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Tailored activities for older adults with dementia: A systematic review and meta-analysis

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ABSTRACT

Objectives To understand and assess the degree of tailoring of tailored activities for people with dementia (PWD); and to estimate the magnitude of effects of levels of tailoring activities on reducing behavioural and psychological symptoms of dementia (BPSDs), improving Quality of life (QoL) and other relevant outcomes among PWDs.

Design Systematic review with meta-analysis. ProQuest, PubMed, Ovid, Cochrane Library, Web of Science and CINAHL were searched from the start of indexing to May 2020.

Results Thirty-five studies covering a total of 2,390 participants from 16 countries/regions were included in the review. We developed a rating schema based on three dimensions: approaches to assessing PWD's characteristics for the design of tailored activities, the degree of individualization in intervention design, and to what extent the implementation manifested person-centered care. Studies with a high level of tailoring interventions (n=8) had a significant and moderate effect on reducing BPSDs (Standardized Mean Differences, SMD= -0.52, p <0.05), followed by medium (n=6; SMD= -0.38, p =0.071) and low level of tailoring interventions (n=4; SMD= -0.15, p =0.076). A high level of tailoring activities had a moderate effect size on improving QoL (n=5; SMD=0.52, p<0.05), followed by a medium level (n=3; SMD=0.41, p <0.05) of tailoring.

Conclusions Our review provides new directions for tailored activities development. To develop high-level tailoring activities to reduce BPSD and improve QoL among PWD, we recommended the application of structured and comprehensive assessments to identify and address two or more PWD characteristics in designed tailored activities, and allow modification of interventions to respond to changing PWD needs or circumstances.

Strengths and limitations of this study

- The major contribution of this systematic reviews and meta-analyses is to develop a rating schema of the level of tailoring interventions
- To provide empirical evidence to the rating schema by investigating the effects of different levels of tailoring interventions on reducing behavioural and psychological symptoms of dementia and improving quality of life among people with dementia.
- Exclusion of papers not published in English may mean that important additional findings are missed.

Tailored activities for older adults with dementia: A systematic review and meta-analysis

INTRODUCTION

Dementia is particularly common among older adults, affecting 5-8% of people aged 60 and over at any given time worldwide.¹ Behavioural and psychological symptoms of dementia (BPSDs) are common among people living with dementia (PWD), such as agitation, depression, and resistance to care,² which occur throughout the disease process, associated with decreased quality of life (QoL).³

Non-pharmacological interventions are recommended as first-line treatments over pharmacological approaches to treat BPSDs and have less adverse effects.⁴ Tailored activities to PWD are promising non-pharmacological approaches that reduce BPSDs and increase QoL. Two recently published NICE guidelines recommend that healthcare professionals offer activities to promote QoL that are tailored to personal preferences and consider using a structured tool to assess their likes, dislikes, routines and personal history.^{5,6}

To our knowledge, six systematic reviews and meta-analyses have attempted to synthesize the effects of tailored activities on reducing BPSDs and enhancing QoL among PWD, based on tailored strategies, activity types, personal characteristics, and frequency and duration of delivery.⁷⁻¹² The first of these, published between 2000 and 2011 focused on the effectiveness of various tailored strategies to foster activity engagement and reduce BPSDs in PWD.⁷ Changes to tools and materials used in activities were most common but yielded mixed outcomes of BPSDs reduction; modifications to space and social demands were rarely tested but yielded consistently positive outcomes.⁷ In addition, a systematic review of studies published between 2000 and 2012 found that personalized pleasant activities yielded strong evidence for treating BPSDs, but limited evidence for physical and music activities⁸. Another meta-analysis found that individualized recreational activities were effective for reducing

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3 BPSDs.⁹ Recently, Mohler and colleagues conducted three meta-analyses regarding the effects
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5 of tailored activities among PWD living in care facilities, communities and home settings,
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7 respectively, found that, compared with usual care, tailored activities slightly reduced
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9 BPSDs.¹⁰⁻¹² However, no differences in other desired outcomes between intervention and
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11 control groups among different specific types of activities or duration of delivery were
12
13 evident. Although different activity components (e.g. activity types, PWD's characteristics,
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15 frequency and duration of delivery) were discussed,⁷⁻¹² none of these reviews further
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17 investigated the degree of tailoring among the tailored activities and synthesized its
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19 associations with the desired outcomes.
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24 Understanding the degree of tailoring of tailored activities is important. We define the
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26 degree of tailoring of the tailored activities as the extent to which non-pharmacological
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28 interventions are tailored, individualized or personalized for PWD. The conceptualization of
29
30 the degree of tailoring echoes the rationales and principles of effective interventions working
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32 on BPSDs, level of engagement and QoL, embedded in occupational therapy,¹³ engagement in
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34 meaningful activities,¹⁴ and person-centered care.¹⁵ Occupational therapy emphasizes the fit
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36 between PWD's capabilities and the occupation (e.g. activities or roles) through task
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38 simplification and removing barriers in the physical and social environment.¹³ Environmental
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40 docility theory suggests that both underloading and overloading of external stimulations (e.g.
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42 cognitive activities and social interactions) may lead to PWD's disengagement or excessive
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44 disability.¹⁶ Thus, maintaining PWD's engagement in meaningful activities through tailored
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46 activities based on their physical strength, mental state, and psychosocial needs is essential.¹⁴
47
48 The person-centered care approach stresses service providers' and caregivers' autonomy to
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50 determine specific ways of delivering care to maintain participants' engagement during the
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52 intervention.¹⁵ These theories imply that the degree of tailoring can significantly influence the
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54 effectiveness of tailored tailored for PWD. Thus, the degree of tailoring could depend on how
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3 to assess PWD's characteristics and their environment, how to design tailored activities based
4 on PWD's characteristics, and interventionists' autonomy to address PWD's spontaneous
5 needs.
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10 Conceptualizing and quantifying the tailoring levels of existing tailored activities can
11 advance our knowledge on developing highly tailored activities for PWD, deciding on the
12 appropriate "dose" of tailoring, and translating this cumulative evidence into clinical practice.
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14 However, there is little knowledge about how to assess the degree of tailoring among tailored
15 activities and their effectiveness on targeted outcomes in existing literature.
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21 **OBJECTIVES**

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23 This systematic review and meta-analysis aimed to: (1) assess the degree of tailoring of existing
24 tailored activities for PWD; (2) estimate the magnitude of the effects of levels of tailoring
25 among existing tailored activities on reducing BPSDs, improving QoL and the level of
26 engagement among PWD.
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32 **METHODS AND ANALYSIS**

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34 We conducted the review in accordance with the PRISMA procedure (see PRISMA-Checklist).
35 Eligibility criteria required studies to: (a) include **participants** with dementia or cognitive
36 impairment and aged 60 years or older; (b) include activities tailored to at least one of the
37 participants' characteristics (e.g. needs, physical or/and mental ability, present or previous
38 preference for particular activities or interests, habits, and physical living environment like
39 housing conditions and caregiver management style); (c) report BPSDs (measured by multi-
40 domain scales, such as Neuropsychiatric Inventory, and scales specific to agitation and
41 depression/anxiety, such as Cohen-Mansfield Agitation Inventory and Cornell Scale for
42 Depression in Dementia), QoL and level of engagement as outcomes; (d) include randomized
43 controlled trials or quasi-experimental **study design**; and (e) apply a **control group** (e.g. usual
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3 care, wait-list, attention control etc.). The review included studies published in English from
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5 the start of indexing to May 2020.
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8 We searched ProQuest, PubMed, Ovid, Cochrane Library, Web of Science and CINAHL,
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10 using the search terms: (1) “cognitive impairment” OR “cognitive disorder” OR “dement*”
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12 OR “Alzheimer”; (2) “tailor*” OR “engag*” OR “individual*” OR “personal*”; and (3)
13
14 “activit*” OR “program*” OR “therap*” OR “intervention*” OR “treatment*”. The full search
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16 strategy is shown in Supplementary Table 1.
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19 The studies were initially screened for relevance by SYL and the final stage was undertaken
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21 by SYL and AYZ. Data were extracted and checked by SYL and MSLM. Where there were
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23 disagreements, data were rechecked for relevance and accuracy. Where available, raw data
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25 (e.g. clinical interventions, strategies, outcomes and results) were extracted and entered into a
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27 spreadsheet.¹⁷ For each intervention we additionally extracted the following information:
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29 PWD’s characteristics taken into account, intervention delivery, and information about the
30
31 tailoring process.
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34 35 ***Patient and Public Involvement***

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37 No patient involved.
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39 40 ***Developing the tailoring and classification scheme***

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42 The authors formed an expert panel to develop a scheme for the level of tailoring interventions
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44 based on the included studies. It comprised AYZ (a licensed social worker in Hong Kong with
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46 two years’ clinical experience of dementia care and five years’ research experience focusing
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48 on the mechanisms of non-pharmacological interventions for PWD), TYL, JCPC and SYL
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50 (each of whom had over ten years’ experience in psychology and elderly care).
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54 Based on the theories and approaches mentioned above, we hypothesized that tailoring is
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56 embedded in the whole process at three interrelated phases: assessments, design and
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58 implementation, and the degree of tailoring is determined by these three dimensions: how to
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3 assess PWD's characteristics before designing the intervention, the extent to which
4 interventions are tailored according to PWD's characteristics, and the level of the
5 interventionists' autonomy to address PWD's needs, as suggested by occupational therapy,
6 engagement in meaningful activities, and the person-centered care approach.¹³⁻¹⁵ To this end,
7 we developed three corresponding criteria to rate levels of tailoring (Supplementary Table 2):

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14 ***Assessment for the purpose of tailoring*** indicates how much detail about the targeted
15 dimensions of PWD's characteristics is taken into account for designing tailored activities.
16 Operationally, we distinguished levels of assessments based on their comprehensivity and
17 systematicity, such as whether simple pre-assessments were conducted mainly on the
18 individual's capacities, unstructured/semi-structured assessments, or well-structured
19 assessments that captured a full picture of the individual's characteristics.

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28 ***Individualization in intervention design*** refers to how the intervention design accounted
29 for individuals' uniqueness and variations of their needs. To avoid counting the number or
30 arbitrarily weighting specific PWD's characteristics, we distinguished the degree of
31 individualization based on whether the protocol tailored for one versus two or more PWDs'
32 characteristics.

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41 ***Person-centered care in implementation*** refers to the extent to which the interventionists
42 was able to adjust the intervention based on their professional judgement of changing dynamics
43 or PWD's needs during implementation. For examples, the intervention is a standardized
44 protocol of tailored activities regardless of spontaneous needs of PWD would be rated as low
45 feasibility to pursuing person-centred care.

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51 ***Rating criteria.*** Based on these dimensions, we rated the level of tailoring of tailored
52 activities as high, medium or low. High level refers to interventions targeting two or more
53 domains (e.g., capabilities, preference, interests, life experience, and external environment)
54 using systematic assessments and comprehensive activity plans while allowing the
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3 interventionists to exercise their professional judgement to adjust the intervention in
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5 accordance with PWD's needs. Medium level refers to tailoring that is assessed by unstructured
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7 or semi-structured interviews rather than a systematic approach and professional judgements
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9 are treated as supplements for pre-defined activity plans. Low level interventions targeted one
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11 domain only with or without clear measures, and either did not mention professional judgement
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13 or afforded it little weight. AYZ and SYL independently rated the level of tailoring for the
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15 included tailored activities. Any conflicting ratings were resolved through discussions.
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19 ***Data synthesis and analysis***

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21 Given that outcomes in our review were continuous, effect sizes were expressed using
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23 standardized mean differences (SMD) at 95% confidence intervals (CI),²⁰ interpreted as
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25 Cohen's d.¹⁸ Specifically, the values of 0.2, 0.5, and 0.8 reflected small, moderate and large
26
27 effect sizes, respectively.¹⁸ Due to differences in settings and methods, we used the random-
28
29 effects model to pool the results. Heterogeneity was determined by Chi² and I² statistics.^{19, 20}
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31 We classified subgroup analyses of the effectiveness of tailored activities according to the
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33 levels of tailoring of the interventions. All meta-analyses were conducted using Comprehensive
34
35 Meta-Analysis Software. Where raw data are not provided, summary results are given in the
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37 text but not the forest plots.
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41 ***Quality Appraisal***

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43 SYL and MSLM independently assessed the risk of bias for the studies using a revised
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45 Cochrane risk of bias tool for randomized trials,^{19, 21} including: (a) bias arising from the
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47 randomization process; (b) deviations from intended interventions; (c) bias due to missing
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49 outcome data; (d) bias in measurement of the outcome; and (e) bias in selection of the reported
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51 results. Risk Of Bias In Non-randomised Studies - of Interventions was used to categorize risk
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53 of bias as "low," "high" or "some concerns".²² Conflicting results were resolved through
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55 discussions.
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RESULTS

Summary of Search Results

The search and study selection process is summarized in the PRISMA flow diagram (Supplementary Figure 1). In the identification phase, 14,238 abstracts were identified and imported into Endnote; 7,471 duplicate articles were removed. In the screening phase, the titles and abstracts of 6,767 articles were screened, and 6,476 irrelevant articles were excluded. In the eligibility phase, full-text screening was conducted for 291 articles according to the inclusion and exclusion criteria, and 35 studies were finally included in this review.

Included studies were conducted in 16 countries/regions: Australia, Brazil, Mainland China, Denmark, France, Germany, Hong Kong, Italy, Japan, Korea, the Netherlands, Norway, Switzerland, Taiwan, the United Kingdom, and the United States, published between 2000 and 2020. The average age of participants ranged from 62.1 to 89.2 years. Twenty-six studies included participants with dementia only, and the remaining studies included participants with different level of cognitive impairment (mild to moderate). The total size of the intervention groups (IG) was 1,248 (range = 6-158), and the total size of the control groups (CG) was 1,142 (range = 5-107). Fourteen studies (40%) had no more than 20 participants for each arm. Thirty studies were randomized controlled trials (RCTs). Five applied a quasi-experimental study design. Twenty-two applied usual care as the comparison, and the remaining applied placebo control, active control or wait-list control. Twenty-four studies were conducted in care facilities (such as a nursing home, geriatric health service facility, or hospital), and remaining studies were conducted in community settings or home-based settings (Supplementary Table 3).

Description of the interventions

The components of activities can be categorized into four groups: physical (n=3),²²⁻²⁴ cognitive (n=2),^{25, 26} music (n=7)²⁷⁻³³ and multiple activities (n=23).^{16, 34-55} Twenty-three studies reported their interventions as individual mode, five reported group-based mode, and six reported mixed

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3 modes, while the remaining studies did not provide details. Intervention was provided by
4 specialists (e.g. occupational therapists, clinicians, psychologists, physical therapists, and
5 speech therapists), researchers and by trained nursing home caregivers and staff. A detailed
6 description of interventions is shown in Supplementary Table 4.
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12 ***Level of tailoring***

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14 Table 1 shows the level of tailoring in the interventions reported in the reviewed studies.

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16 *Level of assessment for tailoring.* Sixteen studies systematically assessed PWD's
17 characteristics.^{16, 22, 31, 34-38, 42, 45, 47, 49-52, 55} For instance, five studies followed the protocols of
18 the Tailored Activity Program (TAP), which posits that with disease progression, dementia
19 patients become increasingly vulnerable to their environment and experience lower thresholds
20 for tolerating stimuli, which can result in behavioral disturbances. Therefore, TAP applied
21 systematic approaches to discern PWD and their caregivers' daily routines, identify previous
22 and current activity interests and collection information about dyadic communication and home
23 environmental features for designing the activities for the participants.
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36 *Degree of individualization in design.* Activities tailored according to PWD's characteristics
37 included cognitive or/and physical capacities (n = 22),^{22-24, 26, 34, 35, 37-43, 45, 47, 49-55} personal
38 experience and history (n=2),^{30, 44} role identity (n=3),^{35, 47, 51} preferences and interests (n=14)
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22, 25, 36-38, 42, 43, 46, 49-53, 55 habits (n=2),^{47, 50} music preference (n=6),^{27-29, 31-33} cultural
backgrounds (n=1),⁴³ and living environment (n=5).^{45, 47, 49, 50, 52} Five studies also considered
caregivers' characteristics.^{42, 47, 49, 50, 52} Twelve studies tailored the intervention for a single
aspect of PWD's characteristics only, while the remainder tailored the activities for at least
two. One study used 3-arm in intervention groups with one tailoring both for PWD's capacity
and interests, the second only tailoring for the capacities yet opposite to PWD's preference and
the third only tailoring for the interests yet challenging to PWD's capacity.³⁷

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3 *Degree of person-centered care in delivery.* Twenty-six studies indicted the level of
4 flexibility for modification of activities during the intervention. Sixteen studies explicitly
5 permitted the interventionists to review and modify the intervention according to participants'
6 spontaneous needs and circumstances,^{16, 22, 31, 32, 35-38, 42, 45, 47-52} thus were rated as offering a
7 high degree of person-centered care. Five allowed some flexibility for adjusting interventions
8 during implementation,^{30, 43, 53-55} thus were rated as offering some flexibility. Five studies
9 enabled relatively limited adjustment of intervention to take account of PWD's changed needs
10 or circumstances.^{23, 28, 30, 33, 46} The remaining studies provided insufficient information to judge
11 the extent of flexibility allowed during the intervention.
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24 Based on the three-dimension rating schema, we identified the tailoring level of 12 studies
25 as high,^{16, 22, 31, 35, 36, 42, 45, 47, 49-52} 11 as medium,^{30, 32, 34, 38, 40, 41, 43, 48, 54, 55} and 11 as the low.^{23-29,}
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Quality appraisal

The risk bias of 10 RCT studies was judged as low, while that of 12 was rated as high, and the remainder were judged as giving some concern (Supplementary Figure 2). Among all RCT studies, 19 reported the method of random sequence generation (e.g. computer generated programs, random list generator, random allocation by an external researchers and block randomization).^{16, 24-26, 29, 30, 33, 37-39, 42, 45, 47, 49-52, 54, 55} Eleven were rated as high risk of deviation from intended intervention as they were judged as high risk of blinding participants, personnel and appropriate analysis used to estimate the effect of assignment to intervention.^{23-26, 29, 32, 36, 38, 39, 44, 48} Five quasi-experimental studies were excluded from the meta-analysis since none were rated at low risk of bias and thus comparable to RCTs (Supplementary Figure 3).

Effects of tailored interventions

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3 Twenty-six studies reported the outcomes of BPSDs measured by multi-dimension or specific
4 scales of agitation.^{16, 23-25, 27, 29-33, 35-38, 40, 42, 43, 46, 47, 49-55} The higher scores indicated more BPSDs.
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7 According to our meta-analysis, 18 RCTs with 20 tailored activities had an overall small effect
8 on BPSDs at post-intervention ($SMD_{pooled} = -0.38$; 95% CI: -0.54 to -0.23, $p < 0.001$), although
9 significant heterogeneity was found ($I^2 = 64.17\%$, $p < 0.001$) (Figure 1). Eight studies were
10 excluded from the meta-analysis either because of their quasi-experimental design or lack of
11 comparable data,^{27, 32, 33, 40, 43, 46, 51, 53} and four of these did not find difference in reducing BPSDs
12 between IG and CG.^{27, 32, 33, 46}

21 <Insert Figure 1>

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24 Nine studies reported the outcome of QoL.^{16, 30, 44, 45, 47, 48, 50, 52, 54} The higher score indicates
25 higher QoL. Tailored interventions had an overall small effect on QoL at post-intervention
26 ($SMD_{pooled} = 0.45$; 95% CI: 0.25 to 0.64, $p < 0.001$), and no significant heterogeneity was
27 found ($I^2 = 11.56\%$, $p > 0.05$) (Figure 2).

32 <Insert Figure 2>

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35 Sixteen studies reported the outcome of depression,^{16, 22, 24-26, 28, 35, 39-42, 44-46, 48, 54} measured
36 by the Cornell Scale for Depression in Dementia, Geriatric Depression Scale, Multidimensional
37 Observation Scale for Elderly Subjects, Geriatric Depression Scale, Neuropsychiatric
38 Inventory subscale for depression, or Patient Health Questionnaire-9. The higher score
39 indicates more depression. Thirteen RCT studies with 14 tailored activities indicated those
40 activities had a small overall effect on depression at post-intervention ($SMD_{pooled} = -0.26$; 95%
41 CI: -0.40 to -0.12, $p < 0.001$), and no significant heterogeneity was found (Supplementary
42 Figure 4). The remaining three studies were excluded from the meta-analysis because of their
43 quasi-experimental design or lack of comparable data,^{28, 40, 46} and only one study did not find
44 difference in reducing depression between IG and CG.⁴⁰

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3 Seven studies with nine interventions reported the outcome of engagement.^{16, 34, 35, 37, 38, 47,}
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6 ⁴⁸ Higher scores indicate higher level of engagement. The meta-analysis indicated that tailored
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8 interventions of eight matched IGs and CGs in six studies had an overall large effect on level
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10 of engagement at post-intervention (SMD_{pooled} = 0.86; 95% CI: 0.23 to 1.48, p < 0.001)
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12 (Supplementary Figure 5). Significant heterogeneity was found, primarily generated by the
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14 outlier study whose intervention specifically targeted participants' self-identity roles and which
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16 reported large effects on the engagement (SMD_{pooled} = 3.52; 95% CI: 2.87 to 4.17, p < 0.001).³⁵
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18 Removal of this study resulted in lower and non-significant heterogeneity with significant
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20 small effect size (SMD_{adjusted pooled} = 0.47; 95% CI: 0.23 to 0.60, p < 0.001). One study with a
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22 quasi-experimental design reported increased engagement at post-intervention.³⁴
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26 ***Subgroup analysis***

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28 Subgroup analysis was performed to test the difference of the effects of the level of tailoring
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30 on outcomes (Figures 3 & 4). Studies with a high level of tailoring activities had significant
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32 and the largest effect size regarding the reduction of BPSDs (SMD_{pooled} = -0.52, p < 0.001)
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34 with non-significant heterogeneity, followed by medium (SMD_{pooled} = -0.38, p = 0.071) and
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36 low groups (SMD_{pooled} = -0.15, p = 0.076), although both the latter two groups had marginally
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38 significant effect sizes and significant heterogeneity. The high group had a moderate effect size
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40 on improvement in QoL (SMD_{pooled} = 0.52, p < 0.01), followed by the medium group (SMD
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42 _{pooled} = 0.41, p < 0.05). Only one study with low level of tailoring reported the outcome of QoL
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44 with moderate effect size (SMD = 0.72, p < 0.05).
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51 <Insert Figure 4>

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54 Subgroup analysis was performed to test the difference of the effects of level of tailoring on
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56 depression and engagement (Supplementary Figures 6 & 7). The medium group had a moderate
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58 effect size regarding reduction in depression (SMD_{pooled} = -0.64, p < 0.05), followed by the
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3 high group ($SMD_{pooled} = -0.33, p < 0.01$). The three studies with medium level of tailoring
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5 activities all involved social or group interaction components that have beneficial effects on
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7 PWD's mental health. Only one study rated high on tailoring had a large effect on improving
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9 engagement level at post-intervention ($SMD = 0.85, p < 0.01$). The medium group had small
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11 effect size ($SMD_{pooled} = 0.44, p < 0.05$), followed by the low group ($SMD_{pooled} = 0.39, p <$
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13 0.05).
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16 17 **Discussion**

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19 Our systematic review aimed to assess the degree of individualization/personalization of
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21 tailored activities and estimate the effect of levels of tailoring interventions on reducing BPSD,
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23 improving QoL and other relevant outcomes among PWDs. Thirty-five studies met our
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25 inclusion criteria, covering a total of 2,390 participants from 16 countries/regions. The
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27 activities included in the interventions comprised physical, cognitive, music and multiple
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29 activities. The number of studies in our review helped increase the generalizability of our
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31 findings.
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35 We employed meta-analysis to estimate the overall effects of tailored activities on the
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37 outcomes of BPSD, QoL, depression and engagement. We found that tailored activities slightly
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39 reduced BPSDs, consistent with previous meta-analyses targeting facilities, communities, and
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41 PWDs' own home.¹⁰⁻¹² We also found that tailored activities had a small effect on improving
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43 QoL. In contrast, previous reviews found inconclusive evidence regarding QoL: no effect in
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45 facilities, and a slight improvement in both community- and home-based settings.¹⁰⁻¹² Our
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47 findings also showed that tailored activities had small effects on depression, and large effects
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49 on engagement, contradicting previous reviews reporting little or no effect on these outcomes.^{11,}
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56 We developed the rating schema of tailoring level based on three essential components:
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58 assessment for tailoring, individualization in intervention design and person-centered care in
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3 implementation. Overall, we rated only 12 studies as high regarding activities, 11 as medium,
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5 11 as low and 1 study was rated as mixed because it has 3-arm intervention groups with one
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7 medium and two low levels of tailoring activities for comparison.
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10 We further investigated how the degree of tailoring influenced intervention effectiveness on
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12 the interested outcomes. Interventions with a high level of tailoring activities had a significant
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14 and moderate effect, followed by medium (small) and low groups (trivial), and the latter two
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16 groups had significant heterogeneity and marginally significant effect sizes. Interventions with
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18 a high level of tailoring intervention had a moderate effect size on improving QoL, followed
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20 by the medium group. Only one study with a low level of tailoring reported the outcome of
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22 QoL with moderate effect size. These findings lend support to our rating schema as the overall
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24 goals of tailoring activities are to reduce BPSDs and improve QoL.^{50, 52} A similar pattern was
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26 found in the level of engagement; but since the degree of tailoring was rated high in only one
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28 study, this should be interpreted with caution.
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33 This systematic review has several limitations. The generalizability of our results may be
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35 limited since we only included studies reported in English. The included studies had risks of
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37 bias that may undermine the quality of evidence. Furthermore, noticeable heterogeneity was
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39 found among studies with outcomes of BPSDs and engagement, which may affect the
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41 conclusions synthesized from these studies. Thus, these results must be interpreted with caution.
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44 This review has implications for clinical practice. It provides new insights into non-
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46 pharmacological tailored activities by developing a rating schema for the level of tailoring and
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48 tested its validity by investigating the effectiveness of interventions with different levels of
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50 tailoring on BPSDs and QoL. Healthcare professionals and practitioners can use our findings
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52 to tailor interventions to benefit patients' outcomes. We recommended the application of
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54 structural and comprehensive assessment approaches to identify and address two or more
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56 PWD's characteristics (capacities, preference, habits and living environment etc.) in designing
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3 tailored activities, and allow interventionists to use their professional judgement to modify the
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5 interventions to respond to spontaneous needs of PWD to develop a high level of tailoring
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7 interventions.
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10 Our systematic review has implications for future intervention research. Fourteen studies
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12 had no more than 20 participants for each arm, and only 10 RCT studies were judged as low
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14 risk. Evaluation studies should adhere to current methodological standards, e.g. a randomized
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16 and concealed allocation; adequate blinding (at least participants and outcome assessors); and
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18 recruitment of adequate samples.¹⁹
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21 **CONCLUSION**

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23 This systematic review shows that tailored activities slightly reduced BPSDs and depression,
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25 had a small effect on improving QoL, and have large effects on facilitating level of engagement
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27 among PWD. Additionally, we advanced existing literature by proposing and testing the
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29 validity of a rating schema for level of tailoring. Our findings can provide new directions into
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31 developing tailored activities. Additional high-quality tailored intervention studies with
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33 sufficient samples are needed.
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3 **Contributors** SYL wrote the systematic review, performed the preliminary searches and data
4 extraction, conducted quality assessments and drafted the systematic review paper. AYZ,
5 TYL and JCPC designed the level of tailoring rating schema. MSLM cross-checked data
6 extraction and performed quality ratings independently. GHYW and TYSL made substantial
7 contributions to conception and design of the systematic review and, assisted SYL, AYZ,
8 TYL and JCPC to resolve any discrepancies regarding study inclusion, data extraction and
9 quality ratings. All authors offered critical revisions for the systematic review manuscript.
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15

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References

1. World Health Organization. Dementia 2019 [Available from: <https://www.who.int/news-room/fact-sheets/detail/dementia>].
2. Kales HC, Gitlin LN, Lyketsos CG. Assessment and management of behavioral and psychological symptoms of dementia. *Bmj-Brit Med J*. 2015;350.
3. Gitlin LN, Kales HC, Lyketsos CG. Nonpharmacologic management of behavioral symptoms in dementia. *Journal of the American Medical Association*. 2012;308(19):2020-9.
4. de Oliveira AM, Radanovic M, de Mello PCH, Buchain PC, Vizzotto ADB, Celestino DL, et al. Nonpharmacological Interventions to Reduce Behavioral and Psychological Symptoms of Dementia: A Systematic Review. *Biomed Res Int*. 2015;2015:218980-.
5. NICE. Dementia: Assessment, management and support for people living with dementia and their carers [NG97] 2018 [updated June 2018. Available from: <https://www.nice.org.uk/guidance/ng97>].
6. NICE. Dementia: Quality standard [QS184]. 2019.
7. Trahan MA, Kuo J, Carlson MC, Gitlin LN. A systematic review of strategies to foster activity engagement in persons with dementia. *Health Educ Behav*. 2014;41(1 Suppl):70S-83S.
8. Testad I, Corbett A, Aarsland D, Lexow KO, Fossey J, Woods B, et al. The value of personalized psychosocial interventions to address behavioral and psychological symptoms in people with dementia living in care home settings: a systematic review. *International Psychogeriatrics*. 2014;26(7):1083-98.
9. Travers C, Brooks D, Hines S, O'Reilly M, McMaster M, He W, et al. Effectiveness of meaningful occupation interventions for people living with dementia in residential aged care: a systematic review. *JBI Database System Rev Implement Rep*. 2016;14(12):163-225.
10. Mohler R, Renom A, Renom H, Meyer G. Personally tailored activities for improving psychosocial outcomes for people with dementia in long-term care. *Cochrane Db Syst Rev*. 2018(2).
11. Mohler R, Renom A, Renom H, Meyer G. Personally tailored activities for improving psychosocial outcomes for people with dementia in community settings. *Cochrane Db Syst Rev*. 2020(8).
12. Möhler R, Renom A, Renom H, Meyer G. Personally tailored activities for people with dementia living in their own homes. *Cochrane Database of Systematic Reviews 2020*. 2020.
13. Bennett S, Laver K, Voigt-Radloff S, Letts L, Clemson L, Graff M, et al. Occupational therapy for people with dementia and their family carers provided at home: a systematic review and meta-analysis. *BMJ open*. 2019;9(11).
14. Macaulay S. The broken lens of BPSD: Why we need to rethink the way we label the behavior of people who live with Alzheimer disease. *Journal of the American Medical Directors Association*. 2018;19(2):177-80.
15. Chenoweth L, King MT, Jeon Y-H, Brodaty H, Stein-Parbury J, Norman R, et al. Caring for Aged Dementia Care Resident Study (CADRES) of person-centred care, dementia-care mapping, and usual care in dementia: a cluster-randomised trial. *The Lancet Neurology*. 2009;8(4):317-25.
16. Gitlin LNP, Winter LP, Burke JPOTRLF, Chernett NMPH, Dennis MPP, Hauck WWP. Tailored Activities to Manage Neuropsychiatric Behaviors in Persons With Dementia and Reduce Caregiver Burden: A Randomized Pilot Study. *The American Journal of Geriatric Psychiatry*. 2008;16(3):229-39.
17. Cochrane Effective Practice and Organisation of Care (EPOC). Describing interventions in EPOC reviews 2017 [Available from: <https://epoc.cochrane.org/resources/epoc-resources-review-authors>].
18. Cohen J. Statistical power analysis for the behavioral sciences: Academic press; 2013.
19. Higgins JP, Green S. Cochrane handbook for systematic reviews of interventions. Chichester: John Wiley & Sons; 2011.
20. Higgins JP, Li T, Deeks JJ. Choosing effect measures and computing estimates of effect: The Cochrane Collaboration; 2019 [Available from: www.training.cochrane.org/handbook].

21. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *Bmj-Brit Med J*. 2019;366.
22. Lam CWL, Lui WCV, Luk NYD, Chau R, So C, Poon V, et al. Effectiveness of an individualized functional training program on affective disturbances and functional skills in mild and moderate dementia - a randomized control trial. *International Journal of Geriatric Psychiatry*. 2009;25(2):133-41.
23. Holthoff VA, Marschner K, Scharf M, Steding J, Meyer S, Koch R, et al. Effects of Physical Activity Training in Patients with Alzheimer's Dementia: Results of a Pilot RCT Study. *Plos One*. 2015;10(4).
24. Telenius EW, Engedal K, Bergl A. Effect of a High-Intensity Exercise Program on Physical Function and Mental Health in Nursing Home Residents with Dementia: An Assessor Blinded Randomized Controlled Trial. *Plos One*. 2015;10(5).
25. Davison TED, Nayer KBID, Coxon SP, de Bono AP, Eppingstall BMA, Jeon Y-HP, et al. A personalized multimedia device to treat agitated behavior and improve mood in people with dementia: A pilot study. *Geriatric Nursing*. 2016;37(1):25.
26. Giuli C, Papa R, Lattanzio F, Postacchini D. The Effects of Cognitive Training for Elderly: Results from My Mind Project. *Rejuvenation Research*. 2016;19(6):485-+.
27. Garland K, Beer E, Eppingstall B, O'Connor DW. A comparison of two treatments of agitated behavior in nursing home residents with dementia: simulated family presence and preferred music. *Am J Geriatr Psychiatry*. 2007;15(6):514-21.
28. Sung H-C, Chang AM, Lee W-L. A preferred music listening intervention to reduce anxiety in older adults with dementia in nursing homes. *Journal of Clinical Nursing*. 2009;19(7):1056-64.
29. Lin Y, Chu H, Yang C-Y, Chen C-H, Chen S-G, Chang H-J, et al. Effectiveness of group music intervention against agitated behavior in elderly persons with dementia. *International Journal of Geriatric Psychiatry*. 2011;26(7):670-8.
30. Ridder HMO, Stige B, Qvale LG, Gold C. Individual music therapy for agitation in dementia: an exploratory randomized controlled trial. *Aging & Mental Health*. 2013;17(6):667-78.
31. Sakamoto M, Ando H, Tsutou A. Comparing the effects of different individualized music interventions for elderly individuals with severe dementia. *Int Psychogeriatr*. 2013;25(5):775-84.
32. Kwak J, Anderson K, O'Connell Valuch K. Findings From a Prospective Randomized Controlled Trial of an Individualized Music Listening Program for Persons With Dementia. *J Appl Gerontol*. 2018:733464818778991.
33. Weise L, Töpfer NF, Deux J, Wilz G. Feasibility and effects of individualized recorded music for people with dementia: A pilot RCT study. *Nordic Journal of Music Therapy*. 2020;29(1):39-56.
34. Orsulic-Jeras S, Judge KS, Camp CJ. Montessori-based activities for long-term care residents with advanced dementia: Effects on engagement and affect. *Gerontologist*. 2000;40(1):107-11.
35. Cohen-Mansfield J, Parpura-Gill A, Gol, er H. Utilization of self-identity roles for designing interventions for persons with dementia. *Journals of Gerontology Series B-Psychological Sciences and Social Sciences*. 2006;61(4):P202-P12.
36. Cohen-Mansfield J, Libin A, Marx MS. Nonpharmacological treatment of agitation: a controlled trial of systematic individualized intervention. *J Gerontol A Biol Sci Med Sci*. 2007;62(8):908-16.
37. Kolanowski A, Litaker M, Buettner L, Moeller J, Costa PT, Jr. A randomized clinical trial of theory-based activities for the behavioral symptoms of dementia in nursing home residents. *Journal of the American Geriatrics Society*. 2011;59(6):1032-41.
38. van der Ploeg ES, Eppingstall B, Camp CJ, Runci SJ, Taffe J, O'Connor DW. A randomized crossover trial to study the effect of personalized, one-to-one interaction using Montessori-based activities on agitation, affect, and engagement in nursing home residents with Dementia. *Int Psychogeriatr*. 2013;25(4):565-75.
39. Yoon JE, Lee SM, Lim HS, Kim TH, Jeon JKN, Mun MH. The Effects of Cognitive Activity Combined with Active Extremity Exercise on Balance, Walking Activity, Memory Level and Quality of

- 1
2
3 Life of an Older Adult Sample with Dementia. *Journal of Physical Therapy Science*. 2013;25(12):1601-
4 4.
5
6 40. Toba K, Nakamura Y, Endo H, Okochi J, Tanaka Y, Inaniwa C, et al. Intensive rehabilitation for
7 dementia improved cognitive function and reduced behavioral disturbance in geriatric health service
8 facilities in Japan. *Geriatr Gerontol Int*. 2014;14(1):206-11.
9
10 41. Lu YYF, Bakas T, Yang ZY, Weaver MT, Austrom MG, Haase JE. Feasibility and Effect Sizes of
11 the Revised Daily Engagement of Meaningful Activities Intervention for Individuals With Mild
12 Cognitive Impairment and Their Caregivers. *Journal of Gerontological Nursing*. 2016;42(3):45-58.
13
14 42. Prick AE, de Lange J, Scherder E, Twisk J, Pot AM. The effects of a multicomponent dyadic
15 intervention on the mood, behavior, and physical health of people with dementia: a randomized
16 controlled trial. *Clinical Interventions in Aging*. 2016;11:383-95.
17
18 43. Li DM, Li XX. The effect of folk recreation program in improving symptoms: a study of
19 Chinese elder dementia patients. *International Journal of Geriatric Psychiatry*. 2016;32(8):901-8.
20
21 44. Tanaka S, Honda S, Nakano H, Sato Y, Araya K, Yamaguchi H. Comparison between group and
22 personal rehabilitation for dementia in a geriatric health service facility: single-blinded randomized
23 controlled study. *Psychogeriatrics*. 2017;17(3):177-85.
24
25 45. Jeon Y-H, Krein L, Simpson JM, Szanton SL, Clemson L, Naismith SL, et al. Feasibility and
26 potential effects of interdisciplinary home-based reablement program (i-harp) for people with
27 cognitive and functional decline: A pilot trial. *Aging & Mental Health*. 2019.
28
29 46. Huber A, Oppikofer S, ra, Meister L, Langensteiner F, Meier N, et al. Music & memory:
30 The impact of individualized music listening on depression, agitation, and positive emotions in
31 persons with dementia. *Activities, Adaptation & Aging*. 2020.
32
33 47. Gitlin LNP, Winter LP, Dennis MPPE, Hodgson NPRN, Hauck WWP. A Biobehavioral Home-
34 Based Intervention and the Well-being of Patients With Dementia and Their Caregivers: The COPE
35 Randomized Trial: The Journal of the American Medical Association The Journal of the American
36 Medical Association. *JAMA*. 2010;304(9):983-91.
37
38 48. Bailey EM, Stevens AB, LaRocca MA, Scogin F. A Randomized Controlled Trial of a
39 Therapeutic Intervention for Nursing Home Residents With Dementia and Depressive Symptoms. *J*
40 *Appl Gerontol*. 2017;36(7):895-908.
41
42 49. Gitlin LN, Arthur P, Piersol C, Hessels V, Wu SS, Dai YF, et al. Targeting Behavioral Symptoms
43 and Functional Decline in Dementia: A Randomized Clinical Trial. *Journal of the American Geriatrics*
44 *Society*. 2017;66(2):339-45.
45
46 50. Novelli M, Machado SCB, Lima GB, Cantatore L, Sena BP, Rodrigues RS, et al. Effects of the
47 Tailored Activity Program in Brazil (TAP-BR) for Persons With Dementia A Randomized Pilot Trial.
48 *Alzheimer Disease & Associated Disorders*. 2018;32(4):339-45.
49
50 51. Oliveira A, Martini r, Radanovic M, Homem de Mello PC, Buchain PC, Dias Vizzotto A, et al.
51 An intervention to reduce neuropsychiatric symptoms and caregiver burden in dementia:
52 Preliminary results from a randomized trial of the tailored activity program—outpatient version.
53 *International Journal of Geriatric Psychiatry*. 2018.
54
55 52. O'Connor CM, Clemson L, Brodaty H, Low LF, Jeon YH, Gitlin LN, et al. The tailored activity
56 program (TAP) to address behavioral disturbances in frontotemporal dementia: a feasibility and pilot
57 study. *Disability and Rehabilitation*. 2019;41(3):299-310.
58
59 53. Van Haitsma KS, Curyto K, Abbott KM, Towsley GL, Spector A, Kleban M. A randomized
60 controlled trial for an individualized positive psychosocial intervention for the affective and
behavioral symptoms of dementia in nursing home residents. *J Gerontol B Psychol Sci Soc Sci*.
2013;70(1):35-45.
54
55 54. Dechamps A, Alban R, Jen J, Decamps A, Traissac T, Dehail P. Individualized Cognition-Action
56 intervention to prevent behavioral disturbances and functional decline in institutionalized older
57 adults: a randomized pilot trial. *International Journal of Geriatric Psychiatry*. 2009;25(8):850-60.

1
2
3 55. Cohen-Mansfield J, Thein K, Marx MS, Dakheel-Ali M, Freedman L. Efficacy of
4 nonpharmacologic interventions for agitation in advanced dementia: a randomized, placebo-
5 controlled trial. *J Clin Psychiatry*. 2012;73(9):1255-61.
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For peer review only

Table 1. Level of tailoring of interventions

#	Author (Year)	Level of assessment for tailoring	Degree of individualization in design	Degree of person-centered care in intervention delivery	Level of tailoring
1	Orsulic-Jeras et al. (2000)	Structured assessments of participants' preference using the Montessori-Based Assessment System developed by the authors for selecting appropriate activities for participants	Preserved abilities and preference (Two and above)	No description	Medium
2	Cohen Mansfield (2006)	Structured assessments for tailoring relating to participants' medical history, self-identity, and social functioning	Identity roles, the severity of dementia and ability (Two and above)	High flexibility. Flexibility during implementation could be high as the choice of intervention was at times affected by availability of materials, family members' cooperation and the practicability of the intervention.	High
3	Garland et al. (2007)	No pre-assessments for tailoring	Music preference. (One)	No description	Low
4	Cohen-Mansfield et al. (2007)	Structured assessments for tailoring in regard to participants' medical history, self-identity, and social functioning	Ability, past history and preference (Two and above)	High flexibility. The study clearly indicated that prevention, accommodation, and flexibility are essential elements of intervention	High
5	Gitlin et al. (2008)	Structured assessments for tailoring. Semi structured investigator-developed interviews to discern daily routines, and the Pleasant Event Schedule to identify previous and current activity interests. Interventionists observed dyadic communication and home environmental features and assessed dementia patients.	Capabilities, previous roles, habits, interests, home environment and dyadic communication (Two and above)	High flexibility. Activity prescriptions were reviewed and modified if necessary during the implementation.	High
6	Lam et al. (2009)	Structured assessments for tailoring. Individual functional profiles were mapped with personal selection.	Abilities, preference, and needs. (Two and above)	High flexibility. Content of training was dynamic and adjusted to the changing needs of the demented person.	High
7	Dechamps et al. (2009)	Pre-assessments on physical and psychological functions	Abilities (One)	Some flexibility. The interventionists were afforded maximum flexibility to address needs of service recipients.	Medium
8	Gitlin et al. (2010)	Structured assessments for tailoring taking account of PwD's deficits and capabilities, medical testing, home environment, caregiver communication, and caregiver-identified concerns). Interventionists interviewed caregivers to identify patient routines, previous and current roles, habits and interest.	Home environment, Caregiver-identified concerns and patient capabilities, routines, previous and current roles, habits and interests (Two and above)	High flexibility	High
9	Sung et al. (2010)	Using the Music Preference Survey and interviews with participants and their family members to assess their music preference and information on the importance of music to life	Music preference (One)	Low (participants listened to recorded CDs based on scheduled timeslots)	Low

Table 1. (Continued) Level of tailoring of interventions

#	Author (Year)	Level of assessment for tailoring	Degree of individualization in design	Degree of person-centered care in intervention delivery	Level of tailoring
10	Kolanowski et al. (2011)	Structured assessments on capacities and personality of interest	Capacity and Preference (Two and above)	High flexibility. The intervention encourages and allows great flexibility for facility staff to use their own clinical judgment and knowledge about residents to tailor and implement individualized M&M.	Medium
10.1	Kolanowski et al. (2011)	Structured assessments on capacities and personality of interest	Capacity only but opposite to their interests (One)	No description	Low
10.2	Kolanowski et al. (2011)	Structured assessments on capacities and personality of interest	Preference only but activities chosen which were challenging to participants (One)	No description	Low
11	Lin et al. (2011)	Pre-assessment and one-on-one interviews on participants' music preference	Music Preference (One)	No description	Low
12	Cohen-Mansfield et al. (2012)	Structured assessments concerning participants' medical history, self-identity, and social functioning. The TREA decision tree protocol was used to identify the possible reasons for agitated behaviour, needs, preferences	Past identity, ability and preferences (Two and above)	Some flexibility. Research assistants who implemented the intervention were allowed to seek director of therapy's approval for possible adjustment if needed by participants.	Medium
13	van der Ploeg et al. (2012)	Structured assessments (Myers Menorah Park/Montessori-Based Assessment System) for tailoring	Preserved abilities and Interest (Two and above)	High flexibility. Facilitators sought to engage residents in selected activities, with flexibility to respond to their perceived level of interest.	Medium
14	Ridder et al. (2013)	Semi-structured interviews to elicit life-story information either from journal or relatives.	Life-story/history, psychosocial needs (Two and above)	Low/some flexibility. Interventionists were instructed to be aware of at least three different way of applying music in therapy with PwDs. No specific description.	Medium
15	Sakamoto et al. (2013)	Structural assessments for tailoring to analyze participants' personal life history, and interview with each participant and family member	Music preference, special memories (Two and above)	High flexibility. The facilitators directed participants' attention to the music, and used an interactive approach that responded to participants' emotional reactions to the music.	High
16	Van Haitsma et al. (2013)	Pre-assessments	Interest and ability (Two and above)	Some flexibility. The intervention was adjusted according to the time when residents might be most alert or in need of stimulation or comfort.	Medium
17	Yoon et al. (2013)	Pre-assessments	Ability (One)	Low flexibility	Low
18	Toba et al. (2014)	Pre-assessment on individual's functional profiles assessed with regard to both abilities and disabilities to evaluate how to enhance abilities and compensate for disabilities	Abilities (One)	No description	Medium

Table 1. (Continued) Level of tailoring of interventions

#	Author (Year)	Level of assessment for tailoring	Degree of individualization in design	Degree of person-centered care in intervention delivery	Level of tailoring
19	Holthoff et al. (2015)	Pre-assessments	Ability (One)	Low flexibility	Low
20	Telenius et al. (2015)	Pre-assessments	Ability (One)	No description.	Low
21	Davison et al. (2016)	Pre-assessment. The researchers met with participants and their families to determine the preferred materials to load onto the device.	Interest only (One)	Low flexibility	Low
22	Giuli et al. (2016)	Pre-assessments on patients' cognitive status	Cognition (One)	No description	Low
23	Lu et al. (2016)	Pre-assessments on PwDs' functional ability, types and frequencies of meaningful activity, perceived barriers to engaging in these activities	Functional ability, types and frequencies of meaningful activity (Two and above)	No description.	Medium
24	Prick et al. (2016)	Structural assessments for tailoring	Physical capacities, information about pleasant activities for the dyad (Two and above)	Medium to High	High
25	Bailey et al. (2017)	No pre-assessments for tailoring. However, after the QAR-depression intervention as part of the intervention component, the group leaders developed the individualized behavioural activity programme for each experimental participant based on information they observed during the group session.	Interest and past history (Two and above)	High flexibility. The group leaders had the flexibility to develop and tailor the individualized behavioural activity programmes during implementation	Medium
26	Li et al. (2017)	The preliminary survey was implemented to investigate participants' preference, cultural background, cognitive function and daily living abilities.	Interest and capacities (Two and above)	Some flexibility. The interventionist was allowed to choose activities to match PwDs' ability and interest during personalized activity	Medium
27	Gitlin et al. (2017)	Structured assessments on participants' capacities, fall risk, daily routines, interests, caregivers (routines, employment, readiness), and environments (lighting, seating, clutter, noise)	Capabilities, functioning, interest, environment, caregivers (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during implementation)	High
28	Tanaka et al. (2017)	Pre-assessments	Personal history (One)	No description.	Low

Table 1. (Continued) Level of tailoring of interventions

#	Author (Year)	Level of assessment for tailoring	Degree of individualization in design	Degree of person-centered care in intervention delivery	Level of tailoring
29	Novelli et al. (2018)	Structured assessments to identify preserved capacities, previous interests, frequency/intensity of BPSD in the PWD, communication techniques and daily care routines of caregivers and home environment features. The interventionist applied the assessment findings to design the activity plan.	Capabilities, previous interests, frequency, and intensity of BPSD in PWD, daily care routines of the caregiver and home environment. (Two and above)	High flexibility. Interventionists are allowed to tailor and adjust the chosen activities to match participants' capabilities during implementation.	High
30	Kwak et al. (2018)	Unstructured interviews with participants and their family members as the best sources for identifying an individual's music preferences	Music preference and songs significant to PwDs' life experience (Two and above)	High flexibility. The intervention allowed flexibility for facility staff to use their own clinical judgment and knowledge to tailor and implement the M&M programme for each resident	Medium
31	Joel et al. (2019)	Structured assessments: comprehensive individual assessment (physical, medical and psychosocial) and their environment, medication review and adherence, a review of communication with health service providers and cognitive needs and existing strategies.	Capacities/needs, environment (Two and above)	High flexibility. A multi- and interdisciplinary plan tailored to meet the client's needs to enhance self-care ability using person-centered goal setting.	High
32	Oliveira et al. (2019)	Structured assessments. Semi structured investigator-developed interview to identify daily routines, and the Pleasant Event Schedule to identify previous and current activity interests. Interventionists observed dyadic communication and home environmental features and assessed dementia patients.	Cognitive and functional capacities, previous abilities, interests, and roles (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during the implementation)	High
33	O'Connor et al. (2019)	Structured assessments of participants' capacities, fall risk, daily routines, interests, caregivers (routines, employment, readiness), and environments (lighting, seating, clutter, noise)	Capabilities, functioning, interest, environment, caregivers (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during implementation)	High
34	Weise et al. (2020)	Pre-assessment for participants' personal music preference from family members, nursing staff and directly from participants	Preference for music (One)	Low flexibility	Low
35	Huber et al. (2020)	Pre-assessments	Preference (One)	Low flexibility	Low

Notes: One = The intervention design was tailored for only one aspect of PWD's characteristics; Two and above = The intervention design was tailored for two and above aspects of PWD's characteristic

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FIGURE LEGENDS

Figure 1. Effects of tailored interventions on challenging behaviour at post-intervention (N=20). Notes: SD=Standard Deviation, CI= Confidence Interval, C=activities tailored for capacities of participants only, P = activities tailored for preference of participants only, C+P= activities tailored for capacities and preference of participants. IG = Intervention Group, CG=Control Group.

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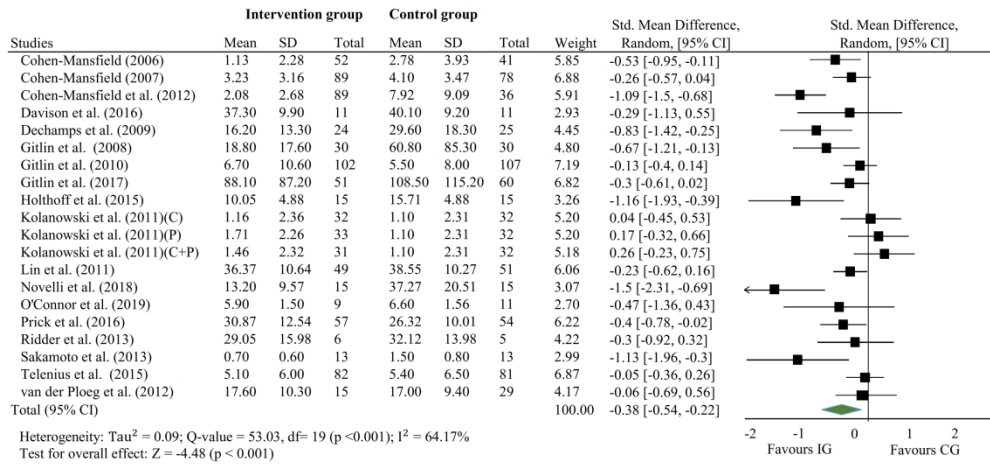
Figure 2. Effects of tailored interventions on quality of life at post-intervention (N=9). Notes: SD=Standard Deviation, CI= Confidence Interval. IG = Intervention Group, CG=Control Group.

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Figure 3. Subgroup analysis: Effects of tailored interventions on challenging behaviour at post-intervention by level of tailoring (N=20). Notes: SD=Standard Deviation, CI= Confidence Interval, C=activities tailored for capacities of participants only, P = activities tailored for preference of participants only, C+P= activities tailored for capacities and preference of participants. IG = Intervention Group, CG=Control Group.

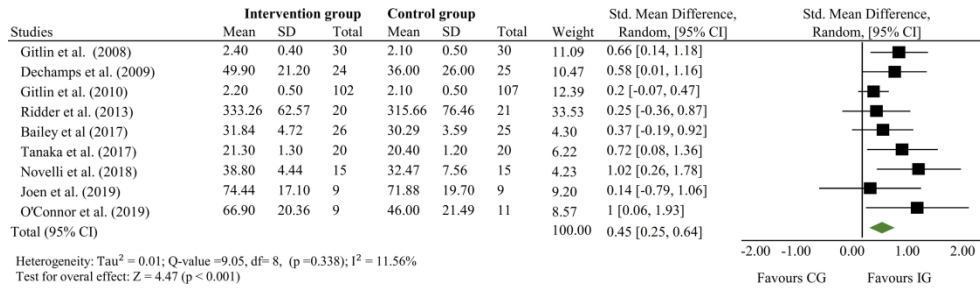
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Figure 4. Subgroup analysis: Effects of tailored interventions on quality of life at post-intervention by level of tailoring (N=9). Notes: SD=Standard Deviation, CI= Confidence Interval. IG = Intervention Group, CG=Control Group.

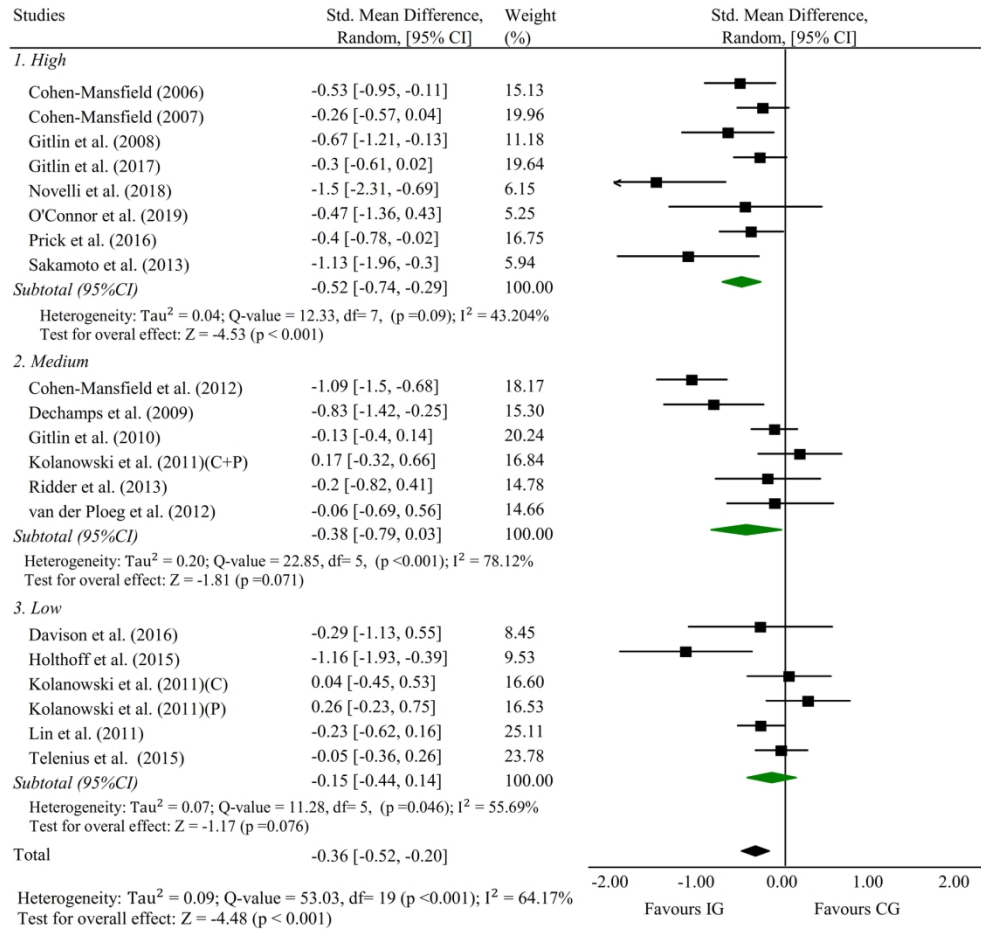


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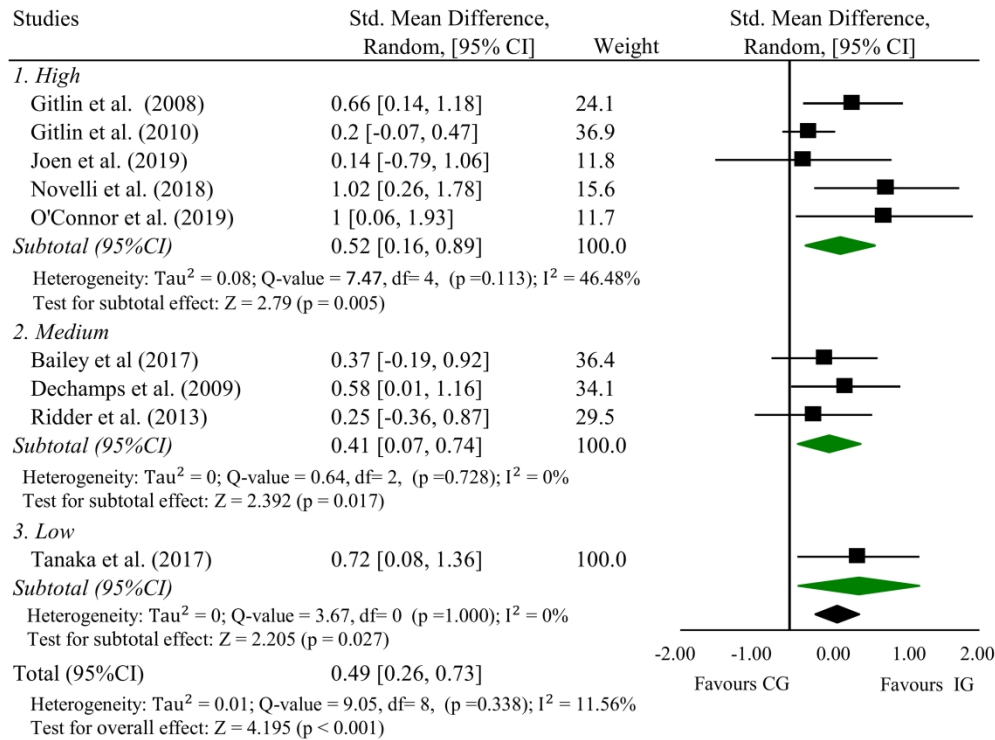
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Supplementary Table 1. Full search strategy

Database	Search strategy
ProQuest	ab("Cognitive impairment" OR "cognitive disorder" OR "dementia" OR "Alzheimer") AND ab("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "personalized" OR "person-centered") AND ab("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Web of Science	TS=("Cognitive impairment" OR "cognitive disorder" OR "dementia" OR "Alzheimer") AND TS=("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "personalized" OR "person-centered") AND TS=("activities" OR "program*" OR "therapy" OR "intervention" OR "treatment")
PubMed	((("Cognitive impairment"[Title/Abstract] OR "cognitive disorder"[Title/Abstract] OR "dementia"[Title/Abstract] OR "Alzheimer"[Title/Abstract])) AND ("tailor*" [Title/Abstract] OR "engage*" [Title/Abstract] OR "individualized" [Title/Abstract] OR "individual-centered" [Title/Abstract] OR "personalized" [Title/Abstract] OR "personalized" [Title/Abstract] OR "person-centered" [Title/Abstract])) AND ("activities" [Title/Abstract] OR "program*" [Title/Abstract] OR "therapy" [Title/Abstract] OR "intervention" [Title/Abstract] OR "treatment" [Title/Abstract])
Ovid	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Cochrane Library	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Cumulative Index to Nursing and Allied Health Literature (CINAHL)	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")

Note: No limit on the publication date

Supplementary Table 2. Level of tailoring of interventions

Level	Criteria
Low	<ul style="list-style-type: none"> • Pre-assessments for purpose of tailoring were not clearly stated. • Activity design targeted only one domain of tailoring as listed below, including capabilities, preference, interests, life experience, and living environment; • Interventionists had low flexibility and only minimal/marginal modifications were allowed.
Middle	<ul style="list-style-type: none"> • Pre-assessments for purpose of tailoring were conducted by unstructured, semi-structured interviews only; • Activity design targeted two or more domains of tailoring systematically as listed below, including capabilities, preference, interests, life experience, and external environment; • Interventionists had some flexibility and some modifications could be made based on their professional judgement to accommodate the spontaneous needs of PwD during the intervention
High	<ul style="list-style-type: none"> • Pre-assessments for the purpose of systematic tailoring were conducted by systematic interviews; • Activity design targeted two or more domains of tailoring systematically as listed below, including capabilities, preference, interests, life experience, and external environment; • Interventionists had high flexibility and any modifications based on their professional judgement to accommodate the spontaneous needs of PwD during the intervention

Supplementary Table 3. Characteristics of included studies

#	Author (Year) [Countries]	Age Mean(SD)	Dementia types/stage	Sample size	Study design	Study setting
1	Orsulic-Jeras et al. (2000) [USA]	I: 88 (4.3) C: 88 (4.3)	Dementia	I: 16; C: 16	Quasi- experiment	LTC facility
2	Cohen-Mansfield (2006) [USA]	I: 87.2 (6.6) C: 87.3 (7.1)	Dementia	I: 52; C: 41	RCT	LTC facility and adult day centres
3	Garland et al. (2007) [Australia]	I: 79.0 (66-93) C: 79 (66-93)	Dementia	I: 10; C: 10	RCT	LTC facility
4	Cohen-Mansfield (2007) [USA]	I: 88 (6.4) C: 85 (8.6)	Dementia	I: 89; C: 78	RCT	LTC facility
5	Gitlin et al. (2008) [USA]	I: 78 (9.2) C: 80.8 (9.5)	Dementia	I: 30; C: 30	RCT	Home
6	Dechamps et al. (2009) [France]	I: 83.2 (8.3) C: 83.2 (8.3)	Dementia	I: 24; C: 25	RCT	Hospital
7	Gitlin et al. (2010) [USA]	I: 83.1 (7.8) C: 81.8 (9.9)	Dementia	I: 102; C: 107	RCT	Community
8	Lam et al. (2010) [Hong Kong]	I: 83.1 (6.9) C: 83.8 (7)	Dementia	I: 37; C: 37	RCT	LTC facility
9	Sung et al. (2010) [Taiwan]	I: 78.1 (7.2) C: 82.7 (7.4)	Dementia	I: 29; C: 23	Quasi- experiment	LTC facility
10	Kolanowski et al. (2011) [USA]	I: 86 (7.1) C: 85.9 (4.9)	Dementia	I: 31; C: 32	RCT	LTC facility
11	Lin et al. (2011) [Taiwan]	I: 81.5 (7.3) C: 82.2 (6.3)	Dementia	I: 49; C: 51	RCT	LTC facility
12	Cohen-Mansfield et al. (2012) [USA]	I: 85.9 (8.6) C: 85.3 (9.6)	Dementia	I: 89; C: 36	RCT	LTC facility
13	van der Ploeg et al. (2012) [Australia]	I: 78.1 (9.8) C: 78.1 (9.8)	Dementia	I: 15; C: 29	Crossover RCT	LTC facility
14	Ridder et al. (2013) [Denmark and Norway]	I: 82.2 (8.8) C: 80.2 (8.7)	Dementia	I: 6; C: 5	RCT	LTC facility
15	Sakamoto et al. (2013) [Japan]	I: 80.4 (7.4) C: 81.5 (7.9)	Dementia	I: 13; C: 13	RCT	Hospital
16	Van Haitsma et al. (2013) [USA]	I: 87.7 (8.7) C: 89.2 (6.9)	Dementia	I: 44; C: 93	RCT	LTC facility
17	Yoon et al. (2013) [Korea]	I: 77.9 (7.5) C: 70.1 (12.2)	Dementia	I: 11; C: 9	RCT	LTC facility
18	Toba et al. (2014) [Japan]	I: 84.1 (7.1) C: 87.3 (7.1)	Dementia	I: 158; C: 54	Quasi- experiment	Geriatric health service facilities
19	Holthoff et al. (2015) [Germany]	I: 72.4 (4.3) C: 70.7 (5.4)	Early and moderate stage AD	I: 15; C: 15	RCT	Home
20	Telenius et al. (2015) [Norway]	I: 86.9 (7) C: 86.4 (7.8)	mild or moderate	I: 82; C: 81	RCT	LTC facility
21	Davison et al. (2016) [Australia]	I: 86 (5.2) C: 86 (5.2)	Dementia	I: 11; C: 11	RCT	LTC facility
22	Giuli et al. (2016) [Italy]	I: 76 (6.3) C: 76.5 (5.7)	Mild cognitive impairment/D ementia	I: 48; C: 49	RCT	Hospital
23	Lu et al. (2016) [USA]	I: 71.2 (0.8) C: 76.5 (7.1)	Mild cognitive impairment	I: 20; C: 20	RCT	Community

Notes: I = Intervention group; C = control group; RCT = randomized clinical trial; LTC = long-term care

Supplementary Table 3. (Continued) Characteristics of included studies

#	Author (Year) [Countries]	Age Mean(SD)	Dementia types/stage	Sample size	Study design	Study setting
24	Prick et al. (2016) [Netherlands]	I: 76 (7.6) C: 78 (7.2)	Dementia	I: 57; C: 54	RCT	Home
25	Bailey et al (2017) [USA]	I: 84.4 (7.7) C: 83.9 (9.2)	Mild to moderate cognitive impairment	I: 26; C: 25	RCT	LTC facility
26	Li et al. (2017) [China]	I: 83.1 (4.1) C: 81.1 (6.7)	Dementia	I: 19; C: 21	Quasi- experiment	LTC facility
27	Gitlin et al. (2017) [USA]	I: 80.4 (8.7) C: 80.4 (8.7)	Dementia	I: 51; C: 60	RCT	Home
28	Tanaka et al. (2017) [Japan]	I: 86 (7.4) C: 86.5 (8.3)	Dementia	I: 20; C: 20	RCT	Geriatric health service facility
29	Novelli et al. (2018) [Brazil]	I: 79.4 (7.7) C: 83.5 (7.1)	Dementia	I: 15; C: 15	RCT	Community
30	Kwak et al. (2018) [USA]	I: 88.9 (5.4) C: 84.9 (8.6)	Dementia or Alzheimer's disease	I: 30; C: 29	Crossover RCT	LTC facility
31	Joel et al. (2019) [Australia]	I: 79.0 (N.A) C: 81.0 (N.A)	Mild cognitive impairment/Dementia	I: 9; C: 9	RCT	Home
32	de Oliveira et al. (2019) [Brazil]	I: 79 (5.7) C: 78.4 (6.2)	Dementia	I: 11; C: 10	RCT	Community medical centers
33	O'Connor et al. (2019) [Australia]	I: 62.1 (N.A) C: 65.6 (N.A)	Dementia	I: 9; C: 11	RCT	Home
34	Weise et al. (2020) [Germany]	I: 85.1 (5.9) C: 85.1 (5.9)	Moderate or severe stages of Dementia	I: 10; C: 10	RCT	LTC facility
35	Huber et al. (2020) [Switzerland]	I: 74-92 C: 74-92	Moderate to severe stages of dementia	I: 10; C: 13	Quasi- experiment	Community

Notes: I = Intervention group; C = control group; RCT = randomized clinical trial; LTC = long-term care

Supplementary Table 4. Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD's characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
1	Orsulic-Jeras et al. (2000)	Preserved abilities	MP	Montessori-Based Activities included individual-based and group activities. In individual activities, various aesthetically pleasing materials taken from the everyday environment were used. Group activities include memory bingo and group sorting.	Mode: Mixed; Interventionist: Research assistant/activities therapist; Duration: 3 months. Follow-up: 6 months	usual care	Level of engagement	IG showed more engagement than CG at post-intervention.
2	Cohen-Mansfield (2006)	Salience of identity roles, the severity of the dementia, ability	MP	Role-identity-based treatment involved a 2-step procedure, including the determination of role-identity salience and the determination of the intervention. Chosen activities were tailored for the roles identified. For example, a participant with a great sense of professional accomplishment enjoyed looking at his awards.	Mode: Individual; Interventionist: Research assistants; Duration: 5 days.	usual care	BPSDs (Agitation), Engagement and Depression.	IG showed more increase in engagement and fewer BPSDs in the treatment than CG.
3	Garland et al. (2007)	Preferred songs, performers and titles.	MU	Preferred music selected based on family members' reports of participants' reference.	Mode: Individual; Interventionist: Researcher; Duration: 4 weeks.	usual care	BPSDs (Overall)	No significant difference in reducing BPSDs between IG and CG.
4	Cohen-Mansfield (2007)	Ability, past history and preference	MP	Nonpharmacologic individualized interventions based on TREA framework	Mode: Mixed; Interventionist: Research assistants; Duration: 10 days. No follow-up assessment.	placebo	BPSDs	IG showed decreases in overall BPSDs compared to CG at post-intervention.
5	Gitlin et al. (2008)	Capabilities, previous roles, habits and interests	MP	TAP is based on the environmental vulnerability/reduced stress-threshold model, including a three-stage intervention: (1) structural assessments, (2) activity prescriptions, chosen activities tailored to match the PWD's characteristics, providing training to and working with caregivers in the implementation, and (3) helping caregivers to generalize strategies for future care challenges.	Mode: Individual; Interventionist: Occupational therapists and caregivers; Duration: 4 months.	wait-list	BPSDs (overall), QoL, depression, and level of engagement	IG showed greater reduction in frequency of BPSDs and greater engagement than CG.
6	Dechamps et al. (2009)	Abilities and discourse	MP	The Cognition-Action method does not rely on the use of a specific exercise, but rather is a guidance method intended to enhance active living and social interaction using motor actions as incentives.	Mode: Individual; Interventionist: Research assistants; Duration: 12 weeks.	usual care	BPSDs (Overall), QoL, and depression	IG showed greater reduction in BPSDs, depression and improvement in QoL compared to CG.
7	Gitlin et al. (2010)	Home environment, Caregiver-identified concerns and patient capabilities, routines, previous and current roles, habits and interests	MP	Care of Persons with Dementia in their Environments (COPE) targeted modifiable environmental stressors to decrease sensorial, physical, and cognitive demands, align with patient capabilities, and re-engage patients in daily activities.	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months. Follow-up: 9 months	usual care	BPSDs, QoL and engagement	IG showed increases in the level of engagement compared to the CG at post-intervention.

Supplementary Table 4. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD's characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
8	Lam et al. (2010)	Abilities, preference, needs	P	Individualized functional training programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 8 weeks. Follow-up: 4 months	Attention control	BPSD (Depression) and cognition	IG showed reduction in depression compared to CG only at 4-month follow up.
9	Sung et al. (2010)	Music preference	MU	Preferred music listening intervention	Mode: Individual; Interventionist: Trained nursing staff; Duration: 6 weeks.	usual care	BPSD (Depression/Anxiety)	IG had a lower anxiety score compared with CG.
10	Kolanowski et al. (2011)	Functional level, personality style of interest	MP	Activities derived from the Need driven Dementia-compromised Behavior model which were tailored to the resident's functional level (cognitive and physical) and personality style of interest 3-arm intervention group design: (1) Personality style of interest group (PI); (2) Functional level (FL); (3) PI + FL	Mode: Group ; Interventionist: Nursing staff; Duration: 3 weeks	Active control	BPSDs (Agitation) and Engagement	IG (PI) showed greater engagement than the other groups.
11	Lin et al. (2011)	Music Preference	MU	Group music intervention	Mode: Group; Interventionist: Researcher; Duration: 6 weeks. One-month follow up.	usual care	BPSDs (Agitation)	IG showed reduction in BPSDs compared to the CG at post-intervention and follow-up.
12	Cohen-Mansfield et al. (2012)	Past identity, ability and preferences	MP	The TREA decision tree protocol was used to identify the possible reasons for agitated behaviour, needs, and preferences of participants. The activities included simulated animal-assisted therapy, one-on-one interaction, simulated interaction, group activities, arts and crafts, physical activities, games and music based on participants' preference etc.	Mode: Mixed; Interventionist: Research assistants; Duration: 2 weeks.	placebo	BPSDs (Agitation)	IG showed reduction in total agitation compared to CG.
13	van der Ploeg et al. (2012)	preserved abilities and Interest	MP	Montessori-based activities	Mode: Mixed; Interventionist: Psychologists and higher degree psychology student; Duration: 4 weeks	usual care	BPSDs, engagement	IG showed more engagement than control group.
14	Ridder et al. (2013)	life-story/history	MU	Individual music therapy	Mode: Individual; Interventionist: Clinicians; Duration: 6 weeks. Follow-up: 7 weeks.	usual care	BPSDs (Agitation), QoL	IG showed reduction in total agitation compared to CG at post-intervention.

Supplementary Table 4. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD's characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
15	Sakamoto et al. (2013)	Music preference	MU	Individualized music interventions	Mode: Individual; Interventionist: Music facilitator; Duration: 10 weeks.	usual care	BPSDs (overall)	Greater long-term reduction in BPSD was observed in IG compared with CG.
16	Van Haitsma et al. (2013)	Interest and ability	MP	Individualized Positive Psychosocial Intervention based on participants' leisure interests that included physical exercise, music, ADLs, reminiscence and sensory stimulation.	Mode: Individual; Interventionist: Certified nursing assistants; Duration: 3 weeks	Attention control	BPSDs (overall)	IG experienced more pleasure, alertness, engagement, positive touch, and positive verbal behavior compared with CG.
17	Yoon et al. (2013)	Ability level	MP	Cognitive activity combined with physical exercise	Mode: Group ; Interventionist: Unspecified; Duration: 12 weeks	Attention control	Depression	IG showed improvement in cognition and reduction in depression compared to CG.
18	Toba et al. (2014)	Abilities and needs	MP	Intensive rehabilitation programme included reminiscence, reality orientation, memory rehabilitation, music therapy, physical exercise, occupational therapy, speech communication therapy and learning sessions	Mode: Individual; Interventionist: Physical, occupational or speech therapists; Duration: 3 months	usual care	BPSD, depression,	IG showed more reduction in BPSD and improvement in cognition compared to CG.
19	Holthoff et al. (2015)	Ability level	P	Physical Activity Training. Patients in the intervention group trained their lower body on a movement trainer with individually preassigned training flow. Caregivers were asked to choose a familiar chair prior to commencement of study.	Mode: Unspecified; Interventionist: Caregivers/ computer; Duration: 12 weeks. 3-month follow up test.	usual care	BPSD	Intervention group experienced remained stable in BPSDs while control group experienced increases in BPSDs at follow-up.
20	Telenius et al. (2015)	Performance levels	P	Individually fitted High-Intensity Exercise Program	Mode: Individual; Interventionist: Physiotherapist; Duration: 12 weeks	Attention control	BPSD, QoL, depression,	IG experienced more reduction in BPSD compared to CG.
21	Davison et al. (2016)	Interest	C	Using a personal computer to play favourite music and display photographs, movies and messages selected by participants and family members	Mode: Individual; Interventionist: Research staff; Duration: 4 weeks	usual care	BPSDs (Agitation), Depression, Anxiety	IG experienced reduction in depression and anxiety compared to CG.
22	Giuli et al. (2016)	cognitive function	C	Nonpharmacological intervention consisting of comprehensive cognitive training	Mode: Individual; Interventionist: Experienced psychologists; Duration: 10 weeks	usual care	Depression and cognition	Compared to CG, IG with Alzheimer's disease experienced improvement in cognition. Improvement in cognition of IG with mild cognitive impairment was found.

Supplementary Table 4. (Continued) Interventions and activities tailored for participants' characteristics

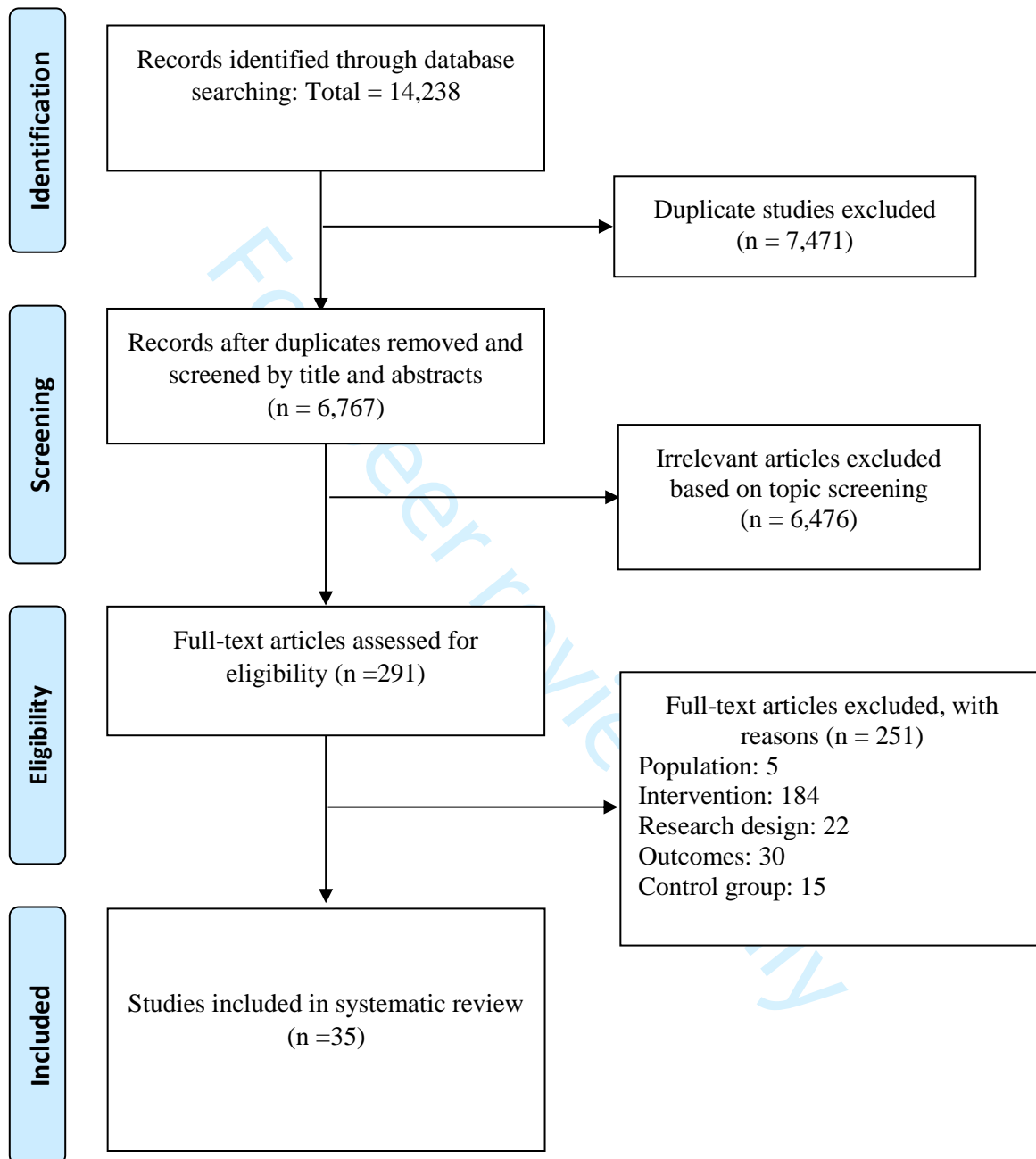
#	Author (Year)	PWD's characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
23	Lu et al. (2016)	Congruence in level of awareness of functional ability, types and frequencies of meaningful activity, perceived barriers to engaging in these activities	MP	Daily Engagement of Meaningful Activities using the principles of problem-solving therapy and, consistent with the overall goals of this intervention, providing autonomy support by helping patients identify and prioritize meaningful activities, identify needs and goals, generate manageable solutions, and engage in self-selected activities with family support, etc.	Mode: Group; Interventionist: Trained nurse; Duration: 2 weeks. Follow up: 3 months	Attention control	BPSD (Depression)	IG showed less improvement in depressive symptoms than CG at follow-up.
24	Prick et al. (2016)	Physical capacities, information about pleasant activities for the dyad	MP	Multicomponent dyadic intervention comprising physical exercise training, psychoeducation, communication skills training, and pleasant activities training.	Mode: Individual; Interventionist: Personal coach; Duration: 3 months. 6 month follow up.	usual care	BPSDs, depression, health	Analyses showed no beneficial effects over time on any of the outcome measures.
25	Bailey et al. (2017)	participant's specific area of interest	MP	Multicomponent intervention including group activity sessions using question-asking-reading (QAR), reminiscence, cognitive-behavioural therapy techniques, environmental support and individualized behavioural activity programme.	Mode: Group; Interventionist: Two upper-level graduate students in clinical psychology and one PhD psychologist; Duration: 6 weeks	usual care	Depression, QoL and engagement	IG showed more improvement in depression than CG.
26	Li et al. (2017)	Interest, capacities and culture background	MP	Folk recreation programme plus personalized training on daily life activities and individual activity programme according to participants' interest.	Mode: Mixed; Interventionist: Researcher; Duration: 16 weeks	usual care	BPSD	The folk recreation program has the potential to improve cognitive function, ability of daily living and behavioral and psychological symptoms of the elders with dementia.
27	Gitlin et al. (2017)	Capabilities, functioning, interest, environment, caregivers	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months	Attention control	BPSDs	Intervention group showed reduction in BPSDs and functional dependence.
28	Tanaka et al. (2017)	Meaningfulness, personal history	MP	Personal rehabilitation comprising cognitive rehabilitation and involving reminiscence therapy, reality orientation, and physical activity.	Mode: Mixed; Interventionist: Staff member ; Duration: 12 weeks	usual care	Depression & QoL	No statistically significant differences between IG and CG in interested outcomes.
29	Novelli et al. (2018)	Capabilities, previous interests, frequency, and intensity of BPSD in PWD, daily care routines of the caregiver and home environment.	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapy, caregiver; Duration: 4 months	wait-list	BPSD and QoL	IG experienced reduced in BPSD and improvement in QoL compared to CG

Supplementary Table 4. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD's characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
30	Kwak et al. (2018)	Music preference	MU	A passive music intervention using personalized music playlists delivered on digital music players.	Mode: Individual; Interventionist: Nursing home staff; Duration: 14 weeks	usual care	BPSD	No statistically significant differences between IG and CG in any of the outcomes measured.
31	Joen et al. (2019)	Capacities/needs, environment	MP	A multi- and interdisciplinary plan tailored to meet the client's needs to enhance self-care ability and using person-centred goal setting included cognitive rehabilitation techniques, energy conservation and task simplification strategies, balance and strength exercises, pain relief management, anxiety management, problem solving, and medication simplification.	Mode: Individual; Interventionist: Occupational therapists, registered nurse, neuropsychologist; Duration: 4 months. 12 month follow-up.	usual care	Depression and QoL	No statistically significant differences between IG and CG in any of the outcomes measured.
32	de Oliveira et al. (2019)	Cognitive and functional capacities, previous abilities, interests, and roles	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 3 months	Attention control	BPSD	Compared to CG, IGS experienced reduction in BPSD.
33	O'Conn or et al. (2019)	Capabilities, functioning, interest, environment, caregivers	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months	usual care	BPSDs and QoL	IG showed an overall reduction of behavioral symptoms and maintenance of functional performance in the person with dementia, compared to CG.
34	Weise et al. (2020)	Preference for music	MU	Individualized recorded music	Mode: Individual; Interventionist: Social service staff and project staff; Duration: 4 weeks	wait-list	BPSD	No significant findings on reduction in BPSD between IG and CG.
35	Huber et al. (2020)	Preference, meaningfulness	MP	Individualized music listening	Mode: Individual; Interventionist: Caregivers/staff member; Duration: 4 weeks	usual care	BPSD, depression	Depression scores decreased significantly over time while agitated behavior showed a constant moderate level without any significant decreases.

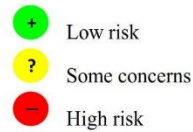
Note: P=physical; C=cognitive; MU=musical; MP=multiple; TAP = Tailored Activity Programme. IG=intervention group; CG=control group. BPSD = behavioural and psychological symptoms of dementia; QoL=Quality of life.

Supplementary Figure 1. Flowchart of included articles



Supplementary Figure 2. Risk of Bias Graph for RCT studies (N=30)

Study	Randomization process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall
Cohen Mansfield (2006)	?	?	+	?	?	!
Garland et al. (2007)	?	?	+	+	?	!
Cohen-Mansfield (2007)	?	-	+	-	+	-
Gitlin et al. (2008)	+	+	+	+	+	+
Dechamps et al. (2009)	+	+	+	+	+	+
Gitlin et al. (2010)	+	+	+	+	+	+
Lam et al. (2010)	+	+	+	+	+	+
Kolanowski et al. (2011)	+	+	+	+	+	+
Lin et al. (2011)	+	-	+	-	?	-
Cohen-Mansfield et al. (2012)	+	+	+	+	+	+
van der Ploeg et al. (2012)	+	-	+	+	+	-
Ridder et al. (2013)	+	?	+	?	?	!
Sakamoto et al. (2013)	?	?	+	+	+	!
Van Haitsma et al. (2013)	+	?	+	+	+	!
Yoon et al. (2013)	+	-	-	-	+	-
Holthoff et al. (2015)	+	-	+	-	?	-
Telenius et al. (2015)	+	-	+	+	?	-
Davison et al. (2016)	+	-	+	+	?	-
Giuli et al. (2016)	?	-	-	-	+	-
Lu et al. (2016)	+	+	+	+	+	+
Prick et al. (2016)	+	+	+	+	+	+
Bailey et al (2017)	+	-	+	-	+	-
Gitlin et al. (2017)	+	+	+	+	+	+
Tanaka et al. (2017)	+	-	-	+	+	-
Novelli et al. (2018)	+	?	+	+	+	!
Kwak et al. (2018)	+	-	-	-	+	-
Joen et al. (2019)	+	+	+	+	+	+
de Oliveira et al. (2019)	?	?	-	+	+	-
O'Connor et al. (2019)	+	?	+	+	+	!
Weise et al. (2020)	+	+	?	?	+	!



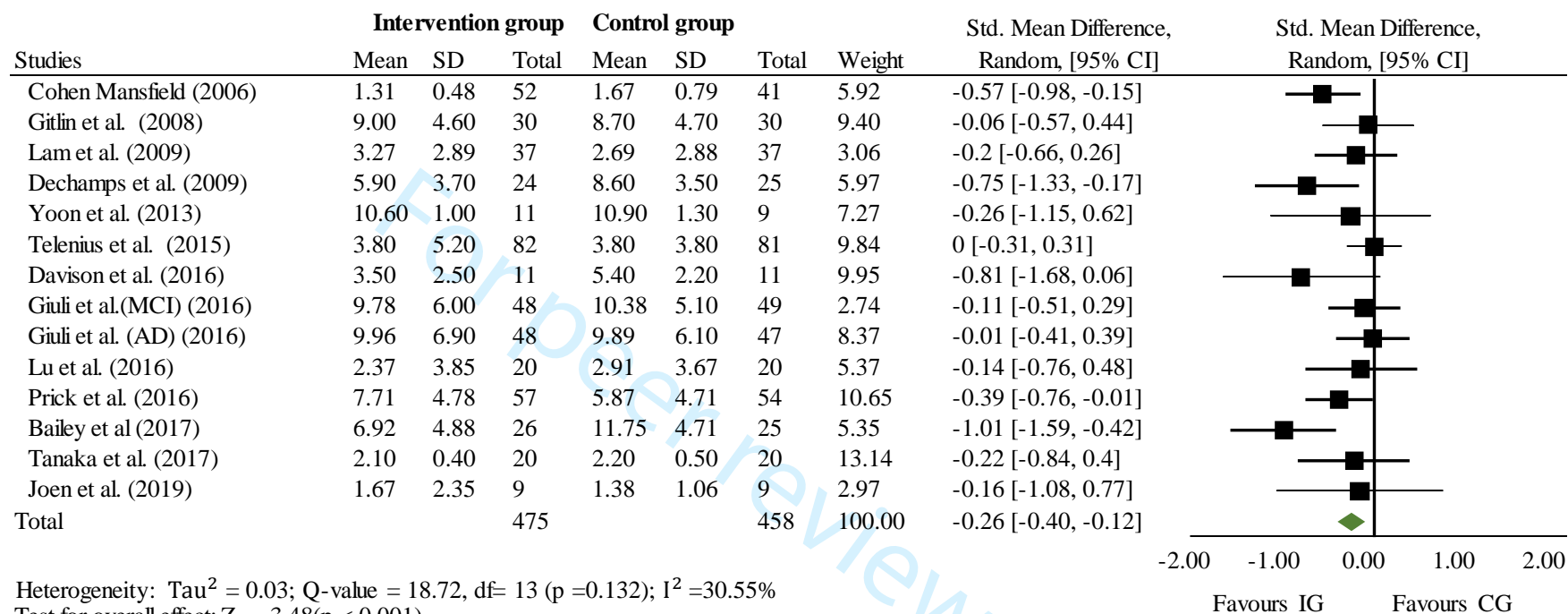
Supplementary Figure 3. Risk of Bias Graph for quasi-experimental studies (N=5)

Study	Risk of bias domains							Overall
	D1	D2	D3	D4	D5	D6	D7	
Toba et al. (2014)	+	+	+	+	+	-	+	-
Li et al. (2017)	+	+	+	+	+	-	+	-
Sung et al. (2010)	+	+	+	+	?	-	+	?
Huber et al. (2020)	+	?	+	+	+	-	+	?
Orsulic-Jeras et al. (2000)	+	+	?	-	?	-	+	?

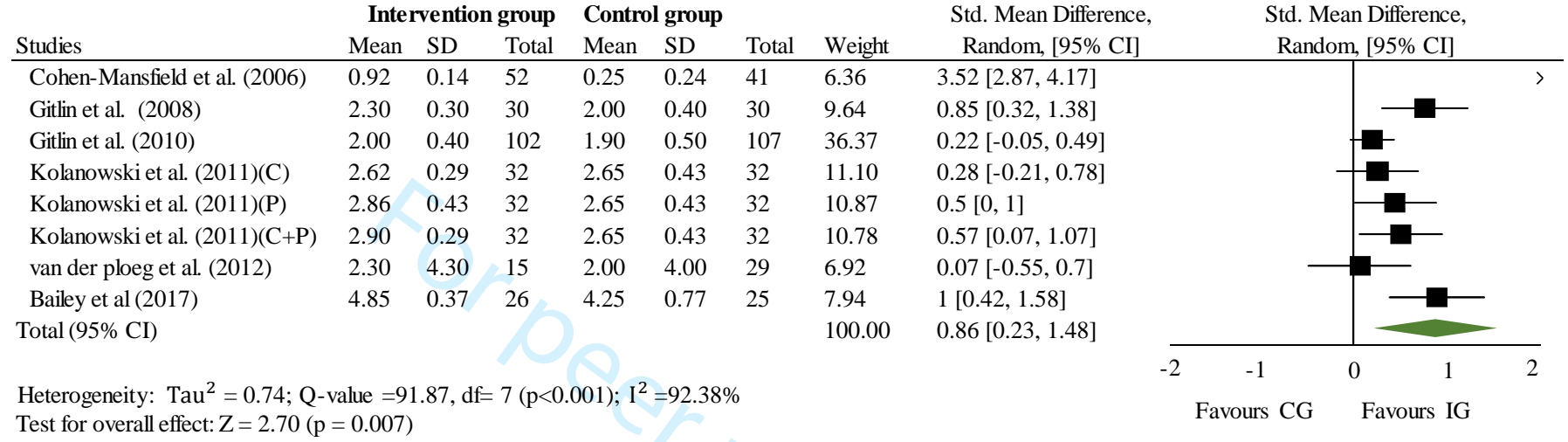
Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Judgement
- Moderate
+ Low
? No information

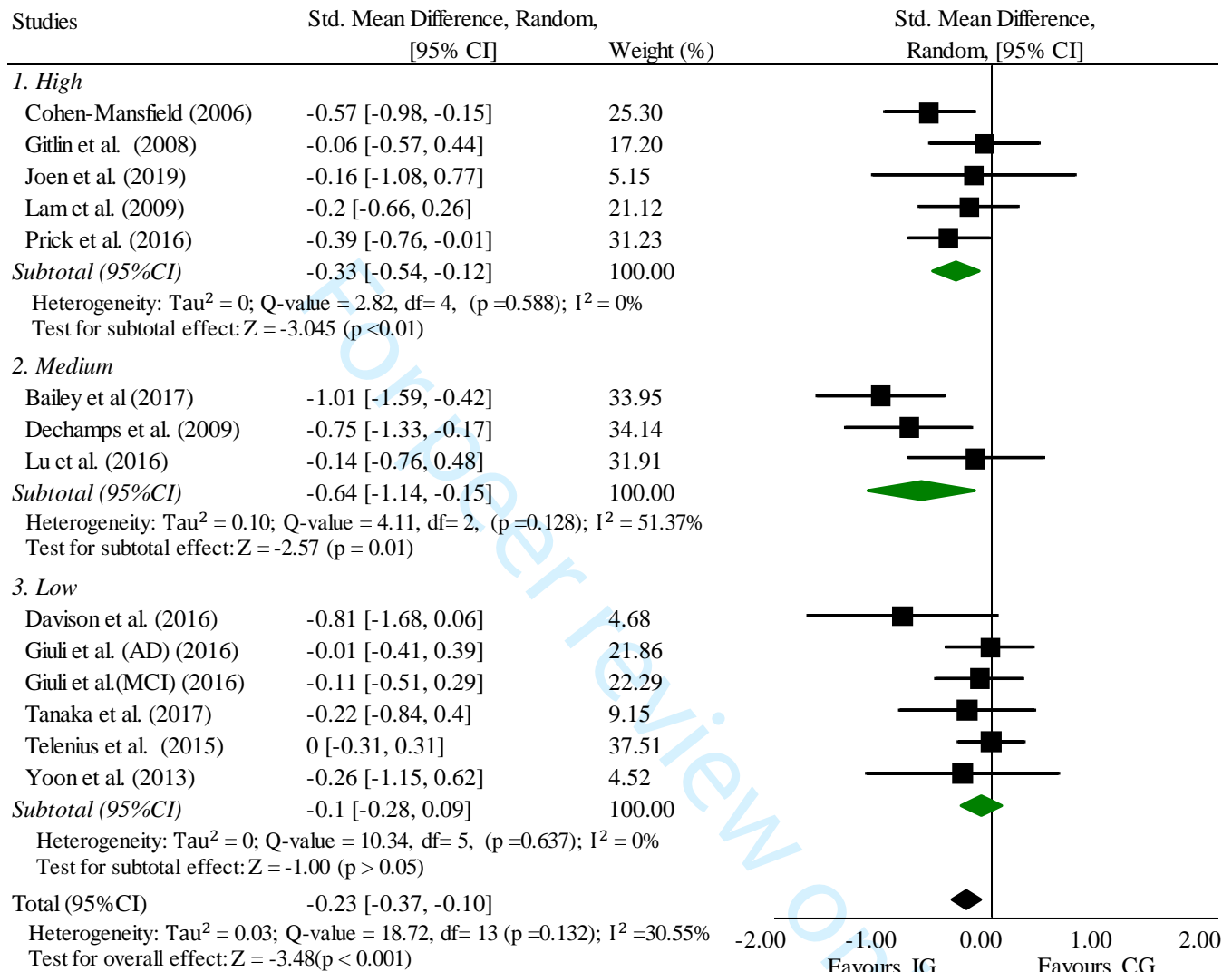
Supplementary Figure 4. Effects of tailored interventions on depression at post-intervention (N=14)



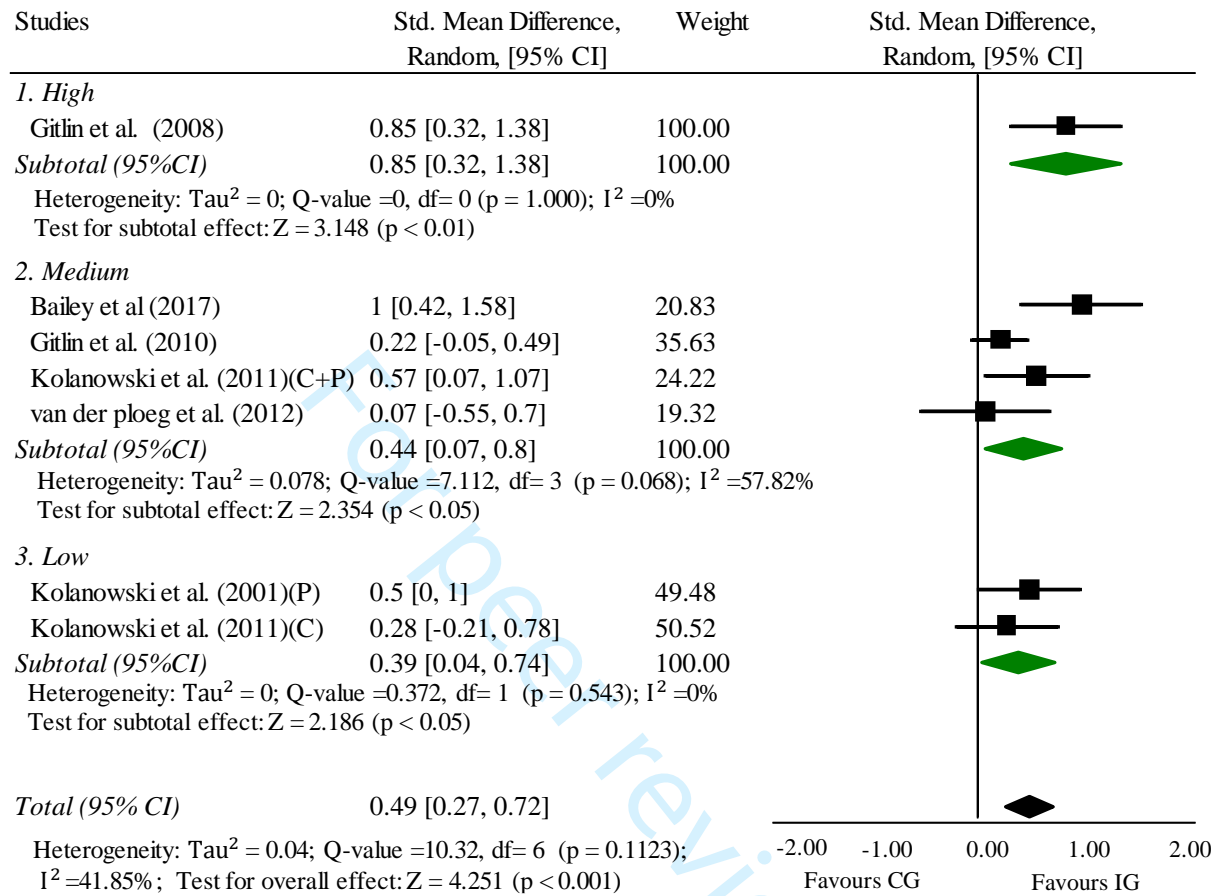
Supplementary Figure 5. Effects of tailored interventions on engagement at post-intervention (N =8)



Supplementary Figure 6. Subgroup analysis: Effects of tailored interventions on depression at post-intervention by level of tailoring (N=14)



Supplementary Figure 7. Subgroup analysis: Effects of tailored interventions on engagement at post-intervention by level of tailoring (N=7)



Note: One study was not included in this meta-analysis based on the findings from Supplementary Figure 5 in order to reduce heterogeneity.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement

Section/topic	#	Checklist item	Reported on page
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Page 2, PROSPERO: CRD42020168556.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Page 6 & Supplementary Table 1.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 6-8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Page 8

Section/topic	#	Checklist item	Page #
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	Page 8
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Page 8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 8
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 9 & Supplementary Figure 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Page 9-10 & Supplementary table 3 & 4
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Page 11 & Supplementary Figure 2 & 3
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Page 11-13 Supplementary table 4
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 11-13
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Page 11
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 13-14
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 14-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 15
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 15
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Page 17

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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Degree of personalisation in tailored activities and its effect on behavioural and psychological symptoms and quality of life among people with dementia: A systematic review and meta-analysis

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Primary Subject Heading:	Global health
Secondary Subject Heading:	Public health, Mental health
Keywords:	Dementia < NEUROLOGY, MENTAL HEALTH, Old age psychiatry < PSYCHIATRY

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5 psychological symptoms and quality of life among people with dementia: A systematic
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7 review and meta-analysis
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ABSTRACT

Objectives To understand and assess the degree of personalisation of tailored activities for people with dementia (PWD); and to estimate the magnitude of the effects of levels of personalisation on reducing behavioural and psychological symptoms of dementia (BPSD), improving Quality of life (QoL).

Design Systematic review with meta-analysis.

Data Sources ProQuest, PubMed, Ovid, Cochrane Library, Web of Science and CINAHL were searched from the start of indexing to May 2020.

Eligibility Criteria We included randomised controlled trials and quasi-experimental studies assessing the effects of tailored activities for people aged 60 years or older with dementia or cognitive impairment on the outcomes of BPSD, QoL, depression, and level of engagement with control groups.

Data extraction and synthesis Two researchers screened studies, extracted data and assessed risks of bias. A rating scheme to assess the degree of personalisation of tailored activities was developed to classify tailored activities into high/medium/low groups. Effect sizes were expressed using standardised mean differences at 95% confidence intervals. Subgroup analyses were conducted to assess whether the degree of personalisation of tailored activities affects outcomes of interest.

Results Thirty-five studies covering 2,390 participants from 16 countries/regions were identified. Studies with a high-level of personalisation interventions (n=8) had a significant and moderate effect on reducing BPSD (Standardized Mean Differences, SMD= -0.52, p <0.05), followed by medium (n=6; SMD= -0.38, p=0.071) and low-level personalisation interventions (n=4; SMD= -0.15, p=0.076). Tailored activities with a high-level of personalisation had a moderate effect size on improving QoL (n=5; SMD=0.52, p<0.05), followed by a medium level (n=3; SMD=0.41, p <0.05) of personalisation.

Conclusions To develop high-level tailored activities to reduce BPSD and improve QoL among PWD, we recommend applying comprehensive assessments to identify and address two or more PWD characteristics in designed tailored activities and allow modification of interventions to respond to changing PWD needs/circumstances.

Strengths and limitations of this study

- The major contribution of this systematic review and meta-analyses is developing a rating scheme to assess the level of personalisation for interventions.
- To assess whether the degree of personalisation of the tailored activities affects reduction of behavioural and psychological symptoms of dementia and improves quality of life among people with dementia or cognitive impairment.
- Exclusion of papers not published in English may mean that important additional findings are missed.

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3 **Degree of personalisation in tailored activities and its effect on behavioural and**
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5 **review and meta-analysis**
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12 **INTRODUCTION**
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14 Dementia is particularly common among older adults, affecting 5-8% of people aged 60 and
15 over at any given time worldwide.¹ Behavioural and psychological symptoms of dementia
16 (BPSD) are common among people living with dementia (PWD), such as agitation, depression,
17 and resistance to care,² which occur throughout the disease process, associated with decreased
18 quality of life (QoL).³
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26 Non-pharmacological interventions are recommended as first-line treatments over
27 pharmacological approaches to treat BPSD and have less adverse effects.⁴ Tailored activities
28 for PWD are promising non-pharmacological approaches that reduce BPSD and increase QoL.
29 Two recently-published National Institute for Health and Care Excellence (NICE) guidelines
30 recommend that healthcare professionals offer activities to promote QoL that are tailored to
31 personal preferences and consider using a structured tool to assess their likes, dislikes, routines
32 and personal history.^{5,6}
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42 To our knowledge, six systematic reviews and meta-analyses (summarised in
43 Supplementary Table 1) have synthesised the effects of tailored activities on reducing BPSD
44 and enhancing QoL among PWD, based on tailored strategies, activity types, personal
45 characteristics, and frequency and duration of delivery.⁷⁻¹² The first of these, incorporating
46 studies published between 2000 and 2011, focused on the effectiveness of various tailored
47 strategies to foster activity engagement and reduce BPSD in PWD.⁷ Changes to tools and
48 materials used in activities were most common but yielded mixed outcomes of BPSD reduction;
49 modifications to space and social demands were rarely tested but yielded consistently positive
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3 outcomes.⁷ In addition, a systematic review of studies published between 2000 and 2012 found
4 that personalised pleasant activities yielded strong evidence for treating BPSD but limited
5 evidence for physical and music activities.⁸ Another meta-analysis found that individualised
6 recreational activities were effective for reducing BPSD.⁹ Recently, Mohler and colleagues
7 conducted three meta-analyses regarding the effects of tailored activities among PWD living
8 in care facilities, communities and home settings, respectively, and found that, compared with
9 usual care, tailored activities slightly reduced BPSD.¹⁰⁻¹² However, no differences in other
10 desired outcomes between intervention and control groups among different specific types of
11 activity or duration of delivery were evident. Although different activity components (e.g.,
12 activity types, PWD characteristics, frequency, and duration of delivery) were discussed,⁷⁻¹² no
13 review further investigated the degree of tailoring among the tailored activities and synthesised
14 its associations with the desired outcomes.

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31 Understanding the degree of personalisation of tailored activities is important. We define
32 the degree of personalisation of tailored activities as the extent to which non-pharmacological
33 interventions are tailored, individualised or personalised for PWD. The conceptualisation of
34 the degree of personalisation echoes the rationales and principles of effective interventions
35 working on BPSD, level of engagement and QoL, embedded in occupational therapy,¹³
36 engagement in meaningful activities,¹⁴ and person-centred care.¹⁵ Occupational therapy
37 emphasises the fit between PWD capabilities and the occupation (e.g., activities or roles)
38 through task simplification and removing barriers in the physical and social environment.¹³
39 Environmental docility theory suggests that both underloading and overloading of external
40 stimulations (e.g., cognitive activities and social interactions) may lead to PWD disengagement
41 or excessive disability.¹⁶ Thus, maintaining PWD engagement in meaningful activities through
42 tailored activities based on their physical strength, mental state, and psychosocial needs is
43 essential.¹⁴ The person-centred care approach stresses service providers' and caregivers'

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3 autonomy to determine specific ways of delivering care to maintain participants' engagement
4 during the intervention.¹⁵ These theories imply that the degree of personalisation can
5 significantly influence the effectiveness of tailored activities for PWD. Thus, the degree of
6 personalisation could depend on the assessment of PWD characteristics and their environment,
7 the design of tailored activities based on PWD characteristics, and interventionists' autonomy
8 to address PWD spontaneous needs.
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Conceptualising and quantifying the levels of personalisation of existing tailored activities can advance our knowledge on developing a high level of personalisation of tailored activities for PWD, deciding on the appropriate “dose” of tailoring, and translating this cumulative evidence into clinical practice. However, existing literature provides little knowledge about assessing the degree of personalisation among tailored activities and their effectiveness on targeted outcomes.

OBJECTIVES

This systematic review and meta-analysis aimed to: (1) assess the degree of personalisation of existing tailored activities for PWD; (2) estimate the magnitude of the effects of existing tailored activities on reducing BPSD, improving QoL and the level of engagement among PWD; and (3) assess whether the degree of personalisation of tailored activities affects the outcomes of interest.

METHODS AND ANALYSIS

We conducted the review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) procedure.¹⁷ Eligibility criteria required studies to: (a) include participants with dementia or cognitive impairment and aged 60 years or older; (b) include activities tailored to at least one of the participants' characteristics (e.g., needs, physical or/and mental ability, present or previous preferences for particular activities or interests, habits, and physical living environment like housing conditions and caregiver management style); (c)

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3 report BPSD (measured by multi-domain scales, such as the Neuropsychiatric Inventory, and
4 scales specific to agitation and depression/anxiety, such as the Cohen-Mansfield Agitation
5 Inventory and the Cornell Scale for Depression in Dementia),¹⁸⁻²⁰ QoL and level of engagement
6 as outcomes; (d) include randomised controlled trials or quasi-experimental study design; and
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8 (e) apply a control group (e.g., usual care, wait-list, attention control etc.). The review included
9 studies published in English from the start of indexing to May 2020.

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12 We searched ProQuest (e.g., APA PsycInfo), PubMed, Ovid (e.g., Embase), Cochrane
13 Library, Web of Science and CINAHL, using the search terms: (1) “cognitive impairment” OR
14 “cognitive disorder” OR “dement*” OR “Alzheimer”; (2) “tailor*” OR “engag*” OR
15 “individual*” OR “personal*”; and (3) “activit*” OR “program*” OR “therap*” OR
16 “intervention*” OR “treatment*”. The full search strategy is shown in Supplementary Table 2.

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SYL and AYZ independently completed the title/abstract review and full-text review. We
conducted title/abstract screening using Rayyan (<https://www.rayyan.ai/>) and full-text review
using Endnote. The two researchers discussed disagreements in the title/abstract screening and
full-text review to reach consensus. Data were extracted and checked by SYL and MSLM.
Where there were disagreements, data were rechecked for relevance and accuracy. Where
available, raw data (e.g., clinical interventions, strategies, outcomes and results) were extracted
and entered into a spreadsheet.²¹ For each intervention, we additionally extracted the following
information: PWD characteristics taken into account, intervention delivery, and information
about the tailoring process (The data extraction form is shown in Appendix 1).

PROSPERO registration number: CRD42020168556.

Ethics approval statement

This study does not involve human participants.

Patient and public involvement

No patient involved.

Developing the tailoring and classification scheme

The authors formed an expert panel to develop a scheme for the level of personalisation interventions based on the included studies, comprising AYZ (a licensed social worker in Hong Kong with two years clinical experience of dementia care and five years research experience focusing on the mechanisms of non-pharmacological interventions for PWD), TYL, JCPC and SYL (each of whom had over ten-year experience in psychology and elderly care).

Based on the theories and approaches mentioned above, we hypothesised that tailoring is embedded in the whole process at three interrelated phases: assessment, design and implementation, and the degree of personalisation is determined by these three dimensions: (a) how to assess PWD characteristics before designing the intervention; (b) the extent to which interventions are tailored according to PWD characteristics; and (c) the level of the interventionists' autonomy to address PWD needs, as suggested by occupational therapy, engagement in meaningful activities, and the person-centred care approach (Supplementary Figure 1).¹³⁻¹⁵ To this end, we developed three corresponding criteria to rate levels of personalisation (Supplementary Table 3):

First, the level of assessment for tailoring refers to how comprehensive the PWD characteristics were considered and how systematically the assessment results were utilised for designing tailored activities. Operationally, we rated the level of assessment as “unclear/incomprehensive”, “semi-structured”, or “structured”. “Unclear/incomprehensive” indicated that pre-assessment was missing/not clearly described, only a single domain of PWD characteristics was assessed, or no description of how the assessment results were utilised to inform the tailored activities design. “Semi-structured” referred to pre-assessments conducted by unstructured/semi-structured interviews, with some descriptions on how the assessment results were utilised for activities design, “Structured” pre-assessments employed structured

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3 interviews with clear and detailed descriptions on how the assessment results were
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5 systematically utilised for the activities design.
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8 Second, individualisation in intervention design refers to how the intervention design
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10 accounted for individuals' uniqueness and variations of their needs. To avoid counting the
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12 number or arbitrarily weighting specific PWD characteristics, we distinguished the degree of
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14 individualisation based on whether the protocol tailored for one versus two or more PWD
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16 characteristics.
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19 Third, the degree of person-centred care in implementation refers to how the
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21 interventionists were able to adjust the intervention based on their clinical knowledge and
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23 observation of participants' performance in the intervention to maintain participants'
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25 engagement and respond to participants' spontaneous needs during the implementation.
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27 Intervention with a standardised protocol of tailored activities regardless of spontaneous needs
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29 of PWD were rated as low flexibility for pursuing person-centred care, and interventions
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31 encouraging and allowing great flexibility for interventionists to adjust the tailored activities
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33 based on clinical knowledge and observation of participants' performance were rated as high
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35 flexibility.
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40 Based on the dimensions mentioned above, we rated the level of personalisation of tailored
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42 activities as high, medium, or low. A study was rated as high level only if it met all the
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44 following criteria: (a) structured assessments were utilised for systematically tailored activities
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46 plan; (b) interventions targeted two or more domains (e.g., capabilities, preferences, interests,
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48 life experience, and external environment); and (c) allowed the interventionists to exercise
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50 flexibility to adjust the intervention in accordance with PWD spontaneous needs. A study was
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52 rated as medium if: (a) unstructured/semi-structured assessments on participants'
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54 characteristics were performed; (b) interventions targeted two or more domains; and (c) some
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56 flexibility and modifications were allowed for adjusting the intervention in response to PWD
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3 needs. A study was rated as low if: (a) assessment was unclear/incomprehensive, or there was
4 no clear description on how assessment results informed tailoring; (b) interventions targeted
5 only one domain of participants' characteristics; and (c) low/marginal flexibility to pursue
6 person-centred care for interventionists was allowed. AYZ and SYL independently rated the
7 level of personalisation for the included tailored activities. The inter-rater reliability was 88.8%
8 in the initial stage of rating. Conflicting ratings were resolved through discussion.
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19 ***Data synthesis and analysis***

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21 Given that outcomes in our review were continuous, effect sizes were expressed using
22 standardised mean differences (SMD) at 95% confidence intervals (CI),²⁰ interpreted as
23 Cohen's d.²² Specifically, the values of 0.2, 0.5, and 0.8 reflected small, moderate and large
24 effect sizes, respectively.²² Due to differences in settings and methods, we used the random-
25 effects model to pool the results. Heterogeneity was determined by Chi² and I² statistics.^{23, 24}
26 We classified subgroup analyses of the effectiveness of tailored activities according to the
27 levels of tailoring of the interventions. All meta-analyses were conducted using Comprehensive
28 Meta-Analysis Software. Where raw data are not provided, summary results are given in the
29 text but not the forest plots. The meta-analyses included results from randomised controlled
30 studies (RCTs) only because the findings from quasi-experimental studies were not comparable
31 to those from RCTs. Sensitivity analyses were conducted to check the robustness of the
32 findings.
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49 ***Quality Appraisal***

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51 SYL and MSLM independently assessed the risk of bias for the studies using a revised
52 Cochrane risk of bias tool for randomised trials,^{23, 25} including: (a) bias arising from the
53 randomisation process; (b) deviations from intended interventions; (c) bias due to missing
54 outcome data; (d) bias in measurement of the outcome; and (e) bias in selection of the reported
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3 results. Risk of Bias in Non-randomised Studies of Interventions (ROBINS) was used to
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results. Risk of Bias in Non-randomised Studies of Interventions (ROBINS) was used to
categorise the risk of bias as “low,” “high”, or “some concerns” for non-RCT studies.²²
Conflicting results were resolved through discussions.

RESULTS

Summary of Search Results

The search and study selection process are summarised in the PRISMA flow diagram (Supplementary Figure 2). In the identification phase, 14,238 abstracts were identified and imported into Endnote; 7,471 duplicate articles were removed. In the screening phase, the titles and abstracts of 6,767 articles were screened, and 6,476 irrelevant articles were excluded. In the eligibility phase, full-text screening was conducted for 291 articles according to the inclusion and exclusion criteria, and 35 studies were finally included in this review.

Included studies were conducted in 16 countries/regions: Australia, Brazil, Mainland China, Denmark, France, Germany, Hong Kong, Italy, Japan, Korea, the Netherlands, Norway, Switzerland, Taiwan, the United Kingdom, and the United States, published between 2000 and 2020. The average age of participants ranged from 62.1 to 89.2 years. Twenty-nine studies included participants with dementia only, and the remaining studies included participants with mild to moderate levels of cognitive impairment. The total size of the intervention groups (IG) was 1,248 (range = 6-158), and the total size of the control groups (CG) was 1,142 (range = 5-107). Fourteen studies (40%) had no more than 20 participants for each arm. Thirty studies were RCTs. Five applied a quasi-experimental study design. Twenty-two applied usual care as the comparison, and the remaining applied placebo control, active control or wait-list control. Twenty-four studies were conducted in care facilities (such as a nursing home, geriatric health service facility, or hospital), and the remaining studies were conducted in community settings or home-based settings (Supplementary Table 4).

Description of the interventions

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3 The components of activities can be categorized into four groups: physical (n=3),²⁶⁻²⁸ cognitive
4 (n=2),^{29,30} music (n=7)³¹⁻³⁷ and multiple activities (n=23).^{16,38-59} Twenty-three studies reported
5 their interventions as individual mode, five reported group-based mode, and six reported mixed
6 modes, while the remaining studies did not provide details. Intervention was provided by
7 specialists (e.g., occupational therapists, clinicians, psychologists, physical therapists, and
8 speech therapists), researchers and trained nursing home caregivers and staff. A detailed
9 description of interventions is shown in Supplementary Table 5.
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19 ***Level of personalisation***

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21 Based on the three-dimension rating scheme for the personalisation of tailored activities, we
22 identified 12 studies as high level,^{16, 26, 35, 39, 40, 46, 49, 51, 53-56} 11 as medium,^{34, 36, 38, 42, 44, 45, 47, 52,}
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One was rated as mixed because it had 3-arm intervention groups with one medium and two low levels of tailoring activities for comparison.⁴¹ Table 1 shows the level of personalisation among the interventions reported in the reviewed studies.

Level of assessment for tailoring. Sixteen studies assessed the full picture of PWD characteristics using structural assessments.^{16, 26, 35, 38-42, 46, 49, 51, 53-56, 59} For instance, five studies followed the protocol of the Tailored Activity Program (TAP) incorporating the Progressive Lowered Stress Threshold Model.⁶⁰ This posits that with disease progression, dementia patients become increasingly vulnerable to their environment and experience lower thresholds for tolerating stimuli that can result in behavioural disturbances. TAP applied systematic approaches to discern PWD and their caregivers' daily routines, identify previous and current activity interests and collect information about dyadic communication and home environmental features to design activities for participants.

Degree of individualisation in design. Activities tailored according to PWD characteristics included cognitive or/and physical capacities (n = 22),^{26-28, 30, 38, 39, 41-47, 49, 51, 53-59} personal experience and history (n=2),^{34, 48} role identity (n=3),^{39, 51, 55} preferences and interests (n=20)

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3 26, 29, 31-33, 35-37, 40-42, 46, 47, 50, 53-57, 59 habits (n=2),^{51, 54} cultural backgrounds (n=1),⁴⁷ and living
4 environment (n=5).^{49, 51, 53, 54, 56} Five studies also considered caregivers' characteristics.^{46, 51, 53,}
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54, 56 Twelve studies tailored the intervention for a single aspect of PWD characteristics only, while the remainder tailored the activities for at least two. One study used a 4-arm study design (3 intervention groups plus one control group), with one tailoring both for PWD capacity and interests, the second only tailoring for the capacities yet opposite to PWD preference, and the third only tailoring for the interests yet challenging to PWD' capacity in the three intervention groups.⁴¹

Degree of person-centred care in delivery. Twenty-six studies indicated the level of flexibility for modification of activities during the intervention. Sixteen studies explicitly permitted the interventionists to review and modify the intervention according to participants' spontaneous needs and circumstances,^{16, 26, 35, 36, 39-42, 46, 49, 51-56} thus were rated as offering a high degree of person-centred care. Five allowed some flexibility for adjusting interventions during implementation,^{34, 47, 57-59} thus were rated as offering some flexibility. Five studies enabled relatively limited adjustment of intervention to take account of changed PWD needs or circumstances.^{27, 32, 34, 37, 50} The remaining studies provided insufficient information to judge the extent of flexibility allowed during the intervention.

<Insert Table 1>

Quality appraisal

The risk bias of ten RCT studies was judged as low, while that of 12 was rated as high, and the remainder were judged as giving some concern (Supplementary Figure 3). Nineteen RCT studies reported the method of random sequence generation (e.g., computer-generated programmes, random list generator, random allocation by an external researchers and block randomisation).^{16, 28-30, 33, 34, 37, 41-43, 46, 49, 51, 53-56, 58, 59} Eleven were rated as high risk of deviation from intended intervention as they were judged as high risk of blinding participants, personnel

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3 and appropriate analysis used to estimate the effect of assignment to intervention.^{27-30, 33, 36, 40,}
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5 42, 43, 48, 52 Five quasi-experimental studies were excluded from the meta-analysis since none
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7 were rated at low risk of bias and thus comparable to RCTs (Supplementary Figure 4).
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10 ***Meta-analysis: The effects of tailored interventions***

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12 Twenty-six studies reported the outcomes of BPSD measured by multi-dimension or specific
13 scales of agitation (Figure 1).^{16, 27-29, 31, 33-37, 39-42, 44, 46, 47, 50, 51, 53-59} The measurements used for
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15 BPSD included the Neuropsychiatric Inventory (NPI), the Agitation Behavior Mapping
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17 Instrument (AMI), the Cohen-Mansfield Agitation Inventory (CMAI), the Agitated Behaviors
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19 in Dementia Scale, the Behavioral Pathology in Alzheimer's Disease (BEHAVE-AD) Rating
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21 Scale, and the short version of the Dementia Behavior Disturbance Scale.^{18, 20, 61-64} A higher
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23 score indicates more BPSD. According to our meta-analysis, 18 RCTs with 20 tailored
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25 activities had an overall small effect on BPSD at post-intervention (SMD_{pooled} = -0.38; 95%
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27 CI: -0.54 to -0.23, p < 0.001), although significant heterogeneity was found (I² = 64.17%, p<
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29 0.001). Eight studies were excluded from the meta-analysis either because of their quasi-
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31 experimental design or for not reporting the raw data,^{31, 36, 37, 44, 47, 50, 55, 57}. Four of these
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33 identified no differences in reducing BPSD between IG and CG.^{31, 36, 37, 50}
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40 <Insert Figure 1>

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42 Nine studies reported the outcome of QoL (Figure 2).^{16, 34, 48, 49, 51, 52, 54, 56, 58} The
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44 measurements used for QoL included Quality of Life-Alzheimer's Disease, the 3-Level version
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46 of the EuroQol five dimensions (EQ5D-3L), the EuroQol 5-D, and the Health-related Quality
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48 of Life Questionnaire for the Elderly with Dementia.⁶⁵⁻⁶⁷ A higher score indicates higher QoL.
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50 Tailored interventions had an overall small effect on QoL at post-intervention (SMD_{pooled} =
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52 0.45; 95% CI: 0.25 to 0.64, p < 0.001), and no significant heterogeneity was found (I² = 11.56%,
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54 p > 0.05).
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58 <Insert Figure 2>

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3 Sixteen studies reported the outcome of depression,^{16, 26, 28-30, 32, 39, 43-46, 48-50, 52, 58} measured
4 by the Cornell Scale for Depression in Dementia, the Geriatric Depression Scale, the
5 Multidimensional Observation Scale for Elderly Subjects, the Geriatric Depression Scale, the
6 Neuropsychiatric Inventory subscale for depression, or Patient Health Questionnaire-9.^{18, 19, 68-}
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⁷⁰ A higher score indicates more depression. Thirteen RCT studies with 14 tailored activities indicated those activities had a small overall effect on depression at post-intervention (SMD_{pooled} = -0.26; 95% CI: -0.40 to -0.12, $p < 0.001$), and no significant heterogeneity was found (Supplementary Figure 5). The remaining three studies were excluded from the meta-analysis because of their quasi-experimental design or lack of comparable data,^{32, 44, 50} and only one study found no difference in reducing depression between IG and CG.⁴⁴

Seven studies with nine interventions reported the outcome of engagement.^{16, 38, 39, 41, 42, 51,}
⁵² The measurements of engagement included one item on the ABMI, the Menorah Park Engagement Scale (MPES), direct observation or caregiver report.^{61, 71} A higher score indicates a higher level of engagement. The meta-analysis indicated that tailored interventions of eight matched IGs and CGs in six studies had an overall large effect on the level of engagement at post-intervention (SMD_{pooled} = 0.86; 95% CI: 0.23 to 1.48, $p < 0.001$) (Supplementary Figure 6). Significant heterogeneity was found, primarily generated by the outlier study whose intervention specifically targeted participants' self-identity roles and which reported large effects on engagement (SMD_{pooled} = 3.52; 95% CI: 2.87 to 4.17, $p < 0.001$).³⁹ Removal of this study resulted in lower and non-significant heterogeneity with a significant small effect size (SMD_{adjusted pooled} = 0.47; 95% CI: 0.23 to 0.60, $p < 0.001$). One study with a quasi-experimental design reported increased engagement post-intervention.³⁸

Subgroup analysis

Subgroup analysis was performed to test the difference of the effects of tailored activities with different levels of personalisation on outcomes (Figures 3 & 4). Studies with a high level of

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3 personalisation tailored activities had a significant and the largest effect size regarding the
4 reduction of BPSD ($SMD_{pooled} = -0.52$, 95% CI: -0.74 to -0.29, $p < 0.001$) with non-significant
5 heterogeneity, followed by medium ($SMD_{pooled} = -0.38$, 95% CI: -0.79 to 0.03, $p = 0.071$) and
6 low groups ($SMD_{pooled} = -0.15$, 95% CI: -0.44 to 0.14, $p = 0.076$), although both the latter two
7 groups had marginally significant effect sizes and significant heterogeneity. The high group
8 had a moderate effect size on improvement in QoL ($SMD_{pooled} = 0.52$, 95% CI: 0.16 to 0.89,
9 $p < 0.01$), followed by the medium group ($SMD_{pooled} = 0.41$, 95% CI: 0.07 to 0.74, $p < 0.05$).
10 Only one study with a low level of personalisation tailored activities reported the outcome of
11 QoL with moderate effect size ($SMD = 0.72$, 95% CI: 0.08 to 1.36, $p < 0.05$).
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25 <Insert Figure 4>

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28 Subgroup analysis was performed to test the difference of the effects of the level of
29 personalisation on depression and engagement (Supplementary Figures 7 & 8). The medium
30 group had a moderate effect size regarding reduction in depression ($SMD_{pooled} = -0.64$, 95%
31 CI: -1.14 to -0.15, $p < 0.05$), followed by the high group ($SMD_{pooled} = -0.33$, 95% CI: -0.54 to
32 -0.12, $p < 0.01$). The three studies with a medium level of personalisation of tailored activities
33 all involved social or group interaction components that have beneficial effects on PWD mental
34 health. Only one study rated high on tailoring had a large effect on improving engagement level
35 post-intervention ($SMD = 0.85$, 95% CI: 0.32 to 1.38, $p < 0.01$). The medium group had a small
36 effect size ($SMD_{pooled} = 0.44$, 95% CI: 0.07 to 0.80, $p < 0.05$), followed by the low group
37 ($SMD_{pooled} = 0.39$, 95% CI: 0.04 to 0.74, $p < 0.05$).
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51 ***Sensitivity analysis***

52 We conducted a series of sensitivity analyses that excluded studies that combined participants
53 with dementia and those with cognitive impairment. No substantial differences were found
54 between the findings of studies focussing exclusively on people with dementia and studies that
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3 included participants with dementia and participants with cognitive impairment
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5 (Supplementary Table 6). Sensitivity analyses were also conducted to examine whether the
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7 effect sizes of tailored activities on the outcomes of interest were associated with each study's
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9 sample size. The only significant association was found between sample size and effect size on
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11 QoL. We also tested whether a study's intervention mode (individual, group and mixed with
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13 mixed mode set as the reference group) would be associated with its findings. No significant
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15 associations were found between intervention mode and the outcomes.
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22 **Discussion**

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24 Our systematic review aimed to assess the degree of personalisation of tailored activities and
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26 estimate the effect of levels of personalisation of tailored activities on reducing BPSD,
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28 improving QoL and other relevant outcomes among PWD. Thirty-five studies met our
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30 inclusion criteria, covering a total of 2,390 participants from 16 countries/regions. The
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32 activities included in the interventions comprised physical, cognitive, music and multiple
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34 activities.
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38 We employed meta-analysis to estimate the overall effects of tailored activities on the
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40 outcomes of BPSD, QoL, depression and engagement. Our findings on the effect sizes of
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42 tailored activities of the outcomes of interests differ from previous review studies. First, we
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44 found that tailored activities slightly reduced BPSD, consistent with previous meta-analyses
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46 targeting facilities, communities, and PWD living in their own home.¹⁰⁻¹² Second, we found
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48 that tailored activities had a small effect on improving QoL, compared with previous reviews
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50 that found inconclusive evidence regarding QoL: no effect in facilities, and a slight
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52 improvement in both community- and home-based settings.¹⁰⁻¹² Third, our findings showed
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54 that tailored activities had small effects on depression, and large effects on engagement,
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56 contradicting previous reviews reporting little or no effect on these outcomes.^{11, 12}
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3 Unlike previous review studies, we further developed the rating scheme of tailoring level
4 based on three essential components: assessment for tailoring, individualisation in intervention
5 design and person-centred care in implementation. Based on our rating scheme, the activities
6 with optimal tailoring conditions possess the following characteristics. In the assessment stage,
7 systematic interviews on individuals' characteristics were conducted. In the design stage, two
8 or more domains of individuals' characteristics were targeted in the activity plan, including
9 capabilities, preferences, interests, life experience, and external environment. In the
10 implementation stage, interventionists were allowed high flexibility and any modifications
11 based on their professional judgement to accommodate the spontaneous needs of PWD during
12 the intervention. Overall, we rated only 12 studies as high level of personalisation of tailored
13 activities, 11 as medium, 11 as low, and one study was rated as mixed because it had 3-arm
14 intervention groups with one medium and two low levels of tailoring activities for comparison.

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31 Based on our rating scheme, we extended previous review studies to investigate how the
32 degree of tailoring influenced intervention effectiveness on the outcomes of interest.
33 Interventions with a high level of personalisation of tailored activities had a significant and
34 moderate effect, followed by medium (small) and low groups (trivial); the latter two groups
35 had significant heterogeneity and marginally significant effect sizes. Interventions rated as
36 having a high level of personalisation had a moderate effect size on improving QoL, followed
37 by the medium group. Only one study with a low level of personalisation of tailored activities
38 reported the outcome of QoL with moderate effect size. These findings support our rating
39 scheme as the overall goals of tailoring activities are to reduce BPSD and improve QoL.^{54, 56} A
40 similar pattern was found in the level of engagement. However, because the degree of
41 personalisation was rated high in one study only, this should be interpreted with caution.

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56 This systematic review has several limitations. The generalizability of our results may be
57 limited since we included English-language studies only. The included studies had risks of bias
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3 that may undermine the quality of evidence. Furthermore, noticeable heterogeneity was found
4 among studies with outcomes of BPSD and engagement, which may affect the conclusions
5 synthesised from these studies. Thus, these results must be interpreted with caution. In addition,
6 the rating scheme for the level of personalisation was subjective regarding the level of
7 assessments for tailoring and the degree of person-centred care in implementation.
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15 This review has implications for clinical practice. It provides new insights into non-
16 pharmacological tailored activities by developing a rating scheme for the level of
17 personalisation and tested its validity by investigating the effectiveness of interventions with
18 different levels of tailoring on BPSD and QoL. Healthcare professionals and practitioners can
19 use our findings to tailor interventions to benefit patients' outcomes. We recommend the
20 application of structural and comprehensive assessment approaches to identify and address two
21 or more PWD characteristics (capacities, preferences, habits and living environment etc.) in
22 designing tailored activities, and allow interventionists to use their professional judgment to
23 modify the interventions to respond to spontaneous needs of PWD to develop tailored activities
24 with a high level of personalisation.
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38 Our systematic review has implications for future intervention research. Fourteen studies
39 had no more than 20 participants for each arm, and only ten RCTs were judged as low risk.
40 Evaluation studies should adhere to current methodological standards, e.g., a randomised and
41 concealed allocation, adequate blinding (at least participants and outcome assessors), and
42 recruitment of adequate samples.²³
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49 **CONCLUSION**

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51 This systematic review shows that tailored activities slightly reduced BPSD and depression,
52 had a small effect on improving QoL, and had large effects on facilitating the level of
53 engagement among PWD. Additionally, we advanced existing literature by proposing and
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3 testing the validity of a rating scheme for the level of personalisation. Additional high-quality
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5 tailored intervention studies with sufficient samples are needed.
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For peer review only

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3 **Contributors** SYL wrote the systematic review, performed the preliminary searches and data
4 extraction, conducted quality assessments and drafted the systematic review paper. SYL, AYZ,
5 TYL and JCPC designed the rating scheme for the level of personalisation. MSLM cross-
6 checked data extraction and performed quality ratings independently. GHYW and TYSL made
7 substantial contributions to the conception and design of the systematic review and assisted
8 SYL, AYZ, TYL and JCPC to resolve any discrepancies regarding study inclusion, data
9 extraction and quality ratings. All authors offered critical revisions for the systematic review
10 manuscript.
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16
17

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23 **Data sharing statement** No additional data are available.
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References

1. World Health Organization. Dementia 2019 [Available from: <https://www.who.int/news-room/fact-sheets/detail/dementia>].
2. Kales HC, Gitlin LN, Lyketsos CG. Assessment and management of behavioral and psychological symptoms of dementia. *BMJ*. 2015;350.
3. Gitlin LN, Kales HC, Lyketsos CG. Nonpharmacologic management of behavioral symptoms in dementia. *JAMA*. 2012;308(19):2020-9.
4. de Oliveira AM, Radanovic M, de Mello PCH, Buchain PC, Vizzotto ADB, Celestino DL, et al. Nonpharmacological interventions to reduce behavioral and psychological symptoms of dementia: a systematic review. *Biomed Res Int*. 2015; 218980.
5. NICE. Dementia: Assessment, management and support for people living with dementia and their carers [NG97] 2018 [updated June 2018. Available from: <https://www.nice.org.uk/guidance/ng97>].
6. NICE. Dementia: Quality standard [QS184. 2019.
7. Trahan MA, Kuo J, Carlson MC, Gitlin LN. A systematic review of strategies to foster activity engagement in persons with dementia. *Health Educ Behav*. 2014;41(1 Suppl):70S-83S.
8. Testad I, Corbett A, Aarsland D, Lexow KO, Fossey J, Woods B, et al. The value of personalized psychosocial interventions to address behavioral and psychological symptoms in people with dementia living in care home settings: a systematic review. *Int Psychogeriatr*. 2014;26(7):1083-98.
9. Travers C, Brooks D, Hines S, O'Reilly M, McMaster M, He W, et al. Effectiveness of meaningful occupation interventions for people living with dementia in residential aged care: A systematic review. *JBI Database System Rev Implement Rep*. 2016;14(12):163-225.
10. Mohler R, Renom A, Renom H, Meyer G. Personally tailored activities for improving psychosocial outcomes for people with dementia in long-term care. *Cochrane Db Syst Rev*. 2018(2).
11. Mohler R, Renom A, Renom H, Meyer G. Personally tailored activities for improving psychosocial outcomes for people with dementia in community settings. *Cochrane Db Syst Rev*. 2020(8).
12. Möhler R, Renom A, Renom H, Meyer G. Personally tailored activities for people with dementia living in their own homes. *Cochrane Db Syst Rev* 2020. 2020.
13. Bennett S, Laver K, Voigt-Radloff S, Letts L, Clemson L, Graff M, et al. Occupational therapy for people with dementia and their family carers provided at home: a systematic review and meta-analysis. *BMJ Open*. 2019;9(11).
14. Macaulay S. The broken lens of BPSD: Why we need to rethink the way we label the behavior of people who live with Alzheimer disease. *J Am Med Dir Assoc*. 2018;19(2):177-80.
15. Chenoweth L, King MT, Jeon Y-H, Brodaty H, Stein-Parbury J, Norman R, et al. Caring for Aged Dementia Care Resident Study (CADRES) of person-centred care, dementia-care mapping, and usual care in dementia: a cluster-randomized trial. *Lancet Neurol*. 2009;8(4):317-25.
16. Gitlin LNP, Winter LP, Burke JPOTRLF, Chernett NMPH, Dennis MPP, Hauck WWP. Tailored activities to manage neuropsychiatric behaviors in persons with dementia and reduce caregiver burden: a randomised pilot study. *Am J Geriatr Psychiatry*. 2008;16(3):229-39.
17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
18. Cummings JL, Mega M, Gray K, Rosenbergthompson S, Carusi DA, Gornbein J. The neuropsychiatric inventory - Comprehensive assessment of psychopathology in dementia. *Neurology*. 1994;44(12):2308-14.
19. Alexopoulos GS, Abrams RC, Young RC, Shamoian CA. Cornell Scale for Depression in Dementia. *Biol Psychiat*. 1988;23(3):271-84.
20. Cohen-Mansfield J, Billig N. Agitated behaviors in the elderly. I. A conceptual review. *J Am Geriatr Soc*. 1986;34(10):711-21.
21. Cochrane Effective Practice and Organisation of Care (EPOC). Describing interventions in EPOC reviews 2017 [Available from: <https://epoc.cochrane.org/resources/epoc-resources-review-authors>].

22. Cohen J. Statistical power analysis for the behavioral sciences: Academic Press; 2013.
23. Higgins JP, Green S. Cochrane handbook for systematic reviews of interventions. Chichester: John Wiley & Sons; 2011.
24. Higgins JP, Li T, Deeks JJ. Choosing effect measures and computing estimates of effect: The Cochrane Collaboration; 2019 [Available from: www.training.cochrane.org/handbook].
25. Sterne JAC, Savovic J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: A revised tool for assessing risk of bias in randomized trials. *BMJ*. 2019;366.
26. Lam CWL, Lui WCV, Luk NYD, Chau R, So C, Poon V, et al. Effectiveness of an individualized functional training program on affective disturbances and functional skills in mild and moderate dementia - a randomized control trial. *I J Geriatr Psychiatry*. 2009;25(2):133-41.
27. Holthoff VA, Marschner K, Scharf M, Steding J, Meyer S, Koch R, et al. Effects of physical activity training in patients with Alzheimer's Dementia: results of a pilot RCT study. *Plos One*. 2015;10(4).
28. Telenius EW, Engedal K, Bergl, A. Effect of a high-intensity exercise program on physical function and mental health in nursing home residents with dementia: an assessor blinded randomized controlled trial. *Plos One*. 2015;10(5).
29. Davison TED, Nayer KBID, Coxon SP, de Bono AP, Eppingstall BMA, Jeon Y-HP, et al. A personalized multimedia device to treat agitated behavior and improve mood in people with dementia: a pilot study. *Geriatr Nurs*. 2016;37(1):25.
30. Giuli C, Papa R, Lattanzio F, Postacchini D. The effects of cognitive training for elderly: results from My Mind Project. *Rejuvenation Res*. 2016;19(6):485-494.
31. Garland K, Beer E, Eppingstall B, O'Connor DW. A comparison of two treatments of agitated behavior in nursing home residents with dementia: simulated family presence and preferred music. *Am J Geriatr Psychiatry*. 2007;15(6):514-21.
32. Sung H-C, Chang AM, Lee W-L. A preferred music listening intervention to reduce anxiety in older adults with dementia in nursing homes. *J Clin Nurs*. 2009;19(7):1056-64.
33. Lin Y, Chu H, Yang C-Y, Chen C-H, Chen S-G, Chang H-J, et al. Effectiveness of group music intervention against agitated behavior in elderly persons with dementia. *I J Geriatr Psychiatry*. 2011;26(7):670-8.
34. Ridder HMO, Stige B, Qvale LG, Gold C. Individual music therapy for agitation in dementia: an exploratory randomized controlled trial. *Aging Ment Health*. 2013;17(6):667-78.
35. Sakamoto M, Ando H, Tsutou A. Comparing the effects of different individualized music interventions for elderly individuals with severe dementia. *Int Psychogeriatr*. 2013;25(5):775-84.
36. Kwak J, Anderson K, O'Connell Valuch K. Findings From a prospective randomized controlled trial of an individualized music listening program for persons with dementia. *J Appl Gerontol*. 2018;733464818778991.
37. Weise L, Töpfer NF, Deux J, Wilz G. Feasibility and effects of individualized recorded music for people with dementia: a pilot RCT study. *Nordic J Music Ther*. 2020;29(1):39-56.
38. Orsulic-Jeras S, Judge KS, Camp CJ. Montessori-based activities for long-term care residents with advanced dementia: effects on engagement and affect. *Gerontologist*. 2000;40(1):107-11.
39. Cohen-Mansfield J, Parpura-Gill A, Gol, er H. Utilization of self-identity roles for designing interventions for persons with dementia. *J Gerontol B Psychol Sci Soc Sci*. 2006;61(4):P202-P12.
40. Cohen-Mansfield J, Libin A, Marx MS. Nonpharmacological treatment of agitation: a controlled trial of systematic individualized intervention. *J Gerontol A Biol Sci Med Sci*. 2007;62(8):908-16.
41. Kolanowski A, Litaker M, Buettner L, Moeller J, Costa PT, Jr. A randomized clinical trial of theory-based activities for the behavioral symptoms of dementia in nursing home residents. *J Am Geriatr Soc*. 2011;59(6):1032-41.
42. van der Ploeg ES, Eppingstall B, Camp CJ, Runci SJ, Taffe J, O'Connor DW. A randomized crossover trial to study the effect of personalized, one-to-one interaction using Montessori-based activities on agitation, affect, and engagement in nursing home residents with dementia. *Int Psychogeriatr*. 2013;25(4):565-75.
43. Yoon JE, Lee SM, Lim HS, Kim TH, Jeon JKN, Mun MH. The effects of cognitive activity combined with active extremity exercise on balance, walking activity, memory level and quality of life of an older adult sample with dementia. *J Phys Ther Sci*. 2013;25(12):1601-4.

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- 3
- 4 44. Toba K, Nakamura Y, Endo H, Okochi J, Tanaka Y, Inaniwa C, et al. Intensive rehabilitation
- 5 for dementia improved cognitive function and reduced behavioral disturbance in geriatric health
- 6 service facilities in Japan. *Geriatr Gerontol Int*. 2014;14(1):206-11.
- 7 45. Lu YYF, Bakas T, Yang ZY, Weaver MT, Austrom MG, Haase JE. Feasibility and effect
- 8 sizes of the revised daily engagement of meaningful activities intervention for individuals with mild
- 9 cognitive impairment and their caregivers. *J Gerontol Nurs*. 2016;42(3):45-58.
- 10 46. Prick AE, de Lange J, Scherder E, Twisk J, Pot AM. The effects of a multicomponent dyadic
- 11 intervention on the mood, behavior, and physical health of people with dementia: a randomized
- 12 controlled trial. *Clin Interv Aging*. 2016;11:383-95.
- 13 47. Li DM, Li XX. The effect of folk recreation program in improving symptoms: a study of
- 14 Chinese elder dementia patients. *I J Geriatr Psychiatry*. 2016;32(8):901-8.
- 15 48. Tanaka S, Honda S, Nakano H, Sato Y, Araya K, Yamaguchi H. Comparison between group
- 16 and personal rehabilitation for dementia in a geriatric health service facility: single-blinded
- 17 randomized controlled study. *Psychogeriatrics*. 2017;17(3):177-85.
- 18 49. Jeon Y-H, Krein L, Simpson JM, Szanton SL, Clemson L, Naismith SL, et al. Feasibility and
- 19 potential effects of interdisciplinary home-based reablement program (I-HARP) for people with
- 20 cognitive and functional decline: a pilot trial. *Aging Ment Health*. 2019.
- 21 50. Huber A, Oppikofer S, Meister L, Langensteiner F, Meier N, et al. Music and memory: the
- 22 impact of individualized music listening on depression, agitation, and positive emotions in persons
- 23 with dementia. *Act Adapt Aging*. 2021;45(1).
- 24 51. Gitlin LNP, Winter LP, Dennis MPPE, Hodgson NPRN, Hauck WWP. A biobehavioral
- 25 home-based intervention and the well-being of patients with dementia and their caregivers: the COPE
- 26 Randomized Trial. *JAMA*. 2010;304(9):983-91.
- 27 52. Bailey EM, Stevens AB, LaRocca MA, Scogin F. A randomized controlled trial of a
- 28 therapeutic intervention for nursing home residents with dementia and depressive symptoms. *J Appl*
- 29 *Gerontol*. 2017;36(7):895-908.
- 30 53. Gitlin LN, Arthur P, Piersol C, Hessels V, Wu SS, Dai YF, et al. Targeting behavioral
- 31 symptoms and functional decline in dementia: a randomized clinical trial. *J Am Geriatr Soc*.
- 32 2017;66(2):339-45.
- 33 54. Novelli M, Machado SCB, Lima GB, Cantatore L, Sena BP, Rodrigues RS, et al. Effects of
- 34 the Tailored Activity Program in Brazil (TAP-BR) for persons with dementia: a randomized pilot
- 35 trial. *Alzheimer Dis Assoc Disord*. 2018;32(4):339-45.
- 36 55. Oliveira A, Martini R, Radanovic M, Homem de Mello PC, Buchain PC, Dias Vizzotto A, et
- 37 al. An intervention to reduce neuropsychiatric symptoms and caregiver burden in dementia:
- 38 preliminary results from a randomized trial of the Tailored Activity Program–Outpatient Version. *I J*
- 39 *Geriatr Psychiatry*. 2018.
- 40 56. O'Connor CM, Clemson L, Brodaty H, Low LF, Jeon YH, Gitlin LN, et al. The Tailored
- 41 Activity Program (TAP) to address behavioral disturbances in frontotemporal dementia: a feasibility
- 42 and pilot study. *Disabil Rehabil*. 2019;41(3):299-310.
- 43 57. Van Haitsma KS, Curyto K, Abbott KM, Towsley GL, Spector A, Kleban M. A randomized
- 44 controlled trial for an individualized positive psychosocial intervention for the affective and
- 45 behavioral symptoms of dementia in nursing home residents. *J Gerontol B Psychol Sci Soc Sci*.
- 46 2013;70(1):35-45.
- 47 58. Dechamps A, Alban R, Jen J, Decamps A, Traissac T, Dehail P. Individualized cognition-
- 48 action intervention to prevent behavioral disturbances and functional decline in institutionalized older
- 49 adults: a randomized pilot trial. *I J Geriatr Psychiatry*. 2009;25(8):850-60.
- 50 59. Cohen-Mansfield J, Thein K, Marx MS, Dakheel-Ali M, Freedman L. Efficacy of
- 51 nonpharmacologic interventions for agitation in advanced dementia: a randomized, placebo-controlled
- 52 trial. *J Clin Psychiatry*. 2012;73(9):1255-61.
- 53 60. Hall GR, Buckwalter KC. Progressively lowered stress threshold: a conceptual model for care
- 54 of adults with Alzheimer's disease. *Arch Psychiatr Nurs*. 1987;1(6):399-406.
- 55 61. Cohen-Mansfield J, Werner P, Marx MS. An observational study of agitation in agitated
- 56 nursing home residents. *Int Psychogeriatr*. 1989;1(2):153-65.
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3 62. Logsdon RG, Teri L, Weiner MF, Gibbons LE, Raskind M, Peskind E, et al. Assessment of
4 agitation in Alzheimer's disease: the Agitated Behavior in Dementia Scale. *J Am Geriatr Soc*.
5 1999;47(11):1354-8.
6 63. Reisberg B, Borenstein J, Salob SP, Ferris SH, Franssen E, Georgotas A. Behavioral
7 symptoms in Alzheimer's disease: phenomenology and treatment. *J Clin Psychiatry*. 1987;48
8 Suppl:9-15.
9 64. Machida A. [Estimation of the reliability and validity of the short version of the 28-item
10 Dementia Behavior Disturbance Scale]. *Nihon Ronen Igakkai Zasshi*. 2012;49(4):463-7.
11 65. Logsdon RG, Gibbons LE, McCurry SM, Teri L. Quality of life in Alzheimer's disease:
12 patient and caregiver reports. *J Ment Health Aging*. 1999;5(1):21-32.
13 66. Williams A. Euroqol - a new facility for the measurement of health-related quality-of-life.
14 *Health Policy*. 1990;16(3):199-208.
15 67. Terada S, Ishizu H, Fujisawa Y, Fujita D, Yokota O, Nakashima H, et al. Development and
16 evaluation of a health-related quality of life questionnaire for the elderly with dementia in Japan. *I J*
17 *Geriatr Psychiatry*. 2002;17(9):851-8.
18 68. Yesavage JA. Geriatric Depression Scale. *Psychopharmacol Bull*. 1988;24(4):709-11.
19 69. Helmes E, Csapo KG, Short JA. Standardization and validation of the Multidimensional
20 Observation Scale for Elderly Subjects (Moses). *J Gerontol*. 1987;42(4):395-405.
21 70. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9 - Validity of a brief depression severity
22 measure. *J Gen Intern Med*. 2001;16(9):606-13.
23 71. Skrajner MJ, Camp CJ. Resident-assisted Montessori Programming (RAMP™): use of a
24 small group reading activity run by persons with dementia in adult day health care and long-term care
25 settings. *Am J Alzheimers Dis Other Dement*. 2007;22(1):27-36.
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Table 1. Level of personalisation of tailored activities

#	Author (Year)	Level of assessment for tailoring	Degree of individualisation in design	Degree of person-centred care in intervention delivery	Level of personalisation
1	Orsulic-Jeras et al. (2000)	Structured assessments of participants' preferences using the Montessori-Based Assessment System developed by the authors for selecting appropriate activities for participants	Preserved abilities and preference (Two and above)	No description	Medium
2	Cohen Mansfield (2006)	Structured assessments for tailoring relating to participants' medical history, self-identity, and social functioning	Identity roles, the severity of dementia and ability (Two and above)	High flexibility. The choice of intervention was affected by availability of materials, family members' cooperation and the practicability of the intervention.	High
3	Garland et al. (2007)	No pre-assessments for tailoring	Music preference. (One)	No description	Low
4	Cohen- Mansfield et al. (2007)	Structured assessments for tailoring regarding participants' medical history, self-identity, and social functioning	Ability, past history and preference (Two and above)	High flexibility. The study clearly indicated that flexibility was essential element of intervention	High
5	Gitlin et al. (2008)	Semi structured interviews to discern daily routines, and the Pleasant Event Schedule to identify previous/current activity interests. Interventionists observed dyadic communication and home environmental features and assessed dementia patients.	Capabilities, previous roles, habits, interests, home environment and dyadic communication (Two and above)	High flexibility. Activity prescriptions were reviewed and modified if necessary, during the implementation.	High
6	Lam et al. (2009)	Structured assessments for tailoring. Individual functional profiles were mapped with personal selection.	Abilities, preference, & needs. (Two and above)	High flexibility. Training content was dynamic and adjusted to the changing needs of PWD	High
7	Dechamps et al. (2009)	Semi-structured assessments on physical/psychological functions	Abilities (One)	Some flexibility.	Medium
8	Gitlin et al. (2010)	Structured assessments of PWD capabilities, medical testing, home environment, caregiver communication, and caregiver-identified concerns. Interventionists interviewed caregivers to identify patient's routines, previous/current roles, habits and interest.	Home environment, Caregiver-identified concerns and capabilities, routines, previous /current roles, habits & interests (Two and above)	High flexibility	High
9	Sung et al. (2010)	Semi-structured assessments of participants' preferences and information on the importance of music to life	Music preference (One)	Low	Low
10	Kolanowski et al. (2011)	Structured assessments of capacities and personality of interest	Capacity and Preference (Two and above)	High flexibility. Great flexibility was allowed to use staff's own clinical judgment and knowledge to implement individualised activities.	Medium
a			Capacity (One)	No description	Low
b			Preference (One)	No description	Low
11	Lin et al. (2011)	Semi-structured pre-assessment of participants' music preference	Music Preference (One)	No description	Low
12	Cohen-Mansfield et al. (2012)	Structured assessments of participants' medical history, self-identity, and social functioning.	Past identity, ability and preferences (Two and above)	Some flexibility. Interventionists were allowed to seek approval for possible adjustment if needed.	Medium
13	van der Ploeg et al. (2012)	Structured assessments (Myers Menorah Park/Montessori-Based Assessment System) for tailoring	Preserved abilities and Interest (Two and above)	High flexibility. Flexibility to respond to patients' perceived level of interest was allowed	Medium
14	Ridder et al. (2013)	Semi-structured interviews to elicit life-story information either from journal or relatives.	Life-story/history, psychosocial needs (Two and above)	Low/some flexibility. No specific description.	Medium
15	Sakamoto et al. (2013)	Structural assessments for tailoring to analyse participants' personal life history, and interview with each participant and family member	Music preference, special memories (Two and above)	High flexibility.	High
16	Van Haitsma et al. (2013)	Incomprehensive pre-assessments	Interest and ability (Two and above)	Some flexibility. The intervention was adjusted according to the time when residents need stimulation.	Medium
17	Yoon et al. (2013)	Incomprehensive pre-assessments	Ability (One)	Low flexibility	Low
18	Toba et al. (2014)	Pre-assessment of individuals' abilities and disabilities to evaluate how to enhance abilities and compensate for disabilities	Abilities (One)	No description	Medium

Table 1. (Continued) Level of personalisation of tailored activities

#	Author (Year)	Level of assessment for tailoring	Degree of individualisation in design	Degree of person-centred care in delivery	Level of personalisation
19	Holthoff et al. (2015)	Incomprehensive pre-assessments	Ability (One)	Low flexibility	Low
20	Telenius et al. (2015)	Incomprehensive pre-assessments	Ability (One)	No description.	Low
21	Davison et al. (2016)	Pre-assessment. The researchers met with participants and their families to determine the preferred materials.	Interest only (One)	Low flexibility	Low
22	Giuli et al. (2016)	Incomprehensive pre-assessments on patients' cognitive status	Cognition (One)	No description	Low
23	Lu et al. (2016)	Pre-assessments on PWD functional ability, types and frequencies of meaningful activity, perceived barriers to engaging in activities	Functional ability, types and frequencies of meaningful activity (Two and above)	No description.	Medium
24	Prick et al. (2016)	Structured assessments for tailoring	Physical capacities, information about pleasant activities for the dyad (Two and above)	Medium to High	High
25	Bailey et al (2017)	No pre-assessments for tailoring.	Interest and past history (Two and above)	High flexibility. The group leaders had the flexibility to develop and tailor the individualised behavioural activity programmes during implementation	Medium
26	Li et al. (2017)	The preliminary survey was implemented to investigate participants' preferences, cultural background, cognitive function and abilities.	Interest and capacities (Two and above)	Some flexibility. The interventionist was allowed to choose activities to match PWD ability and interest during personalised activity	Medium
27	Gitlin et al. (2017)	Structured assessments of participants' capacities, fall risk, daily routines, interests, caregivers (routines, employment, readiness), and environments (lighting, seating, clutter, noise)	Capabilities, functioning, interest, environment, caregivers (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during implementation)	High
28	Tanaka et al. (2017)	Incomprehensive pre-assessments	Personal history (One)	No description.	Low
29	Novelli et al. (2018)	Structured assessments to identify preserved capacities, previous interests, frequency/intensity of BPSD in the PWD, daily care routines of caregivers and home environment features.	Capabilities, previous interests, frequency, and intensity of BPSD in PWD, daily care routines of the caregiver and home environment. (Two and above)	High flexibility. Interventionists are allowed to tailor and adjust the chosen activities to match participants' capabilities during implementation.	High
30	Kwak et al. (2018)	Unstructured interviews with participants and their family members as the best sources for identifying an individual's music preferences	Music preference and songs significant to PWD life experience (Two and above)	High flexibility. The intervention allowed flexibility for facility staff to use their own clinical judgment and knowledge to tailor and implement the intervention.	Medium
31	Joen et al. (2019)	Comprehensive individual assessment (physical, medical and psychosocial) and their environment, medication review and adherence, a review of communication with health service providers and cognitive needs and existing strategies.	Capacities/needs, environment (Two and above)	High flexibility. A multi- and interdisciplinary plan tailored to meet the client's needs to enhance self-care ability using person-centred goal setting.	High
32	Oliveira et al. (2019)	Structured assessments. Semi structured investigator-developed interview to identify daily routines, and the Pleasant Event Schedule to identify previous and current activity interests.	Cognitive and functional capacities, previous abilities, interests, and roles (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during the implementation)	High
33	O'Connor et al. (2019)	Structured assessments of participants' capacities, fall risk, daily routines, interests, caregivers (routines, employment, readiness), and environments (lighting, seating, clutter, noise)	Capabilities, functioning, interest, environment, caregivers (Two and above)	High flexibility (prescriptions were reviewed and modified if necessary during implementation)	High
34	Weise et al. (2020)	Pre-assessment of participants' personal music preference from family members, nursing staff and directly from participants	Preference for music (One)	Low flexibility	Low
35	Huber et al. (2020)	Incomprehensive pre-assessments	Preference (One)	Low flexibility	Low

Notes: One = The intervention design was tailored for only one aspect of PWD characteristics; Two and above = The intervention design was tailored for two and above aspects of PWD characteristics

FIGURE LEGENDS

Figure 1. Effects of tailored interventions on challenging behaviour at post-intervention (N=20). Notes: SD=Standard Deviation, CI= Confidence Interval, C=activities tailored for capacities of participants only, P = activities tailored for preference of participants only, C+P= activities tailored for capacities and preference of participants. IG = Intervention Group, CG=Control Group.

Notes: Fixed effect: $SMD_{pooled} = -0.32$, 95% CI = -0.42 to -0.22, $p < 0.001$

Figure 2. Effects of tailored interventions on quality of life at post-intervention (N=9). Notes: SD=Standard Deviation, CI= Confidence Interval. IG = Intervention Group, CG=Control Group.

Notes: Fixed effect: $SMD_{pooled} = 0.42$, 95% CI = 0.24 – 0.59, $p < 0.001$

Figure 3. Subgroup analysis: Effects of tailored interventions on challenging behaviour at post-intervention by level of personalisation (N=20). Notes: SD=Standard Deviation, CI= Confidence Interval, C=activities tailored for capacities of participants only, P = activities tailored for preference of participants only, C+P= activities tailored for capacities and preference of participants. IG = Intervention Group, CG=Control Group.

Notes: (1) High group. Fixed effect: $SMD_{pooled} = -0.46$, 95% CI = -0.62 to -0.30, $p < 0.001$; Middle group. Fixed effect: $SMD_{pooled} = -0.34$, 95% CI = -0.51 to -0.16, $p < 0.001$; Low group. Fixed effect: $SMD_{pooled} = -0.11$, 95% CI = -0.30 to 0.08, $p = 0.254$. (2) Test for the difference across three subgroups: Q-value = 7.78, df (Q) = 2, p-value = 0.02.

Figure 4. Subgroup analysis: Effects of tailored interventions on quality of life at post-intervention by level of personalisation (N=9). Notes: SD=Standard Deviation, CI= Confidence Interval. IG = Intervention Group, CG=Control Group.

Notes: High group, fixed effect: $SMD_{pooled} = 0.39$, 95% CI = 0.17 to 0.60, $p < 0.001$; Middle group, fixed effect: $SMD_{pooled} = 0.41$, 95% CI = 0.07 to 0.74, $p = 0.017$; Low group, fixed effect: $SMD_{pooled} = 0.72$, 95% CI = 0.08 to 1.36, $p = 0.027$. (2) Test for the difference across three subgroups: Q-value = 0.94, df (Q) = 2, p-value = 0.626.

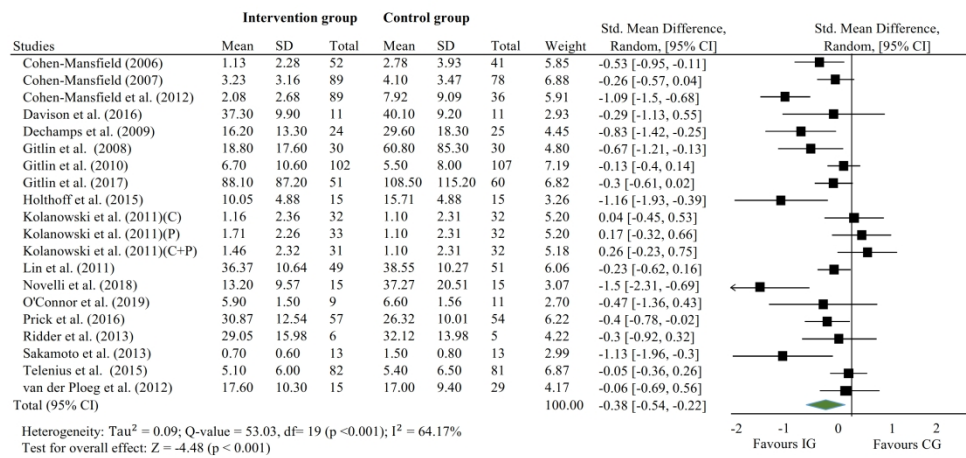


Figure 1. Effects of tailored interventions on challenging behaviour at post-intervention (N=20).

Figure 1. Effects of tailored interventions on challenging behaviour at post-intervention (N=20).

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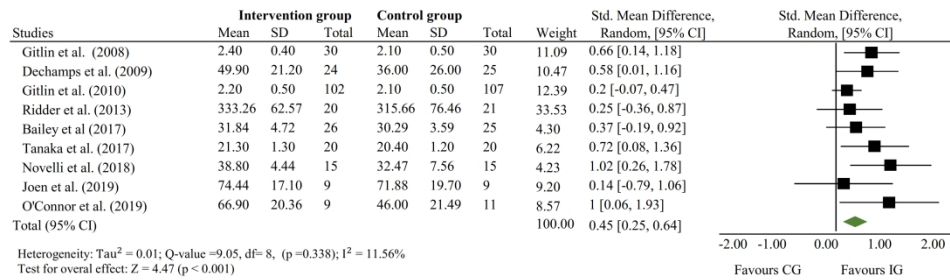


Figure 2. Effects of tailored interventions on quality of life at post-intervention (N=9)

Figure 2. Effects of tailored interventions on quality of life at post-intervention (N=9).

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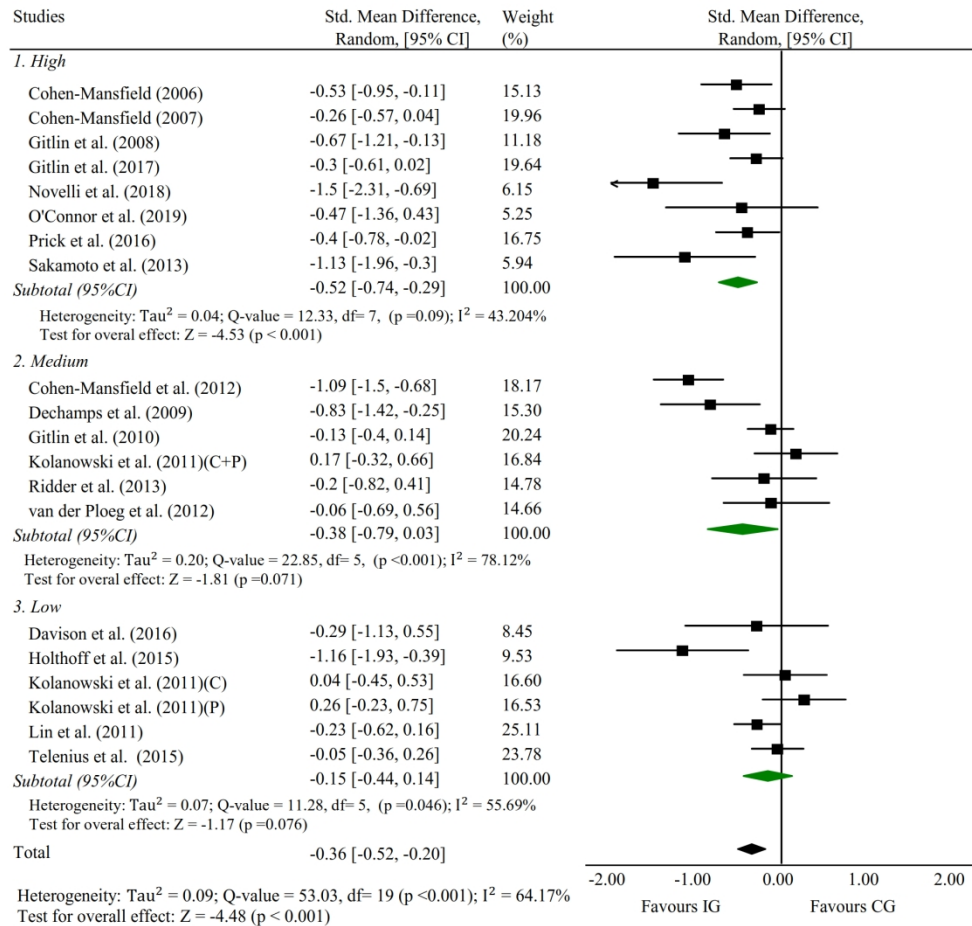


Figure 3. Subgroup analysis: Effects of tailored interventions on challenging behaviour at post-intervention by level of personalisation (N=20)

Figure 3. Subgroup analysis: Effects of tailored interventions on challenging behaviour at post-intervention by the level of personalisation (N=20).

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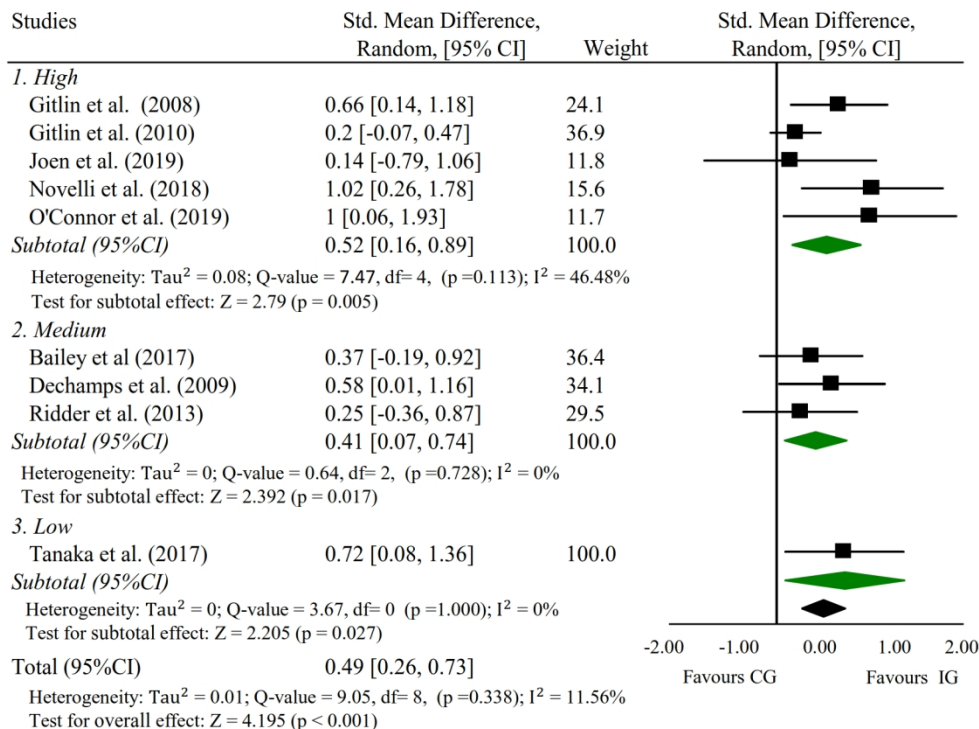


Figure 4. Subgroup analysis: Effects of tailored interventions on quality of life at post-intervention by level of personalisation (N=9).

Figure 4. Subgroup analysis: Effects of tailored interventions on quality of life at post-intervention by level of personalisation (N=9).

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Supplementary Table 1. Summary of existing reviews on tailored activities for people with dementia/cognitive impairment

Author (Year)	Study aim	Range of Years & # of studies included	Study Design	Targeted Group	Settings	Targeted Outcomes	Main Findings
1.Trahan et al. (2014)	To identify different ways of engaging persons living with dementia effectively to enhance their quality of life and reduce BPSD	2000-2011 (N=28)	RCT, crossover, single-subject, etc.	Older adults aged 60 or above	Community or residential care	Patient engagement, behavioural disturbance, psychological symptoms, another patient-oriented behavioural outcome	Compared with the consistent effect of changes to space and social demands on engagement and BPSD, changes to objects are more common but the impact is mixed.
2.Testad et al. (2014)	To review the benefits of personalised psychosocial interventions for BPSD	2000-2012 (N=40)	RCT, quasi-experimental design	People with dementia	Care home and nursing home	Depression, anxiety, agitation, and psychotic symptoms	Pleasant activities with or without social interactions and reminiscence therapy showed strong effect on reducing agitation and improving mood respectively. The tailoring of care package according to the symptoms a person is experiencing is probably one of the explanations for the differential effects of the interventions
3.Travers et al (2016)	To review the effectiveness of meaningful occupational interventions on persons living with dementia	2004-2015 (N=34)	RCT, quasi-experimental design, pre-post-test design, cohort study, case study, cross-sectional study	People with dementia	Nursing home	Depression, anxiety, agitation, wandering, apathy, quality of life, mood, function, cognition, sleep	Individualised activities/recreational interventions work well on a range of BPSD; preferred music shows effectiveness on agitation, depression and anxiety.

Supplementary Table 1 (Continued). Summary of existing reviews on tailored activities for people with dementia/cognitive impairment

Author (Year)	Study aim	Range of Years & # of studies included	Study Design	Targeted Group	Settings	Targeted Outcomes	Main Findings
4.Möhler et al (2018)	To assess the effects of personally tailored activities on psychosocial outcomes of persons living with dementia in long-term care	Up to 2017 (N=7)	RCT, quasi-experimental design	People with dementia	Long-term care facilities	Challenging behaviours, quality of life	As the effect of personally tailored activities on challenging behaviours of persons living with dementia is slight, recommendations on how to modify the factors (e.g., delivery, duration, frequency) for enhancing the intervention effectiveness cannot be made.
5.Möhler et al (2020)	To assess the effects of activities tailored to personal interests on psychosocial outcomes of persons living with dementia in the community	Up to 2019 (N=5)	RCT, quasi-experimental design	People with mild to moderate dementia	Community or home	Challenging behaviours, quality of life	Personally tailored activities may improve challenging behaviours and quality of life but have no effect on depression, affect, passivity, and engagement.
6.Möhler et al (2020)	To assess the effects of offering people with dementia living in their own homes activities tailored to their personal interests.	Up to 2019 (N=5)	RCT	People with dementia	Home only	challenging behaviour, quality of life, depression, and engagement, etc.	Personally tailored activities may improve challenging behaviour and slightly improve quality of life of people with dementia living in their own homes, but may have little or no effect on depression and engagement

Note: The full references for six reviews summarized in this table can be found in the Reference section #7-12.

Supplementary Table 2. Full search strategy

Database	Search strategy
ProQuest (APA PsycArticles, APA PsycInfo, Applied Social Sciences Index & Abstracts, Sociological Abstracts, Medical Database, PAIS Index)	ab("Cognitive impairment" OR "cognitive disorder" OR "dementia" OR "Alzheimer") AND ab("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "personalized" OR "person-centered") AND ab("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Web of Science	TS=("Cognitive impairment" OR "cognitive disorder" OR "dementia" OR "Alzheimer") AND TS=("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "personalized" OR "person-centered") AND TS=("activities" OR "program*" OR "therapy" OR "intervention" OR "treatment")
PubMed	((("Cognitive impairment"[Title/Abstract] OR "cognitive disorder"[Title/Abstract] OR "dementia"[Title/Abstract] OR "Alzheimer"[Title/Abstract])) AND ("tailor*" [Title/Abstract] OR "engage*" [Title/Abstract] OR "individualized" [Title/Abstract] OR "individual-centered" [Title/Abstract] OR "personalized" [Title/Abstract] OR "personalized" [Title/Abstract] OR "person-centered" [Title/Abstract])) AND ("activities" [Title/Abstract] OR "program*" [Title/Abstract] OR "therapy" [Title/Abstract] OR "intervention" [Title/Abstract] OR "treatment" [Title/Abstract])
Ovid (Global health, Embase, Social Work abstract)	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Cochrane Library	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")
Cumulative Index to Nursing and Allied Health Literature (CINAHL)	[Title and abstract search] (Cognitive impairment OR cognitive disorder OR dementia OR Alzheimer) AND ("tailor*" OR "engage*" OR "individualized" OR "individual-centered" OR "personalized" OR "person-centered") AND ("activities" OR "program" OR "therapy" OR "intervention" OR "treatment*")

Note: No limit on the publication date

Supplementary Table 3. Rating scheme for assessing the degree of personalisation in tailored activities

Level	Criteria
Low	<ul style="list-style-type: none"> • Unclear/incomprehensive: No pre-assessment / Pre-assessments were not clearly described / Pre-assessments on one PWD characteristic only, without describing how the assessment results were utilised to inform the tailored activities design; • Activity design targeted only one domain of tailoring as listed below, including capabilities, preferences, interests, life experience, and living environment; • Interventionists had low flexibility and only minimal/marginal modifications were allowed.
Middle	<ul style="list-style-type: none"> • Semi-structured: Pre-assessments were conducted by unstructured or semi-structured interviews, with some description on how the assessment results were utilised to inform the tailored activities design; • Activity design targeted two or more domains of tailoring systematically as listed below, including capabilities, preferences, interests, life experience, and external environment; • Interventionists had some flexibility and some modifications could be made based on their clinical knowledge and observation to accommodate the spontaneous needs of PWD during the intervention
High	<ul style="list-style-type: none"> • Structured: Pre-assessments were conducted by structured interviews, with clear and detailed description on how the assessment results were utilised to systematically inform the tailored activities design; • Activity design targeted two or more domains of tailoring systematically as listed below, including capabilities, preferences, interests, life experience, and external environment; • Interventionists had high flexibility and any modifications based on their clinical knowledge and observation to accommodate the spontaneous needs of PWD during the intervention.

Supplementary Table 4. Characteristics of included studies

#	Author (Year) [Countries]	Age Mean(SD)	Dementia types/stage	Sample size	Study design	Study setting
1	Orsulic-Jeras et al. (2000) [USA]	I: 88 (4.3) C: 88 (4.3)	Dementia	I: 16; C: 16	Quasi- experiment	LTC facility
2	Cohen-Mansfield (2006) [USA]	I: 87.2 (6.6) C: 87.3 (7.1)	Dementia	I: 52; C: 41	RCT	LTC facility and adult day centres
3	Garland et al. (2007) [Australia]	I: 79.0 (66-93) C: 79 (66-93)	Dementia	I: 10; C: 10	RCT	LTC facility
4	Cohen-Mansfield (2007) [USA]	I: 88 (6.4) C: 85 (8.6)	Dementia	I: 89; C: 78	RCT	LTC facility
5	Gitlin et al. (2008) [USA]	I: 78 (9.2) C: 80.8 (9.5)	Dementia	I: 30; C: 30	RCT	Home
6	Dechamps et al. (2009) [France]	I: 83.2 (8.3) C: 83.2 (8.3)	Dementia	I: 24; C: 25	RCT	Hospital
7	Gitlin et al. (2010) [USA]	I: 83.1 (7.8) C: 81.8 (9.9)	Dementia	I: 102; C: 107	RCT	Community
8	Lam et al. (2010) [Hong Kong]	I: 83.1 (6.9) C: 83.8 (7)	Dementia	I: 37; C: 37	RCT	LTC facility
9	Sung et al. (2010) [Taiwan]	I: 78.1 (7.2) C: 82.7 (7.4)	Dementia	I: 29; C: 23	Quasi- experiment	LTC facility
10	Kolanowski et al. (2011) [USA]	I: 86 (7.1) C: 85.9 (4.9)	Dementia	I: 31; C: 32	RCT	LTC facility
11	Lin et al. (2011) [Taiwan]	I: 81.5 (7.3) C: 82.2 (6.3)	Dementia	I: 49; C: 51	RCT	LTC facility
12	Cohen-Mansfield et al. (2012) [USA]	I: 85.9 (8.6) C: 85.3 (9.6)	Dementia	I: 89; C: 36	RCT	LTC facility
13	van der Ploeg et al. (2012) [Australia]	I: 78.1 (9.8) C: 78.1 (9.8)	Dementia	I: 15; C: 29	Crossover RCT	LTC facility
14	Ridder et al. (2013) [Denmark and Norway]	I: 82.2 (8.8) C: 80.2 (8.7)	Dementia	I: 20; C: 21	RCT	LTC facility
15	Sakamoto et al. (2013) [Japan]	I: 80.4 (7.4) C: 81.5 (7.9)	Dementia	I: 13; C: 13	RCT	Hospital
16	Van Haitsma et al. (2013) [USA]	I: 87.7 (8.7) C: 89.2 (6.9)	Dementia	I: 44; C: 93	RCT	LTC facility
17	Yoon et al. (2013) [Korea]	I: 77.9 (7.5) C: 70.1 (12.2)	Dementia	I: 11; C: 9	RCT	LTC facility
18	Toba et al. (2014) [Japan]	I: 84.1 (7.1) C: 87.3 (7.1)	Dementia	I: 158; C: 54	Quasi- experiment	Geriatric health service facilities
19	Holthoff et al. (2015) [Germany]	I: 72.4 (4.3) C: 70.7 (5.4)	Early and moderate stage AD	I: 15; C: 15	RCT	Home
20	Telenius et al. (2015) [Norway]	I: 86.9 (7) C: 86.4 (7.8)	Mild or moderate dementia	I: 82; C: 81	RCT	LTC facility
21	Davison et al. (2016) [Australia]	I: 86 (5.2) C: 86 (5.2)	Dementia	I: 11; C: 11	RCT	LTC facility
22	Giuli et al. (2016) [Italy]	I: 76 (6.3) C: 76.5 (5.7)	Mild cognitive impairment/ Dementia	I: 48; C: 49	RCT	Hospital
23	Lu et al. (2016) [USA]	I: 71.2 (0.8) C: 76.5 (7.1)	Mild cognitive impairment	I: 20; C: 20	RCT	Community

Notes: I = Intervention group; C = control group; RCT = randomized clinical trial; LTC = long-term care

Supplementary Table 4. (Continued) Characteristics of included studies

#	Author (Year) [Countries]	Age Mean(SD)	Dementia types/stage	Sample size	Study design	Study setting
24	Prick et al. (2016) [Netherlands]	I: 76 (7.6) C: 78 (7.2)	Dementia	I: 57; C: 54	RCT	Home
25	Bailey et al (2017) [USA]	I: 84.4 (7.7) C: 83.9 (9.2)	Mild to moderate cognitive impairment	I: 26; C: 25	RCT	LTC facility
26	Li et al. (2017) [China]	I: 83.1 (4.1) C: 81.1 (6.7)	Dementia	I: 19; C: 21	Quasi- experiment	LTC facility
27	Gitlin et al. (2017) [USA]	I: 80.4 (8.7) C: 80.4 (8.7)	Dementia	I: 51; C: 60	RCT	Home
28	Tanaka et al. (2017) [Japan]	I: 86 (7.4) C: 86.5 (8.3)	Dementia	I: 20; C: 20	RCT	Geriatric health service facility
29	Novelli et al. (2018) [Brazil]	I: 79.4 (7.7) C: 83.5 (7.1)	Dementia	I: 15; C: 15	RCT	Community
30	Kwak et al. (2018) [USA]	I: 88.9 (5.4) C: 84.9 (8.6)	Dementia or Alzheimer's disease	I: 30; C: 29	Crossover RCT	LTC facility
31	Joel et al. (2019) [Australia]	I: 79.0 (N.A) C: 81.0 (N.A)	Mild cognitive impairment/Dementia	I: 9; C: 9	RCT	Home
32	de Oliveira et al. (2019) [Brazil]	I: 79 (5.7) C: 78.4 (6.2)	Dementia	I: 11; C: 10	RCT	Community medical centers
33	O'Connor et al. (2019) [Australia]	I: 62.1 (N.A) C: 65.6 (N.A)	Dementia	I: 9; C: 11	RCT	Home
34	Weise et al. (2020) [Germany]	I: 85.1 (5.9) C: 85.1 (5.9)	Moderate or severe stages of Dementia	I: 10; C: 10	RCT	LTC facility
35	Huber et al. (2020) [Switzerland]	I: 74-92 C: 74-92	Moderate to severe stages of dementia	I: 10; C: 13	Quasi- experiment	Community

Notes: I = Intervention group; C = control group; RCT = randomized clinical trial; LTC = long-term care

Supplementary Table 5. Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
1	Orsulic-Jeras et al. (2000)	Preserved abilities	MP	Montessori-Based Activities included individual-based and group activities. In individual activities, various aesthetically pleasing materials taken from the everyday environment were used. Group activities included memory bingo and group sorting.	Mode: Mixed; Interventionist: Research assistant/activities therapist; Duration: 3 months. Follow-up: 6 months	usual care	Level of engagement	IG showed more engagement than CG at post-intervention.
2	Cohen-Mansfield (2006)	Salience of identity roles, the severity of the dementia, ability	MP	Role-identity-based treatment involved a 2-step procedure, including the determination of role-identity salience and the determination of the intervention. Chosen activities were tailored for the roles identified. For example, a participant with a great sense of professional accomplishment enjoyed looking at his awards.	Mode: Individual; Interventionist: Research assistants; Duration: 5 days.	usual care	BPSD (Agitation), Engagement and Depression.	IG showed increased engagement and fewer BPSD in the treatment than CG.
3	Garland et al. (2007)	Preferred songs, performers and titles.	MU	Preferred music selected based on family members' reports of participants' preference.	Mode: Individual; Interventionist: Researcher; Duration: 4 weeks.	usual care	BPSD (Overall)	No significant difference in reducing BPSD between IG and CG.
4	Cohen-Mansfield (2007)	Ability, past history and preference	MP	Non-pharmacologic individualised interventions based on TREA framework	Mode: Mixed; Interventionist: Research assistants; Duration: 10 days. No follow-up assessment.	placebo	BPSD	IG showed decreases in overall BPSD compared to CG at post-intervention.
5	Gitlin et al. (2008)	Capabilities, previous roles, habits and interests	MP	TAP is based on the environmental vulnerability/reduced stress-threshold model, including a three-stage intervention: (1) structural assessments, (2) activity prescriptions, chosen activities tailored to match PWD characteristics, providing training to and working with caregivers in the implementation, and (3) helping caregivers to generalise strategies for future care challenges.	Mode: Individual; Interventionist: Occupational therapists and caregivers; Duration: 4 months.	wait-list	BPSD (overall), QoL, depression, and level of engagement	IG showed greater reduction in frequency of BPSD and greater engagement than CG.
6	Dechamps et al. (2009)	Abilities and discourse	MP	The Cognition-Action method does not rely on the use of a specific exercise, but rather is a guidance method intended to enhance active living and social interaction using motor actions as incentives.	Mode: Individual; Interventionist: Research assistants; Duration: 12 weeks.	usual care	BPSD (Overall), QoL, and depression	IG showed greater reduction in BPSD, depression and improvement in QoL compared to CG.
7	Gitlin et al. (2010)	Home environment, Caregiver-identified concerns and patient capabilities, routines, previous and current roles, habits and interests	MP	Care of Persons with Dementia in their Environments (COPE) targeted modifiable environmental stressors to decrease sensory, physical, and cognitive demands, align with patient capabilities, and re-engage patients in daily activities.	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months. Follow-up: 9 months	usual care	BPSD, QoL and engagement	IG showed increases in the level of engagement compared to the CG at post-intervention.

Supplementary Table 5. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
8	Lam et al. (2010)	Abilities, preference, needs	P	Individualised functional training programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 8 weeks. Follow-up: 4 months	Attention control	BPSD (Depression) and cognition	IG showed reduction in depression compared to CG only at 4-month follow up.
9	Sung et al. (2010)	Music preference	MU	Preferred music listening intervention	Mode: Individual; Interventionist: Trained nursing staff; Duration: 6 weeks.	usual care	BPSD (Depression/Anxiety)	IG had a lower anxiety score compared with CG.
10	Kolanowski et al. (2011)	Functional level, personality style of interest	MP	Activities derived from the Need driven Dementia-compromised Behavior model tailored to the resident's functional level (cognitive and physical) and personality style of interest 3-arm intervention group design: (1) Personality style of interest group (PI); (2) Functional level (FL); (3) PI + FL	Mode: Group ; Interventionist: Nursing staff; Duration: 3 weeks	Active control	BPSD (Agitation) and Engagement	IG (PI) showed greater engagement than the other groups.
11	Lin et al. (2011)	Music Preference	MU	Group music intervention	Mode: Group; Interventionist: Researcher; Duration: 6 weeks. One-month follow up.	usual care	BPSD (Agitation)	IG showed reduction in BPSD compared to CG at post-intervention and follow-up.
12	Cohen-Mansfield et al. (2012)	Past identity, ability and preferences	MP	The TREA decision tree protocol was used to identify the possible reasons for agitated behaviour, needs, and preferences of participants. The activities included simulated animal-assisted therapy, one-on-one interaction, simulated interaction, group activities, arts and crafts, physical activities, games and music based on participants' preferences etc.	Mode: Mixed; Interventionist: Research assistants; Duration: 2 weeks.	placebo	BPSD (Agitation)	IG showed reduction in total agitation compared to CG.
13	van der Ploeg et al. (2012)	preserved abilities and Interest	MP	Montessori-based activities	Mode: Mixed; Interventionist: Psychologists and higher degree psychology student; Duration: 4 weeks	usual care	BPSD, engagement	IG showed more engagement than CG.
14	Ridder et al. (2013)	life-story/history	MU	Individual music therapy	Mode: Individual; Interventionist: Clinicians; Duration: 6 weeks. Follow-up: 7 weeks.	usual care	BPSD (Agitation), QoL	IG showed reduction in total agitation compared to CG at post-intervention.

Supplementary Table 5. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
15	Sakamoto et al. (2013)	Music preference	MU	Individualised music interventions	Mode: Individual; Interventionist: Music facilitator; Duration: 10 weeks.	usual care	BPSD (overall)	Greater long-term reduction in BPSD was observed in IG compared with CG.
16	Van Haitsma et al. (2013)	Interest and ability	MP	Individualised Positive Psychosocial Intervention based on participants' leisure interests that included physical exercise, music, ADLs, reminiscence and sensory stimulation.	Mode: Individual; Interventionist: Certified nursing assistants; Duration: 3 weeks	Attention control	BPSD (overall)	IG experienced more pleasure, alertness, engagement, positive touch, and positive verbal behavior compared with CG.
17	Yoon et al. (2013)	Ability level	MP	Cognitive activity combined with physical exercise	Mode: Group; Interventionist: Unspecified; Duration: 12 weeks	Attention control	Depression	IG showed improvement in cognition and reduction in depression compared to CG.
18	Toba et al. (2014)	Abilities and needs	MP	Intensive rehabilitation programme included reminiscence, reality orientation, memory rehabilitation, music therapy, physical exercise, occupational therapy, speech communication therapy and learning sessions	Mode: Individual; Interventionist: Physical, occupational or speech therapists; Duration: 3 months	usual care	BPSD, depression,	IG showed more reduction in BPSD and improvement in cognition compared to CG.
19	Holthoff et al. (2015)	Ability level	P	Physical activity training. Patients in the intervention group trained their lower body on a movement trainer with individually preassigned training flow. Caregivers were asked to choose a familiar chair prior to commencement of study.	Mode: Unspecified; Interventionist: Caregivers/ computer; Duration: 12 weeks. 3-month follow up test.	usual care	BPSD	IG experienced stable BPSD and CG experienced increases in BPSDs at follow-up.
20	Telenius et al. (2015)	Performance levels	P	Individually fitted High-Intensity Exercise Program	Mode: Individual; Interventionist: Physiotherapist; Duration: 12 weeks	Attention control	BPSD, QoL, depression,	IG experienced more reduction in BPSD compared to CG.
21	Davison et al. (2016)	Interest	C	Using a personal computer to play favourite music and display photographs, movies and messages selected by participants and family members	Mode: Individual; Interventionist: Research staff; Duration: 4 weeks	usual care	BPSD (Agitation), Depression, Anxiety	IG experienced reduction in depression and anxiety compared to CG.
22	Giuli et al. (2016)	cognitive function	C	Non-pharmacological intervention consisting of comprehensive cognitive training	Mode: Individual; Interventionist: Experienced psychologists; Duration: 10 weeks	usual care	Depression and cognition	Compared to CG, IG with Alzheimer's disease experienced improvement in cognition. IG with mild cognitive impairment experienced improvement in cognition.

Supplementary Table 5. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
23	Lu et al. (2016)	Congruence in level of awareness of functional ability, types and frequencies of meaningful activity, perceived barriers to engaging in these activities	MP	Daily Engagement of Meaningful Activities using the principles of problem-solving therapy and, consistent with the overall goals of this intervention, providing autonomy support by helping patients identify and prioritise meaningful activities, identify needs and goals, generate manageable solutions, and engage in self-selected activities with family support, etc.	Mode: Group; Interventionist: Trained nurse; Duration: 2 weeks. Follow up: 3 months	Attention control	BPSD (Depression)	IG showed less improvement in depressive symptoms than CG at follow-up.
24	Prick et al. (2016)	Physical capacities, information about pleasant activities for the dyad	MP	Multicomponent dyadic intervention comprising physical exercise training, psychoeducation, communication skills training, and pleasant activities training.	Mode: Individual; Interventionist: Personal coach; Duration: 3 months. 6 month follow up.	usual care	BPSD, depression, health	Analyses showed no beneficial effects over time on any of the outcome measures.
25	Bailey et al. (2017)	participant's specific area of interest	MP	Multicomponent intervention including group activity sessions using question-asking-reading (QAR), reminiscence, cognitive-behavioural therapy techniques, environmental support and individualised behavioural activity programme.	Mode: Group; Interventionist: Two upper-level graduate students in clinical psychology and one PhD psychologist; Duration: 6 weeks	usual care	Depression, QoL and engagement	IG showed more improvement in depression than CG.
26	Li et al. (2017)	Interest, capacities and culture background	MP	Folk recreation programme plus personalised training on daily life activities and individual activity programme according to participants' interest.	Mode: Mixed; Interventionist: Researcher; Duration: 16 weeks	usual care	BPSD	The folk recreation programme has the potential to improve cognitive function, ability of daily living and behavioural and psychological symptoms of older people with dementia.
27	Gitlin et al. (2017)	Capabilities, functioning, interest, environment, caregivers	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months	Attention control	BPSD	Intervention group showed reduction in BPSDs and functional dependence.
28	Tanaka et al. (2017)	Meaningfulness, personal history	MP	Personal rehabilitation comprising cognitive rehabilitation and involving reminiscence therapy, reality orientation, and physical activity.	Mode: Mixed; Interventionist: Staff member; Duration: 12 weeks	usual care	Depression & QoL	No statistically significant differences between IG and CG in interested outcomes.
29	Novelli et al. (2018)	Capabilities, previous interests, frequency, and intensity of BPSD in PWD, daily care routines of the caregiver and home environment.	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapy, caregiver; Duration: 4 months	wait-list	BPSD and QoL	IG experienced reduced BPSD and improvement in QoL compared to CG

Supplementary Table 5. (Continued) Interventions and activities tailored for participants' characteristics

#	Author (Year)	PWD characteristics	Types	Content of tailored activities/intervention	Delivery	Comparator	Outcomes	Findings
30	Kwak et al. (2018)	Music preference	MU	A passive music intervention using personalised music playlists delivered on digital music players.	Mode: Individual; Interventionist: Nursing home staff; Duration: 14 weeks	usual care	BPSD	No statistically significant differences between IG and CG in any of the outcomes measured.
31	Joen et al. (2019)	Capacities/needs, environment	MP	A multi- and interdisciplinary plan tailored to meet the client's needs to enhance self-care ability and using person-centred goal setting included cognitive rehabilitation techniques, energy conservation and task simplification strategies, balance and strength exercises, pain relief management, anxiety management, problem solving, and medication simplification.	Mode: Individual; Interventionist: Occupational therapists, registered nurse, neuropsychologist; Duration: 4 months. 12 month follow-up.	usual care	Depression and QoL	No statistically significant differences between IG and CG in any of the outcomes measured.
32	de Oliveira et al. (2019)	Cognitive and functional capacities, previous abilities, interests, and roles	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 3 months	Attention control	BPSD	Compared to CG, IG experienced reduction in BPSD.
33	O'Conn or et al. (2019)	Capabilities, functioning, interest, environment, caregivers	MP	Tailored activity programme	Mode: Individual; Interventionist: Occupational therapists; Duration: 4 months	usual care	BPSD and QoL	IG showed an overall reduction of behavioural symptoms and maintenance of functional performance in the person with dementia, compared to CG.
34	Weise et al. (2020)	Preference for music	MU	Individualised recorded music	Mode: Individual; Interventionist: Social service staff and project staff; Duration: 4 weeks	wait-list	BPSD	No significant findings on reduction in BPSD between IG and CG.
35	Huber et al. (2020)	Preference, meaningfulness	MP	Individualised music listening	Mode: Individual; Interventionist: Caregivers/staff member; Duration: 4 weeks	usual care	BPSD, depression	Depression scores decreased significantly over time while agitated behaviour showed a constant moderate level without any significant decrease.

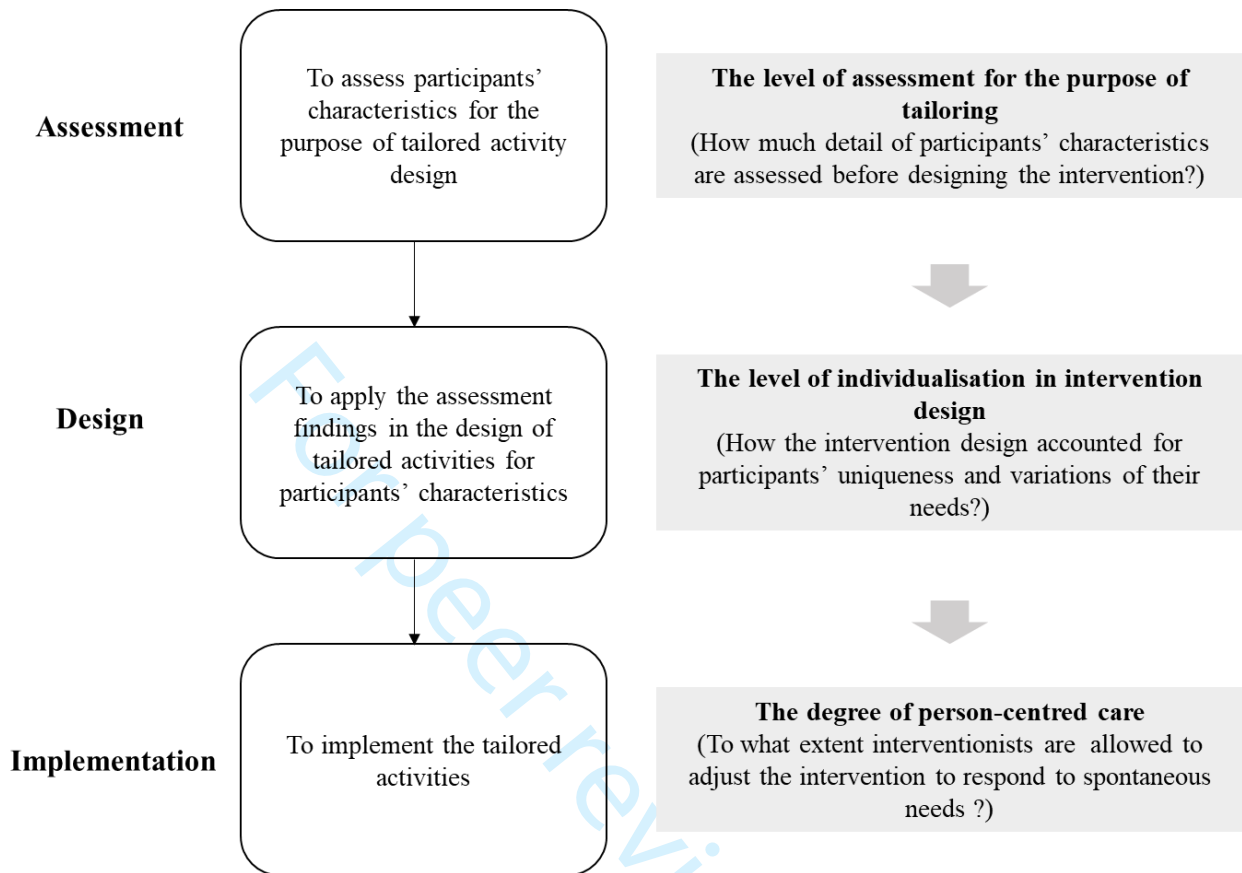
Note: P=physical; C=cognitive; MU=musical; MP=multiple; IG=intervention group; CG=control group. BPSD = behavioural and psychological symptoms of dementia; QoL=Quality of life.

Supplementary Table 6. Sensitivity analyses: effect sizes when including studies with people with dementia only in their samples

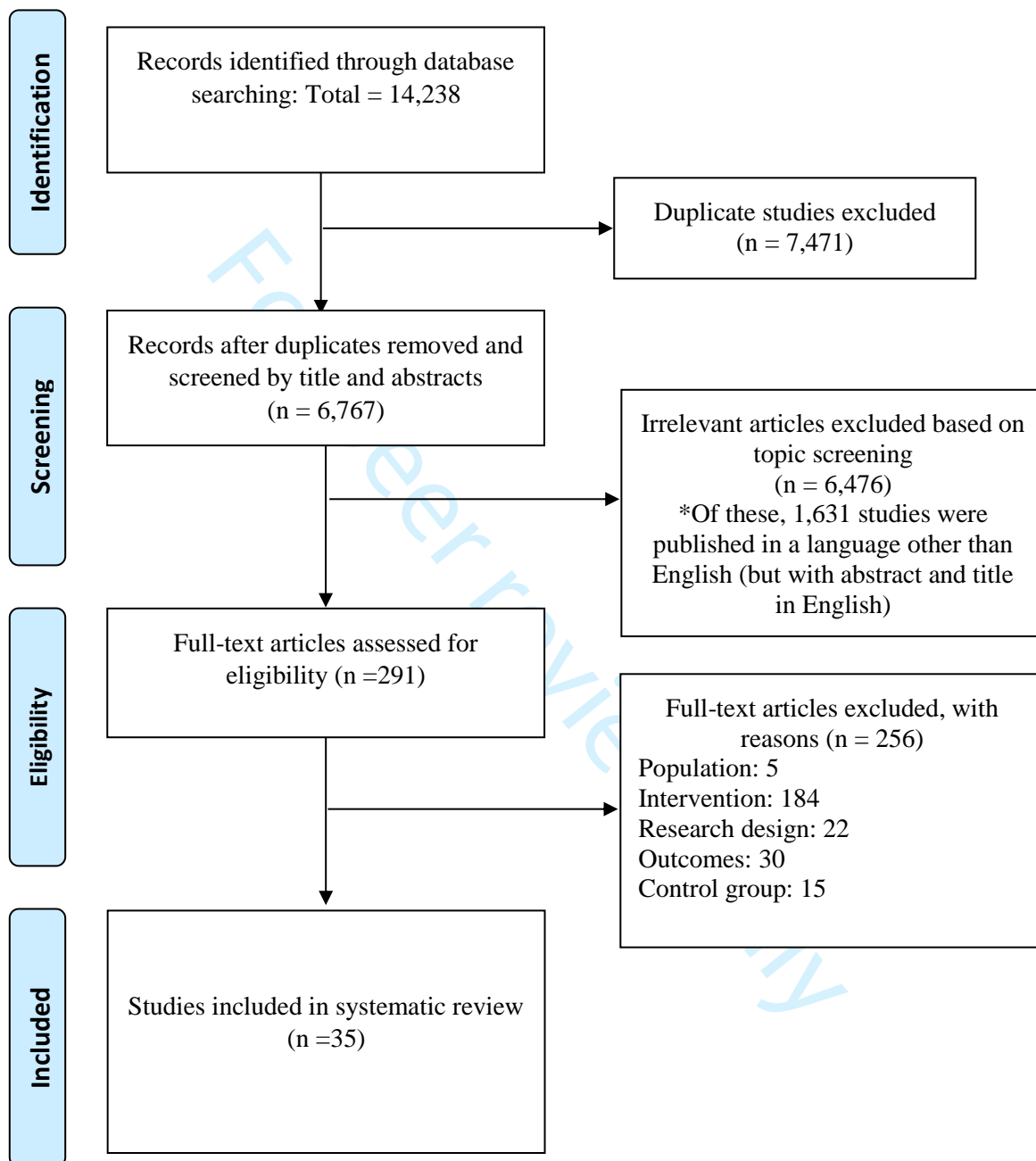
Outcome	Fixed effect models		Random effect models	
	SMD (95% CI)	p-value	SMD (95% CI)	p-value
<i>Main effects</i>				
BPSD	-0.34 (-0.44 to -0.23)	<0.001	-0.38 (-0.56 to -0.19)	<0.001
Quality of life	0.43 (0.25 - 0.62)	<0.001	0.52 (0.27 - 0.77)	<0.001
Depression	-0.38 (-0.57 to -0.20)	<0.001	-0.38 (-0.57 to -0.20)	<0.001
Engagement	0.58 (0.41 - 0.75)	<0.001	0.84 (0.14 - 1.54)	0.019
<i>Subgroup Analysis</i>				
BPSD				
High	-0.46 (-0.62 to -0.3)	<0.001	-0.524 (-0.752 to -0.296)	<0.001
Medium	-0.34 (-0.51 to -0.16)	0.000	-0.363 (-0.774 to 0.048)	0.083
Low	-0.04 (-0.29 to 0.21)	0.750	-0.04 (-0.289 to 0.208)	0.750
Quality of life				
High	0.4 (0.18 to 0.62)	<0.001	0.6 (0.17 to 1.04)	0.010
Medium	0.43 (0.01 to 0.85)	0.027	0.43 (0.01 to 0.85)	0.040
Low	0.72 (0.08 to 1.36)	0.044	0.72 (0.08 to 1.36)	0.030
Depression				
High	-0.34 (-0.55 to -0.12)	0.002	-0.34 (-0.55 to -0.12)	0.002
Medium	-0.75 (-1.33 to -0.17)	0.011	-0.75 (-1.33 to -0.17)	0.011
Low	-0.38 (-0.82 to 0.06)	0.089	-0.38 (-0.82 to 0.06)	0.089
Engagement				
High	0.85 (0.32 to 1.38)	0.002	0.85 (0.32 to 1.38)	0.002
Medium	0.27 (0.05 to 0.49)	0.018	0.27 (0.05 to 0.49)	0.018
Low	0.39 (0.04 to 0.74)	0.029	0.39 (0.04 to 0.74)	0.029

Notes: Excluded studies that included patients with dementia and patients with cognitive impairment in the samples. BPSD: Holthoff et al. (2015) & Telenius et al. (2015); Quality of life: Bailey et al (2017) & Jeon et al. (2019); Depression: Bailey et al(2017) & Jeon et al. (2019) & Lu et al (2016) & Giuli et al (2016); Engagement: Bailey et al (2017)

Supplementary Figure 1. The process of tailoring and rating criteria



Supplementary Figure 2. Flowchart of included articles

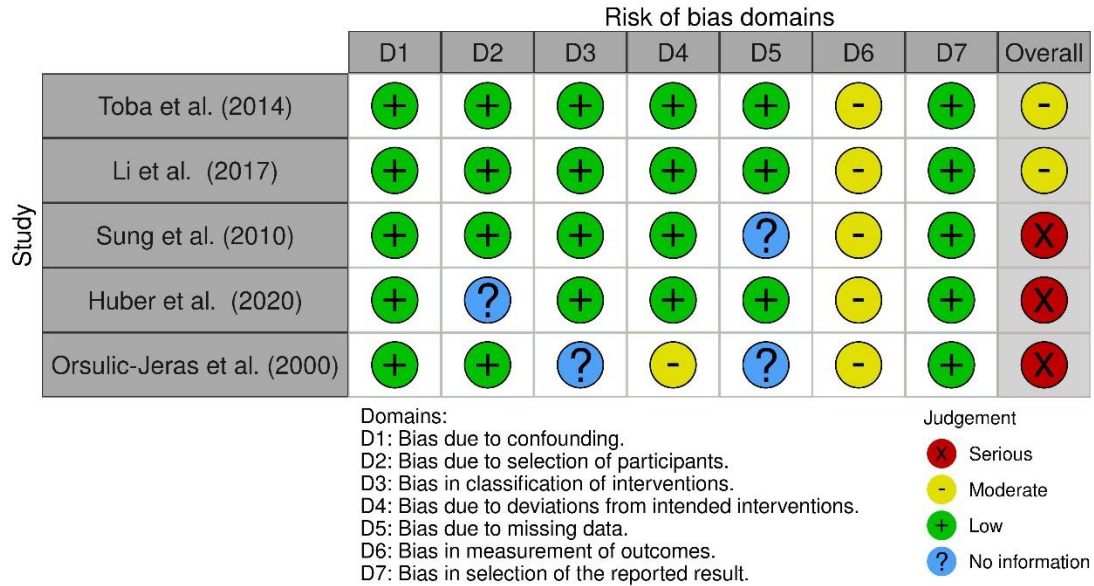


Supplementary Figure 3. Risk of Bias Graph for RCT studies (N=30)

Study	Randomization process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall
Cohen Mansfield (2006)	?	?	+	?	?	!
Garland et al. (2007)	?	?	+	+	?	!
Cohen-Mansfield (2007)	?	-	+	-	+	-
Gitlin et al. (2008)	+	+	+	+	+	+
Dechamps et al. (2009)	+	+	+	+	+	+
Gitlin et al. (2010)	+	+	+	+	+	+
Lam et al. (2010)	+	+	+	+	+	+
Kolanowski et al. (2011)	+	+	+	+	+	+
Lin et al. (2011)	+	-	+	-	?	-
Cohen-Mansfield et al. (2012)	+	+	+	+	+	+
van der Ploeg et al. (2012)	+	-	+	+	+	-
Ridder et al. (2013)	+	?	+	?	?	!
Sakamoto et al. (2013)	?	?	+	+	+	!
Van Haitsma et al. (2013)	+	?	+	+	+	!
Yoon et al. (2013)	+	-	-	-	+	-
Holthoff et al. (2015)	+	-	+	-	?	-
Telenius et al. (2015)	+	-	+	+	?	-
Davison et al. (2016)	+	-	+	+	?	-
Giuli et al. (2016)	?	-	-	-	+	-
Lu et al. (2016)	+	+	+	+	+	+
Prick et al. (2016)	+	+	+	+	+	+
Bailey et al. (2017)	+	-	+	-	+	-
Gitlin et al. (2017)	+	+	+	+	+	+
Tanaka et al. (2017)	+	-	-	+	+	-
Novelli et al. (2018)	+	?	+	+	+	!
Kwak et al. (2018)	+	-	-	-	+	-
Joen et al. (2019)	+	+	+	+	+	+
de Oliveira et al. (2019)	?	?	-	+	+	-
O'Connor et al. (2019)	+	?	+	+	+	!
Weise et al. (2020)	+	+	?	?	+	!

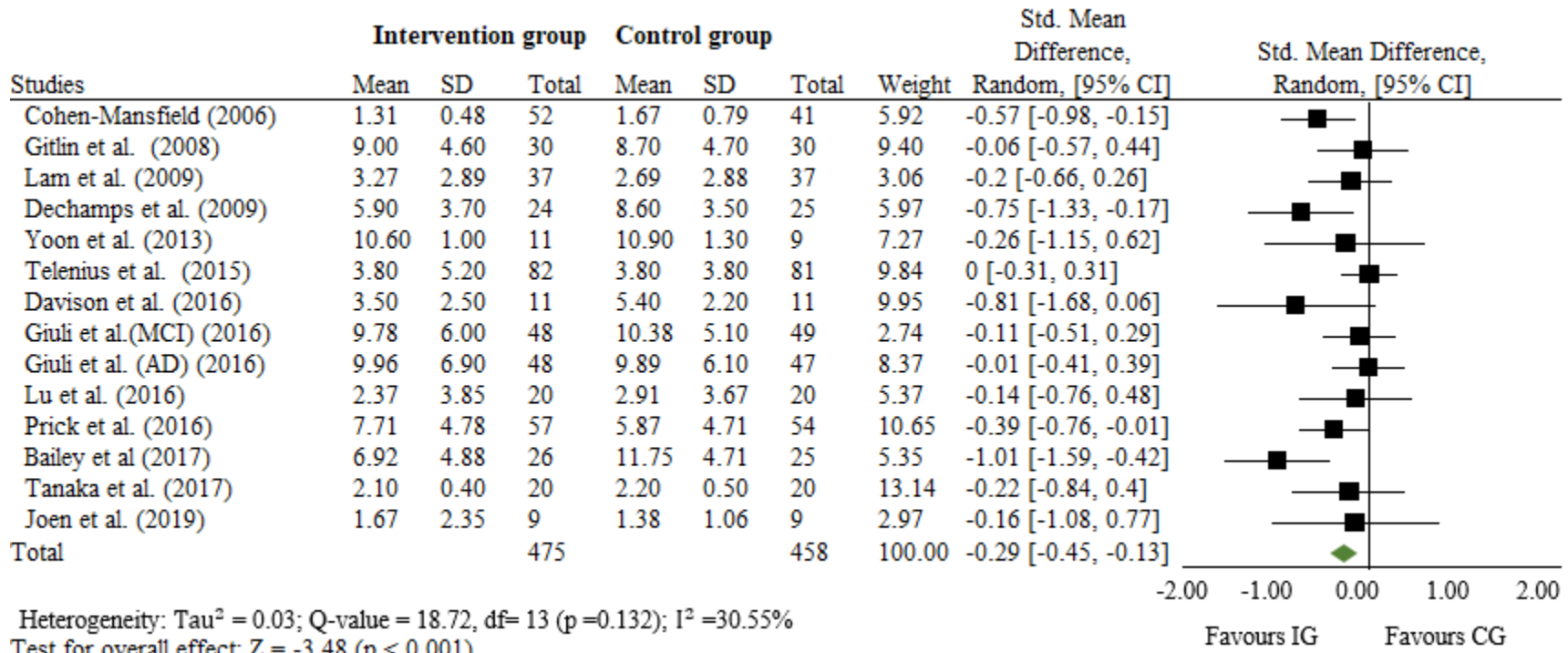
 Low risk
 Some concerns
 High risk

Supplementary Figure 4. Risk of Bias Graph for quasi-experimental studies (N=5)



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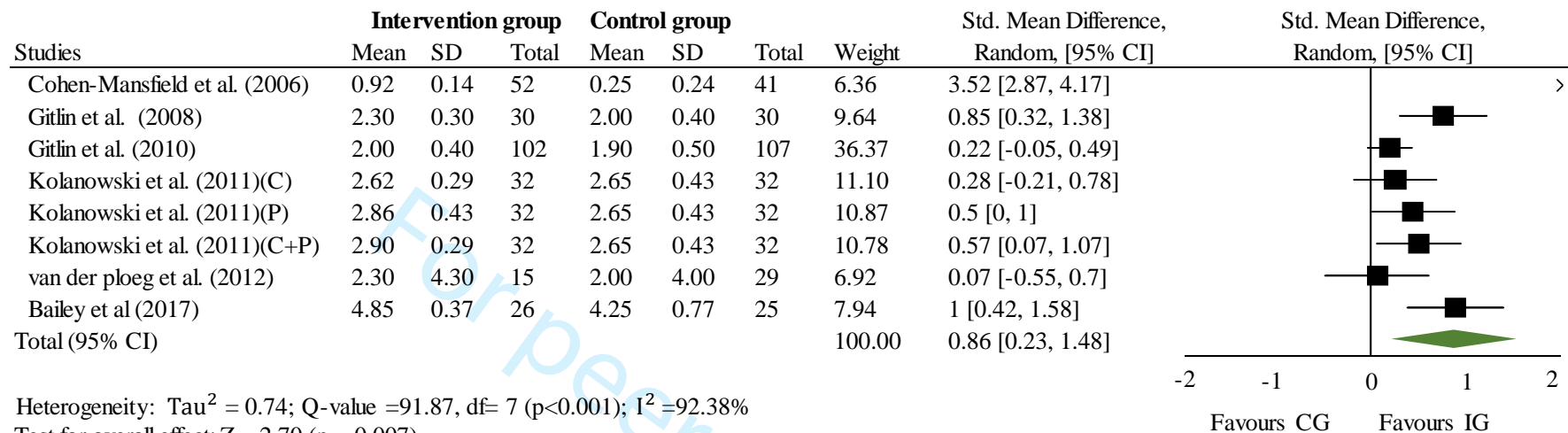
Supplementary Figure 5. Effects of tailored interventions on depression at post-intervention (N=14)



Notes: Fixed effect: SMD_{pooled} = -0.26, 95% CI = -0.39 to -0.13, p < 0.001

Only

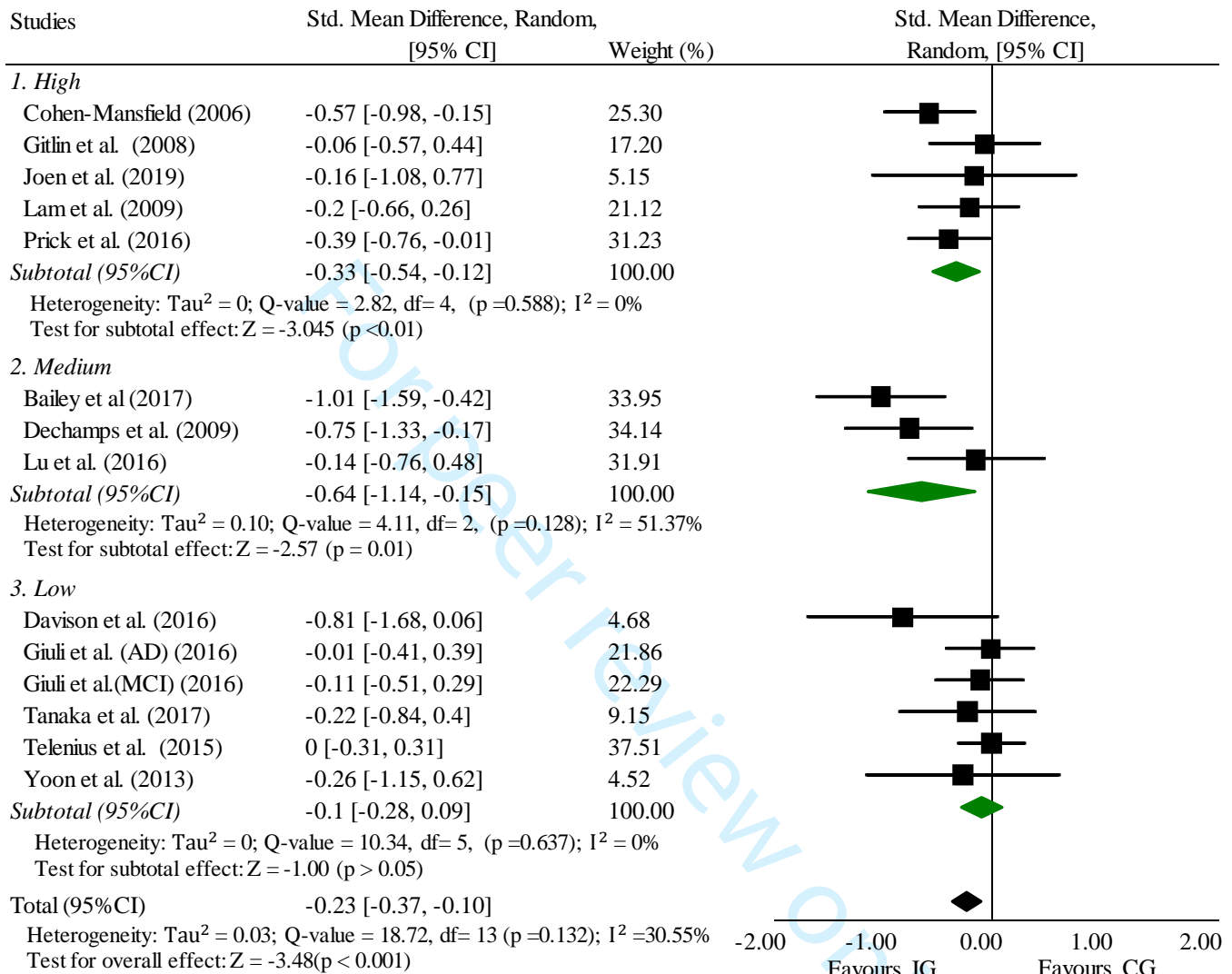
Supplementary Figure 6. Effects of tailored interventions on engagement at post-intervention (N =8)



Heterogeneity: $\tau^2 = 0.74$; Q -value = 91.87, $df = 7$ ($p < 0.001$); $I^2 = 92.38\%$
 Test for overall effect: $Z = 2.70$ ($p = 0.007$)

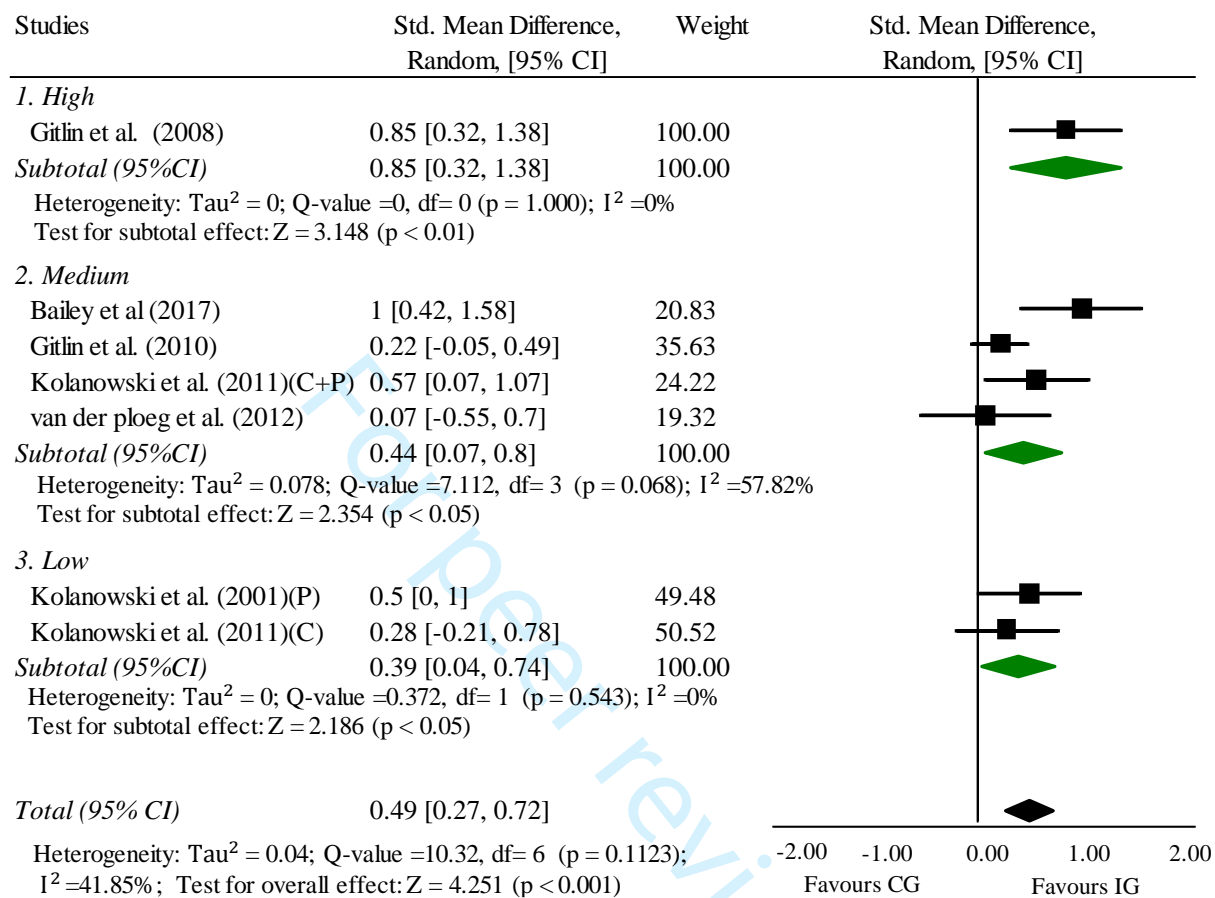
Notes: Fixed effects: $SMD_{pooled} = 0.62$, 95 % CI: (0.45 – 0.78), $p < 0.001$.

Supplementary Figure 7. Subgroup analysis: Effects of tailored interventions on depression at post-intervention by level of personalisation (N=14)



Notes: (1) High group. Fixed effect: $\text{SMD}_{\text{pooled}} = -0.33$, 95% CI = -0.54 to -0.12, p = 0.002; Middle group. Fixed effect: $\text{SMD}_{\text{pooled}} = -0.65$, 95% CI = -1.00 to -0.31, p < 0.001; Low group. Fixed effect: $\text{SMD}_{\text{pooled}} = -0.10$, 95% CI = -0.28 to 0.09, p = 0.316. (2) Test for the difference across three subgroups: Q-value = 8.373, df (Q) = 2, p = 0.015.

Supplementary Figure 8. Subgroup analysis: Effects of tailored interventions on engagement at post-intervention by level of personalisation (N=7)



Note: (1) One study was not included in this meta-analysis based on the findings from Supplementary Figure 5 in order to reduce heterogeneity. (2) Fixed effects for three groups. High group: SMD_{pooled} = 0.85, 95% CI = 0.32 to 1.38, p = 0.002; Middle group: SMD_{pooled} = 0.36, 95% CI = 0.16 to 0.57, p = 0.001; Low group: SMD_{pooled} = 0.39, 95% CI = 0.04 to 0.74, p = 0.029. (3) Test for the difference across three subgroups: Q-value = 2.836, df (Q) = 2, p = 0.242.

Appendix 1. Data extraction form

#	Information	Instruction
1	Author (Year)	n/a
2	Countries	n/a
3	Age, Mean(SD)	n/a
4	Dementia/Cognitive impairment or mixed	n/a
5	Sample size [Intervention and control group)	Separate the sample size for the intervention and control groups
6	Study design	RCT/Quasi-experimental design
7	Study setting	Home/Community/long-term care facilities, etc.
8	Tailored for PWD characteristics	Capacity, interest/preferences, habits, roles, personal history, living environment, etc.
9	Activity Type	Physical, cognitive, musical, multiple activities
10	Content of tailored activities/intervention	Document the content of tailored activities in detail
11	Delivery mode	Individual, group or mixed
12	Interventionist	Document type of interventionist
13	Duration of the intervention	Document duration of the intervention
14	Comparator	Control group
15	Outcomes	Identify reported outcome(s) of interest in the study
16	Statistics	Pre and Post Mean and SD
17	Findings	Summarise the findings
18	Level of assessment for tailoring	Describe how the studies assessed participants' characteristics for the purpose of tailoring
19	Degree of individualization in design	Document the aspects of participants' characteristics targeted in the tailored activities
20	Degree of person-centred care in intervention delivery	Document the extent to which interventionists had the autonomy to adjust the intervention to respond to participants' needs

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement

Section/topic	#	Checklist item	Reported on page
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Page 2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Page 3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Page 4-5
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Page 6
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Page 7, PROSPERO: CRD42020168556.
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Page 6-7
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Page 7
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Page 7 & Supplementary Table 2.
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Page 7
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Page 7
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Page 7 (Appendix 1)
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Page 10

Section/topic	#	Checklist item	Page #
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Page 10
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I ²) for each meta-analysis.	Page 10
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Page 10-11
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Page 10
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Page 11 & Supplementary Figure 2
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Page 11 & Supplementary table 4 & 5
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Page 13 & Supplementary Figure 3 & 4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Page 14-16 Supplementary table 5
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Page 14-16
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Page 12
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Page 15-16
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Page 17-19
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Page 19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Page 19-20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Page 21

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097