Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.
**eTable 1. Search Strategy with for Each Corresponding Database**

| Database                        | Concept 1: older adult | Concept 2: social isolation OR loneliness | Concept 3: social intervention | Concept 4: technology | Concept 5: music therapy |
|---------------------------------|------------------------|------------------------------------------|-------------------------------|-----------------------|-------------------------|
| OVID/MeSH terms                 | aged/ OR "aged, 80 and over"/ OR geriatrics/ | social isolation/ OR loneliness/        | social support/ OR socialization/ OR intergenerational relations/ OR psychosocial support systems/ | culturally appropriate technology/ OR biomedical technology/ OR educational technology/ OR internet/ | music therapy/ |
| CINAHL MeSH terms*             | MH "aged" OR MH "frail elderly" OR MH "aged, 80 and over" OR MH "geriatrics" OR MH "gerontological care" | MH "social isolation" OR MH "loneliness" | (MH "social networking" OR MH "social participation" OR MH "socialization" OR MH "community programs" OR MH "intergenerational relations") | MH "educational technology" | MH "music therapy" OR MH "pet therapy" |
| CENTRAL (Cochrane) MeSH terms  | aged/ OR geriatrics/   | social isolation/ OR loneliness/         | social support/ OR socialization/ | educational technology/ OR internet/ | music therapy/ |
| Embase MeSH terms               | aged/ OR "institutionalized adult"/ OR geriatrics/ | social isolation/ OR loneliness/         | social support/ OR socialization/ OR social network/ OR psychosocial care/ | educational technology/ OR internet/ | music therapy/ |
| PsychINFO MeSH terms            | aging/ OR geriatrics/  | social isolation/ OR loneliness/         | social programs/ OR social support/ OR social network/ OR socialization/ OR intergenerational relations/ OR | internet/ OR groupware/ | music therapy/ OR animal assisted therapy/ |
therapeutic social clubs/

| Database     | MeSH terms available |
|--------------|----------------------|
| Web of Science | No MeSH terms available |
| Scopus       | No MeSH terms available |

| Search terms used for all databases† | Older adult OR senior citizen OR elder OR elder* OR geriatric OR gerontol* OR grandparent OR retire* | Loneliness OR alone* OR social isolation OR emotional isolation | (social* OR psychosocial OR community OR intergeneration*) adj3 (support* OR intervention* OR involve* OR therap* OR participat*) | technology OR computer OR mobile OR phone | music therapy OR animal therapy |

*CINAHL was searched via only MeSH terms.
†Where relevant, proximity indicators were adapted according to the specific database.
MeSH: Medical Subject Headings
**eTable 2.** Cohen’s kappa for reviewed abstracts

| Author Group            | Cohen’s Kappa |
|-------------------------|---------------|
| P.H. and J.M.           | 0.5975        |
| J.M. and S.M.           | 0.50649       |
| K.R. and H.S.           | 0.53290       |
| C.T. and P.H.           | 0.63159       |
| P.H. and K.M./J.M.*     | 0.57479       |
| P.H. and C.W./J.M.*     | 0.775925      |

*Average was taken of the two authors with P.H.*
**eTable 3**: Estimated methods for Cohen’s $d$ (effect sizes)

| Study                  | N* | Treatment | Control | RMD | SMD | Estimated method¹ | compute.es procedure¹ | Notes                                                                 |
|------------------------|----|-----------|---------|-----|-----|-------------------|-----------------------|-----------------------------------------------------------------------|
| **Animals**            |    |           |         |     |     |                   |                       |                                                        |
| Jessen et al,⁷⁵ 1996   | 20 | 20        | +0.80   | +0.25 |     | Imputed change in SDs from mean correlation coefficient of other studies² | mes                   | Two intervention groups were not separated out for analysis as variations of same intervention |
| Sollami, et al,⁷³ 2017 | 14 | 14        | −8.43   | −2.95 |     | Mean changes and SDs provided in study          | mes                   |                                                        |
| Banks and Banks,⁷⁰ 2002| 30 | 15        | N/A     | −0.72 |     | $F$-value from ANCOVA provided in study           | fes                   |                                                        |
| Banks, and Banks,⁷¹ 2005| 17 | 16        | +2.81   | +1.49 |     | Mean changes and SDs provided in study           | mes                   | Both groups received a different type of the intervention.             |
| Banks et al,⁷² 2008    | 25 | 13        | N/A     | −2.09 |     | $F$-value from ANOVA provided in study           | fes                   | Two intervention groups were not separated out for analysis as variations of same intervention |
| Robinson et al,⁷⁴ 2013 | 17 | 17        | −7.67   | −1.11 |     | Adjusted mean changes and SDs provided in study  | mes                   |                                                        |
| **Therapy**            |    |           |         |     |     |                   |                       |                                                        |
| Study                  | n1  | n2  | ΔM  | SD  | Effect Size | Methodology | Notes                                                                 |
|-----------------------|-----|-----|-----|-----|-------------|-------------|----------------------------------------------------------------------|
| Jarvis et al, 2019    | 13  | 17  | -2.49 | -1.50 | Mean changes and SDs provided in study | mes         |                                                                      |
| Theeke et al, 2016    | 15  | 12  | -0.81 | -0.79 | F-value from ANOVA provided in study | fes         |                                                                      |
| Parry et al, 2016     | 151 | 162 | +0.21 | +0.10 | Mean differences and 95% CIs provided. Estimated SD from 95% confidence intervals for each group | mes         | For De Jong De Jong Gierveld Scale                                    |
| Huang et al, 2011     | 60  | 60  | +1.47 | +0.32 | Imputed change in SDs from mean correlation coefficient of other studies | mes         | Excluded arm that had both cognitive behavioural therapy and Tai Chi. Social satisfaction went down in both groups, but magnitude larger in control group |
| Nelson et al, 2019    | 25  | 23  | -2.08 | -0.18 | SMD and associated 95% confidence intervals provided in study | N/A         |                                                                      |
| Li et al, 2018        | 61  | 122 | N/A  | +0.41 | p-value from multilevel model provided in study | pes         | Exact p-value not provided, so upper limit used                      |
| **Combined**          |     |     |      |      |             |             |                                                                      |
| Boen et al, 2012      | 37  | 52  | +0.17 | +0.12 | SMD provided in study | des         |                                                                      |
| Reference | N1 | N2 | Change | SMD / p-value | Notes |
|-----------|----|----|--------|---------------|-------|
| Li et al,\textsuperscript{60} 2018 | 61 | 122 | N/A | +0.41 | *p*-value from mixed effect modelling provided in study |
| Huang et al,\textsuperscript{59} 2011 | 56 | 60 | N/A | +0.32 | Imputed change in SDs from mean correlation coefficient of other studies\textsuperscript{2} |
| Gustafson et al,\textsuperscript{76} 2019 | 14 | 11 | −0.19 | −0.54 | SMD provided in study |
| Tse et al,\textsuperscript{108} 2012 | 296 | 239 | −3.59 | −0.32 | Mean changes and SDs provided in study |
| Tse et al,\textsuperscript{109} 2013 | 48 | 42 | −13.10 | −0.72 | *p*-value from independent-sample *t*-test provided in study |
| Saito et al,\textsuperscript{77} 2012 | 20 | 37 | −1.40 | −0.73 | *p*-value from linear mixed model provided in study |
| Markle-Reid et al,\textsuperscript{64} 2006 | 120 | 122 | −5.26 | −0.35 | Mean changes and SDs provided in study |
| Kapan et al,\textsuperscript{58} 2017 | 34 | 32 | −1.30 | −0.04 | *p*-value from ANCOVA provided in study |
| Wan et al,\textsuperscript{91} 2017 | 57 | 52 | +0.20 | +0.29 | Mean changes and SDs provided in study |

| Counselling |
|-------------|
| Chow et al,\textsuperscript{81} 2019 | 68 | 33 | −0.24 | −0.18 | SMD provided in study |
| Kremers et al,\textsuperscript{84} 2006 | 36 | 62 | −1.30 | −0.37 | Calculated change in SDs from correlation |

*Exact *p*-value not provided, so upper limit used

No loneliness improvement in treatment, just increase in controls

Mean changes and SDs provided in study

Correlation coefficients based on
|                         |       |       |       |                                                                 |                                                                 |
|-------------------------|-------|-------|-------|------------------------------------------------------------------|------------------------------------------------------------------|
|                         |       |       |       | coefficients provided in study \(^2\)                           | Wilcoxon signed rank tests                                       |
| **Mountain et al,\(^{83}\) 2017** | 121   | 117   | −0.70 | −0.29                                                          | p-value from adjusted mean difference provided in study \(^1\) |
|                         |       |       |       | Mean differences and 95\% CIs provided. Estimated SD from 95\% confidence intervals for each group \(^2\) | mes                                                             |
| **Routasalo et al,\(^{85}\) 2009** | 117   | 118   | 0.00  | 0.00                                                          | Imputed change in SDs from mean correlation coefficient of other studies \(^2\) |
| **Alaviani et al,\(^{86}\) 2015** | 65    | 75    | −13.10| −3.79                                                          | SMD provided in study                                            |
| **Cohen-Mansfield et al,\(^{82}\) 2018** | 35    | 28    | −0.33 | −0.24                                                          |                                                                  |

**Exercise**

|                         |       |       |       |                                                                 |                                                                 |
|-------------------------|-------|-------|-------|------------------------------------------------------------------|------------------------------------------------------------------|
| **Tse et al,\(^{78}\) 2012** | 296   | 239   | −3.59 | −0.32                                                          | mes                                                             |
| **Tse et al,\(^{80}\) 2016** | 32    | 18    | −6.30 | −0.79                                                          | mes                                                             |
| **Kapan et al,\(^{58}\) 2017** | 34    | 32    | −1.30 | −0.04                                                          | pes                                                             |
| **Huang et al,\(^{59}\) 2011** | 56    | 60    | N/A   | +0.32                                                          | fes                                                             |
| **Ehlers et al,\(^{57}\) 2017** | 45    | 124   | N/A   | −0.19                                                          | SMD provided in study                                            | SMD based on mean latent change                                 |

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| Study Reference | Sample Size | Intervention Group | Control Group | Methodology | Notes |
|------------------|-------------|--------------------|---------------|-------------|-------|
| Baez et al, 2017 | 20          | 16                 | +0.91         | +0.44       | Mean changes and SDs provided in study | mes |
| Wang et al, 2010 | 7           | 10                 | +0.27         | +0.30       | Mean changes and SDs provided in study | mes |
| Jones et al, 2019| 29          | 26                 | -0.60         | -0.35       | SMD provided in study | des |
| Chan et al, 2017 | 20          | 15                 | -1.40         | -0.60       | SMD provided in study | des |
| Jansons et al, 2017 | 46    | 39                 | -0.40         | -0.12       | Raw data available for download to estimate mean changes and SDs | mes |
| Wan et al, 2017  | 57          | 52                 | +0.20         | +0.29       | Mean changes and SDs provided in study | mes |
| **Music** | | | | | |
| Giovagnoli et al, 2018 | 22 | 21               | +1.17         | +0.07       | Adjusted mean changes and SDs provided in study | mes |
| Yap et al, 2017  | 16          | 15                 | N/A           | -0.36       | p-value from generalized linear model using generalized estimating equation provided in study | pes |
| Johnson et al, 2020 | 187       | 170               | -2.20         | -0.34       | SMD provided in study | des |
| **Occupational therapy** | | | | | |

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| Study                                | Group 1 | Group 2 | F (or t) Value | Effect Size | Notes                                                                 |
|-------------------------------------|---------|---------|----------------|-------------|----------------------------------------------------------------------|
| Larsson et al, 2016                 | 14      | 14      | N/A            | −1.37       | F-value from repeated measures ANOVA provided in study               |
| De Craen et al, 2006                | 143     | 154     | 0.00           | 0.00        | Mean changes and SEs (used to calculate SD) provided                |
| **Reminiscence therapy**            |         |         |                |             |                                                                      |
| Chiang et al, 2009                  | 45      | 47      | −7.33          | −1.20       | Imputed change in SDs from mean correlation coefficient of other studies² |
| Westerhof et al, 2017               | 28      | 23      | +0.20          | +0.41       | SMD provided in study                                               |
| Moieni et al, 2020                  | 38      | 35      | N/A            | −0.70       | t-statistic provided in study                                       |
| **Social**                          |         |         |                |             |                                                                      |
| Hartke and King, 2003               | 43      | 45      | −0.98          | −0.22       | t-statistic provided in study                                       |
| Rook et al, 2003                    | 20      | 27      | −0.55          | −0.13       | Imputed change in SDs from mean correlation coefficient of other studies² |
| Mountain et al, 2014                | 26      | 30      | +0.60          | +0.32       | Estimated p-value from 95% CIs for the adjusted mean difference provided in study³ |
| Charlesworth et al, 2008            | 93      | 97      | −0.17          | −0.09       | p-value from generalized linear                                     |
| Study                                           | N  | N  | Mean Change | SD  | Model Provided in Study | SDs Provided in Study | Estimated SDs from P-values for the First and Second Measurements Within Both Groups | χ² from Generalized Estimating Equation Provided in Study | SMD Provided in Study | SMD is Specific to the 6-Month Follow-Up | P-Value from ANOVA Provided in Study | P-Value from Repeated Measures ANOVA Provided in Study | Mean Differences and 95% CIs Provided. |
|------------------------------------------------|----|----|-------------|-----|-------------------------|----------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------|--------------------|------------------------------------------|-------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------|
| Maclntyre et al, 1999                          | 12 | 10 | +5.48       | +1.02|                         |                      | Mean changes and SDs provided in study                                               | mes                                                        |                    |                                          |                                            |                                                                                  | mes                                  |
| Andersson et al, 1985                          | 35 | 22 | +0.15       | +0.31|                         |                      | Estimated SDs from p-values for the first and second measurements within both groups² | mes                                                        |                    |                                          |                                            |                                                                                  | mes                                  |
| Technology                                      |    |    |             |      |                         |                      |                                                                                      |                                                             |                    |                                          |                                            |                                                                                  | mes                                  |
| Czaja et al, 2018                               | 135| 120| N/A         | −0.17|                         | SMD provided in study | SMD provided in study                                                                  | des                                                        |                    | SMD is specific to the 6-month follow-up |                                            |                                                                                  | mes                                  |
| Tsai et al, 2011                                | 27 | 28 | −6.34       | −0.96|                         | x² from generalized estimating equation provided in study                             | chies                                                      |                    |                                            |                                            |                                                                                  | mes                                  |
| Tsai et al, 2020                                | 20 | 20 | −4.80       | −1.95|                         | x² from generalized estimating equation provided in study                             | chies                                                      |                    |                                            |                                            |                                                                                  | mes                                  |
| Gustafson et al, 2019                          | 14 | 11 | −0.19       | −0.54|                         | SMD provided in study                                                                  | des                                                        |                    |                                            |                                            |                                                                                  | mes                                  |
| Sidner et al, 2018                              | 26 | 10 | N/A         | +0.05|                         | p-value from ANOVA provided in study                                                  | pes                                                        |                    | Two intervention groups were not separated out for analysis as variations of technological intervention. |                                            |                                                                                  | mes                                  |
| Slegers et al, 2008                             | 57 | 133| N/A         | +0.03|                         | p-value from repeated measures ANOVA provided in study                                | pes                                                        |                    |                                            |                                            |                                                                                  | mes                                  |
| Morgenstern et al, 2015                         | 112| 122| −0.08       | −0.18|                         | Mean differences and 95% CIs provided.                                                 | mes                                                        |                    |                                            |                                            |                                                                                  | mes                                  |
| Study                  | Group 1 | Group 2 | Mean Difference | SD Difference | Notes                                                                 |
|-----------------------|---------|---------|-----------------|---------------|----------------------------------------------------------------------|
| Dodge et al, 2015     | 41      | 42      | -0.20           | -0.18         | Author provided mean differences and changes in SD                   |
| Bond et al, 2010      | 31      | 31      | +0.65           | +1.00         | SMD provided in study                                                |
| Wan et al, 2017       | 57      | 52      | +0.20           | +0.29         | Mean changes and SDs provided in study                               |
| Bickmore et al, 2005  | 8       | 9       | N/A             | +0.79         | t-statistic provided in study                                        |

RMD = raw mean difference; SMD = standardized mean difference; SD = standard deviation; SE = standard error; CI = confidence interval; ANOVA = analysis of variance; ANCOVA = analysis of covariance

*Sample sizes were derived from the number of participants that completed the trial for the most conservative estimates.

References
1. Del Re A. compute.es: Compute Effect Sizes. https://cran.r-project.org/web/packages/compute.es/index.html. Published 2020. Accessed September 19, 2021.
2. Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.handbook.cochrane.org.
3. Altman DG, Bland JM. How to obtain the P value from a confidence interval. Bmj. 2011 Aug 8;343.
### Table 4. Intervention and control arm characteristics of included studies

| Author/Year       | Intervention description                                                                 | Control description                        | Duration of intervention |
|-------------------|------------------------------------------------------------------------------------------|--------------------------------------------|--------------------------|
| **Animal assisted therapy** |                                                                                         |                                            |                          |
| Banks et al, 2008 | Living dog or robot dog                                                                  | No animal assisted therapy                 | 8 weeks                  |
| Banks, and Banks, 2005 | Animal assisted therapy once per week or three times per week                          | No animal assisted therapy                 | 6 weeks                  |
| Banks and Banks, 2002 | Animal assisted therapy in a group setting                                              | Animal assisted therapy on a one on one basis | 6 weeks                  |
| Jessen et al, 1996 | A bird was placed in the room.                                                           | Routine care                               | 10 days                  |
| Robinson et al, 2013 | PARO interactive robot                                                                   | Bus trips around the city or an alternate activity | 12 weeks                |
| Sollami et al, 2017 | Animal therapy with a dog. Caregiving activities and teaching on physical interaction. Re-elaboration of the experience through recognition, images, and words. | Usual activities                           | 8 weeks                  |
| **Therapy**       |                                                                                         |                                            |                          |
| Cox et al, 2007   | 1) Individual psychotherapy  
2) Small-group psychotherapy  
Includes psychosocial coping, self-care, communication, health and social services, working with caregivers, quality of life, and end-of-life decisions | Standard case management                   | 5 weeks                  |
| Jarvis et al, 2019 | Cognitive behavioural therapy via WhatsApp (Living in Network Connected Communities)    | Usual care: generic wellness program for residents | 3 months                |
| Li et al, 2018    | Psychotherapy and family and community supports with health education                   | Health education only                      | 6 months                 |
| Study Authors | Intervention | Control Group | Duration |
|---------------|--------------|---------------|----------|
| Nelson et al, 2019 | Psychotherapy | Social work calls | 7 weeks |
| Parry et al, 2016 | Cognitive behavioural therapy | Usual care | 8 weeks |
| Theeke et al, 2016 | Cognitive behavioural therapy: LISTEN intervention | Attention control: educational sessions | 5 weeks |
| **Multi-component** | | | |
| Boen et al, 2012 | Three hour meetings on addressing psychosocial problems (depression symptoms, loneliness, isolation) | Daily activities, offered the same group activities after one year | 35-38 weeks |
| Huang et al, 2011 | 1) Combined: Tai Chi and CBT | 1) Cognitive behavioural therapy only 2) No intervention | 8 weeks |
| Joubert et al, 2013 | Combined: integrated management plan | No intervention | 6 weeks |
| Kapan et al, 2017 | Combined: physical training and nutritional intervention | Social meetings | 12 weeks |
| Markle-Reid et al, 2006 | Combined: home care and phone intervention | Usual home care | 6 months |
| Ollongvist et al, 2008 | Combined: rehabilitation program (group activities, education) | Usual care | 3 weeks |
| Saito et al, 2012 | Combined: group based education, cognitive, and social support program | No intervention | 6 months |
| Tse et al, 2012 | Combined: physical exercise and arts and crafts | Regular care | 8 weeks |
| Tse et al, 2013 | Combined: nursing intervention, physiotherapy, and horticulture | No intervention | 8 weeks |
| Tse et al, 2016 | Pain management program: physical exercise, interactive teaching, education with peer volunteers | Weekly pain management program without peer volunteers | 12 weeks |
| Study                        | Description                                                        | Intervention Type               | Duration |
|-----------------------------|--------------------------------------------------------------------|----------------------------------|----------|
| Alaviani et al, 2015        | Educational program on symptoms of loneliness, social relationships, interpersonal action, and motivation/self-efficacy | NR                              | 2 weeks  |
| Chow et al, 2019            | Bereavement counseling                                             | Conventional loss-oriented      | 8 weeks  |
| Cohen-Mansfield et al, 2018 | Individual or group counseling                                    | No social engagement            | 6 months |
| Estebarsari et al, 2018     | Eight sessions of restoration oriented and loss-components         | Conventional loss-oriented      | 8 weeks  |
| Kremers et al, 2006         | Self-management counseling                                         | No intervention                 | 6 weeks  |
| Mountain et al, 2017        | Lifestyle matters intervention                                     | Standard care                    | 4 months |
| Routasalo et al, 2009       | Psychosocial group sessions                                       | No intervention                 | 3 months |
| Baez et al, 2017            | Adapted OTAGO Exercise Program for falls prevention               | Home-based program without social/individual persuasion | 10 weeks |
| Chan et al, 2017            | Tai chi                                                            | Usual care                       | 3 months |
| Ehlers et al, 2017          | Social dance program                                               | 1) Walk: walking sessions        | 24 weeks |
| Jansons et al, 2017         | Gym-based individualized exercise program                         | 2) Walk Plus: walking sessions   |          |
|                             |                                                                    | and nutritional supplement       |          |
|                             |                                                                    | 3) Strength, stretching, and     |          |
|                             |                                                                    | stability exercise sessions      |          |
| Study                      | Intervention Type                      | Control/Comparison Group          | Duration   |
|----------------------------|----------------------------------------|-----------------------------------|------------|
| Jones et al, 2019          | Exercise and walking                   | Group audiological rehabilitation only | 10 weeks   |
| McAuley, et al 2000        | Aerobic exercise intervention          | Stretching and toning only        | 6 months   |
| Tse et al, 2014            | Physical exercise program              | No treatment                      | 8 weeks    |
| Wang et al, 2010           | Group yoga                             | Socialization only                | 4 weeks    |
| Music therapy              |                                        |                                   |            |
| Giovagnoli et al, 2018     | Music therapy and acetylcholinesterase inhibitor | Acetylcholinesterase inhibitor only | 24 weeks   |
| Johnson et al, 2020        | Choir program                          | Waitlist control                  | 6 months   |
| Yap et al, 2017            | Rhythm wellness program                | Waitlist control                  | 11 weeks   |
| Other/Miscellaneous        |                                        |                                   |            |
| De Craen et al, 2006       | Occupational therapy visit             | Standard support from social services program | 24 months   |
| Larsson et al, 2016        | Client-based occupational therapy intervention process model | No intervention                   | 3 months   |
| Pynnönen et al, 2018       | Combined: option of exercise, social activity program, or personal counseling | One counseling session, usual services | 6 months   |
| Taube et al, 2018          | Case management                        | Standard care                     | 12 months   |
| Reminiscence therapy       |                                        |                                   |            |
| Chiang et al, 2009         | Reminiscence therapy                   | Waitlist control                  | 8 weeks    |
| Study Authors | Type of Intervention | Description | Duration |
|---------------|----------------------|-------------|----------|
| Moieni et al, 2020 | Generativity reminiscence therapy: writing on life experiences | Writing on neutral topics | 6 weeks |
| Westerhof et al, 2017 | Precious memories: autobiographical memory intervention | Individual unstructured contacts with a volunteer | 8 weeks |
| Andersson et al, 1985 | Social group meetings | No intervention | 2 months |
| Charlesworth et al, 2008 | Befriender facilitator intervention | Standard services | 6 months |
| Hartke and King, 2003 | Telephone support group | Usual care | 8 weeks |
| Heller et al, 1991 | Telephone contact | No intervention | 10 weeks |
| MacIntyre et al, 1999 | Friendly visitor program | No intervention | 6 weeks |
| Mountain et al, 2014 | Befriend one-to-one call | No treatment | 18 weeks |
| Rook et al, 2003 | Foster grandparent program | 1) Participation in meals and activity programming 2) No intervention | 2 years |
| Walshe et al, 2016 | Volunteer support intervention | Usual care | 8 weeks |
| Bickmore et al, 2005 | Embodied conversational agents | Physical activity intervention | 2 months |
| Bond et al, 2010 | Behavioural and motivation strategies, and problem-solving skills over the internet | Standard diabetes care | 6 months |
| Czaja et al, 2018 | PRISM software and connection to a PRISM buddy | Binder with resources | 12 months |
| Study Reference | Study Description | Intervention Details | Letters/Intervention Details | Duration |
|-----------------|-------------------|----------------------|-----------------------------|----------|
| Dodge et al,105 2015 | Video chat with trainer interviewers | Weekly telephone calls | 6 weeks |
| Gustafson et al,76 2019 | CHESS system: motivation, decision making, stress reduction, and access to services | Book for family caregivers for patients with dementia | 6 months |
| Morgenstern et al,68 2015 | Medical assistance device | No medical alert device | 90 days |
| Morton et al,46 2018 | EasyPC computer platform | Care as usual | 3 months |
| Nikitina et al,51 2018 | GymCentral program: tailored training, group exercise, persuasion, remote monitoring under supervision of a remote coach | Gym Central program with limited contacts to the coach |
| Sidner et al,106 2018 | AlwaysOn system 1) Robot 2) Virtual agent | No intervention | 30 days |
| Slegers et al,107 2008 | Computer training and personal computer with internet access | 1) Computer training, no intervention 2) No training, no intervention | 12 months |
| Tsai et al,108 2011 | Smartphone based videoconference program | NR | 6 months |
| Tsai et al,109 2020 | Videoconference interaction with family members | Usual activities | 12 months |
| Wan et al,60 2017 | Pedometer plus website: goal-setting, feedback, disease education, online community forum | Pedometer alone and written materials about exercise | 13 weeks |
| White et al,47 2002 | Small group internet training | Waitlist | 22 weeks |
| Woodward et al,45 2011 | Technology training | No intervention | 6 months |

Studies in which there are multiple arms are numbered in the control or intervention groups.
**eTable 5. Reasons for exclusion from meta-analysis**

| Author               | Reason for Exclusion                                                                 | Findings                                      |
|----------------------|--------------------------------------------------------------------------------------|-----------------------------------------------|
| Cox et al,48 2007    | Mixed long-term care with another setting                                             | No difference in intervention vs. control     |
| Estebsari et al,43 2018 | Insufficient quantitative data                                                        | Benefit in intervention vs. control*         |
| Heller et al,44 1991 | Large variation in groups; data not divided by those who completely received and did not receive the intervention | No difference in intervention vs. control     |
| Joubert et al,49 2013 | Insufficient quantitative data                                                        | Benefit in intervention vs. control          |
| McAuley et al,50 2000 | Insufficient quantitative data                                                        | No difference between intervention vs. control|
| Morton et al,46 2018 | Mixed long-term care with another setting                                             | No difference between intervention vs. control|
| Nikitina et al,51 2018 | Insufficient quantitative data                                                        | No difference between intervention vs. control|
| Ollongvist et al,52 2008 | Substitution methodology for drop-outs                                               | No difference between intervention vs. control|
| Pynnönen et al,53 2018 | Intervention was selected by participants among three possible programs; this was not amenable to a single categorization. Data was not divided by type of intervention. | N/A (insufficient reporting)                  |
| Taube et al,54 2018  | Insufficient quantitative data                                                        | No benefit in intervention vs. control        |
| Tse et al,55 2014    | Same data present from a separate study                                               | No benefit in intervention vs. control        |
| Walshe et al,56 2016 | Insufficient quantitative data                                                        | No difference in intervention vs. control     |
| White et al,47 2002  | Mixed long-term care with another setting                                             | No difference in intervention vs. control     |
| Woodward et al,45 2011 | Insufficient quantitative data                                                        | No difference in intervention vs. control     |

*Information describes the finding of the study with respect to the outcome of interest*
### eTable 6: Meta-analyses by intervention and sensitivity analyses

| Intervention                     | Loneliness | No outliers | No combined | No active controls | Social isolation | Social support |
|----------------------------------|------------|-------------|-------------|--------------------|------------------|---------------|
|                                  | N          | Cohen’s d (95% CI) | I² | N          | Cohen’s d (95% CI) | I² | N          | Cohen’s d (95% CI) | I² | N          | Cohen’s d (95% CI) | I² |
| Animal therapy                   |            |              |             |                    |                  |    |            |                  |    |            |                  |    |
| Community                        | 2          | -0.41 (-1.75, 0.92) | 87% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | N/A       | N/A               | N/A |
| LTC                              | 4          | -1.05 (-2.93, 0.84) | 95% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | N/A       | N/A               | N/A |
| Combined/Multi-Component         |            |              |             |                    |                  |    |            |                  |    |            |                  |    |
| interventions                    | 57-60,63-64,76-80 |            |             |                    |                  |    |            |                  |    |            |                  |    |
| Community                        | 2          | -0.67 (-1.13, -0.21) | 0% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | N/A       | N/A               | N/A |
| LTC                              | 3          | -0.53 (-0.86, -0.20) | 57% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | N/A       | N/A               | N/A |
| Counselling                      |            |              |             |                    |                  |    |            |                  |    |            |                  |    |
| Community                        | 6          | -0.80 (-1.96, 0.36) | 97% | 5          | -0.19 (-0.35, -0.03) | 0% | N/A       | N/A               | N/A | 5          | -0.93 (-2.32, 0.46) | 97% |
| LTC                              | N/A       | N/A          | N/A         | N/A               | N/A               | N/A | N/A       | N/A               | N/A | N/A       | N/A               | N/A |
| Exercise                         |            |              |             |                    |                  |    |            |                  |    |            |                  |    |
| Community                        | 5          | -0.15 (-0.44, 0.15) | 35% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | 2          | -0.45 (-0.86, -0.03) | 0% |
| LTC                              | 3          | -0.53 (-0.86, -0.20) | 57% | N/A       | N/A               | N/A | N/A       | N/A               | N/A | 1          | -0.32 (-0.49, -0.15) | N/A |
| Music                            |            |              |             |                    |                  |    |            |                  |    |            |                  |    |

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|                      | Community | LTC | Occupational therapist guided interventions<sup>93,94</sup> | Community | LTC | Reminiscence therapy<sup>95-97</sup> | Community | LTC | Social<sup>61,98-102</sup> | Community | LTC | Technology<sup>60,62,68,76,94,103-109</sup> | Community | LTC | Therapy<sup>63,65,110-112</sup> | Community | LTC |
|----------------------|-----------|-----|----------------------------------------------------------|-----------|-----|--------------------------------------|-----------|-----|--------------------------------|-----------|-----|---------------------------------|-----------|-----|---------------------------------|-----------|-----|
|                      | 1         |     | -0.34 (-0.55, -0.13)                                     | 2         |     | -0.63 (-1.96, 0.71)                  | 2         |     | -0.40 (-1.98, 1.17)            | 5         |     | -0.02 (-0.21, 0.17)           | 7         |     | -0.19 (-0.51, 0.14)           | 7         |     |
|                      | N/A       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | 90%       | N/A | 7% N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A | 59% 6 -0.09 (-0.26, 0.07)       | 10%       | 6   | -0.15 (-0.53, 0.24)           | 63%       | 4   | -0.04 (-0.24, 0.17)           | 25%       | 1   | -0.18 (-0.43, 0.08)           | N/A       | 2   |
|                      | N/A       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | 90%       | N/A | 7% N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A | 70% 6 -1.40 (-2.37, -0.44)     | 70%       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A |
|                      | N/A       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | 90%       | N/A | 7% N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A | 83% 6 -0.52 (-1.21, 0.17)      | 83%       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A |
|                      | N/A       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | 90%       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A | N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A N/A | N/A       | N/A |

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*a positive Cohen’s $d$ favors intervention
Table 7. GRADE table of included studies

| Intervention       | Sub-interventions                                                                 | Number of studies | GRADE of evidence | Interventions   | Number of studies | GRADE of evidence |
|--------------------|-----------------------------------------------------------------------------------|-------------------|-------------------|------------------|-------------------|-------------------|
|                    |                                                                                   | Community 2       | LTC 4             | Community Very low | LTC Very low      |                   |
| Animal therapy     | Living dog                                                                        |                   |                   | Robot dog/seal   |                   |                   |
|                    | Bird                                                                              |                   |                   | Bird             |                   |                   |
| Combined/Multi-    | Tai Chi and CBT                                                                  | 2                 | 3                 | Very low         | Very low          |                   |
| component          | Integrated management, home care, rehabilitation, pain management                |                   |                   | Physical training |                   |                   |
|                    | with nutrition, arts, horticulture                                               |                   |                   | with nutrition,  |                   |                   |
|                    |                                                                                   |                   |                   | arts, horticulture|                   |                   |
| Counseling         | Individual or group counseling on self-management, lifestyle, bereavement,      | 6                 | N/A               | Very Low         | N/A               |                   |
|                    | psychosocial problems                                                             |                   |                   |                  |                   |                   |
| Exercise           | Tai chi or yoga                                                                   | 5                 | 3                 | Very low         | Very low          |                   |
|                    | Dance                                                                             |                   |                   |                  |                   |                   |
|                    | Physical exercise                                                                  |                   |                   |                  |                   |                   |
| Music therapy      | Choir                                                                             | 1                 | N/A               | Very low         | N/A               |                   |
|                    | Instruments: rhythm and melodic instruments                                       |                   |                   |                  |                   |                   |
| Occupational       | Occupational therapy                                                             | 2                 | N/A               | Very low         | N/A               |                   |
| therapy            | Case management                                                                    |                   |                   |                  |                   |                   |
| Reminiscence       | N/A                                                                               | 1                 | 2                 | Very low         | Very low          |                   |
| therapy            |                                                                                   |                   |                   |                  |                   |                   |
| Social intervention| Social meetings, befriending, friendly visitor, volunteers                        | 5                 | N/A               | Very low         | N/A               |                   |
|                    | Telephone groups                                                                  |                   |                   |                  |                   |                   |
| Technology         | Conversational agents                                                             | 7                 | 2                 | Very low         | Very low          |                   |
|                    | Therapy over internet setting                                                     |                   |                   |                  |                   |                   |
|                    | Computer: platforms, programs, training                                           |                   |                   |                  |                   |                   |
|                    | Videoconferencing                                                                 |                   |                   |                  |                   |                   |

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| Therapy                      | Psychotherapy | N/A | Very low | N/A |
|-----------------------------|---------------|-----|----------|-----|
| Cognitive behavioral therapy| 4             | N/A |          |     |

1Includes only studies with loneliness outcomes
### eTable 8. Risk of bias table of included studies

| Author/Year             | Randomization | Effect of assignment to intervention | Effect of adhering to intervention | Missing outcome data | Measurement of the outcome | Selection of reporting results | Overall risk of bias |
|-------------------------|---------------|---------------------------------------|-------------------------------------|----------------------|-----------------------------|-----------------------------|---------------------|
| Alaviani et al, 86, 2015| Unclear       | Unclear                               | High                                | Low                  | High                        | Unclear                     | High                |
| Andersson, 100, 1985    | Low           | High                                  | High                                | High                 | High                        | High                        | High                |
| Baez, M. et al, 88, 2017| Unclear       | High                                  | High                                | High                 | High                        | Unclear                     | High                |
| Banks, 72, 2008         | Low           | High                                  | High                                | High                 | High                        | High                        | High                |
| Banks, and Banks, 71, 2005| Unclear      | High                                  | High                                | High                 | High                        | High                        | High                |
| Banks, 70, 2002         | Low           | Unclear                               | High                                | Low                  | High                        | Unclear                     | High                |
| Bickmore et al, 103, 2005| Unclear      | Unclear                               | High                                | High                 | High                        | High                        | High                |
| Boen et al, 57, 2012    | High          | High                                  | High                                | High                 | High                        | High                        | High                |
| Bond et al, 62, 2010    | Low           | Unclear                               | Unclear                             | Low                  | High                        | High                        | High                |
| Chan et al, 90, 2017    | Low           | High                                  | High                                | High                 | High                        | High                        | High                |
| Charlesworth et al, 102, 2008| Unclear | High                                  | High                                | High                 | High                        | High                        | High                |
| Chow et al, 81, 2019    | Unclear       | Unclear                               | Unclear                             | High                 | Unclear                     | High                        | High                |
| Cohen-Mansfield et al, 82, 2018| Unclear | High                                  | High                                | High                 | High                        | High                        | High                |
| Cox et al, 48, 2007     | Unclear       | High                                  | High                                | Low                  | High                        | High                        | High                |
| Czaja et al, 104, 2018  | High          | Unclear                               | High                                | High                 | High                        | High                        | High                |
| Study                        | Year | Country | Method | Sample Size | Data Collection | Statistical Analysis | Methodological Quality | Findings          |
|-----------------------------|------|---------|--------|-------------|------------------|----------------------|------------------------|-------------------|
| De Craen et al, 2006        | Low  | Unknown | Low    | Unknown     | High             | High                 | Unclear               | High              |
| Dodge et al, 2015           | Low  | Unknown | High   | Unknown     | High             | High                 | Low                   | High              |
| Ehlers et al, 2017          | Low  | Unknown | High   | High        | High             | High                 | Unclear               | High              |
| Estebsari et al, 2018       | High | High    | Unknown| Unknown     | High             | Unclear              | High                  | High              |
| Giovagnoli et al, 2018      | Low  | Unknown | High   | High        | High             | High                 | High                  | High              |
| Gustafson et al, 2019       | Unclear | High   | High   | High        | High             | High                 | High                  | High              |
| Hartke and King, 2003       | High | High    | High   | High        | High             | High                 | High                  | High              |
| Heller et al, 1991          | Unclear | High   | High   | High        | High             | High                 | High                  | High              |
| Huang et al, 2011           | Low  | Unknown | High   | Low         | Low              | High                 | High                  | High              |
| Jansons et al, 2017         | Unclear | Unknown | High   | High        | High             | High                 | High                  | High              |
| Jarvis et al, 2019          | Low  | Unknown | Unclear| High        | Low              | High                 | High                  | High              |
| Jessen et al, 1996          | Unclear | High   | Low    | Low         | High             | High                 | High                  | Unclear           |
| Johnson et al, 2020         | Unclear | Unclear| Unclear| High        | High             | Unclear              | Low                   | Unclear           |
| Jones et al, 2019           | Unclear | Unclear| High   | Low         | High             | High                 | High                  | High              |
| Joubert et al, 2013         | High | High    | High   | High        | High             | High                 | Unclear               | High              |
| Kapan et al, 2017           | Unclear | Unclear| High   | Low         | High             | High                 | Low                   | High              |
| Authors                        | Year | Unclear | Unclear | Unclear | High | High | Unclear | High | High |
|-------------------------------|------|---------|---------|---------|------|------|---------|------|------|
| Kremers et al,84              | 2006 | Unclear | Unclear | Unclear | High | High | Unclear | High | High |
| Larsson et al,94              | 2016 | High    | High    | High    | Low  | Unclear | High | High | High |
| Li et al,63                   | 2018 | Unclear | Unclear | Unclear | High | Unclear | High | High | High |
| MacIntyre et al,61            | 1999 | Unclear | Unclear | High    | Low  | High   | Unclear | High | High |
| Markle-Reid et al,84          | 2006 | Low     | High    | High    | High | High   | High | High | High |
| McAuley et al,50              | 2000 | Unclear | Unclear | High    | High | High   | Unclear | High | High |
| Moieni et al,97               | 2020 | Unclear | High    | High    | High | High   | High | High | High |
| Morganstern et al,68          | 2015 | Low     | High    | High    | High | High   | High | High | High |
| Morton et al,46               | 2018 | Unclear | Unclear | High    | Low  | High   | High | High | High |
| Mountain et al,99             | 2014 | Low     | Unclear | Unclear | Low  | High   | High | High | High |
| Mountain et al,83             | 2017 | Low     | High    | Unclear | Low  | High   | High | High | High |
| Nelson et al,112              | 2019 | Low     | Unclear | High    | Unclear | High | Low  | High | High |
| Nikitina et al,51             | 2018 | Unclear | High    | High    | High | High   | High | High | High |
| Ollongvist et al,52           | 2008 | Unclear | High    | High    | High | High   | High | High | High |
| Parry et al,65                | 2016 | Unclear | Unclear | High    | Unclear | High | High | High | High |
| Pynnönen et al,53             | 2018 | Unclear | High    | High    | High | High   | High | High | High |
| Robinson et al,74             | 2013 | High    | Unclear | High    | High | High   | Unclear | High | High |

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| Study               | Year | Methodology | Study Design | Risk of Bias | Publication Bias | Detection Bias | Reporting Bias | Funding Bias | Overall Quality |
|--------------------|------|-------------|--------------|--------------|------------------|---------------|---------------|--------------|-----------------|
| Rook et al.         | 2003 | High        | High         | High         | High             | High          | High          | High         | High             |
| Routasalo et al.    | 2009 | Low         | Unclear      | High         | Unclear          | High          | High          | High         | High             |
| Saito et al.        | 2012 | Unclear     | High         | High         | High             | High          | High          | High         | High             |
| Sidner et al.       | 2018 | Unclear     | High         | High         | High             | Unclear       | High          | High         | High             |
| Slegers et al.      | 2008 | Unclear     | High         | High         | High             | High          | High          | Unclear      | High             |
| Sollami et al.      | 2017 | Low         | Unclear      | High         | Low              | High          | Unclear       | High         | High             |
| Taube et al.        | 2018 | Low         | Unclear      | High         | High             | High          | High          | High         | High             |
| Theeke et al.       | 2016 | Unclear     | High         | High         | High             | High          | High          | High         | High             |
| Tsai et al.         | 2011 | High        | High         | Unclear      | High             | Unclear       | High          | High         | High             |
| Tsai et al.         | 2020 | Unclear     | Unclear      | High         | Un unclear       | High          | Unclear       | High         | High             |
| Tse et al.          | 2012 | Unclear     | Un unclear   | Un unclear   | Low              | Un unclear    | Low           | Un unclear   | High             |
| Tse et al.          | 2013 | High        | Low          | Unclear      | Low              | Un unclear    | Low           | High         | High             |
| Tse et al.          | 2014 | High        | Unclear      | Low          | High             | Low           | High         | High         | High             |
| Tse et al.          | 2016 | High        | Low          | Unclear      | Unclear          | High          | Low           | High         | High             |
| Walshe et al.       | 2016 | Low         | Un clear     | High         | Low              | High          | High          | Unclear      | High             |
| Wan et al.          | 2017 | Low         | Un clear     | Low          | Low              | High          | Low           | Unclear      | High             |
| Wang et al.         | 2010 | High        | High         | High         | High             | High          | High          | High         | High             |
| Westerhof et al.    | 2017 | Unclear     | High         | Low          | High             | High          | High          | High         | High             |

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| Study                  | Quality Assessment | Memory | Communication | Treatment | Outcome | Administration | Follow-up | Publication Year |
|------------------------|---------------------|--------|---------------|-----------|---------|----------------|-----------|------------------|
| White et al, 2002      | Unclear             | High   | High          | High      | High    | Unclear        | High      |                  |
| Woodward et al, 2011   | Unclear             | High   | High          | High      | High    | High           | High      |                  |
| Yap et al, 2017        | Low                 | High   | High          | High      | Unclear | High           | High      |                  |
**eFigure 1.** Funnel plot analysis of studies included in meta-analysis

a) *Animal therapy: Community*
b) Animal therapy: LTC
c) Combined/Multi-component: community
d) Combined/Multi-component: LTC
e) Counselling: community
f) Exercise: community
g) Exercise: LTC
h) Occupational therapy: community
i) Reminiscence therapy: LTC
j) Social intervention: community
k) Technology: community
I) Technology: LTC
m) Therapy: community
a) Animal therapy: Community

| Study          | Intervention               | N   | Cohen’s d | 95% CI      | Weight |
|----------------|----------------------------|-----|-----------|-------------|--------|
| Jessen 1996 (75) | Bird                      | 40  | 0.25      | [−0.37; 0.88] | 50.9%  |
| Robinson 2013 (70) | Interactive seal robot   | 34  | −1.11     | [−1.83; −0.39] | 49.1%  |

**Random effects model**

Heterogeneity: $I^2 = 87\%$ [50\%; 97\%], $p < 0.01$

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b) Combined/Multi-component: Community

| Study                  | Intervention             | N    | Cohen's d  | 95% CI       | Weight |
|------------------------|--------------------------|------|------------|--------------|--------|
| Saito 2012 (77)        | Group program            | 57   | -0.73      | [-1.29; -0.17] | 67.3%  |
| Gustafson 2019 (76)    | Website and pedometer    | 25   | -0.54      | [-1.34; 0.26] | 32.7%  |

Random effects model
Heterogeneity: $I^2 = 0\%$, $p = 0.70$
c) Music therapy: Community

| Study          | Intervention               | N   | Cohen's d | 95% CI          | Weight |
|----------------|----------------------------|-----|-----------|-----------------|--------|
| Johnson 2020 (92) | Music therapy (choir)     | 357 | -0.34     | [-0.55; -0.13]  | 100.0% |

Favours intervention  Favours control
d) Occupational therapy: Community

| Study            | Intervention          | N   | Cohen’s d | 95% CI        | Weight |
|------------------|-----------------------|-----|------------|---------------|--------|
| de Craen 2006 (93) | Occupational therapy | 297 | 0.00       | [-0.23; 0.23] | 54.3%  |
| Larsson 2016 (94) | Occupational therapy | 28  | -1.37      | [-2.19; -0.55] | 45.7%  |

Random effects model

Heterogeneity: $I^2 = 90\%$ [63%; 97%], $p < 0.01$
e) Reminiscence therapy: Community

| Study       | Intervention          | N   | Cohen's d | 95% CI        | Weight |
|-------------|-----------------------|-----|-----------|---------------|--------|
| Moieni 2020 (97) | Reminiscence therapy | 73  | -0.70     | [-1.17; -0.22] | 100.0% |

![Effect Size Diagram]

Favours intervention  Favours control

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f) Reminiscence therapy: LTC

| Study         | Intervention       | N   | Cohen's d | 95% CI       | Weight |
|---------------|--------------------|-----|-----------|---------------|--------|
| Chiang 2009 (95) | Reminiscence therapy | 92  | -1.20     | [-1.65; -0.76] | 50.6%  |
| Westerhof 2017 (96) | Reminiscence therapy | 51  | 0.41      | [-0.15; 0.97]  | 49.4%  |

Random effects model
Heterogeneity: $I^2 = 95\% [85\%; 98\%], p < 0.01
eFigure 2: Risk of bias assessment of studies included in the systematic review.