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# Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

<table>
<thead>
<tr>
<th>Journal:</th>
<th>BMJ Open</th>
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</thead>
<tbody>
<tr>
<td>Manuscript ID</td>
<td>bmjopen-2022-067930</td>
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<tr>
<td>Article Type:</td>
<td>Protocol</td>
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<td>Date Submitted by the Author:</td>
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</tbody>
</table>
| Complete List of Authors: | Schladitz, Katja; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health  
Luppa, Melanie; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health  
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Loebner, Margrit; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health |
| Keywords:        | MENTAL HEALTH, NUTRITION & DIETETICS, Depression & mood disorders < PSYCHIATRY, Eating disorders < PSYCHIATRY, PUBLIC HEALTH |
Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

Katja Schladitz¹,², Melanie Luppa¹,³, Steffi G. Riedel-Heller¹,³, Margrit Löbner¹,⁴

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Abstract

Introduction. Internet- and mobile based interventions (IMIs) provide innovative low-threshold and cost-effective prevention and self-management options for mental health problems complementary to standard treatment. The objective of this systematic review is to summarize the effectiveness and to critically evaluate studies on IMIs addressing comorbid depressive symptoms in adults with overweight or obesity.
**Methods and analysis.** The study authors will systematically search the databases MEDLINE, Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature) for randomized controlled trials of IMIs for individuals with overweight or obesity and comorbid depressive symptoms. Two reviewers will independently extract and evaluate data from studies eligible for inclusion by assessing quality of evidence and qualitatively synthesizing results. Preferred Reporting Items for Systematic Reviews (PRISMA) standards and the revised Cochrane Risk of Bias tool in RCTs (RoB 2) will be applied.

**Ethics and dissemination.** Ethical approval is not required as no primary data will be collected. Study results will be disseminated through publication in a peer-reviewed journal and presentations on conferences.

**Prospero registration number.** Will be supplemented after the peer review (in case methodological changes are required during this process)

**Keywords**
Overweight, obesity, comorbidity, depressive disorder, internet- and mobile based intervention

**Strengths and limitations of this study**
- First study providing a comprehensive summary of studies examining the effectiveness of internet- and mobile based interventions (IMIs) for adults with overweight or obesity with comorbid depressive symptoms.
- IMIs for this target group can be used at a low threshold for both preventive purposes and as a complementary treatment option in healthcare settings.

**Background**
Overweight and obesity are among the major global public health problems reaching near-pandemic levels [1]: The worldwide prevalence of overweight and obesity has nearly tripled since 1975, with a steady upward trend [2–4]. The World Health Organization (WHO) defines overweight and obesity “as abnormal or excessive fat accumulation that may impair health” [4], with adults having a body mass index (BMI) of ≥ 25 defined to be overweight and a BMI of ≥ 30 defined to be obese. In 2016, 39 % of the world’s adult population were overweight and 13 % were obese [4].

Obesity and overweight cause a number of adverse health consequences: they reduce physical as well as mental health and increase the risk of developing chronic diseases such as diabetes, hypertension or cancer [5–7]. Obesity thus indirectly increases mortality [8] and represents an important economic burden on the health care system [9–12]. Overweight and obesity are also associated with increased negative psychosocial consequences and an increased prevalence of mental disorders, including depression as one of the most prevalent [13, 14].

Depressive disorders are belong the most common mental disorders, with global cross-age point prevalence rates in 2019 of 3.8 % [15] and increasing tendency [16, 17]. They are among the most significant contributors to the global burden of disease causing significant direct and indirect costs [18, 19]. There are well-established, effective treatment methods such as cognitive behavioral therapy (CBT), interpersonal or supportive therapy for depressive disorders [20, 21].

For obesity and comorbid depressive disorders, meta-analyses of cross-sectional studies [22–28] showed a pooled odds ratio (OR) between 1.18–1.38 among individuals with obesity compared to
eutrophic people to experience a depressive symptomatology in studies based on clinical diagnoses and/or self-reported symptoms (and \( \text{OR}=1.07 \) for overweight people [27]). A meta-analysis of longitudinal studies [29] identified obesity as a predictor for increased risk of onset of depressive symptoms at follow-up with \( \text{OR} = 1.55 \) and overweight with \( \text{OR}=1.27 \).

Co-occurrence of overweight or obesity and depressive disorders amplifies the negative impact on physical and mental health and social life [30, 31]. There is evidence that obesity and depressive disorders share the same dysregulations of some biological mechanisms such as neurotransmitter balance, immuno-inflammatory processes or oxidative stress [32–35]. Behavioral factors such as unhealthy eating habits or low physical activity appear to mediate the association between overweight or obesity and depressive disorders [34]. Psychosocial factors such as weight discrimination and double stigma of obesity and mental disorders can also act as chronic stressors and aggravate depressive symptomatology [36, 37]. There is empirical evidence of a higher prevalence of comorbid depressive disorders [13, 22–25, 27, 28] in women with overweight or obesity.

The effectiveness of internet- and mobile-based interventions (IMIs) has been demonstrated for a wide range of mental health conditions [38, 39]. They can be applied as an innovative, efficient, low-threshold and location-independent prevention and treatment method to complement existing outpatient and inpatient services and to offer support while waiting for therapy vacancies [40]. They are appropriate for different target and risk groups. IMIs for depressive disorders are effective and have a high acceptance of use with effectiveness comparable to conventional “face-to-face” interventions [39, 41, 42]. They can be accessed at low thresholds and relatively low costs [43, 44].

Given the high prevalence of overweight, obesity and depressive disorders alone, as well as overweight or obesity with comorbid depressive disorders, there is a high demand of cost-effective interventions. IMIs tailored to the specifics of overweight or obesity with comorbid depressive disorders could mitigate this need. Current systematic reviews and meta-analyses show that IMIs have been established as effective and acceptable in weight loss and physical activity management (e.g., 45–50). A recent review of mobile interventions for the management of overweight or obesity with comorbid depressive disorders [51] found no single smartphone-based intervention that addressed both the physical and mental illness equally and most of the identified studies focused on the monitoring of weight and physical activity. We found no review of internet-based interventions for people with overweight or obesity and comorbid depressive disorders. Yet there is an increasing number of randomized controlled trials (RCTs) of specific IMIs with psychotherapeutic elements that address both overweight or obesity with comorbid depressive symptoms (e.g., 41, 52–54). To the best of our knowledge, there is no review which reflects the current state of research of IMIs with psychotherapeutic elements for adults with overweight or obesity and comorbid depressive disorders.

Objectives

Therefore, the purpose of this planned study is an systematic evaluation and synthesis of empirical findings based on RCTs of IMIs for adults aged 18 years and older with overweight or obesity who experience comorbid depressive symptoms, focusing on the effectiveness of these interventions (e.g., the improvement of objective measures of depressive symptoms) compared to treatment-as-usual, low-level support or no intervention. If possible (depending on the number of eligible studies), it is also planned to combine data across RCTs for an estimation of pooled effect sizes for the reduction of depressive symptomatology.
Methods and analysis

This review protocol outlines the planned strategies for a review of RCTs on the topic of IMIs for adults with overweight or obesity and comorbid depressive disorder. It describes how data will be systematically evaluated and synthesized to examine the effectiveness of these IMIs according to the 24-step guide by Muka et al. [55]. It follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA)-statement for systematic reviews [56]. Therefore the study selection process will be in accordance with the four-phase PRISMA flow diagram (figure 1).

Eligibility criteria

The planned review will follow the PICO scheme and include effectiveness RCTs involving adults aged 18 years and older with overweight or obesity and comorbid depressive symptoms (participant criteria) applying IMIs. The studies must examine clinical psychological interventions as defined by Kampling et al. [57] (intervention criteria):

- CBT
- psychodynamic psychotherapy
- behavior therapy or behavior modification
- systemic therapy
- third wave CBT
- humanistic therapies
- integrative therapies
- other psychological-oriented interventions.

Any type of control condition with the following types of comparison groups will be included (comparison criteria):

- treatment as usual
- waiting list
- low-level support
- psychosocial support
- attention placebo (both researcher and participants are inactive)
- psychological placebo (participants are active and researchers inactive).

Any measures of effectiveness (e.g., improvement of objective measures of depressive symptoms) will be included (outcome criteria). Data from clinician-rated scales will be rated higher than self-report questionnaires. The literature search will cover articles written in English or German (language criteria) and will not be restricted by publication date. Articles examining a highly specific population (e.g., pregnant women or a population with a specific somatic disease) will be excluded.
Information sources and search strategy

It is planned to include the following databases in the literature search: MEDLINE (via PubMed Interface), Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature). KS and another researcher (NN) will search independently using the following combination of search terms: (1) obesity or overweight or adiposity or metabolic syndrome or body mass index; and (2) depress*; and (3) internet or online or web or computer or mobile or app or smartphone or m-health or mobile health or e-health or e-mental health or iCBT or cCBT or IMI; and (4) intervention or psychotherapy or therapy or cognitive behavioral therapy or cbt. The MEDLINE search strategy will be adapted to specifications of each database.

Both researchers will screen titles and abstracts and, when eligible, full texts of the studies will be assessed for the defined criteria. In addition, reference lists of all included studies and systematic reviews will be searched manually to identify further potentially relevant articles, and a grey literature search for unpublished studies will be conducted using Google and Google Scholar with the search terms. Searches will be rerun before starting the final analysis to include more recently published studies.

Data management

The authors plan to use the software package Review Manager Web (RevMan Web) V.4.12.0 [58], which was specifically designed for the management, analyzing and synthesizing bibliographic information and data from systematic reviews, or another suitable software. Additional data analyses and meta-analyses will be conducted using SPSS V.27.0 [59].

Selection process

KS and another researcher (NN) will screen all titles and abstracts independently and divide the retrieved articles into the categories “potentially relevant”, “irrelevant” and “uncertain” (classification as “irrelevant” will be explained). In a second step, both researchers will read “potentially relevant” and “uncertain” articles in full text and assess their study eligibility based on the criteria listed above (participant, intervention, comparison, outcome). Discrepancies in each step will first be discussed between both reviewers, and, if they cannot be solved, then with a third senior researcher (MLö).

Data collection process and data items

A standardized data extraction form for the extraction of the study data will be developed. To ensure that all relevant data will be extracted correctly, both reviewers will independently test the pilot version of the form on a subsample of relevant articles, discuss difficulties and adopt the data extraction form accordingly. Both reviewers will extract data from each study independently. Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing data, study authors will be contacted.

The following data will be extracted:

1. Study identification items (e.g., first author, year of publication, country)
2. Study design characteristics (e.g., sample size, recruitment strategy, inclusion and exclusion criteria, classification of obesity levels, assessment of depression, assessment of concurring
conditions like comorbidities and pharmaco- or psychotherapy, intervention design/duration, control group condition, follow-up assessments)

3. Participant characteristics (e.g., mean age and age range, gender)
4. Methodological factors (e.g., risk of bias, study limitations)
5. Outcome data (in case of follow up-assessments, all waves will be included): effectiveness = reduction of depressive symptoms

Quality assessment

The authors plan to use the revised Cochrane Risk of Bias tool in RCTs (RoB 2) [60]. KS and another researcher (NN) will independently assess the methodological quality of the included studies in the following domains:

1. Bias arising from the randomization process
2. Bias due to deviations from intended interventions
3. Bias due to missing outcome data
4. Bias in measurement of the outcome
5. Bias in selection of the reported result.

On this base, all studies will be assigned to the three corresponding overall risk-of-bias-grades following [60]: “high risk of bias” (at high risk of bias in at least one domain, or some concerns for multiple domains), “some concerns” (some concerns in at least one domain, but no high risk of bias for any domain) and “low risk of bias” (low risk of bias for all domains). Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing methodological information, study authors will be contacted. In the risk of bias table, results of the ratings will be shown for each domain.

Data synthesis and presentation

The characteristics (as listed under “Data collection process and data items”) of all included studies will be presented in a narrative synthesis, starting with study and sample characteristics and descriptions of intervention and control group conditions, followed by outcome measurements, effect sizes and overall results.

If a sufficient number of eligible studies is found, an optional second part will be done. The authors will include these studies in a meta-analyses that provide quantitative measures of depression and analyze heterogeneity between RCTs with the use of \( I^2 \) statistics, funnel and forest plots. A moderate level of heterogeneity of 30–60 % between studies for \( I^2 \) will be assumed according to the Cochrane standards [61]. If studies fail to show sufficient heterogeneity (\( I^2 < 60 \% \)) in at least two trials [62], meta-analytic pooling will not be undertaken. Since the cause of inconsistency may result from study characteristics [61], sources of heterogeneity in subgroups of studies in terms of type of BMI-classification (overweight or obesity) or intervention type (type of psychotherapeutic intervention) will be explored. As studies with different outcome measures (depressive symptoms) and various interventions will be included, a random effects model will be applied and standardized mean difference values and their associated 95 % confidence intervals will be estimated. In case of missing date, the authors will handle them according to the Cochrane Handbook for Systematic Reviews of Interventions [61]. RevMan Web V.4.12.0 [58] or another eligible software will be used for data analyses.
Patient and public involvement
No patient and/or the public involved.

Discussion
The planned systematic review will provide a comprehensible summary of the effectiveness of IMIs for adults with overweight or obesity and comorbid depressive disorders.

If prevention and treatment interventions for adults with overweight or obesity and comorbid depressive disorders based on internet or mobile technology show effectiveness, this has the potential to complement existing therapeutic options and to be used for prevention purposes: IMIs as low-threshold and location-independent interventions can reach significantly more affected people worldwide than face-to-face-interventions and thus be an element to reduce health disparities [63, 64]. They proved their cost-effectiveness for depressive disorders [65–67].

Given the high worldwide prevalence rate of overweight and obesity and the increased risk for developing comorbid depressive disorders, low-threshold options like IMIs for adults with overweight or obesity and comorbid depressive disorders would enable the provision of adequate care to more affected individuals.

If the study selection shows an insufficient number of studies that meet the inclusion criteria of overweight or obesity with comorbid depressive disorders with psychotherapeutic elements or that have examined gender differences, this will be discussed as a need and implication for future research.

Furthermore, this review could motivate researchers to construct specific internet- or mobile based interventions for adults with overweight or obesity and comorbid mental health problems based on cognitive behavioral principles and to test them in randomized trials.

Amendments
If amendments to this protocol need to be made, the authors will provide their date, description, and rationale.

Author Contributions
All authors contributed substantially to the conception of the work; KS and MLö drafted the manuscript; MLu and SRH revised the manuscript critically for important intellectual content; all authors finally approved the version to be published. All authors gave agreement to be accountable for all aspects of the work.

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The study “@ktivPLUS” is funded by the German Federal Ministry for Education and Research (BMBF, Grant number: 01GY2108). The BMBF is not involved in the design of the study, and will have no role regarding the execution of the study, the data analysis or the interpretation of the data. We were funded by the Open Access Publishing Fund of Leipzig University supported by the German Research Foundation within the program Open Access Publication Funding.
Competing interests
The authors declare that there are no competing interests.

Patient consent for publication
Not required.

Ethics approval
As no primary data will be collected, ethical approval and consent to participate are not required. The results of this systematic review are intended to be published in an international peer-reviewed journal and be presented at relevant professional conferences.

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Author note
All authors approved the final version of the manuscript.

Figure Legend
Figure 1. Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement (Moher et al. 2009).

REFERENCES


Figure 1 Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement (Moher et al. 2009).

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## PRISMA 2020 Checklist

<table>
<thead>
<tr>
<th>Section and Topic</th>
<th>Item #</th>
<th>Checklist item</th>
<th>Location where item is reported</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TITLE</strong></td>
<td>1</td>
<td>Identify the report as a systematic review.</td>
<td>Page 1</td>
</tr>
<tr>
<td><strong>ABSTRACT</strong></td>
<td>2</td>
<td>See the PRISMA 2020 for Abstracts checklist.</td>
<td>Page 1-2</td>
</tr>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td>3</td>
<td>Describe the rationale for the review in the context of existing knowledge.</td>
<td>Page 3</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>4</td>
<td>Provide an explicit statement of the objective(s) or question(s) the review addresses.</td>
<td>Page 3</td>
</tr>
<tr>
<td><strong>METHODS</strong></td>
<td>5</td>
<td>Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.</td>
<td>Page 4</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.</td>
<td>Page 4</td>
</tr>
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<td>7</td>
<td>Present the full search strategies for all databases, registers and websites, including any filters and limits used.</td>
<td>Page 4-5</td>
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<td></td>
<td>8</td>
<td>Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
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<td>9</td>
<td>Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
</tr>
<tr>
<td></td>
<td>10a</td>
<td>List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.</td>
<td>Page 5</td>
</tr>
<tr>
<td></td>
<td>10b</td>
<td>List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.</td>
<td>Page 5</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.</td>
<td>Page 6</td>
</tr>
<tr>
<td><strong>Study risk of bias assessment</strong></td>
<td>12</td>
<td>Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.</td>
<td>Page 6</td>
</tr>
<tr>
<td><strong>Effect measures</strong></td>
<td>13a</td>
<td>Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).</td>
<td>Page 6</td>
</tr>
<tr>
<td><strong>Synthesis methods</strong></td>
<td>13b</td>
<td>Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.</td>
<td>Page 6</td>
</tr>
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<td>13c</td>
<td>Describe any methods used to tabulate or visually display results of individual studies and syntheses.</td>
<td>Page 6</td>
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<td>13d</td>
<td>Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.</td>
<td>Page 6</td>
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<td>13e</td>
<td>Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).</td>
<td>Page 6</td>
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<td>13f</td>
<td>Describe any sensitivity analyses conducted to assess robustness of the synthesized results.</td>
<td>Page 6</td>
</tr>
<tr>
<td><strong>Certainty</strong></td>
<td>14</td>
<td>Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).</td>
<td>Page 6</td>
</tr>
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<td>15</td>
<td>Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.</td>
<td>Page 6</td>
</tr>
</tbody>
</table>
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<tr>
<td><strong>RESULTS</strong></td>
<td></td>
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</tr>
<tr>
<td>Study selection</td>
<td>16a</td>
<td>Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.</td>
<td>Figure 1</td>
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<tr>
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<td>16b</td>
<td>Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.</td>
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<td>Study characteristics</td>
<td>17</td>
<td>Cite each included study and present its characteristics.</td>
<td>n.a.</td>
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<tr>
<td>Risk of bias in studies</td>
<td>18</td>
<td>Present assessments of risk of bias for each included study.</td>
<td>n.a.</td>
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<tr>
<td>Results of individual studies</td>
<td>19</td>
<td>For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.</td>
<td>n.a.</td>
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<tr>
<td>Results of syntheses</td>
<td>20a</td>
<td>For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.</td>
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<td></td>
<td>20b</td>
<td>Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.</td>
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<td>20c</td>
<td>Present results of all investigations of possible causes of heterogeneity among study results.</td>
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<td>20d</td>
<td>Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.</td>
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<tr>
<td>Reporting biases</td>
<td>21</td>
<td>Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Certainty of evidence</td>
<td>22</td>
<td>Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.</td>
<td>n.a.</td>
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<td><strong>DISCUSSION</strong></td>
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<td>Discussion</td>
<td>23a</td>
<td>Provide a general interpretation of the results in the context of other evidence.</td>
<td>Page 7</td>
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<td>23b</td>
<td>Discuss any limitations of the evidence included in the review.</td>
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<td>23c</td>
<td>Discuss any limitations of the review processes used.</td>
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<td>23d</td>
<td>Discuss implications of the results for practice, policy, and future research.</td>
<td>Page 7</td>
</tr>
<tr>
<td><strong>OTHER INFORMATION</strong></td>
<td></td>
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</tr>
<tr>
<td>Registration and protocol</td>
<td>24a</td>
<td>Provide registration information for the review, including register name and registration number, or state that the review was not registered.</td>
<td>Page 2</td>
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<td>24b</td>
<td>Indicate where the review protocol can be accessed, or state that a protocol was not prepared.</td>
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<td>24c</td>
<td>Describe and explain any amendments to information provided at registration or in the protocol.</td>
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<tr>
<td>Support</td>
<td>25</td>
<td>Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.</td>
<td>Page 7</td>
</tr>
<tr>
<td>Competing interests</td>
<td>26</td>
<td>Declare any competing interests of review authors.</td>
<td>Page 7</td>
</tr>
<tr>
<td>Availability of data, code and other materials</td>
<td>27</td>
<td>Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.</td>
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PRISMA 2020 Checklist

For more information, visit: http://www.prisma-statement.org/
Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

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Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

Katja Schladitz1,2, Melanie Luppa1,3, Steffi G. Riedel-Heller1,4, Margrit Loebner1,5

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Word count: 2976

Abstract

Introduction. Internet- and mobile-based interventions (IMIs) provide innovative low-threshold and cost-effective prevention and self-management options for mental health problems complementary to standard treatment. The objective of this systematic review is to summarize the effectiveness and to critically evaluate studies on IMIs addressing comorbid depressive symptoms in adults with overweight or obesity.
Methods and analysis. The study authors will systematically search the databases MEDLINE, Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature) for randomized controlled trials of IMIs for individuals with overweight or obesity and comorbid depressive symptoms without restrictions on publication date (planned inception 01.06.2023). Two reviewers will independently extract and evaluate data from studies eligible for inclusion by assessing quality of evidence and qualitatively synthesizing results. Preferred Reporting Items for Systematic Reviews (PRISMA) standards and the revised Cochrane Risk of Bias tool in RCTs (RoB 2) will be applied.

Ethics and dissemination. Ethical approval is not required as no primary data will be collected. Study results will be disseminated through publication in a peer-reviewed journal and presentations on conferences.

Prospero registration number. Will be supplemented after the peer review (in case methodological changes are required during this process)

Keywords
Overweight, obesity, comorbidity, depressive disorder, internet- and mobile based intervention

Strengths and limitations of this study
- First study providing a comprehensive summary of studies examining the effectiveness of internet- and mobile-based interventions (IMIs) for adults with overweight or obesity with comorbid depressive symptoms.
- IMIs for this target group can be used at a low threshold for both preventive purposes and as a complementary treatment option in health care settings.
- A limited number of available studies, heterogeneous study designs and different types of interventions may limit generalizability and certainty of results of this systematic review.

Background
Overweight and obesity are among the major global public health problems reaching near-pandemic levels [1]: The worldwide prevalence of overweight and obesity has nearly tripled since 1975, with a steady upward trend [2–4]. The World Health Organization (WHO) defines overweight and obesity “as abnormal or excessive fat accumulation that may impair health” [4], with adults having a body mass index (BMI) of ≥ 25 defined to be overweight and a BMI of ≥ 30 defined to be obese. In 2016, 39 % of the world’s adult population were overweight and 13 % were obese [4].

Obesity and overweight cause a number of adverse health consequences: they reduce physical as well as mental health and increase the risk of developing chronic diseases such as diabetes, hypertension or cancer [5–7]. Obesity thus indirectly increases mortality [8] and represents an important economic burden on the health care system [9–12]. Overweight and obesity are also associated with increased negative psychosocial consequences and an increased prevalence of mental disorders, including depression as one of the most prevalent [13, 14].

Depressive disorders belong to the most common mental disorders, with global cross-age point prevalence rates in 2019 of 3.8 % and a proportion of 28.9 % among all mental disorders [15], with increasing tendency [16, 17]. They are among the most significant contributors to the global burden of disease [18], causing significant direct and indirect costs [19, 20]. Major depression was associated
with 2.79 % higher direct costs in adolescents, with 2.58 % higher direct costs in adults and with 1.73 %
higher direct costs in elderly compared to non-depressed individuals of the same age group [21].

According to the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 depressive
disorders account for the largest proportion (37.5%) of disability-adjusted life-years (DALYs) due to
mental disorders [18].

Standard care treatment methods for depression, involve psychotherapy (e.g. cognitive behavioral
therapy, and psychodynamic therapy [22–24]), pharmacotherapy (e.g. antidepressants) or a
combination of both. A third pillar of treatment are other psychosocial therapies (e.g. self-help, peer
support, art therapy, and sport therapy).

For obesity and comorbid depressive disorders, meta-analyses of cross-sectional studies [25–31]
showed a pooled odds ratio (OR) between 1.18–1.38 among individuals with obesity compared to
eutrophic people to experience a depressive symptomatology in studies based on clinical diagnoses
and/or self-reported symptoms (and OR=1.07 for overweight people [30]). A meta-analysis of
longitudinal studies [32] identified obesity as a predictor for increased risk of onset of depressive
symptoms at follow-up with OR=1.55 and overweight with OR=1.27. Associations are found for obesity
with self-reported depressive symptoms, subsyndromal manifestations, and clinically diagnosed
depressive disorders.

Co-occurrence of overweight or obesity and depressive disorders amplifies the negative impact on
physical and mental health and social life [33, 34]. There is evidence for multiple causal directions: (1)
Obesity and depressive disorders can be caused by the same mechanisms, e.g. sharing the same
dysregulations of some biological mechanisms such as neurotransmitter balance, immuno-
-inflammatory processes or oxidative stress [35–38]. (2) Obesity can cause or aggravate depression, e.g.
psychosocial factors such as weight discrimination and double stigma of obesity and mental disorders
can also act as chronic stressors and aggravate depressive symptomatology [39, 40]. (3) Depression
can cause or aggravate obesity, e.g. as a result of symptoms such as increased eating behavior,
decreased activity and exercise [37] or due to weight gain as a psychopharmacological side effect [41].

Co-morbidity may also lead to a number of interactions, e.g., reduced efficacy of antidepressants in
people with obesity [42]. There is empirical evidence of a higher prevalence of comorbid depressive
disorders [13, 25–28, 30, 31] in women with overweight or obesity.

The effectiveness of internet- (delivered via web browser on desktop, laptop, tablet computer or
smartphone) and mobile-based (delivered via smartphone app) interventions (IMIs) has been
demonstrated for a wide range of mental health conditions [43–45]. They can be applied as an
innovative, efficient, low-threshold and location-independent prevention and treatment method to
complement existing outpatient and inpatient services and to offer support while waiting for therapy
vacancies [45, 46]. They are appropriate for different target and risk groups. IMIs for depressive
disorders are effective and have a high acceptance of use with effectiveness comparable to
conventional “face-to-face” interventions [44, 47, 48]. They can be accessed at low thresholds and
relatively low costs [49–51]. Nevertheless, potential risks and adverse effects may occur, such as
mental overload or limited ability to respond to acute crises [45]. However, some studies have shown
that patients using IMIs experience significantly less deterioration in their mental health than those in
control group conditions (such as attention placebo, no treatment, TAU or waiting list) [52, 53].

Research also suggests that subgroups of individuals may benefit less from IMIs if these interventions
were not adequately tailored to their specific needs [54].

Given the high prevalence of overweight, obesity and depressive disorders alone, as well as overweight
or obesity with comorbid depressive disorders, there is a high demand of cost-effective interventions.
IMIs tailored to the specifics of overweight or obesity with comorbid depressive disorders could
mitigate this need. Current systematic reviews and meta-analyses show that IMIs have been established as effective and acceptable in weight loss and physical activity management (e.g., 55–60). A recent review of mobile interventions for the management of overweight or obesity with comorbid depressive disorders [61] found no single smartphone-based intervention that addressed both the physical and mental illness equally and most of the identified studies focused on the monitoring of weight and physical activity. We found no review of internet-based interventions for people with overweight or obesity and comorbid depressive disorders. Yet there is an increasing number of randomized controlled trials (RCTs) of specific IMIs with psychotherapeutic elements that address both overweight or obesity with comorbid depressive symptoms (e.g., 47, 62–64). To the best of our knowledge, there is no review which reflects the current state of research of IMIs with psychotherapeutic elements for adults with overweight or obesity and comorbid depressive disorders.

Objectives

Therefore, the purpose of this planned study is an systematic evaluation and synthesis of empirical findings based on RCTs of IMIs for adults aged 18 years and older with overweight or obesity who experience comorbid depressive symptoms, focusing on the effectiveness of these interventions (e.g., the improvement of objective measures of depressive symptoms) compared to treatment-as-usual, low-level support or no intervention. We only include RCTs with an adult population because there are significant differences in treating obesity in adults compared to children and adolescents [65, 66] and also in tailoring IMIs to the need of younger age groups [67]. If possible (depending on the number of eligible studies), it is also planned to combine data across RCTs for an estimation of pooled effect sizes for the reduction of depressive symptomatology.

Methods and analysis

This review protocol outlines the planned strategies for a review of RCTs on the topic of IMIs for adults with overweight or obesity and comorbid depressive disorder. It describes how data will be systematically evaluated and synthesized to examine the effectiveness of these IMIs according to the 24-step guide by Muka et al. [68]. It follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA)-statement for systematic reviews [69]. Therefore the study selection process will be in accordance with the four-phase PRISMA flow diagram (figure 1).

Eligibility criteria

The planned review will follow the PICO scheme and include effectiveness RCTs involving adults aged 18 years and older with overweight or obesity and comorbid depressive symptoms (participant criteria) applying IMIs. The studies must examine clinical psychological interventions as defined by Kampling et al. [70] (intervention criteria):

- CBT
- psychodynamic psychotherapy
- behavior therapy or behavior modification
- systemic therapy
• third wave CBT
• humanistic therapies
• integrative therapies
• other psychological-oriented interventions.

Any type of control condition with the following types of comparison groups will be included (comparison criteria):

• treatment as usual (TAU, referring to psychotherapy, pharmacotherapy or both)
• waiting list
• low-level support
• psychosocial support
• attention placebo (both researcher and participants are inactive)
• psychological placebo (participants are active and researchers inactive).

Any measures of effectiveness (e.g., improvement of objective measures of depressive symptoms) will be included (outcome criteria). Data from clinician-rated scales will be rated higher than self-report questionnaires. The literature search will cover articles written in English or German (language criteria) and will not be restricted by publication date. Articles examining a highly specific population (e.g., pregnant women or a population with a specific somatic disease) will be excluded.

Information sources and search strategy

It is planned to include the following databases in the literature search (planned inception 01.06.2023):

MEDLINE (via PubMed Interface), Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature). KS and another researcher (NN) will search independently using the following combination of search terms: (1) obesity or overweight or adiposity or metabolic syndrome or body mass index; and (2) depress*; and (3) internet or online or web or computer or mobile or app or smartphone or m-health or mobile health or e-health or e-mental health or iCBT or cCBT or IMI; and (4) intervention or psychotherapy or therapy or cognitive behavioral therapy or cbt (restricted to title and abstract) (see supplementary file). The MEDLINE search strategy will be adapted to specifications of each database.

Both researchers will screen titles and abstracts and, when eligible, full texts of the studies will be assessed for the defined criteria. In addition, reference lists of all included studies and systematic reviews will be searched manually to identify further potentially relevant articles, and a grey literature search for unpublished studies will be conducted using Google and Google Scholar with the search terms. Searches will be rerun before starting the final analysis to include more recently published studies.

Data management

The authors plan to use the software package Review Manager Web (RevMan Web) V.4.12.0 [71], which was specifically designed for the management, analyzing and synthesizing bibliographic information and data from systematic reviews, or another suitable software. Additional data analyses and meta-analyses will be conducted using SPSS V.27.0 [72].
Selection process

KS and another researcher (NN) will screen all titles and abstracts independently and divide the retrieved articles into the categories “potentially relevant” (matches the eligibility criteria), “irrelevant” (does not match the eligibility criteria) and “uncertain” (information is inconclusive with regard to eligibility criteria). Reasons for each decision will be reported (e.g. “irrelevant” because eligibility criteria “RCT study” or “adult sample” does not apply). Interrater reliability will be assessed by the percentage of agreement between coders.

In a second step, both researchers will read “potentially relevant” and “uncertain” articles in full text and assess their study eligibility based on the criteria listed above (participant, intervention, comparison, outcome). Discrepancies in each step will first be discussed between both reviewers, and, if they cannot be solved, then with a third senior researcher (MLö).

Data collection process and data items

A standardized data extraction form for the extraction of the study data will be developed. To ensure that all relevant data will be extracted correctly, both reviewers will independently test the pilot version of the form on a subsample of relevant articles, discuss difficulties and adopt the data extraction form accordingly. Both reviewers will extract data from each study independently. Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing data, study authors will be contacted.

The following data will be extracted:

1. Study identification items (e.g., first author, year of publication, country)
2. Study design characteristics (e.g., sample size, recruitment strategy, inclusion and exclusion criteria, classification of obesity levels, assessment of depression, assessment of concurring conditions like comorbidities and pharmaco- or psychotherapy, intervention design/duration, control group condition, follow-up assessments)
3. Participant characteristics (e.g., mean age and age range, gender)
4. Methodological factors (e.g., risk of bias, study limitations)
5. Outcome data (in case of follow up-assessments, all waves will be included): effectiveness = reduction of depressive symptoms

Quality assessment

The authors plan to use the revised Cochrane Risk of Bias tool in RCTs (RoB 2) [73]. KS and another researcher (NN) will independently assess the methodological quality of the included studies in the following domains:

1. Bias arising from the randomization process
2. Bias due to deviations from intended interventions
3. Bias due to missing outcome data
4. Bias in measurement of the outcome
5. Bias in selection of the reported result.
On this base, all studies will be assigned to the three corresponding overall risk-of-bias-grades following [73]: “high risk of bias” (at high risk of bias in at least one domain, or some concerns for multiple domains), “some concerns” (some concerns in at least one domain, but no high risk of bias for any domain) and “low risk of bias” (low risk of bias for all domains). Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing methodological information, study authors will be contacted. In the risk of bias table, results of the ratings will be shown for each domain.

Data synthesis and presentation

The characteristics (as listed under “Data collection process and data items”) of all included studies will be presented in a narrative synthesis, starting with study and sample characteristics and descriptions of intervention and control group conditions, followed by outcome measurements, effect sizes and overall results.

If a sufficient number of eligible studies is found, an optional second part will be done. The authors will include these studies in a meta-analyses that provide quantitative measures of depression and analyze heterogeneity between RCTs with the use of $I^2$ statistics, funnel and forest plots. A moderate level of heterogeneity of 30–60 % between studies for $I^2$ will be assumed according to the Cochrane standards [74]. If studies fail to show sufficient heterogeneity ($I^2 < 60 \%$) in at least two trials [75], meta-analytic pooling will not be undertaken. Since the cause of inconsistency may result from study characteristics [74], sources of heterogeneity in subgroups of studies in terms of type of BMI-classification (overweight or obesity) or intervention type (type of psychotherapeutic intervention) will be explored. As studies with different outcome measures (depressive symptoms) and various interventions will be included, a random effects model will be applied and standardized mean difference values and their associated 95 % confidence intervals will be estimated. In case of missing date, the authors will handle them according to the Cochrane Handbook for Systematic Reviews of Interventions [74]. RevMan Web V.4.12.0 [71] or another eligible software will be used for data analyses.

Patient and public involvement

No patient and/or the public involved.

Discussion

The planned systematic review will provide a comprehensible summary of the effectiveness of IMIs for adults with overweight or obesity and comorbid depressive disorders.

If prevention and treatment interventions for adults with overweight or obesity and comorbid depressive disorders based on internet or mobile technology show effectiveness, this has the potential to complement existing therapeutic options and to be used for prevention purposes: IMIs as low-threshold and location-independent interventions can reach significantly more affected people worldwide than face-to-face-interventions and thus be an element to reduce health disparities [76, 77]. They proved their cost-effectiveness for depressive disorders [78–80].

Given the high worldwide prevalence rate of overweight and obesity and the increased risk for developing comorbid depressive disorders, low-threshold options like IMIs for adults with overweight...
or obesity and comorbid depressive disorders would enable the provision of adequate care to more affected individuals.

If the study selection shows an insufficient number of studies that meet the inclusion criteria of overweight or obesity with comorbid depressive disorders with psychotherapeutic elements or that have examined gender differences, this will be discussed as a need and implication for future research. Furthermore, this review could motivate researchers to construct specific internet- or mobile based interventions for adults with overweight or obesity and comorbid mental health problems based on cognitive behavioral principles and to test them in randomized trials.

Amendments

If amendments to this protocol need to be made, the authors will provide their date, description, and rationale.

Author Contributions

All authors contributed substantially to the conception of the work; KS and MLö drafted the manuscript; MLu and SRH revised the manuscript critically for important intellectual content; all authors finally approved the version to be published. All authors gave agreement to be accountable for all aspects of the work.

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Competing interests

The authors declare that there are no competing interests.

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Author note

All authors approved the final version of the manuscript.
**Figure Legend**

Figure 1. Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement [69].

**Ethics and dissemination**

Patient/public consent for publication: As no primary data will be collected, ethical approval and consent to participate are not required.

The results of this systematic review are intended to be published in an international peer-reviewed journal and be presented at relevant professional conferences.

**REFERENCES**


For peer review only


For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml


564
566
568
570
572
574
Figure 1 Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement (Moher et al. 2009).

96x107mm (1200 x 1200 DPI)
Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol

BMJ Open

Example for search strategy:

**MEDLINE via PubMed**

(((obesity[Title/Abstract] OR overweight[Title/Abstract] OR adiposity[Title/Abstract] OR "metabolic syndrome"[Title/Abstract] OR "body mass index"[Title/Abstract])

AND

(depress*[Title/Abstract])

AND


AND

(((intervention[Title/Abstract] OR psychotherapy[Title/Abstract] OR therapy[Title/Abstract] OR "cognitive behavioral therapy"[Title/Abstract] OR cbt[Title/Abstract]))
### PRISMA 2020 Checklist

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<th>Item #</th>
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<th>Location where item is reported</th>
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<td>Describe the rationale for the review in the context of existing knowledge.</td>
<td>Page 3</td>
</tr>
<tr>
<td>Objectives</td>
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<td>Provide an explicit statement of the objective(s) or question(s) the review addresses.</td>
<td>Page 3</td>
</tr>
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<td>Eligibility criteria</td>
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<td>Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.</td>
<td>Page 4</td>
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<tr>
<td>Information sources</td>
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<td>Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.</td>
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<tr>
<td>Search strategy</td>
<td>7</td>
<td>Present the full search strategies for all databases, registers and websites, including any filters and limits used.</td>
<td>Page 4-5</td>
</tr>
<tr>
<td>Selection process</td>
<td>8</td>
<td>Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
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<tr>
<td>Data collection process</td>
<td>9</td>
<td>Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
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<tr>
<td>Data items</td>
<td>10a</td>
<td>List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.</td>
<td>Page 5</td>
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<td>10b</td>
<td>List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.</td>
<td>Page 5</td>
</tr>
<tr>
<td>Study risk of bias</td>
<td>11</td>
<td>Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.</td>
<td>Page 6</td>
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<tr>
<td>Effect measures</td>
<td>12</td>
<td>Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.</td>
<td>Page 6</td>
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<tr>
<td>Synthesis methods</td>
<td>13a</td>
<td>Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).</td>
<td>Page 6</td>
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<td>13b</td>
<td>Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.</td>
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<td>13c</td>
<td>Describe any methods used to tabulate or visually display results of individual studies and syntheses.</td>
<td>Page 6</td>
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<td>13d</td>
<td>Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.</td>
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<td></td>
<td>13e</td>
<td>Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).</td>
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<td>13f</td>
<td>Describe any sensitivity analyses conducted to assess robustness of the synthesized results.</td>
<td>Page 6</td>
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<td>Reporting bias assessment</td>
<td>14</td>
<td>Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting bias).</td>
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<tr>
<td>Certainty</td>
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<td>Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.</td>
<td>Page 6</td>
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<td><strong>Results</strong></td>
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<tr>
<td>Study selection</td>
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<td>Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.</td>
<td>Figure 1</td>
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<td>Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.</td>
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<td>Cite each included study and present its characteristics.</td>
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<td>Risk of bias in studies</td>
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<td>Present assessments of risk of bias for each included study.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Results of individual studies</td>
<td>19</td>
<td>For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.</td>
<td>n.a.</td>
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<tr>
<td>Results of syntheses</td>
<td>20a</td>
<td>For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.</td>
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<tr>
<td>Results of syntheses</td>
<td>20b</td>
<td>Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.</td>
<td>n.a.</td>
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<tr>
<td>Results of syntheses</td>
<td>20c</td>
<td>Present results of all investigations of possible causes of heterogeneity among study results.</td>
<td>n.a.</td>
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<tr>
<td>Results of syntheses</td>
<td>20d</td>
<td>Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.</td>
<td>n.a.</td>
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<tr>
<td>Reporting biases</td>
<td>21</td>
<td>Present results of all investigations of possible causes of heterogeneity among study results.</td>
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<td>Certainty of evidence</td>
<td>22</td>
<td>Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.</td>
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<tr>
<td>Discussion</td>
<td>23a</td>
<td>Provide a general interpretation of the results in the context of other evidence.</td>
<td>Page 7</td>
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<tr>
<td>Discussion</td>
<td>23b</td>
<td>Discuss any limitations of the evidence included in the review.</td>
<td>n.a.</td>
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<tr>
<td>Discussion</td>
<td>23c</td>
<td>Discuss any limitations of the review processes used.</td>
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<tr>
<td>Discussion</td>
<td>23d</td>
<td>Discuss implications of the results for practice, policy, and future research.</td>
<td>Page 7</td>
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<td><strong>Other Information</strong></td>
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<td>Registration and protocol</td>
<td>24a</td>
<td>Provide registration information for the review, including register name and registration number, or state that the review was not registered.</td>
<td>Page 2</td>
</tr>
<tr>
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<td>24b</td>
<td>Indicate where the review protocol can be accessed, or state that a protocol was not prepared.</td>
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<tr>
<td>Registration and protocol</td>
<td>24c</td>
<td>Describe and explain any amendments to information provided at registration or in the protocol.</td>
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<tr>
<td>Support</td>
<td>25</td>
<td>Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.</td>
<td>Page 7</td>
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<tr>
<td>Competing interests</td>
<td>26</td>
<td>Declare any competing interests of review authors.</td>
<td>Page 7</td>
</tr>
<tr>
<td>Availability of data, code and other materials</td>
<td>27</td>
<td>Report which of the following are publicly available and where they can be found: template data collection forms; data used for all analyses; analytic code; any other materials used in the review.</td>
<td>n.a.</td>
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</table>
For more information, visit: http://www.prisma-statement.org/
# Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

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<td>Schladitz, Katja; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health Luppa, Melanie; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health Riedel-Heller, Steffi; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health Loebner, Margrit; Leipzig University, Institute of Social Medicine, Occupational Health and Public Health</td>
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Effectiveness of internet- and mobile-based interventions for adults with overweight or obesity experiencing symptoms of depression: A systematic review protocol.

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Word count: 2934

Abstract

Introduction. Internet- and mobile-based interventions (IMIs) provide innovative low-threshold and cost-effective prevention and self-management options for mental health problems complementary to standard treatment. The objective of this systematic review is to summarize the effectiveness and to critically evaluate studies on IMIs addressing comorbid depressive symptoms in adults with overweight or obesity.
Methods and analysis. The study authors will systematically search the databases MEDLINE, Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature) for randomized controlled trials of IMIs for individuals with overweight or obesity and comorbid depressive symptoms without restrictions on publication date (planned inception 01.06.2023–01.12.2023). Two reviewers will independently extract and evaluate data from studies eligible for inclusion by assessing quality of evidence and qualitatively synthesizing results. Preferred Reporting Items for Systematic Reviews (PRISMA) standards and the revised Cochrane Risk of Bias tool in RCTs (RoB 2) will be applied.

Ethics and dissemination. Ethical approval is not required as no primary data will be collected. Study results will be disseminated through publication in a peer-reviewed journal and presentations on conferences.

Prospero registration number. CRD42023361771

Keywords
Overweight, obesity, comorbidity, depressive disorder, internet- and mobile based intervention

Strengths and limitations of this study

- First study providing a comprehensive summary of studies examining the effectiveness of internet- and mobile-based interventions (IMIs) for adults with overweight or obesity with comorbid depressive symptoms.
- IMIs for this target group can be used at a low threshold for both preventive purposes and as a complementary treatment option in health care settings.
- A limited number of available studies, heterogeneous study designs and different types of interventions may limit generalizability and certainty of results of this systematic review.

Introduction

Overweight and obesity are among the major global public health problems reaching near-pandemic levels [1]: The worldwide prevalence of overweight and obesity has nearly tripled since 1975, with a steady upward trend [2–4]. The World Health Organization (WHO) defines overweight and obesity “as abnormal or excessive fat accumulation that may impair health” [4], with adults having an body mass index (BMI) of ≥ 25 defined to be overweight and a BMI of ≥ 30 defined to be obese. In 2016, 39 % of the world’s adult population were overweight and 13 % were obese [4].

Obesity and overweight cause a number of adverse health consequences: they reduce physical as well as mental health and increase the risk of developing chronic diseases such as diabetes, hypertension or cancer [5–7]. Obesity thus indirectly increases mortality [8] and represents an important economic burden on the health care system [9–12]. Overweight and obesity are also associated with increased negative psychosocial consequences and an increased prevalence of mental disorders, including depression as one of the most prevalent [13, 14].

Depressive disorders belong to the most common mental disorders, with global cross-age point prevalence rates in 2019 of 3.8 % and a proportion of 28.9 % among all mental disorders [15], with increasing tendency [16, 17]. They are among the most significant contributors to the global burden of disease [18], causing significant direct and indirect costs [19, 20]. Major depression was associated with 2.79 % higher direct costs in adolescents, with 2.58 % higher direct costs in adults and with 1.73 %
higher direct costs in elderly compared to non-depressed individuals of the same age group [21]. According to the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 depressive disorders account for the largest proportion (37.5%) of disability-adjusted life-years (DALYs) due to mental disorders [18].

Standard care treatment methods for depression, involve psychotherapy (e.g. cognitive behavioral therapy, and psychodynamic therapy [22–24]), pharmacotherapy (e.g. antidepressants) or a combination of both. A third pillar of treatment are other psychosocial therapies (e.g. self-help, peer support, art therapy, and sport therapy).

For obesity and comorbid depressive disorders, meta-analyses of cross-sectional studies [25–31] showed a pooled odds ratio (OR) between 1.18–1.38 among individuals with obesity compared to eutrophic people to experience a depressive symptomatology in studies based on clinical diagnoses and/or self-reported symptoms (and OR=1.07 for overweight people [30]). A meta-analysis of longitudinal studies [32] identified obesity as a predictor for increased risk of onset of depressive symptoms at follow-up with OR=1.55 and overweight with OR=1.27. Associations are found for obesity with self-reported depressive symptoms, subsyndromale manifestations, and clinically diagnosed depressive disorders.

Co-occurrence of overweight or obesity and depressive disorders amplifies the negative impact on physical and mental health and social life [33, 34]. There is evidence for multiple causal directions: (1) Obesity and depressive disorders can be caused by the same mechanisms, e.g. sharing the same dysregulations of some biological mechanisms such as neurotransmitter balance, immunoinflammatory processes or oxidative stress [35–38]. (2) Obesity can cause or aggravate depression, e.g. psychosocial factors such as weight discrimination and double stigma of obesity and mental disorders can also act as chronic stressors and aggravate depressive symptomatology [39, 40]. (3) Depression can cause or aggravate obesity, e.g. as a result of symptoms such as increased eating behavior, decreased activity and exercise [37] or due to weight gain as a psychopharmacological side effect [41]. Co-morbidity may also lead to a number of interactions, e.g., reduced efficacy of antidepressants in people with obesity [42]. There is empirical evidence of a higher prevalence of comorbid depressive disorders [13, 25–28, 30, 31] in women with overweight or obesity.

The effectiveness of internet- (delivered via web browser on desktop, laptop, tablet computer or smartphone) and mobile-based (delivered via smartphone app) interventions (IMIs) has been demonstrated for a wide range of mental health conditions [43–45]. They can be applied as an innovative, efficient, low-threshold and location-independent prevention and treatment method to complement existing outpatient and inpatient services and to offer support while waiting for therapy vacancies [45, 46]. They are appropriate for different target and risk groups. IMIs for depressive disorders are effective and have a high acceptance of use with effectiveness comparable to conventional “face-to-face” interventions [44, 47, 48]. They can be accessed at low thresholds and relatively low costs [49–51]. Nevertheless, potential risks and adverse effects may occur, such as mental overload or limited ability to respond to acute crises [45]. However, some studies have shown that patients using IMIs experience significantly less deterioration in their mental health than those in control group conditions (such as attention placebo, no treatment, TAU or waiting list) [52, 53]. Research also suggests that subgroups of individuals may benefit less from IMIs if these interventions were not adequately tailored to their specific needs [54].

Given the high prevalence of overweight, obesity and depressive disorders alone, as well as overweight or obesity with comorbid depressive disorders, there is a high demand of cost-effective interventions. IMIs tailored to the specifics of overweight or obesity with comorbid depressive disorders could mitigate this need. Current systematic reviews and meta-analyses show that IMIs have been
established as effective and acceptable in weight loss and physical activity management (e.g., 55–60).

A recent review of mobile interventions for the management of overweight or obesity with comorbid depressive disorders [61] found no single smartphone-based intervention that addressed both the physical and mental illness equally and most of the identified studies focused on the monitoring of weight and physical activity. We found no review of internet-based interventions for people with overweight or obesity and comorbid depressive disorders. Yet there is an increasing number of randomized controlled trials (RCTs) of specific IMIs with psychotherapeutic elements that address both overweight or obesity with comorbid depressive symptoms (e.g., 47, 62–64). To the best of our knowledge, there is no review which reflects the current state of research of IMIs with psychotherapeutic elements for adults with overweight or obesity and comorbid depressive disorders.

Objectives

Therefore, the purpose of this planned study is an systematic evaluation and synthesis of empirical findings based on RCTs of IMIs for adults aged 18 years and older with overweight or obesity who experience comorbid depressive symptoms, focusing on the effectiveness of these interventions (e.g., the improvement of objective measures of depressive symptoms) compared to treatment-as-usual, low-level support or no intervention. We only include RCTs with an adult population because there are significant differences in treating obesity in adults compared to children and adolescents [65, 66] and also in tailoring IMIs to the need of younger age groups [67]. If possible (depending on the number of eligible studies), it is also planned to combine data across RCTs for an estimation of pooled effect sizes for the reduction of depressive symptomatology.

Methods and analysis

This review protocol outlines the planned strategies for a review of RCTs on the topic of IMIs for adults with overweight or obesity and comorbid depressive disorder. It describes how data will be systematically evaluated and synthesized to examine the effectiveness of these IMIs according to the 24-step guide by Muka et al. [68]. It follows the preferred reporting items for systematic reviews and meta-analyses (PRISMA)-statement for systematic reviews [69]. Therefore the study selection process will be in accordance with the four-phase PRISMA flow diagram (figure 1).

Eligibility criteria

The planned review will follow the PICO scheme and include effectiveness RCTs involving adults aged 18 years and older with overweight or obesity and comorbid depressive symptoms (participant criteria) applying IMIs. The studies must examine clinical psychological interventions as defined by Kamping et al. [70] (intervention criteria):

- CBT
- psychodynamic psychotherapy
- behavior therapy or behavior modification
- systemic therapy
- third wave CBT
Any type of control condition with the following types of comparison groups will be included (comparison criteria):

- treatment as usual (TAU, referring to psychotherapy, pharmacotherapy or both)
- waiting list
- low-level support
- psychosocial support
- attention placebo (both researcher and participants are inactive)
- psychological placebo (participants are active and researchers inactive).

Any measures of effectiveness (e.g., improvement of objective measures of depressive symptoms) will be included (outcome criteria). Data from clinician-rated scales will be rated higher than self-report questionnaires. The literature search will cover articles written in English or German (language criteria) and will not be restricted by publication date. Articles examining a highly specific population (e.g., pregnant women or a population with a specific somatic disease) will be excluded.

Information sources and search strategy

It is planned to include the following databases in the literature search (planned inception 01.06.2023–01.12.2023): MEDLINE (via PubMed Interface), Cochrane Library, PsycINFO, Web of Science, Embase, and Google Scholar (for grey literature). KS and another researcher (NN) will search independently using the following combination of search terms: (1) obesity or overweight or adiposity or metabolic syndrome or body mass index; and (2) depress*; and (3) internet or online or web or computer or mobile or app or smartphone or m-health or mobile health or e-health or e-mental health or iCBT or cCBT or IMI; and (4) intervention or psychotherapy or therapy or cognitive behavioral therapy or cbt (restricted to title and abstract) (see supplementary file). The MEDLINE search strategy will be adapted to specifications of each database.

Both researchers will screen titles and abstracts and, when eligible, full texts of the studies will be assessed for the defined criteria. In addition, reference lists of all included studies and systematic reviews will be searched manually to identify further potentially relevant articles, and a grey literature search for unpublished studies will be conducted using Google and Google Scholar with the search terms. Searches will be rerun before starting the final analysis to include more recently published studies.

Data management

The authors plan to use the software package Review Manager Web (RevMan Web) V.4.12.0 [71], which was specifically designed for the management, analyzing and synthesizing bibliographic information and data from systematic reviews, or another suitable software. Additional data analyses and meta-analyses will be conducted using SPSS V.27.0 [72].
Selection process

KS and another researcher (NN) will screen all titles and abstracts independently and divide the retrieved articles into the categories “potentially relevant” (matches the eligibility criteria), “irrelevant” (does not match the eligibility criteria) and “uncertain” (information is inconclusive with regard to eligibility criteria). Reasons for each decision will be reported (e.g. “irrelevant” because eligibility criteria “RCT study” or “adult sample” does not apply). Interrater reliability will be assessed by the percentage of agreement between coders.

In a second step, both researchers will read “potentially relevant” and “uncertain” articles in full text and assess their study eligibility based on the criteria listed above (participant, intervention, comparison, outcome). Discrepancies in each step will first be discussed between both reviewers, and, if they cannot be solved, then with a third senior researcher (MLö).

Data collection process and data items

A standardized data extraction form for the extraction of the study data will be developed. To ensure that all relevant data will be extracted correctly, both reviewers will independently test the pilot version of the form on a subsample of relevant articles, discuss difficulties and adopt the data extraction form accordingly. Both reviewers will extract data from each study independently. Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing data, study authors will be contacted.

The following data will be extracted:

1. Study identification items (e.g., first author, year of publication, country)
2. Study design characteristics (e.g., sample size, recruitment strategy, inclusion and exclusion criteria, classification of obesity levels, assessment of depression, assessment of concurring conditions like comorbidities and pharmaco- or psychotherapy, intervention design/duration, control group condition, follow-up assessments)
3. Participant characteristics (e.g., mean age and age range, gender)
4. Methodological factors (e.g., risk of bias, study limitations)
5. Outcome data (in case of follow up-assessments, all waves will be included): effectiveness = reduction of depressive symptoms

Quality assessment

The authors plan to use the revised Cochrane Risk of Bias tool in RCTs (RoB 2) [73]. KS and another researcher (NN) will independently assess the methodological quality of the included studies in the following domains:

1. Bias arising from the randomization process
2. Bias due to deviations from intended interventions
3. Bias due to missing outcome data
4. Bias in measurement of the outcome
5. Bias in selection of the reported result.
On this base, all studies will be assigned to the three corresponding overall risk-of-bias-grades following [73]: “high risk of bias” (at high risk of bias in at least one domain, or some concerns for multiple domains), “some concerns” (some concerns in at least one domain, but no high risk of bias for any domain) and “low risk of bias” (low risk of bias for all domains). Discrepancies will first be discussed between both reviewers, and, if they cannot be solved, then in a discussion with a third senior researcher (MLö). In case of missing methodological information, study authors will be contacted. In the risk of bias table, results of the ratings will be shown for each domain.

Data synthesis and presentation
The characteristics (as listed under “Data collection process and data items”) of all included studies will be presented in a narrative synthesis, starting with study and sample characteristics and descriptions of intervention and control group conditions, followed by outcome measurements, effect sizes and overall results.

If a sufficient number of eligible studies is found, an optional second part will be done. The authors will include these studies in a meta-analyses that provide quantitative measures of depression and analyze heterogeneity between RCTs with the use of $I^2$ statistics, funnel and forest plots. A moderate level of heterogeneity of 30–60% between studies for $I^2$ will be assumed according to the Cochrane standards [74]. If studies fail to show sufficient heterogeneity ($I^2 < 60\%$) in at least two trials [75], meta-analytic pooling will not be undertaken. Since the cause of inconsistency may result from study characteristics [74], sources of heterogeneity in subgroups of studies in terms of type of BMI-classification (overweight or obesity) or intervention type (type of psychotherapeutic intervention) will be explored. As studies with different outcome measures (depressive symptoms) and various interventions will be included, a random effects model will be applied and standardized mean difference values and their associated 95% confidence intervals will be estimated. In case of missing date, the authors will handle them according to the Cochrane Handbook for Systematic Reviews of Interventions [74]. RevMan Web V.4.12.0 [71] or another eligible software will be used for data analyses.

Patient and public involvement
No patient involved.

Ethics and dissemination
Patient/public consent for publication: As no primary data will be collected, ethical approval and consent to participate are not required. The results of this systematic review are intended to be published in an international peer-reviewed journal and be presented at relevant professional conferences.

Author Contributions
All authors contributed substantially to the conception of the work; KS and MLö drafted the manuscript; MLu and SRH revised the manuscript critically for important intellectual content; all authors finally approved the version to be published. All authors gave agreement to be accountable for all aspects of the work.
Competing interests statement
The authors declare that there are no competing interests.

Funding statement
This work was supported by the German Federal Ministry for Education and Research (BMBF, Grant number: 01GY2108). The BMBF is not involved in the design of the study, and will have no role regarding the execution of the study, the data analysis or the interpretation of the data. We were funded by the Open Access Publishing Fund of Leipzig University supported by the German Research Foundation within the program Open Access Publication Funding.

Figure Legend
Figure 1. Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement [69].

REFERENCES


434 56 Beleigoli AM, Andrade AQ, Cançado AG, et al. Web-based digital health interventions for weight loss and lifestyle habit changes in overweight and obese adults: Systematic review and meta-


Figure 1 Flow diagram of the different phases of the planned study selection process adapted from the Preferred reporting items for systematic reviews (PRISMA)-statement (Moher et al. 2009).

96x107mm (1200 x 1200 DPI)
Example for search strategy:

MEDLINE via PubMed

(((obesity>Title/Abstract) OR overweight>Title/Abstract) OR adiposity>Title/Abstract) OR "metabolic syndrome">Title/Abstract) OR "body mass index">Title/Abstract))

AND

(depress*>Title/Abstract))

AND

((internet>Title/Abstract) OR online>Title/Abstract) OR web>Title/Abstract) OR computer>Title/Abstract) OR mobile>Title/Abstract) OR app>Title/Abstract) OR smartphone>Title/Abstract) OR m-health>Title/Abstract) OR "mobile health">Title/Abstract) OR "e-health">Title/Abstract) OR "e-mental health">Title/Abstract) OR iCBT>Title/Abstract) OR cCBT>Title/Abstract) OR IMI>Title/Abstract)))

AND

((intervention>Title/Abstract) OR psychotherapy>Title/Abstract) OR therapy>Title/Abstract) OR "cognitive behavioral therapy">Title/Abstract) OR cbt>Title/Abstract))
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<td>Describe the rationale for the review in the context of existing knowledge.</td>
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<td>Provide an explicit statement of the objective(s) or question(s) the review addresses.</td>
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<td>Information</td>
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<td>Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.</td>
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<tr>
<td>Search strategy</td>
<td>7</td>
<td>Present the full search strategies for all databases, registers and websites, including any filters and limits used.</td>
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<tr>
<td>Selection process</td>
<td>8</td>
<td>Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
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<tr>
<td>Data collection</td>
<td>9</td>
<td>Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.</td>
<td>Page 5</td>
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<tr>
<td>Data items</td>
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<td>List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.</td>
<td>Page 5</td>
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<td>10b</td>
<td>List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.</td>
<td>Page 5</td>
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<td>Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.</td>
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<td>Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.</td>
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<td>Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).</td>
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<td>Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.</td>
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<td>13c</td>
<td>Describe any methods used to tabulate or visually display results of individual studies and syntheses.</td>
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<td></td>
<td>13d</td>
<td>Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.</td>
<td>Page 6</td>
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<td></td>
<td>13e</td>
<td>Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).</td>
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<td>13f</td>
<td>Describe any sensitivity analyses conducted to assess robustness of the synthesized results.</td>
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<tr>
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<td>Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).</td>
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<td>Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.</td>
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## PRISMA 2020 Checklist

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<thead>
<tr>
<th>Section and Topic</th>
<th>Item #</th>
<th>Checklist item</th>
<th>Location where item is reported</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESULTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study selection</td>
<td>16a</td>
<td>Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.</td>
<td>Figure 1</td>
</tr>
<tr>
<td></td>
<td>16b</td>
<td>Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Study characteristics</td>
<td>17</td>
<td>Cite each included study and present its characteristics.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Risk of bias in studies</td>
<td>18</td>
<td>Present assessments of risk of bias for each included study.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Results of individual studies</td>
<td>19</td>
<td>For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Results of syntheses</td>
<td>20a</td>
<td>For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>20b</td>
<td>Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>20c</td>
<td>Present results of all investigations of possible causes of heterogeneity among study results.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>20d</td>
<td>Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Reporting biases</td>
<td>21</td>
<td>Present results of all investigations of possible causes of heterogeneity among study results.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Certainty of evidence</td>
<td>23</td>
<td>Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.</td>
<td>n.a.</td>
</tr>
<tr>
<td><strong>DISCUSSION</strong></td>
<td>23a</td>
<td>Provide a general interpretation of the results in the context of other evidence.</td>
<td>Page 7</td>
</tr>
<tr>
<td></td>
<td>23b</td>
<td>Discuss any limitations of the evidence included in the review.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>23c</td>
<td>Discuss any limitations of the review processes used.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>23d</td>
<td>Discuss implications of the results for practice, policy, and future research.</td>
<td>Page 7</td>
</tr>
<tr>
<td><strong>OTHER INFORMATION</strong></td>
<td>24a</td>
<td>Provide registration information for the review, including register name and registration number, or state that the review was not registered.</td>
<td>Page 2</td>
</tr>
<tr>
<td></td>
<td>24b</td>
<td>Indicate where the review protocol can be accessed, or state that a protocol was not prepared.</td>
<td>n.a.</td>
</tr>
<tr>
<td></td>
<td>24c</td>
<td>Describe and explain any amendments to information provided at registration or in the protocol.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Support</td>
<td>25</td>
<td>Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.</td>
<td>Page 7</td>
</tr>
<tr>
<td>Competing interests</td>
<td>26</td>
<td>Declare any competing interests of review authors.</td>
<td>Page 7</td>
</tr>
<tr>
<td>Availability of data, code and other materials</td>
<td>27</td>
<td>Report which of the following are publicly available and where they can be found: template data collection forms; data used for all analyses; analytic code; any other materials used in the review.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>
PRISMA 2020 Checklist

For more information, visit: http://www.prisma-statement.org/