasek's model to justify measuring psychosocial outcomes, based its intervention components on the two-component model of mindfulness describing associations of mindfulness components with social support in the workplace and found significant effects sustained over time on depression, job strain, and psychological wellness measures. Another partially theory-informed mindfulness-based study that adopted Karasek's model showed some significant effects on work-related fatigue and showed that acting with awareness fully mediated the effects of the intervention on work-related wellbeing [76]. Finally, a good portion of self-help interventions (6/10) was partially theory-informed [61,62,78,80,88,97]. Overall, those partially theory-informed interventions within this cluster targeted psychological constructs or justified components of their interventions based either on cognitive and behavioural techniques or approaches to happiness and positive psychology interventions [80,88,97]. Only two partially theory-informed interventions [80,88] based on positive psychology techniques showed positive effects on psychological wellness measures. Those studies adopted Lyubomirski's theorising on how developing positive emotions, cognitions and behaviour through performing appropriately tailored activities can be associated with flourishing in the workplace [108].

3.6. Objective 3: Associations with workplace outcomes (secondary outcomes)

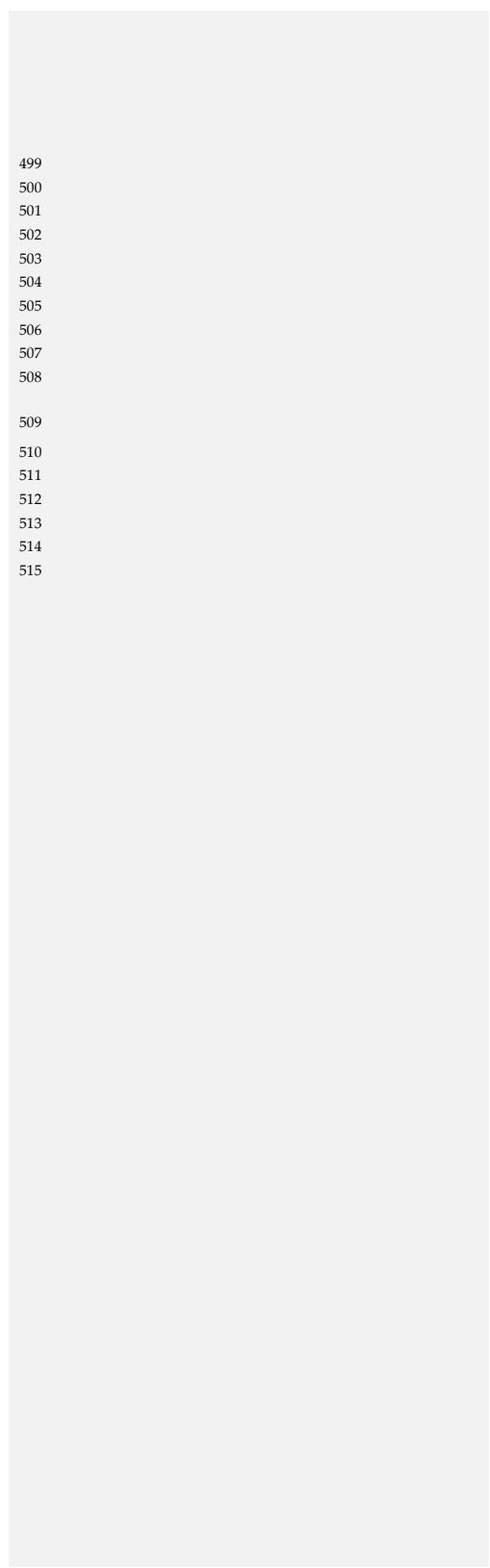
We formed a separate cluster of interventions' secondary outcomes. Those involved effects on workplace outcomes (e.g. job attitudes, job performance, job attendance). Only two studies, two RCT's and one quasi-experimental study, reported positive intervention effects on workplace outcomes. A quasi-experimental study showed that an interactive cCBT [56] had statistically significant effects on presenteeism (post-intervention and one month follow-up). An RCT showed that a web-based CBT had marginally statistically significant effect on sick leave days during the past three months [102]. Finally, another RCT demonstrated that multi-component mental health promotion [45] that included screening, feedback and a tailored choice of online interventions had statistically significant positive effects on work functioning ($p < 0.01$).

3.7. Critical appraisal

All the included studies (n=51) were assessed for risk of bias. Agreement between reviewers was reached in two rounds following an exchange of comments on their assessment. The Cochrane handbook classification guide was followed for RCT's (n=30) and randomised trials (n=2). The robvis online tool was used to generate a risk-of-bias plot for studies that used randomisation [109]. (Table 3).

*Table 3: RCT's quality appraisal

Study ID	Risk of bias						
	D1	D2	D3	D4	D5	D6	D7
1	x	x	x	-	+	+	x
5	-	+	x	-	-	+	x
8	x	x	x	-	-	+	-
9	-	+	x	-	-	+	-
10	x	-	x	-	+	+	-
11	x	-	-	-	-	+	x
12	+	+	-	-	+	+	x
14	+	+	-	-	-	+	-
15	x	-	x	-	+	+	-
16	x	+	x	-	-	+	-
18	x	+	x	-	x	x	+
20	x	+	+	-	x	+	x
22	x	+	x	-	-	+	-
23	+	-	x	-	-	+	+
26	x	+	-	-	x	+	-
28	x	-	-	-	+	-	-
32	x	x	x	-	+	+	-
33	x	+	x	-	+	+	x
34	x	x	x	-	-	-	x
37	x	-	x	-	+	-	-
38	x	+	+	-	+	-	+
39	x	x	x	-	+	-	x
40	x	+	x	-	+	-	-
42	x	-	-	-	-	-	x
43	x	-	x	-	+	-	x
44	x	-	x	-	+	-	x



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45	x	+	x	-	-	-	-
47	x	+	x	-	+	+	-
48	x	+	x	-	+	+	+
49	x	+	x	-	+	+	-
50	x	+	-	-	+	+	+
51	x	x	x	-	+	+	-
	D1: Random sequence allocation D2: Allocation concealment D3: Blinding of participants and personnel D4: Blinding of outcome assessment D5: Incomplete outcome data D6: Selective reporting D7: Other bias			Judgement  High  Unclear  Low			

The greatest risks of bias were associated with small sample sizes, high attrition rates and potential contamination effects. In particular, 14/32 studies were Unclear in describing their randomisation processes, and 6/32 demonstrated insufficient or no allocation concealment. Furthermore, many studies reported high attrition levels, with 11/32 not reporting adequately any processes of managing attrition or missing values and 11/32 studies not reporting power calculations for their sample size. Others reported low power due to small samples. Overall, only a few adequately powered studies used randomisation and demonstrated low attrition bias and low risk for contamination effects [69,71,85]. Among those, only one multi-component, partially theory-informed stress management intervention reported positive effects on work-related wellbeing [69]. The JBI Critical appraisal checklist for quasi-experimental studies was followed for all non-randomised intervention studies (n=19) (table 4).

*Table 4 near here: Quality appraisal of quasi-experimental studies

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
2	+	+	-	x	+	x	n/a	-	-
3	+	+	n/a	x	+	+	n/a	+	-
4	+	+	-	x	+	n/a	n/a	+	-
6	+	+	-	+	+	-	+	+	x
7	+	+	x	x	+	x	n/a	-	-
13	-	-	x	x	-	-	n/a	-	-
17	+	+	+	x	+	x	n/a	+	-
19	-	-	x	x	+	n/a	n/a	-	-
21	+	+	+	x	+	x	n/a	-	+
24	+	+	+	x	+	+	n/a	+	+
25	+	+	+	x	+	+	n/a	+	x
27	+	+	x	x	+	x	n/a	-	+
29	+	+	+	x	+	-	n/a	+	+
30	+	+	+	x	+	x	n/a	-	-
31	+	-	+	x	x	x	-	-	x
35	+	x	x	x	+	x	n/a	+	+
36	+	+	+	x	+	x	n/a	x	-
41	+	+	x	+	+	x	+	+	-

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46	+	+	+	x	+	+	n/a	+	-	
	Judgement									
Q1: "Cause" & "effect"								x		High
Q2: Similar comparisons										
Q3: Receiving same treatment										Unclear
Q4: Control group								-		
Q5: Pre-post										
Q6: Follow up completion										Low
Q7: Outcomes included								+		
Q8: Reliability										
Q9: Appropriate Statistical analysis								n/a		Not applicable

The highest proportion of bias (6/19) involved differences between the treatment groups and differences in treatment received beyond the intervention. Studies reported comparisons between single groups at different time points that received slightly different interventions or included samples with prior exposure to or knowledge of the intervention. In addition, 9/19 studies utilised small samples (N<40) that often faced low statistical power due to high attrition and low sample size. Only two studies showed both low risk of selection bias and low risk to exposure to other treatments, along with adequate reliability of outcome measures and appropriate statistical analysis [60,73]. Both studies reported significant effects of digital mindfulness-based interventions on fatigue scores [60,73].

4. Discussion

This systematic review synthesised the evidence on the effectiveness of digital psychological interventions in the workplace. Previous reviews have shown that group-based in-person psychological interventions delivered in the workplace can have small positive effects on psychological well-being and possibly improve desirable work outcomes [110-112]. ~~At the same time, Furthermore,~~ group-based in-person mindfulness meditation programs may improve some physiological indices of stress among employees [73]. With most of the evidence elicited from studies reporting interventions that require in-person attendance there is less systematic evaluation of the effects of digital psychological interventions across different facets of psychological wellbeing at work.

Recent meta-analyses showed that digital psychological interventions can have small positive effects on mental health, especially in reducing stress, depression symptoms, psychological distress, and improving work performance [23,42]. Moreover, app-supported CBT has been found to produce the largest effects on common mental health problems [113]. However, there is a generally fractured overview of the effectiveness of digital psychological interventions in the workplace. Reasons include a primary focus on specific intervention approaches or methods, evidence syntheses including both digitally delivered and in-person ~~intervention interventions~~, the prioritisation of deficit-based or asset-based wellbeing outcomes, ~~and~~ the extensive variance in interventions' characteristics and low-quality research designs that can limit the robustness of a synthesis' conclusions [111,114,115]. For this reason, we conducted an integrative narrative synthesis of the evidence on effectiveness measures, including any digital psychological interventions in the workplace. Subsequently, we mapped the effects of four groups of digitally delivered psychological interventions (CBT, meditation training/mindfulness-based interventions, stress-management/wellbeing promotion, and self-help interventions) against three categories of outcomes: prevention or management of mental health concerns, work-related wellbeing outcomes, and psychological wellness indicators.

However, just four studies (3 RCT's & 2 quasi-experimental studies) (60, 69, 71, 73, 85) demonstrated a lower proportion of bias than the rest. Thus, it is important to treat any interpretations of results with caution. For example, many RCTs suffered from high attrition however few provided clear details on how this was mitigated. At the same time,

only a small number of quasi-experimental studies offered details on completion of follow-up assessments further diminishing the quality of the evidence they provide. What is more, a significant portion of the studies targeting work-related wellbeing and psychological wellness indicators ~~report~~reported substantially more positive results than negative ones which can be an indicator of publication bias. On the contrary, there was a relative balanced report between positive and negative results ~~-~~reported overall across ~~in~~ interventions targeting mental health concerns which is indicative of the robustness of CBT interventions.

Objective 1: Effectiveness of digitally delivered psychological interventions at work

The most frequently cited type of intervention was self-help interventions, followed by stress management/workplace wellbeing promotion programmes and mindfulness-based interventions and a small cluster of online cognitive behavioural therapy. These interventions targeted three main clusters of psychological outcomes: a) reduction or management of mental health concerns, b) improvement of work-related wellbeing outcomes and c) improvement of psychological wellness indicators. Overall interventions varied substantially in terms of duration, intervention content, and outcomes' measures. Similarly, to previous reviews, they demonstrated a high risk of bias [116] as both randomised and non-randomised studies demonstrated low power due to small sample sizes, increased risk of contamination effects, and high attrition bias.

a) Evidence Group A: Mental Health Concerns at work

Effective digital interventions for the prevention or management of mental health concerns included primarily online CBT-based interventions with four out of five demonstrating sustainable effects in the reduction of depression systems (54-56, 63, 85) and short-term effects for the reduction of anxiety (54). This is in accordance with evidence that app-supported CBT can produce the largest effects on common mental health problems [113]. However, there was no evidence for their effectiveness among employees with already elevated depression scores [61,85,95] that supports previous findings that online CBT in the workplace may be less suitable for the treatment of symptoms among those already suffering from depression [117,118]. The only non-CBT interventions that were effective in reducing depression symptoms was app-based mindfulness practice with the Headspace (59) and two self-help intervention delivering problem-solving therapy (62, 95). Other effective non-CBT interventions included another app-based mindfulness practice, two of six stress management interventions that included relaxation techniques and another self-help intervention that delivered problem-solving therapy and demonstrated some positive effects in reducing anxiety (57, 58, 60,95). Similarly, a meta-analysis showed that mindfulness-based interventions at work could have higher moderate effects on anxiety than depression [111]. Furthermore, a recent review on the effectiveness of mindfulness-based self-help interventions in the general population showed that they can have small effects on depression and anxiety measures post-intervention but do not seem to be retained in follow-ups [119].

b) Evidence Group B: Work-related wellbeing outcomes

Psychological interventions for improving work-related wellbeing outcomes targeted a mixture of deficit-oriented and asset-oriented psychological outcomes. What characterised those outcomes was that they did not necessarily focus on an absence of negative mental health conditions. This was frequently the case in stress management interventions [121] and also applied in this review to interventions targeting work-related stress and stress outcomes as part of workplace health or mental health promotion programmes, an approach frequently adopted as a prevention strategy for job stress [8,120]. For this reason, we clustered together interventions described as stress management interventions with those that combined training in stress management techniques with psychoeducation and other psychological skills' training.

The most frequently utilised interventions targeted work-related wellbeing outcomes and were delivered either via web-based tools or mobile apps. Intervention effects included significant positive effects primarily on perceived stress [62,65,67,68,72], distress [45,64,68], subjective symptoms of stress [69], work-related fatigue [45], as well as in psychosocial demands (i.e. emotional labour, mental workload) [58,70] and work-engagement [83]. Psychoeducation alone showed only some effects in the management of emotional labour and mental workload. It had, though, no effects on any other work-related wellbeing outcomes, which is in line with previous reviews of the literature showing educational interventions to be the least effective for employees' psychological health [122-124]. Relaxation training appeared to be an essential characteristic of effective interventions for stress management and wellbeing promotion programmes [58,65,67,69,72], while tailored brief interventions that were part of e-mental health programmes showed marginal or no effects on perceived stress [45,64]. Stress inoculation training and relaxation techniques [57,58] were the only stress management interventions that showed positive effects in reducing mental health concerns. Previous reviews have also confirmed the existence of strong evidence for the effectiveness of physical relaxation and mindfulness practice for reducing occupational stress [13,125]. However, a systematic review of brief mental health and wellbeing interventions found no evidence for their effectiveness [116]. What is more, mental health promotion programmes and web-based and app-based stress management interventions demonstrated significant effects on psychological wellness (i.e. positive mental health, Ryff's Psychological well-being scale) and psychological resources (i.e. coping skill, mental energy, concentration ability and active coping) [57,67,69,84,87] but there were no significant effects on resilience [58] (27). Finally, there was evidence that in-person stress management interventions may be more effective if not equal to digitally delivered ones [58,65,72]. There is generally less clarity on the overall effectiveness or non-inferiority of digital interventions for improving work-related wellbeing compared to face-to-face interventions. Nigaru et al. [126] showed that virtually-delivered CBT and non-CBT might have a greater effect in reducing depression symptoms than their in-person counterparts [126], while Carolan et al.'s [23] meta-analysis of web-based psychological interventions showed that their effect on psychological wellbeing is comparable to non-digital workplace interventions. Finally, Vanhove et al.'s [11] review showed that face-to-face and group-based resilience-building interventions in the workplace might be more effective in improving work-related wellbeing outcomes than computer-based interventions.

Meditation training and mindfulness-based interventions mainly had significant effects on fatigue-related measures, a finding that has also been previously confirmed among other populations such as cancer survivors [127,128]. Mindfulness-based interventions demonstrated greater variety in delivering methods ranging from self-guided app-based training practice [59,60,74] to instructor-led courses [75,100]. Evidence from quasi-experimental studies and a few RCT's [59,76] suggests that mindfulness-based interventions and guided meditation training or mindfulness practices [66,76] often through mobile applications (i.e. Headspace, wearable neurofeedback system managed via smartphone) [59,60,74] and web-based tools [66,76] may have a significant effect on work-related fatigue. In particular, our synthesis showed significant effects on fatigue scores, compassion fatigue, chronic fatigue and acute fatigue [60,74,76,77] as well as burnout [75,77], job strain [59], and over-commitment [73] especially for those below the threshold for PTSD [77]. Meditation training and mindfulness-based interventions with the strongest evidence-based (i.e. MBSR, third-wave CBT) had the strongest effect on psychological wellness indicators (i.e. resilience, optimism, coping, mindfulness, subjective well-being, acting with awareness, daily positive emotions, gratitude, flourishing, self-compassion) [59,73,74,76,86,87,99], while half of the interventions that had significant effects on such outcome measures were also among those that reported positive effects on work-related wellbeing measures (i.e. Headspace app, MBSR, yoga therapy). Such findings are in accordance with growing evidence supporting the premise for mindfulness interventions in the workplace for employees' wellbeing [129]. However, a recent meta-analysis showed

that non-digitally delivered mindfulness-based self-help interventions have greater effects on psychological wellbeing measures at work than digital interventions [119]. A recent review of mindfulness-based interventions showed that they could be effective, especially among healthcare professionals, due to the high risk of burnout and the associations between mindfulness, compassion, and self-compassion [130]. In our synthesis, four out of five quasi-experimental studies reporting effective meditation training or mindfulness-based interventions targeting work-related well-being outcomes focused on healthcare professionals [73-75,77]. Only one quasi-experimental study, though, assessed their effects on self-compassion (99), whose associations with compassion fatigue and burnout have been increasingly the focus of discussions about healthcare professionals' work-related wellbeing [130-132].

Digital self-help interventions for improving work-related well-being included delivering psychological skills training primarily via web-based tools. The evidence on web-based self-help interventions suggests that guided [62] and unguided [61,78,80] self-help courses delivering evidence-based cognitive-behavioural training (problem-solving, cognitive therapy, positive psychological states' development) can improve perceived stress and emotional stress over time [80]. Only two self-help interventions were delivered via mobile applications [79,82]. They were tested using quasi-experimental research designs, and they showed that mental wellness training based on acceptance and commitment therapy [79] and resilience training [82] might improve ratings of stress [79], burnout and compassion fatigue. Still, there were no effects on compassion satisfaction [82]. Similarly, to stress-management interventions, psychoeducation alone [94] showed no effect on work-related well-being measures. There was also no evidence for the effects of self-directed micro-tasks [96] on work-related wellbeing. Digitally delivered CBT programs only showed marginally significant effects on distress [55] and only marginally significant indirect effects on work-engagement through changes in depression [102]. However, work-related well-being measures were viewed as secondary intervention outcomes for both interventions. A meta-analysis [133] points out that CBT-based interventions may be more suitable for addressing stress manifestations than others, while intervention settings can be a significant moderator of observed intervention efficacy with group-based interventions to demonstrate stronger effects on exhaustion.

c) Evidence Group C: Psychological wellness indicators

Interventions that focused on the improvement of psychological wellness indicators targeted asset-oriented outcomes. This cluster of interventions was also the one with the lower quality of evidence, especially for the effectiveness of self-help interventions.

Digital mindfulness-based and self-help interventions frequently targeted psychological wellness indicators. Studies described a variety of online- and app-based interventions and training courses that demonstrated positive effects on positive affect, life satisfaction, happiness and flourishing, pandemic self-efficacy and perceived workplace resilience. A review of digital self-help interventions in the overall population showed that they could positively affect mental well-being (e.g. mood enhancement) but only if they have adequate uptake and adherence [134]. However, Van Agteren et al.'s [135] meta-analysis showed substantial differences in the quality of the evidence of psychological interventions for mental well-being in the general population. For example, they found high-quality evidence for small to moderate effects for mindfulness-based interventions, low-quality evidence of limited effects for multi-theoretical interventions, and superiority of group-based interventions over individual-based and technology-based interventions. Our synthesis also signals that other intervention-relevant or population-relevant characteristics need to be addressed to explain differences in interventions' effectiveness fully. One quasi-experimental study combining psychoeducation with evidence-based psychological strategies, including acceptance and commitment therapy, showed non-significant improvements in psychological wellbeing. Future research should investigate the impact of digital self-help interventions on psychological wellbeing. Mindfulness-based self-help interventions (87, 99) showed positive effects on online hourly training modules on a variety of psychological wellness indicators (i.e. gratitude, self-compassion, flourishing,

positive and negative affect). Moreover, two RCTs showed no effects of real-time virtual classes and an online training programme on mindfulness [100,101]. What is more, there was no evidence of interventions' effectiveness either using psychoeducation solely or combining it with positive psychology exercises for improving dispositional resilience or other psychological wellness indicators (i.e. happiness, gratitude, job-related affective well-being) irrespectively to their theory-base. Finally, two studies reported that secondary outcomes of interactive CBT programmes involved positive effects on efficacy variables, coping flexibility and self-esteem [55,56].

Objective 2: Relationships between interventions' theory-base and their effectiveness

We evaluated the theory-base of all included RCT's using an adaptation of the 'theory coding scheme' (TSC) categories [103], which has also been used to evaluate the theoretical basis of psychological and occupational health interventions [136, 137]. Our results showed that although many of those interventions were merely partially theory informed, they were still more effective than those that were not theory-informed. However, the actual relationship between interventions' theory base and effectiveness differed across different outcome measures. Previous research has shown that theory-informed interventions, often based on self-determination theory, can have positive effects on mental health self-management [138,139]. However, much less is clear about the effects of theory-informed psychological intervention on individuals' psychological health self-management in the workplace. The most effective interventions for reducing depressive symptoms and anxiety were both theory-informed and evidence-based interventions. Those involved online CBT targeting dysfunctional attributional styles through cognitive restructuring and self-regulation [54,55,102]; problem-solving therapy [61,62] and multi-component cognitive-behavioural training [63]. The only other RCTs that showed effects on such mental health concerns involved training in mindfulness practices using Headspace mobile application [59] and mobile stress inoculation training [57]. Those were both informed by Karasek's job strain model for targeting specific psychological outcomes.

As far as work-related wellbeing is concerned, there was a weaker association between intervention effectiveness and the strength of their theory base as many atheoretical stress management interventions showed significant positive effects primarily on perceived stress [47,64,65,67,72]. At the same time, none of the effective partially theory-informed interventions [68,69] fully described intervention techniques explicitly linked to theory-relevant constructs (e.g. teaching ACT principles without relating them to specific intervention components) [68]. Furthermore, two out of three mindfulness-based interventions that reported effects on work-related wellbeing measures was at least partially theory informed. This finding suggests that the theory-base of intervention mechanisms [59,76] and targeting theory-relevant psychological constructs [59] may be associated with the effectiveness of mindfulness interventions. On the other hand, effective self-help interventions were often partially theory-informed. They frequently incorporated problem-solving therapy, self-regulation, and cognitive therapy and had significant effects on perceived stress [62,78] and emotional exhaustion [61]. On the contrary, all three RCTs (two meditation training interventions and one self-help intervention) [96,100,101] showing no effects at all for work-related wellbeing were also among those that were judged as being not theory-informed.

Contrary to studies targeting work-related wellbeing outcomes, the majority of RCT's reporting positive effects on psychological wellness measures were at least partially theory-informed [57,69,83]. Theoretical mechanisms of effective interventions demonstrating multiple effects over time involved Lyubomirki's theorising on positive emotions' development and goal setting and planning theory (i.e. intentional activities, to cultivate positive feelings, setting and pursuing goals) [80,88] that explained the intervention mechanisms described in those studies although at times with less direct links with specific outcome measures (i.e. flourishing). Similarly, to studies targeting mental health concerns, some of the most effective interventions with the strongest theory-base were those that

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used Karasek's job strain model [57,59]. They adopted that model to explain the targeted effects of stress inoculation training or justify targeting psychosocial outcomes (i.e. social support) and provide an explicit description of how intervention components (i.e. relaxation techniques, regulation of attention) are linked with the theoretical construct of job strain [57,59]. Finally, some theoretical approaches that were associated with effective interventions although, with less clear links to intervention outcomes were mindfulness mechanisms of change or the facets of mindfulness [69,76] and dynamic concepts of health and wellness for positive mental health or psychological wellbeing [83,87,88].

Objective 3: Associations with workplace outcomes

The included studies in our review suggest minimal associations between their intervention effects and workplace outcomes. Those involved effects of online CBT on presenteeism and marginally on the number of sick days. However, they were assessed as secondary intervention outcomes [56,102]. Finally, there were some effects of an online well-being promotion program on work-functioning that was a line of enquiry generated from previous trial arms focusing specifically on work performance [45]. These findings are in accordance with recent findings that workplace interventions have a weaker impact on workplace outcomes than mental health [114].

5. Limitations

There is a number of limitations that also need to be acknowledged. First of all, a significant portion of the included studies demonstrated low quality. Furthermore, we acknowledge that the inclusion of additional reviewers at the abstracts/full-papers screening and the quality appraisal stage but not at the titles/abstract screening stage could have influenced the overall quality of the screening process. Due to the large heterogeneity in intervention characteristics and research designs of studies evaluating digitally-delivered psychological interventions in the workplace, we included only randomised controlled trials and quasi-experimental studies in the review, thus evidence from qualitative or mixed methods studies was **excluded**. Our synthesis showed that many digital mindfulness-based interventions, which have gained popularity in the last years, have not been evaluated using RCT designs. This means that conclusions about their effectiveness may be more problematic than the evidence from digital interventions delivering cognitive behavioural therapy or cognitive-behavioural skills training. However, excluding them would significantly reduce the scope of emerging evidence in the field. Furthermore, the evidence on digital third-wave CBT interventions still lags behind comparatively to other digitally delivered psychological interventions and for this reason we refrained from clustering together studies that included such components. Similarly, emergent digital interventions in the field that have been examined via other methods (e.g. qualitative or mixed methods research designs) were essentially excluded by this review. Furthermore, the review was limited to articles published in English. Thus, relevant literature published in another language may have been missed. Moreover, the searches for this review were completed in July 2019; thus, it only includes studies published before the Covid-19 pandemic. A future update of this review could examine changes in our knowledge on the effectiveness of digitally delivered psychological interventions in the workplace post-pandemic. Finally, our review explicitly focused on interventions delivered in the workplace; thus, studies that followed open community recruitment processes were not included. Previous research has shown that such recruitment strategies may heighten the effectiveness of occupational e-mental health interventions compared to workplace recruitment [140], which further highlights that there may be 'unknown' mediators that may count for interventions' observed effectiveness or its absence.

6. Conclusions

A key finding of this review is that evidence-based interventions that aim to improve psychological wellbeing in the workplace can be significantly benefited by adopting a

clear theoretical framework that informs both the content of the intervention and its targeted outcomes. What is more, more research needs to be directed towards comparing directly digital interventions with equivalent in-person interventions. This also highlights the importance of adopting strategies to capture small differentiations between interventions, such as recording participant preferences before their random assignment to one or another condition and incorporating those in subsequent modelling to address their effect as a confounder or mediator, of a study's targeted measures [141]. Some key recommendations, though, based on our review, are the following:

-Digitally delivered CBT, problem-solving, relaxation techniques, stress inoculation training and meditation practice using the Headspace mobile application can inform well-being programmes to prevent the development of mental health concerns at work.

-Training in relaxation techniques is an essential element for effective stress management interventions at work, and interventions targeting occupational stress may benefit in-person delivery methods.

-Psychoeducation alone is the least effective intervention approach for psychological wellbeing promotion in the workplace

-Theory-informed digital interventions are associated with greater effectiveness

*See column1 Appendix 2 for study numbers shown within the quality appraisal tables

Supplementary Materials: Supplemental material is provided and uploaded and marked within the text as "Appendix".

Author Contributions: M.A and H.B. conceptualised the study. M.A., S.K. and H.B. provided input on the formulation of the research objectives, the inclusion and exclusion criteria and the associated search terms. M.A. developed the search strategy with assistance from S.K. M.A. conducted the searches, registered the systematic review with PROSPERO, and piloted the search strategy. M.A. and E.A. were involved in the screening of the studies and the data extraction from the included studies. M.A. and S.D. conducted the quality appraisal of the included studies. MA conducted the narrative synthesis. H.B. and S.K supervised the progress of synthesis. M.A. drafted the protocol manuscript. All authors reviewed, contributed to the final version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable"

Informed Consent Statement: Not applicable."

Conflicts of Interest: The authors declare no conflict of interest

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