**Supplementary Materials**

# Multiple imputation

Missing data for regression analyses were addressed using multiple imputation through chained equations with a fully conditional specification (Little & Rubin, 2002; Van Buuren, Brand, Groothuis-Oudshoorn, & Rubin, 2006). Multiple imputation produces unbiased estimates when data are missing completely at random or are missing at random, as long as the relevant variables are included. At a minimum, all variables from a substantive model with the same functional form should be included in the imputation (Bartlett, Seaman, White, Carpenter, & Alzheimer’s Disease Neuroimaging Initiative\*, 2015). In addition, any variables that may be causes of missingness or good predictors of the missing values are helpful to include in the imputation model, even if they are not included in the substantive model to increase efficiency and reduce bias. The final multiple imputation model included data from 163 randomised participants and 107 variables. For each variable being imputed, included predictors were: (1) the same variable from all timepoints, (2) all primary and secondary outcome variables at the same time point, (3) sociodemographic factors (e.g., age, gestation at baseline), (4) group, and (5) if not measured at baseline, a group x baseline insomnia symptoms interaction based on previous literature showing more robust benefits of cognitive behavioural therapy for individuals with higher insomnia symptoms (Bei, Ong, Rajaratnam, & Manber, 2015).

The maximum number of iterations was set at 50 to ensure good convergence (default is 5). A total of 100 multiply imputed datasets were generated. Predictive mean matching was used for continuous variables, the recommended default as it performs well both for normally distributed and skewed data (Vink, Frank, Pannekoek, & van Buuren, 2014). Multiple imputation was conducted using R 4.02 (R Core Team, 2020), the mice package (Buuren & Groothuis-Oudshoorn, 2011).

Bartlett, J. W., Seaman, S. R., White, I. R., Carpenter, J. R., & Alzheimer’s Disease Neuroimaging Initiative\*. (2015). Multiple imputation of covariates by fully conditional specification: Accommodating the substantive model. *Statistical Methods in Medical Research*, *24*(4), 462–487.

Bei, B., Ong, J. C., Rajaratnam, S. M. W., & Manber, R. (2015). Chronotype and improved sleep efficiency independently predict depressive symptom reduction after group cognitive behavioral therapy for insomnia. *Journal of Clinical Sleep Medicine: JCSM: Official Publication of the American Academy of Sleep Medicine*, *11*(9), 1021–1027.

Buuren, S. van, & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, *45*(3), 67.

Little, R. J. A., & Rubin, D. B. (2002). *Statistical Analysis with Missing Data*. Hoboken, NJ, USA: John Wiley & Sons, Inc.

R Core Team. (2020). *R: A language and environment for statistical computing*. Retrieved from http://www.R-project.org

Van Buuren, S., Brand, J. P. L., Groothuis-Oudshoorn, C. G. M., & Rubin, D. B. (2006). Fully conditional specification in multivariate imputation. *Journal of Statistical Computation and Simulation*, *76*(12), 1049–1064.

Vink, G., Frank, L. E., Pannekoek, J., & van Buuren, S. (2014). Predictive mean matching imputation of semicontinuous variables: PMM imputation of semicontinuous variables. *Statistica Neerlandica*, *68*(1), 61–90.

**Table S1**

*Post-Baseline Adjusted Means (95% Confidence Interval) and Group Differences for the Overall Sample*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Time** | **CBT** | **CTRL** | **Group difference** | ***p-*value, effect size** |
| **Insomnia Severity Index (First Primary Outcome)** | | | | |
| T2\* | 7.17 [6.30, 8.04] | 9.25 [8.40, 10.11] | -2.08 [-3.31, -0.85] | .001, -0.55 |
| T4 | 7.07 [6.10, 8.03] | 7.19 [6.19, 8.19] | -0.12 [-1.51, 1.26] | .860, -0.03 |
| T5 | 6.18 [5.28, 7.08] | 6.57 [5.60, 7.54] | -0.39 [-1.73, 0.95] | .565, -0.10 |
| T6\* | 6.62 [5.70, 7.53] | 7.79 [6.87, 8.71] | -1.17 [-2.49, 0.14] | .080, -0.29 |
| T7 | 5.90 [4.98, 6.82] | 6.17 [5.24, 7.11] | -0.28 [-1.57, 1.02] | .671, -0.08 |
| T8 | 5.18 [4.15, 6.21] | 7.09 [6.08, 8.10] | -1.90 [-3.37, -0.44] | .012, -0.48 |
| **PROMIS Sleep Disturbance (Second Primary Outcome)** | | | | |
| T2\* | 49.28 [47.74, 50.82] | 53.10 [51.57, 54.62] | -3.81 [-5.98, -1.65] | < .001, -0.56 |
| T4 | 49.88 [48.40, 51.36] | 49.73 [48.20, 51.26] | 0.15 [-1.99, 2.29] | .888, 0.02 |
| T5 | 48.70 [47.23, 50.17] | 48.92 [47.39, 50.46] | -0.23 [-2.36, 1.91] | .835, -0.03 |
| T6\* | 49.92 [48.40, 51.44] | 50.64 [49.09, 52.18] | -0.71 [-2.89, 1.46] | .518, -0.11 |
| T7 | 48.07 [46.41, 49.73] | 48.68 [47.00, 50.36] | -0.61 [-2.95, 1.72] | .604, -0.09 |
| T8 | 47.15 [45.24, 49.05] | 49.85 [47.98, 51.73] | -2.71 [-5.44, 0.03] | .052, -0.36 |
| **PROMIS Sleep Related Impairment** | | | | |
| T2\* | 50.93 [49.48, 52.37] | 54.60 [53.18, 56.02] | -3.67 [-5.70, -1.65] | < .001, -0.58 |
| T4 | 55.47 [53.96, 56.97] | 56.05 [54.52, 57.58] | -0.59 [-2.74, 1.56] | .590, -0.09 |
| T5 | 51.91 [50.33, 53.48] | 53.50 [51.89, 55.11] | -1.60 [-3.84, 0.65] | .162, -0.23 |
| T6\* | 52.65 [51.04, 54.26] | 52.78 [51.17, 54.40] | -0.13 [-2.43, 2.16] | .908, -0.02 |
| T7 | 51.53 [49.83, 53.23] | 51.91 [50.21, 53.61] | -0.38 [-2.79, 2.03] | .757, -0.05 |
| T8 | 49.81 [47.94, 51.67] | 53.10 [51.13, 55.06] | -3.29 [-6.02, -0.56] | .019, -0.44 |
| **Total Sleep Time (hours)** | | | | |
| T2\* | 7.51 [7.23, 7.78] | 7.26 [6.99, 7.54] | 0.25 [-0.15, 0.64] | .216, 0.20 |
| T4 | 6.18 [5.91, 6.44] | 6.14 [5.88, 6.41] | 0.04 [-0.34, 0.41] | .846, 0.03 |
| T5 | 6.94 [6.70, 7.18] | 6.98 [6.73, 7.23] | -0.03 [-0.38, 0.31] | .846, -0.03 |
| T6\* | 6.98 [6.75, 7.21] | 6.86 [6.63, 7.09] | 0.12 [-0.21, 0.45] | .458, 0.12 |
| T7 | 7.29 [7.09, 7.49] | 7.35 [7.15, 7.55] | -0.06 [-0.34, 0.23] | .692, -0.07 |
| T8 | 7.52 [7.28, 7.76] | 7.15 [6.89, 7.41] | 0.37 [0.02, 0.73] | .039, 0.39 |
| **Sleep Efficiency (%)** | | | | |
| T2\* | 82.07 [79.27, 84.87] | 78.94 [76.19, 81.68] | 3.14 [-0.78, 7.05] | .116, 0.26 |
| T4 | 65.89 [62.53, 69.25] | 65.59 [62.17, 69.01] | 0.30 [-4.52, 5.12] | .902, 0.02 |
| T5 | 73.95 [71.13, 76.76] | 76.17 [73.15, 79.20] | -2.23 [-6.40, 1.95] | .293, -0.18 |
| T6\* | 76.20 [73.52, 78.89] | 74.89 [72.17, 77.60] | 1.32 [-2.50, 5.13] | .496, 0.11 |
| T7 | 83.69 [81.44, 85.94] | 85.99 [83.67, 88.32] | -2.30 [-5.58, 0.98] | .167, -0.25 |
| T8 | 86.45 [83.61, 89.29] | 82.46 [79.53, 85.39] | 3.99 [-0.16, 8.14] | .059, 0.36 |
| **Dysfunctional Beliefs and Attitudes about Sleep** | | | | |
| T2\* | 3.30 [3.08, 3.53] | 3.94 [3.72, 4.16] | -0.64 [-0.96, -0.33] | < .001, -0.64 |
| T4 | 3.54 [3.30, 3.79] | 3.70 [3.45, 3.95] | -0.16 [-0.51, 0.19] | .374, -0.14 |
| T5 | 3.46 [3.19, 3.73] | 3.69 [3.41, 3.96] | -0.23 [-0.61, 0.16] | .249, -0.19 |
| T6\* | 3.34 [3.06, 3.62] | 3.76 [3.48, 4.03] | -0.42 [-0.81, -0.03] | .036, -0.34 |
| T7 | 3.32 [3.07, 3.57] | 3.59 [3.34, 3.85] | -0.27 [-0.63, 0.09] | .142, -0.26 |
| T8 | 3.09 [2.78, 3.41] | 3.68 [3.34, 4.01] | -0.58 [-1.03, -0.13] | .012, -0.47 |
| **PROMIS Depression** | | | | |
| T2\* | 45.01 [43.73, 46.30] | 45.27 [43.99, 46.55] | -0.25 [-2.06, 1.55] | .781, -0.04 |
| T4 | 47.76 [46.23, 49.29] | 47.59 [46.03, 49.15] | 0.17 [-2.02, 2.35] | .881, 0.02 |
| T5 | 47.00 [45.44, 48.56] | 46.93 [45.33, 48.53] | 0.07 [-2.17, 2.32] | .948, 0.01 |
| T6\* | 48.15 [46.62, 49.69] | 45.93 [44.38, 47.47] | 2.22 [0.04, 4.41] | .046, 0.33 |
| T7 | 48.42 [46.91, 49.93] | 47.96 [46.42, 49.50] | 0.46 [-1.72, 2.64] | .679, 0.07 |
| T8 | 47.95 [46.42, 49.47] | 47.76 [46.15, 49.36] | 0.19 [-2.03, 2.42] | .864, 0.03 |
| **PROMIS Anxiety** | | | | |
| T2\* | 49.02 [47.56, 50.48] | 48.21 [46.76, 49.66] | 0.81 [-1.27, 2.88] | .443, 0.12 |
| T4 | 48.17 [46.68, 49.66] | 47.66 [46.15, 49.17] | 0.51 [-1.62, 2.63] | .639, 0.08 |
| T5 | 48.87 [47.22, 50.51] | 48.27 [46.60, 49.95] | 0.60 [-1.75, 2.94] | .617, 0.08 |
| T6\* | 48.73 [47.07, 50.39] | 47.18 [45.51, 48.84] | 1.55 [-0.81, 3.91] | .196, 0.21 |
| T7 | 49.44 [47.76, 51.13] | 47.91 [46.25, 49.58] | 1.53 [-0.91, 3.96] | .216, 0.23 |
| T8 | 48.74 [47.02, 50.47] | 47.53 [45.83, 49.23] | 1.22 [-1.22, 3.66] | .326, 0.18 |

*Note.* See Table 2 in the main text for values at baseline (T1, 30 weeks’ gestation). All models adjusted for baseline levels of the outcome. Sample sizes are in main text Figure 2. CBT = Cognitive Behavioural Therapy condition, CTRL = active control condition. T2 = 35 weeks’ gestation (first primary endpoint), T3 (2 weeks postpartum) with no assessment is not shown, T4 = 6 weeks postpartum, T5 – T8 = 3, 6 (second primary endpoint), 12, 24 months postpartum, respectively. \* indicates the two primary endpoints.

**Table S2**

*Numbers (Percentage) of Participants Meeting DSM-5 Insomnia Disorder Criteria at Each Time Point*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Overall Sample** | | **High Baseline Insomnia Symptom** | |
|  | **CBT** | **CTRL** | **CBT** | **CTRL** |
| T1 | 15 (18.5%) | 11 (13.4%) | 14 (41.2%) | 8 (36.4%) |
| T2 | 8 (13.1%) | 17 (26.2%) | 6 (23.1%) | 6 (40.0%) |
| T4 | 8 (12.1%) | 7 (11.3%) | 3 (10.7%) | 3 (23.1%) |
| T5 | 6 (8.1%) | 6 (8.5%) | 4 (12.5%) | 2 (13.3%) |
| T6 | 9 (11.8%) | 7 (9.3%) | 6 (18.8%) | 3 (17.6%) |
| T7 | 3 (5.1%) | 3 (5.5%) | 3 (12.0%) | 1 (8.3%) |
| T8 | 3 (5.0%) | 5 (8.8%) | 1 (3.7%) | 2 (15.4%) |

*Note.* Diagnostic status established using structured clinical interview for DSM-5 Insomnia Disorder without the Duration criterion. High baseline insomnia symptom is defined as scores > 7 on Insomnia Severity Index at baseline (30 weeks’ gestation). CBT = Cognitive Behavioural Therapy condition, CTRL = active control condition. T2 = 35 weeks’ gestation, T3 (2 weeks postpartum) with no assessment is not shown, T4 = 6 weeks postpartum, T5 – T8 = 3, 6, 12, 24 months postpartum, respectively.

**Table S3**

*Post-Baseline Model Estimated Group Mean (95% Confidence Interval) and Their Differences for Participants with High Baseline Insomnia Symptoms.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Time** | **CBT** | **CTRL** | **Group difference** | ***p*-value, effect size** |
| **Insomnia Severity Index (First Primary Outcome)** | | | | |
| T2\* | 9.49 [8.22, 10.76] | 12.93 [11.24, 14.61] | -3.44 [-5.55, -1.33] | .002, -0.97 |
| T4 | 7.94 [6.37, 9.52] | 8.80 [6.54, 11.06] | -0.86 [-3.60, 1.89] | .532, -0.19 |
| T5 | 6.65 [5.20, 8.10] | 9.51 [7.19, 11.83] | -2.86 [-5.59, -0.13] | .041, -0.70 |
| T6\* | 7.83 [6.27, 9.38] | 10.55 [8.38, 12.71] | -2.72 [-5.38, -0.06] | .045, -0.62 |
| T7 | 6.81 [5.41, 8.20] | 9.04 [7.01, 11.07] | -2.23 [-4.65, 0.18] | .069, -0.65 |
| T8 | 5.71 [4.05, 7.37] | 9.94 [7.55, 12.32] | -4.23 [-7.18, -1.27] | .006, -0.97 |
| **PROMIS Sleep Disturbance (Second Primary Outcome)** | | | | |
| T2\* | 53.19 [51.24, 55.14] | 57.70 [55.14, 60.26] | -4.51 [-7.70, -1.32] | .007, -0.85 |
| T4 | 51.24 [49.00, 53.47] | 52.68 [49.38, 55.99] | -1.45 [-5.48, 2.59] | .473, -0.23 |
| T5 | 50.28 [48.04, 52.53] | 51.50 [48.05, 54.95] | -1.22 [-5.34, 2.90] | .553, -0.19 |
| T6\* | 52.37 [49.85, 54.88] | 53.81 [50.27, 57.36] | -1.45 [-5.81, 2.92] | .507, -0.21 |
| T7 | 48.34 [45.99, 50.69] | 52.22 [48.57, 55.88] | -3.88 [-8.19, 0.43] | .076, -0.67 |
| T8 | 48.16 [45.30, 51.03] | 53.81 [49.90, 57.71] | -5.64 [-10.55, -0.73] | .026, -0.75 |
| **PROMIS Sleep Related Impairment** | | | | |
| T2\* | 53.08 [51.22, 54.95] | 59.04 [56.53, 61.56] | -5.96 [-9.08, -2.84] | < .001, -1.16 |
| T4 | 57.38 [55.25, 59.52] | 59.41 [56.32, 62.51] | -2.03 [-5.79, 1.74] | .283, -0.34 |
| T5 | 52.94 [50.53, 55.35] | 57.18 [53.69, 60.68] | -4.25 [-8.48, -0.01] | .049, -0.63 |
| T6\* | 54.79 [52.47, 57.10] | 57.06 [53.80, 60.33] | -2.28 [-6.32, 1.77] | .262, -0.35 |
| T7 | 54.54 [51.94, 57.14] | 56.49 [52.68, 60.30] | -1.95 [-6.47, 2.57] | .387, -0.29 |
| T8 | 50.84 [47.91, 53.77] | 57.46 [53.29, 61.63] | -6.62 [-11.82, -1.42] | .014, -0.86 |
| **Total Sleep Time (hours)** | | | | |
| T2\* | 7.05 [6.61, 7.49] | 6.73 [6.16, 7.30] | 0.32 [-0.40, 1.03] | .374, 0.26 |
| T4 | 6.08 [5.68, 6.48] | 5.69 [5.14, 6.24] | 0.39 [-0.29, 1.07] | .255, 0.34 |
| T5 | 6.74 [6.34, 7.13] | 6.61 [6.03, 7.19] | 0.13 [-0.57, 0.83] | .703, 0.12 |
| T6\* | 6.74 [6.40, 7.08] | 6.46 [5.98, 6.94] | 0.28 [-0.32, 0.88] | .347, 0.30 |
| T7 | 7.20 [6.91, 7.49] | 7.08 [6.66, 7.50] | 0.12 [-0.40, 0.64] | .641, 0.16 |
| T8 | 7.43 [7.07, 7.79] | 6.63 [6.09, 7.17] | 0.80 [0.14, 1.46] | .019, 0.86 |
| **Sleep Efficiency (%)** | | | | |
| T2\* | 76.74 [72.27, 81.20] | 73.45 [67.68, 79.22] | 3.28 [-4.00, 10.56] | .369, 0.26 |
| T4 | 64.77 [59.64, 69.90] | 59.07 [51.95, 66.20] | 5.69 [-3.12, 14.50] | .199, 0.39 |
| T5 | 72.12 [67.16, 77.08] | 70.59 [63.16, 78.01] | 1.53 [-7.39, 10.45] | .731, 0.11 |
| T6\* | 72.75 [68.63, 76.87] | 69.42 [63.66, 75.18] | 3.33 [-3.74, 10.40] | .347, 0.29 |
| T7 | 81.86 [78.32, 85.40] | 84.22 [79.06, 89.39] | -2.37 [-8.68, 3.95] | .450, -0.27 |
| T8 | 86.29 [82.47, 90.11] | 78.44 [72.74, 84.14] | 7.86 [0.90, 14.82] | .028, 0.78 |
| **Dysfunctional Beliefs and Attitudes about Sleep** | | | | |
| T2\* | 3.86 [3.54, 4.18] | 4.70 [4.28, 5.11] | -0.84 [-1.37, -0.32] | .002, -0.93 |
| T4 | 3.93 [3.53, 4.32] | 4.27 [3.73, 4.81] | -0.34 [-1.01, 0.32] | .303, -0.31 |
| T5 | 3.73 [3.30, 4.17] | 4.52 [3.88, 5.15] | -0.79 [-1.55, -0.02] | .044, -0.64 |
| T6\* | 3.73 [3.33, 4.12] | 4.67 [4.14, 5.20] | -0.94 [-1.61, -0.28] | .007, -0.86 |
| T7 | 4.18 [3.80, 4.57] | 4.31 [3.74, 4.89] | -0.13 [-0.83, 0.57] | .716, -0.13 |
| T8 | 3.13 [2.67, 3.60] | 4.52 [3.82, 5.21] | -1.39 [-2.24, -0.53] | .002, -1.21 |
| **PROMIS Depression** | | | | |
| T2\* | 45.76 [43.84, 47.69] | 47.68 [45.15, 50.21] | -1.92 [-5.09, 1.26] | .231, -0.36 |
| T4 | 49.36 [46.65, 52.07] | 49.22 [45.46, 52.99] | 0.14 [-4.49, 4.76] | .953, 0.02 |
| T5 | 47.22 [44.76, 49.67] | 48.46 [44.95, 51.96] | -1.24 [-5.51, 3.03] | .561, -0.18 |
| T6\* | 50.22 [47.71, 52.72] | 47.62 [44.18, 51.06] | 2.59 [-1.68, 6.86] | .228, 0.37 |
| T7 | 50.96 [48.49, 53.42] | 51.18 [47.73, 54.63] | -0.22 [-4.53, 4.08] | .917, -0.04 |
| T8 | 49.76 [47.20, 52.32] | 51.33 [47.83, 54.82] | -1.57 [-5.89, 2.76] | .468, -0.24 |
| **PROMIS Anxiety** | | | | |
| T2\* | 50.24 [48.00, 52.48] | 50.18 [47.28, 53.07] | 0.06 [-3.61, 3.73] | .974, 0.01 |
| T4 | 50.62 [47.87, 53.37] | 49.02 [45.32, 52.72] | 1.60 [-3.01, 6.22] | .488, 0.20 |
| T5 | 50.30 [47.81, 52.78] | 51.11 [47.57, 54.66] | -0.82 [-5.13, 3.49] | .704, -0.12 |
| T6\* | 52.17 [49.64, 54.69] | 49.78 [46.34, 53.23] | 2.38 [-1.89, 6.66] | .267, 0.34 |
| T7 | 52.40 [49.87, 54.92] | 49.92 [46.43, 53.41] | 2.47 [-1.94, 6.89] | .262, 0.38 |
| T8 | 50.62 [47.81, 53.44] | 50.62 [46.90, 54.34] | 0.00 [-4.77, 4.77] | .999, -0.00 |

*Note.* High baseline insomnia symptom is defined as scores > 7 on Insomnia Severity Index. See Table S4 for values at baseline (T1, 30 weeks’ gestation). All models adjusted for baseline levels of the outcome. Sample sizes are in Supplementary Figure S1. CBT = Cognitive Behavioural Therapy condition, CTRL = active control condition. T2 = 35 weeks’ gestation (first primary endpoint), T3 (2 weeks postpartum) with no assessment is not shown, T4 = 6 weeks postpartum, T5 – T8 = 3, 6 (second primary endpoint), 12, 24 months postpartum, respectively. \* indicates the two primary endpoints.

**Table S4**

*Mean (Standard Deviation) for Baseline Sleep and Mood Variables in Participants with High Baseline Insomnia Symptoms*

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All** | **CBT** | **CTRL** |
| *N* | 56 | 34 | 22 |
| Insomnia Severity Index | 11.70 (3.35) | 11.65 (2.86) | 11.77 (4.06) |
| Sleep Disturbance | 57.31 (4.15) | 57.35 (4.38) | 57.24 (3.86) |
| Sleep-Related Impairment | 57.68 (5.62) | 57.63 (5.51) | 57.76 (5.91) |
| Time-in-bed (hr) | 9.04 (1.05) | 8.98 (0.97) | 9.12 (1.17) |
| Total sleep time (hr) | 7.10 (1.03) | 7.12 (1.11) | 7.06 (0.92) |
| Sleep onset latency (min) | 33.39 (27.35) | 33.38 (31.40) | 33.41 (20.26) |
| Sleep efficiency (%) | 79.01 (11.09) | 79.45 (10.77) | 78.33 (11.80) |
| DBAS | 4.65 (1.28) | 4.56 (1.18) | 4.77 (1.44) |
| Depression | 47.83 (7.13) | 47.09 (7.29) | 48.96 (6.88) |
| Anxiety | 50.45 (6.89) | 49.64 (6.52) | 51.70 (7.40) |

*Note.* High baseline insomnia symptom is defined as scores > 7 on Insomnia Severity Index. DBAS = Dysfunctional Beliefs and Attitudes about Sleep. CBT (Cognitive Behavioural Therapy) and CTRL (active control) groups did not differ significantly on any of above variables at baseline (*p*-values range .28 – .99).

**Figure S1**

*Model Estimated Means and 95% Confidence Interval for Sleep-Related Measures in Participants with High Baseline Insomnia Symptoms (Insomnia Severity Index scores > 7)*



*Note.* See Supplement Table S2 for numeric summary. All models adjusted for baseline levels of the outcome. ES = effect size. CBT = Cognitive Behavioural Therapy condition, CTRL = active control condition. DBAS = Dysfunctional Beliefs and Attitudes about Sleep Scale.