Online supporting information for: Improvements of adolescent psychopathology after insomnia treatment: Results from a randomized controlled trial over 1 year – by Eduard J. de Bruinet al.

**Range and clinical scores from the Youth Self-Report.** Table S1. shows the range of the scores of all participants from GT, IT and WL for the DSM-scales of the YSR at each measurement time, and the percentage of participants with scores in the non-clinical, borderline, or clinical range.

[Insert Table S1 here]

**Results at 2-month follow-up compared to baseline directly.** Using an alternative parameterisation in the multilevel regression analyses, we checked whether changes at 2-month follow-up were significant if compared to baseline measurements (See S2). All results from the analyses for psychopathology that were described in the original analyses, were confirmed, with improvements at post-treatment maintained or further increased at 2-month follow-up in comparison to baseline. For IT and GT respectively the effect sizes at 2-month follow-up compared to baseline were: *Affective problems* *ß* = -0.56 and -0.38, *Anxiety problems* *ß* = -0.65 (significant for IT only), *Somatic problems* *ß* = -0.71 and -0.43, *ADHD problems* *ß* = -0.93 and -0.87, *Oppositional defiant problems* *ß* = -0.57 and -0.44.

[Insert Table S2 here]

**Mediation of insomnia for treatment effects on psychopathology for GT and IT separately.** In addition to the main mediation analyses reported in the results, with GT and IT analysed as one group, we conducted similar analyses for GT and IT separately.

**Mediation of treatment effects for GT.** In GT reduction of insomnia symptoms was a significant predictor for *Affective, Anxiety, Somatic,* and *Oppositional defiant problems*, indicating that for these scales also criterion 3 was met, but not for *ADHD problems*. Furthermore, analyses showed that controlling for the effect of insomnia, treatment effect decreased to non-significant levels for *Anxiety, Affective, Somatic* and *Oppositional defiant problems* (see Table 5). These results indicate full mediation of insomnia for effects of group CBTI on *Affective, Anxiety, Somatic* and *Oppositional defiant problems*.

[Insert Table S3 here]

The product of coefficients and bootstrapping procedure showed that the indirect (mediation) effect was significant for *Affective problems* (*z* = -2.65, *p* < .01), and *Somatic problems* (*z* = -3.44, *p* < .001), though not for *Anxiety problems* (*z* = -1.83, *p* = .07), and *Oppositional defiant problems* (*z* = 0.23, *p* = .82).

**Mediation of treatment effects for IT.** In IT improvement of insomnia was a significant predictor for *Affective* and *Oppositional defiant problems*, indicating that for these scales also criterion 3 was met, but not for any of the other DSM-scales. Furthermore, analyses showed that controlling for the effect of insomnia, treatment effects decreased to non-significant levels for both *Anxiety* and *Oppositional defiant problems* (see Table 6). These results indicate full mediation of insomnia for effects of Internet-CBTI on *Affective* and *Oppositional defiant problems*.

[Insert Table S4 here]

The product of coefficients and bootstrapping procedure showed that the indirect (mediation) effect was significant for *Affective problems* (*z* = -3.07, *p* < .01), though not for *Oppositional defiant problems* (*z* = -0.48, *p* = .63).

Table S1. Range of scores and percentage clinical scores for the DSM-scales of the Youth Self-Report at each measurement time.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Affective problems | | | |  | Anxiety problems | | | |  | Somatic problems | | | |  | ADHD problems | | | |  | Oppositional defiant problems | | | |  | Conduct problems | | | |
|  |  | range | % non clinical | % border-line | % clinical |  | range | % non clinical | % border-line | % clinical |  | range | % non clinical | % border-line | % clinical |  | range | % non clinical | % border-line | % clinical |  | range | % non clinical | % border-line | % clinical |  | range | % non clinical | % border-line | % clinical |
| Waitlist | baseline | 17 | 41.0 | 30.8 | 28.2 |  | 9 | 87.2 | 7.7 | 5.1 |  | 10 | 79.5 | 15.4 | 5.1 |  | 10 | 87.2 | 10.3 | 2.6 |  | 7 | 89.7 | 10.3 | 0.0 |  | 8 | 97.4 | 2.6 | 0.0 |
| post-treatment | 15 | 54.1 | 27.0 | 18.9 |  | 8 | 86.5 | 8.1 | 5.4 |  | 9 | 70.3 | 18.9 | 10.8 |  | 10 | 83.8 | 13.5 | 2.7 |  | 6 | 94.6 | 5.4 | 0.0 |  | 7 | 100.0 | 0.0 | 0.0 |
| 2-month follow-up | 12 | 47.1 | 29.4 | 23.5 |  | 8 | 88.2 | 5.9 | 5.9 |  | 8 | 82.4 | 0.0 | 17.6 |  | 8 | 76.5 | 17.6 | 5.9 |  | 5 | 94.1 | 5.9 | 0.0 |  | 7 | 100.0 | 0.0 | 0.0 |
| Internet CBTI | baseline | 16 | 53.8 | 35.9 | 10.3 |  | 8 | 89.7 | 5.1 | 5.1 |  | 6 | 89.7 | 10.3 | 0.0 |  | 10 | 79.5 | 10.3 | 10.3 |  | 8 | 84.6 | 10.3 | 5.1 |  | 9 | 97.4 | 2.6 | 0.0 |
| post-treatment | 15 | 91.9 | 5.4 | 2.7 |  | 7 | 97.3 | 0.0 | 2.7 |  | 8 | 86.5 | 10.8 | 2.7 |  | 12 | 83.8 | 10.8 | 5.4 |  | 7 | 89.2 | 10.8 | 0.0 |  | 9 | 97.3 | 2.7 | 0.0 |
| 2-month follow-up | 11 | 90.9 | 6.1 | 3.0 |  | 6 | 100.0 | 0.0 | 0.0 |  | 5 | 97.0 | 3.0 | 0.0 |  | 9 | 90.9 | 9.1 | 0.0 |  | 6 | 90.9 | 9.1 | 0.0 |  | 7 | 100.0 | 0.0 | 0.0 |
| 6-month follow-up | 10 | 94.4 | 5.6 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |  | 6 | 94.4 | 5.6 | 0.0 |  | 10 | 88.9 | 11.1 | 0.0 |  | 6 | 94.4 | 5.6 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |
| 12-month follow-up | 11 | 75.0 | 25.0 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |  | 5 | 93.8 | 6.2 | 0.0 |  | 7 | 100.0 | 0.0 | 0.0 |  | 6 | 93.8 | 6.2 | 0.0 |  | 6 | 100.0 | 0.0 | 0.0 |
| Group CBTI | baseline | 13 | 60.5 | 23.7 | 15.8 |  | 9 | 89.5 | 2.6 | 7.9 |  | 7 | 81.6 | 15.8 | 2.6 |  | 9 | 89.5 | 7.9 | 2.6 |  | 7 | 84.2 | 13.2 | 2.6 |  | 7 | 100.0 | 0.0 | 0.0 |
| post-treatment | 10 | 80.6 | 19.4 | 0.0 |  | 9 | 94.4 | 0.0 | 5.6 |  | 6 | 86.1 | 13.9 | 0.0 |  | 9 | 88.9 | 8.3 | 2.8 |  | 7 | 94.4 | 5.6 | 0.0 |  | 7 | 100.0 | 0.0 | 0.0 |
| 2-month follow-up | 14 | 78.6 | 10.7 | 10.7 |  | 6 | 100.0 | 0.0 | 0.0 |  | 7 | 85.7 | 14.3 | 0.0 |  | 8 | 92.9 | 7.1 | 0.0 |  | 6 | 96.4 | 3.6 | 0.0 |  | 6 | 100.0 | 0.0 | 0.0 |
| 6-month follow-up | 11 | 83.3 | 11.1 | 5.6 |  | 7 | 94.4 | 5.6 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |  | 9 | 83.3 | 16.7 | 0.0 |  | 4 | 100.0 | 0.0 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |
| 12-month follow-up | 8 | 80.0 | 20.0 | 0.0 |  | 6 | 100.0 | 0.0 | 0.0 |  | 8 | 93.3 | 0.0 | 6.7 |  | 9 | 80.0 | 20.0 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |  | 5 | 100.0 | 0.0 | 0.0 |

Table S2. Multilevel regression analyses for effects of group CBTI and Internet CBTI compared to waitlist on psychopathology, with treatment effects at post-treatment and 2-month follow-up compared to baseline.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | **Affective β(se)** | **Anxiety β(se)** | **Somatic β(se)** | **ADHD β(se)** | **Oppositional Defiant β(se)** | **Conduct β(se)** |
| Group effects at baseline | | | | | | |
| Gender (difference of girls compared to boys, at baseline) | 0.62(0.18)\*\* | 0.79(0.20)\*\*\* | 0.62(0.18)\*\* | 0.30(0.21) | -0.13(0.21) | -0.49(0.21)\* |
| Internet CBTI (difference with waitlist, at baseline) | -0.61(0.19)\*\* | -0.25(0.21) | -0.44(0.21)\* | 0.04(0.22) | 0.23(0.22) | -0.20(0.22) |
| Group CBTI (difference with waitlist, at baseline) | -0.50(0.19)\* | -0.32(0.21) | -0.29(0.21) | 0.23(0.22) | 0.22(0.22) | -0.03(0.22) |
| Treatment effects | | | | | | |
| Post-treatment (change of waitlist from baseline to post-treatment) | -0.01(0.14) | 0.15(0.15) | 0.08(0.12) | 0.13(0.15) | -0.03(0.17) | -0.07(0.19) |
| 2-month follow-up (change of waitlist from baseline to 2-months follow-up) | 0.25(0.19) | 0.44(0.20)\* | 0.24(0.22) | 0.70(0.21)\*\* | 0.05(0.23) | -0.31(0.25) |
| Gender \* post-treatment (additional change of girls from baseline to post-treatment, compared to boys) | -0.32(0.14)\* | -0.37(0.15)\* | 0.10(0.16) | 0.07(0.15) | 0.01(0.17) | 0.08(0.18) |
| Gender \* 2-month follow-up (additional change of girls from baseline to 2-month follow-up, compared to boys) | -0.68(0.16)\*\*\* | -0.53(0.17)\*\* | -0.16(0.19) | -0.30(0.18) | -0.02(0.19) | -0.04(0.22) |
| Internet CBTI \* post-treatment (additional change of Internet CBTI from baseline to post-treatment, compared to waitlist) | -0.44(0.14)\*\* | -0.45(0.15)\*\* | -0.37(0.17)\* | -0.50(0.16)\*\* | -0.24(0.17) | -0.02(0.19) |
| Group CBTI \* post-treatment (additional change of group CBTI from baseline to post-treatment, compared to waitlist) | -0.45(0.14)\*\* | -0.22(0.15) | -0.53(0.17)\*\* | -0.32(0.16)\* | -0.42(0.17)\* | -0.32(0.19) |
| Internet CBTI \* 2-month follow-up (additional change of Internet CBTI from baseline to 2-month follow-up, compared to waitlist) | -0.56(0.17)\*\* | -0.65(0.18)\*\*\* | -0.71(0.20)\*\* | -0.93(0.19)\*\*\* | -0.57(0.21)\*\* | 0.17(0.23) |
| Group CBTI \* 2-month follow-up (additional change of group CBTI from baseline to 2-month follow-up, compared to waitlist) | -0.38(0.18)\* | -0.30(0.19) | -0.43(0.21)\* | -0.87(0.20)\*\*\* | -0.44(0.22)\* | -0.04(0.24) |

\* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001. CBTI = cognitive behavioural therapy for insomnia. All predictor and outcome variables were standardized, which allows for interpretation of the β coefficients as Cohen’s d effect sizes (ESs), with .20, .50, and .80 indicating small, medium, and large ESs, respectively (Cohen, 1988). Regression coefficients represent differences of each effect compared to waitlist at baseline. Separate ESs for group and Internet CBTI can be deduced from ESs for the main effects of group and Internet CBTI and ESs for interaction effects. When there is a significant interaction of condition (group or Internet CBTI) \* time (e.g. post-treatment), the total ES for group or Internet CBTI over time is the addition of the ES of group or Internet CBTI, and the ES of the interaction.Table S3. Mediation multilevel regression analyses of effects from group-treatment and insomnia symptoms on psychopathology, with participants from group CBTI compared to waiting list.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Affective**  **β(se)** | **Anxiety**  **β(se)** | **Somatic**  **β(se)** | **ADHD**  **β(se)** | **Oppositional Defiant**  **β(se)** |
| Step 3a – Model including insomnia symptoms as predictor for psychopathology | | | | | |
| Insomnia symptoms (from baseline to post-treatment as predictor for psychopathology from baseline to 2-month follow-up) | 0.45(0.09)\*\*\* | 0.18(0.09)\* | 0.24(0.09)\* | 0.15(0.10) | 0.22(0.11)\* |
| 2-month follow-up (changes in psychopathology from baseline to 2-month follow-up for all participants) | -0.17(0.12) | -0.03(0.11) | 0.07(0.12) | 0.13(0.13) | -0.13(0.14) |
| Insomnia symptoms \* 2-month follow-up (different change of psychopathology for different insomnia symptoms) | -0.15(0.11) | 0.11(0.10) | 0.02(0.11) | 0.23(0.12) | -0.11(0.30) |
| Step 4a – Model including treatment and insomnia symptoms as predictor for psychopathology | | | | | |
| Insomnia symptoms (at post-treatment as predictor for psychopathology at 2-month follow-up) | 0.42(0.10)\*\*\* | 0.19(0.09)\* | 0.19(0.09)\* | 0.17(0.10) | 0.19(0.11) |
| Group CBTI(compared to waitlist at baseline) | -0.54(0.19)\*\* | -0.36(0.22) | -0.32(0.20) | 0.21(0.20) | 0.21(0.22) |
| 2-month follow-up(compared to baseline) | -0.25(0.22) | -0.02(0.20) | 0.29(0.21) | 0.52(0.23)\* | 0.04(0.26) |
| Insomnia symptoms \* 2-month follow-up (differential effects of treatment at 2-month follow up for different changes in insomnia symptoms at post-treatment) | -0.12(0.15) | 0.09(0.14) | -0.09(0.14) | 0.03(0.16) | -0.15(0.18) |
| Group CBTI \* 2-month follow-up (direct effect of treatment on psychopathology from baseline to 2-month follow-up) | 0.11(0.34) | 0.00(0.30) | -0.47(0.32) | -0.69(0.35) | -0.37(0.39) |

\* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001. CBTI = cognitive behavioural therapy for insomnia.  
aMediation analysis showing results for steps 3 (insomnia symptoms is a significant predictor for psychopathology) and 4 (significant direct effect of predictor treatment by group CBTI is no longer significant in a model with insomnia symptoms as predictor for psychopathology) of the four-step approach (Hayes, 2013; Preacher & Hayes, 2004; Mackinnon et al., 2002).

Table S4. Mediation multilevel regression analyses of effects from Internet treatment and insomnia symptoms on psychopathology, with participants from Internet CBTI compared to waiting list.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | **Affective**  **β(se)** | **Anxiety**  **β(se)** | **Somatic**  **β(se)** | **ADHD**  **β(se)** | **Oppositional Defiant**  **β(se)** |
| Step 3a – Model including insomnia symptoms as predictor for psychopathology | | | | | |
| Insomnia symptoms (from baseline to post-treatment as predictor for psychopathology from baseline to 2-month follow-up) | 0.47(0.09)\*\*\* | 0.18(0.10) | 0.11(0.10) | 0.15(0.11) | 0.21(0.10)\* |
| 2-month follow-up (changes in psychopathology from baseline to 2-month follow-up for all participants) | -0.35(0.10)\*\*\* | -0.19(0.11) | -0.19(0.12) | 0.02(0.13) | -0.16(0.11) |
| Insomnia symptoms \* 2-month follow-up (different change of psychopathology for different insomnia symptoms) | 0.01(0.10) | 0.21(0.11) | 0.34(0.11)\* | 0.15(0.12) | 0.00(0.11) |
| Step 4a – Model including treatment and insomnia symptoms as predictor for psychopathology | | | | | |
| Insomnia symptoms (at post-treatment as predictor for psychopathology at 2-month follow-up) | 0.42(0.09)\*\*\* | 0.15(0.10) | 0.07(0.11) | 0.12(0.11) | 0.20(0.10) |
| Internet CBTI (compared to waitlist at baseline) | -0.45(0.18)\* | -0.12(0.21) | -0.35(0.21) | 0.10(0.23) | 0.25(0.23) |
| 2-month follow-up(compared to baseline) | -0.39(0.18)\* | -0.10(0.21) | 0.00(0.22) | 0.69(0.22)\*\* | 0.00(0.20) |
| Insomnia symptoms \* 2-month follow-up (differential effects of treatment at 2-month follow up for different changes in insomnia symptoms at post-treatment) | 0.03(0.12) | 0.18(0.13) | 0.26(0.13) | -0.12(0.14) | -0.05(0.13) |
| Internet CBTI \* 2-month follow-up (direct effect of treatment on psychopathology from baseline to 2-month follow-up) | 0.02(0.26) | -0.19(0.29) | -0.34(0.30) | -1.12(0.30)\*\*\* | -0.28(0.28) |

\* *p* < .05, \*\* *p* < .01, \*\*\* *p* < .001. CBTI = cognitive behavioural therapy for insomnia.  
aMediation analysis showing results for steps 3 (insomnia symptoms are a significant predictor for psychopathology) and 4 (significant direct effect of predictor treatment by Internet CBTI is no longer significant in a model with insomnia symptoms as predictor for psychopathology) of the four-step approach (Hayes, 2013; Preacher & Hayes, 2004; Mackinnon et al., 2002).