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Sex differences in response to cognitive behavioural therapy for insomnia: A chart review of 455 patients with chronic insomnia

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ABSTRACT

Background: Insomnia is more prevalent in females, however studies examining sex differences in response to insomnia treatment are scarce. This study assessed sex-specific differences in cognitive behavioural therapy for insomnia (CBT-I)-related changes in insomnia symptoms in a large clinical cohort.
Methods: A chart review was conducted of a clinical cohort (females n = 305, males n = 150) referred to a sleep clinic. Participants had a registered psychologist confirm diagnosis of chronic insomnia according to DSM-IV/V criteria and a Level 1 or 2 sleep study. Daily sleep diaries and questionnaires including the Insomnia Severity Index (ISI), Flinders Fatigue Scale (FFS), the Daytime Feelings and Functioning Scale (DFFS), and the Depression, Anxiety and Stress Scale-21 items (DASS), were administered at baseline, post-treatment, and three-month follow-up. Linear mixed models determined interactions between sex and timepoint on symptoms.
Results: Mean (SD) age was 51.7 yrs (15.7, range = 18-90 yrs), and mean BMI was 26.3 kg/m^2 (4.9), neither of which differed by sex. At pre-treatment, females demonstrated higher objective total sleep time (min) [343.5 (97.6) vs 323.8 min (92.1), p = 0.044], ISI [19.7 (4.2) vs 18.6 (4.4), p = 0.033], and FFS scores [19.2 (6.0) vs 16.9 (7.2), p = 0.003]. Compared to males, females experienced a greater reduction in FFS and DFFS scores and DASS depressive symptoms (p for interaction: 0.017, 0.043, 0.016 respectively) from baseline to follow-up. The greater reduction in depressive symptoms did not persist after controlling for age, BMI, and sleep apnea severity. Subjective total sleep time similarly increased across treatment for both males [baseline: 335.7 (15.1), post: 357.9 (15.5)] and females [baseline: 318.3 (10.4), post: 354.4 (10.7)], p for interaction: 0.22.
Conclusion: Females and males experience similar, substantial benefits from CBT-I after accounting for comorbidities, suggesting the same treatment can resolve insomnia in both sexes.

1. Introduction

Chronic insomnia is a common sleep disorder with substantial impacts on the individual, including reduced or impaired daytime functioning and quality of life. It is defined as difficulties initiating or maintaining sleep (despite adequate opportunity to sleep) that occur at least three times per week for at least three months, with complaints of associated daytime impairments [1]. This sleep disorder also predominantly affects females, who are at ~1.5 times greater risk of developing insomnia than males [2]. The mechanisms underlying this higher incidence of insomnia are not well understood. Pregnancy, caregiving responsibilities, and menopause may be contributing factors [3]. Given that insomnia may have more deleterious consequences in females than males, including increased risks for health conditions (e.g., chronic pain [4], depression [5], anxiety [6]), it will be useful to better understand sex differences in response to treatment.

Given the observed sex differences in insomnia prevalence, it is surprising that consideration of sex differences in response to insomnia treatment is relatively limited. Cognitive behavioural therapy for insomnia (CBT-I) is recommended by the American Academy of Sleep Medicine (AASM), the Royal Australian College of General Practitioners

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Abbreviations

AASM	American Academy of Sleep Medicine
AHI	Apnea hypopnea index
BMI	Body mass index
CBT-I	Cognitive behavioural therapy for insomnia
EEG	Electroencephalography
EMG	Electromyography
EOG	Electrooculography
PSG	Polysomnography
RACGP	Royal Australian College of General Practitioners
SD	Standard deviation
SE	Sleep efficiency
SOL	Sleep onset latency
TIB	Time in bed
TST	Total sleep time
WASO	Wake after sleep onset

(RACGP), and the US National Institute of Health as the first-line treatment for insomnia [7–9]. In prior studies, sex was not a significant predictor of CBT-I response in a sample of older adults [10] and in patients through an insomnia clinic [11]. Similarly, in a study of patients with comorbid insomnia and fibromyalgia who underwent CBT-I (n = 28, mean±SD aged 46.29 ± 7.76 years), there were no pre-post differences found between males and females in their sleep latency or sleep efficiency (as measured by the Pittsburgh Sleep Quality Index) [12]. These analyses were all conducted with relatively small samples (n<138). Given this, a recent review of the literature on CBT-I [13] called for more well-powered studies into potential sex differences in response to CBT-I to inform treatment approaches. The current study addresses this call.

While randomised controlled trials give a high level of evidence with respect to the efficacy of CBT-I, evaluation of differences in treatment outcomes is perhaps better assessed using 'real world' data. Individuals tend to engage with treatment differently when participating in clinical trials: they receive more support from trial personnel (which may be therapeutic in itself), and may adhere more closely to the treatment protocol due to greater interaction with researchers and clinicians or due to being observed (i.e., the Hawthorne effect) [14]. Participant experiences in clinical trials may also differ between males and females given that their reasons and influences for clinical trial participation appears to differ and the observed sex biases in some health-related fields [15,16], meaning that the effects of participation in trials on clinical outcomes may be influenced by sex. With these considerations in mind, the investigation of potential sex differences in response to CBT-I may be most reliably explored with a clinical dataset. The current study examined data from an outpatient insomnia treatment clinic to investigate differences between males and females in 1) presentation of insomnia symptoms at baseline, and 2) changes in symptoms both immediately following treatment and at three-month follow up. In addition, a secondary analysis investigated the influence of patients' and therapists' sexes on changes in insomnia symptoms over time, to examine whether patient-therapist dynamics affect treatment outcomes, as has been inconsistently found for treatment of other mental health conditions [17–19].

2. Methods

2.1. Study design

The current study is a chart-review to examine differences in insomnia presentation prior to treatment and response to CBT-I between males and females. These data have been previously used to investigate the effects of comorbid sleep apnea and depressive, anxiety, and stress symptoms on the effectiveness of CBT-I, as published previously [20,21]. This study was reviewed and approved by the Social and Behavioural Research Ethics Committee, Flinders University.

2.2. Participants

Participants were referred for insomnia treatment by either their general practitioner or another healthcare provider (e.g., clinical psychologist) to an outpatient insomnia CBT-I clinic at the Repatriation General Hospital (Adelaide, South Australia) between February 2004 and November 2015. Further inclusion criteria were a confirmed diagnosis of chronic insomnia by a registered psychologist according to the Diagnostic and Statistical Manual of Mental Disorders (fourth edition for patients between 2004 and 2012, fifth edition for patients between 2013 and 2015) and no current hospitalisations. After excluding data from patients who did not provide informed consent for data to be used for research purposes ($n = 27$), those who started positive airway pressure therapy for sleep apnea ($n = 35$), those with no pre-treatment sleep study ($n = 12$), and patients aged <18 ($n = 9$), data from 455 patients were retained for analysis.

2.3. Study measures

2.3.1. Sex

Upon referral to the outpatient clinic, biological sex was automatically downloaded from the patient's public health record. For this cohort, the possible responses were either 'male' or female'. The clinic would have updated the record upon patient request on a case-by-case basis, however it is unknown how often this occurred. As this dataset is from a historical clinical cohort, its limitations do not allow for analyses with respect to gender or other sexes beyond the binary male/female.

2.3.2. Single-night ambulatory sleep study

A combination of home-based and laboratory-based polysomnography sleep studies (Compumedics Somté) were completed after the initial consultation with a psychologist. Participants predominantly underwent home-based polysomnography (88% home-based vs. 12% in-lab). Electroencephalography (EEG: C3, C4, M1, M2), two-site electromyography (EMG), and electrooculography (EOG), leg movements (two-lead electrodes), oximetry, respiratory effort (abdominal and thoracic bands) and airflow (nasal cannula) were recorded. The equipment was set up by a qualified sleep technologist at the Repatriation General Hospital on the night of the sleep study. Data were scored according to the AASM sleep scoring criteria that were current at the time of the sleep study by a qualified, registered scorer on Compumedics Profusion software.

2.3.3. Sleep diaries

Participants were instructed to record daily sleep diaries upon waking for one week at each timepoint (pre-treatment, post-treatment, 3-month follow up). Weekly averaged time in bed (TIB), total sleep time (TST), sleep latency, wake after sleep onset, and sleep efficiency (SE = TST/TIBx100) were calculated from diary responses.

2.3.4. Questionnaires

The questionnaire battery administered at each timepoint consisted of the following: the Insomnia Severity Index to assess insomnia symptom severity (scores ≥15 clinical symptoms) [22]; the Epworth Sleepiness Scale to assess excessive daytime sleepiness (scores ≥11 excessively sleepy) [23]; the Flinders Fatigue Scale to assess daytime fatigue symptoms (scores ≥21 severe fatigue) [24,25]; the Daytime Feelings and Functioning Scale to assess overall daytime impairment [26]; the Depression, Anxiety and Stress Scale-21 items to assess depressive, anxiety, and stress symptoms [27,28] (depression: scores 14-20

moderate, 21+ severe; anxiety: scores 10-14 moderate, 15+ severe; stress: scores 19-25 moderate, 26+ severe), and the Dysfunctional Beliefs and Attitudes about Sleep scale to assess sleep-related cognitions that commonly co-occur with, and exacerbate, chronic insomnia [29,30].

2.3.5. Study procedure

Participants completed the baseline sleep diary and questionnaires prior to attending their first session with a registered psychologist. Session 1 comprised a clinical interview to confirm a diagnosis of insomnia (~1hr duration). Participants then attended a group education session facilitated by a registered psychologist. This session incorporated basic sleep knowledge (e.g., the two-process model of sleep regulation, sleep stages and need), sleep hygiene recommendations (e.g., napping, bedroom environment, caffeine, and alcohol consumption), and information about sedative hypnotic medications (e.g., issues of tolerance and dependence). As already outlined above, all participants underwent a Level 1 (laboratory-based) or Level 2 (home-based) sleep study at baseline which was later used in-session to provide further personalised sleep education and discussion about sleep-wake state discrepancy (differences between polysomnography-derived and self-reported sleep and wakefulness) [31].

All participants were scheduled to attend five weekly in-person sessions with an experienced registered psychologist to receive CBT-I (~45mins duration per session). Session content was tailored to each patient based on their individual presentations, and usually consisted of bedtime restriction therapy (otherwise known as sleep restriction therapy) [32], stimulus control therapy [33], relaxation therapy, further sleep hygiene recommendations, and bright light therapy for circadian misalignment, either alone or in combination. Elements of cognitive therapy were also integrated into each session, with particular emphasis on challenging maladaptive beliefs (e.g., that brief awakenings across the night are harmful), addressing discrepancies of sleep/wake between PSG and sleep diary reports, decreasing anxiety about perceived poor sleep, and dispelling exaggerated fears of insomnia through sleep education. Following CBT-I, participants were asked to complete the sleep diary and questionnaires again at two timepoints: immediately post-treatment and at three-months following the end of treatment.

2.4. Statistical analyses

Independent samples t-tests were conducted to investigate differences between females and males on each outcome at baseline. Linear mixed models were conducted to investigate interactions between sex and timepoint on symptoms of insomnia. Unadjusted and adjusted models controlling for age, BMI, and obstructive sleep apnea severity (apnea hypopnea index [AHI]), and also for baseline insomnia severity were performed. Significant interactions were required before inspecting pairwise comparisons. All pairwise comparisons were Bonferroni adjusted for multiple comparisons. Alpha levels of <0.05 were considered statistically significant. Cohen's *d* effect sizes were calculated and interpreted according to standard benchmarks [34].

As data were drawn from a clinical sample outside of a structured research trial, there were high rates of missing data at post-treatment and follow-up. Missing data are reported according to sex and timepoint in the supplement (see Table S1). There were no significant between-group differences in rates of missing data for any outcome at baseline, post-treatment or 3-month follow-up. In addition to primary mixed model analyses, a series of complete case analyses were performed to investigate between-group changes in insomnia symptoms from baseline to post-treatment.

3. Results

3.1. Baseline characteristics

Comparisons of baseline characteristics between males and females are displayed in Table 1. Independent samples t-tests showed that females reported higher global insomnia severity, daytime fatigue, and general daytime impairment scores than males. Males had higher apnea-hypopnea index scores, and shorter sleep duration during the baseline polysomnography study than females.

3.1.1. Changes in insomnia symptoms

Mixed models were performed to investigate the interaction between sex and time on insomnia symptoms. All interactions are shown in Table 2. Compared to males, females experienced greater reductions in daytime fatigue, overall daytime impairment, and depressive symptoms from baseline to 3-month follow-up (see Fig. 1). After controlling for age, BMI, and sleep apnea severity (AHI), the sex-by-time interaction on depressive symptoms was no longer statistically significant ($p = 0.368$). Interaction effects on daytime fatigue and overall daytime impairment remained significant after controlling for age, BMI, and sleep apnea severity. These significant interactions were also maintained after

Table 1
Mean (SD) baseline demographic and clinical characteristics for total sample and differences between males and females.

	Total (n = 455)	Females (n = 305)	Males (n = 150)	p	*Cohen's d*
Age, y	51.7 (15.7)	52.2 (15.3)	50.6 (16.3)	0.327	0.10
Weight, kg	74.3 (16.7)	69.1 (15.4)	84.3 (14.5)	**<0.001**	**1.01**
Height, cm	167.9 (09.7)	163.0 (7.1)	177.3 (6.9)	**<0.001**	**2.03**
BMI, kg/m^2	26.3 (4.9)	26.0 (5.4)	26.7 (3.8)	0.156	0.14
Diary average TST, min	323.7 (92.1)	318.3 (93.6)	335.2 (88.3)	0.108	0.18
Diary average TIB, min	494.5 (85.5)	491.9 (84.4)	500.0 (88.0)	0.414	0.10
Diary average SOL, min	63.4 (55.5)	65.7 (57.6)	58.5 (51.0)	0.259	0.13
Diary average WASO, min	106.1 (73.8)	107.7 (76.1)	102.8 (68.9)	0.569	0.07
Diary average SE, %	66.3 (16.8)	65.5 (17.6)	68.1 (14.9)	0.182	0.16
Insomnia Severity Index	19.4 (04.3)	19.7 (4.2)	18.6 (4.4)	**0.033**	**0.26**
Flinders Fatigue Scale	18.5 (06.5)	19.2 (6.0)	16.9 (7.2)	**0.003**	**0.36**
Daytime Feelings and Functioning Scale	17.8 (07.3)	18.3 (7.2)	16.7 (7.5)	**0.040**	**0.19**
Epworth Sleepiness Scale	5.7 (04.6)	5.8 (4.5)	5.7 (4.8)	0.940	0.02
Dysfunctional beliefs and attitudes about sleep	39.5 (09.4)	39.6 (8.4)	39.2 (11.1)	0.687	0.04
DASS-21 Depression scale	12.2 (10.0)	12.5 (10.3)	11.7 (9.3)	0.479	0.08
DASS-21 Anxiety scale	7.6 (07.8)	8.1 (8.3)	6.6 (6.6)	0.072	0.19
DASS-21 Stress scale	16.3 (9.6)	16.6 (9.7)	15.7 (9.5)	0.415	0.09
PSG total sleep time, min	336.9 (96.2)	343.5 (97.6)	323.8 (92.1)	**0.044**	**0.21**
PSG total wake time, min	85.3 (65.5)	83.2 (61.1)	89.3 (73.4)	0.358	0.09
PSG sleep efficiency, %	70.3 (17.8)	70.8 (18.3)	69.4 (16.7)	0.457	0.08
PSG AHI, events/hour	14.9 (20.1)	13.2 (18.2)	18.3 (23.1)	**0.021**	**0.26**

Table 2
Sleep and daytime symptoms according to sex from baseline to 3-month follow-up.

	Baseline		Post-treatment		3-Month Follow-up		Mixed Models Output			
	Females	Males	Females	Males	Females	Males	Effect	F	DFs	p
ISI	19.7 (0.7)	18.6 (1.0)	9.4 (0.8)	9.7 (1.2)	7.8 (0.8)	7.5 (1.2)	Time	413.85	2, 451.07	<0.001
							Sex	0.61	1, 347.95	0.43
							Time*Sex	1.53	2, 451.07	0.22
Diary TST, min	318.3 (10.4)	335.7 (15.1)	354.4 (10.7)	357.9 (15.5)	369.5 (11.4)	372.8 (16.6)	Time	42.29	2, 409.64	<0.001
							Sex	0.97	1, 407.60	0.33
							Time*Sex	1.52	2, 409.64	0.22
Diary SOL, min	65.4 (5.1)	58.7 (7.3)	29.5 (5.2)	25.4 (7.6)	25.3 (5.7)	22.3 (8.2)	Time	118.89	2, 402.25	<0.001
							Sex	1.58	1, 307.79	0.21
							Time*Sex	0.22	2, 402.25	0.80
Diary WASO, min	108.1 (7.0)	102.1 (10.3)	44.0 (07.3)	47.1 (10.6)	46.4 (08.0)	43.6 (11.7)	Time	170.16	2, 432.06	<0.001
							Sex	0.14	1, 341.25	0.71
							Time*Sex	0.94	2, 432.06	0.39
Diary SE, %	65.5 (1.7)	68.3 (2.5)	82.5 (1.8)	82.6 (2.6)	83.6 (2.0)	84.9 (2.9)	Time	230.22	2, 430.89	<0.001
							Sex	1.15	1, 379.07	0.28
							Time*Sex	1.33	2, 430.89	0.27
ESS	5.7 (0.5)	5.7 (0.8)	5.9 (0.6)	5.8 (0.8)	5.0 (0.6)	5.1 (0.9)	Time	5.47	2, 440.70	0.005
							Sex	0.00	1, 407.76	0.99
							Time*Sex	0.06	2, 440.70	0.95
FFS	19.2 (0.7)	16.9 (1.1)	12.0 (0.9)	12.1 (1.3)	10.3 (0.9)	9.4 (1.4)	Time	177.92	2, 512.56	<0.001
							Sex	3.41	1, 422.29	0.07
							Time*Sex	4.08	2, 512.56	**0.02**
DFFS	18.2 (0.8)	16.5 (1.2)	11.1 (0.9)	11.2 (1.4)	9.3 (1.0)	9.5 (1.5)	Time	173.48	2, 505.50	<0.001
							Sex	0.51	1, 419.88	0.48
							Time*Sex	3.16	2, 505.50	**0.04**
DBAS	39.6 (1.1)	39.1 (1.5)	27.9 (1.2)	28.5 (1.8)	25.2 (1.3)	26.2 (1.9)	Time	293.27	2, 459.09	<0.001
							Sex	0.22	1, 412.79	0.64
							Time*Sex	0.76	2, 459.09	0.47
DASS Depression	12.6 (1.1)	11.7 (1.6)	8.0 (1.2)	9.5 (1.8)	6.6 (1.3)	8.7 (1.9)	Time	34.85	2, 377.03	<0.001
							Sex	0.93	1, 390.25	0.33
							Time*Sex	4.18	2, 377.03	**0.02**
DASS Anxiety	8.1 (0.8)	6.7 (1.2)	5.1 (0.9)	4.9 (1.4)	4.5 (1.0)	4.5 (1.4)	Time	27.73	2, 366.81	<0.001
							Sex	0.58	1, 392.34	0.45
							Time*Sex	1.93	2, 366.81	0.15
DASS Stress	16.5 (1.1)	15.7 (1.5)	10.6 (1.2)	11.0 (1.7)	9.2 (1.2)	9.4 (1.9)	Time	79.94	2, 385.39	<0.001
							Sex	0.01	1, 402.92	0.94
							Time*Sex	0.74	2, 385.39	0.48

Descriptive statistics are Estimated Marginal Means (Standard Deviation). Bold indicates a significant time-by-sex interaction.

controlling for baseline insomnia severity (ISI), and no other interactions were significant after this adjustment.

A series of complete case analyses were performed, investigating the effect of sex and time on changes in insomnia symptoms from baseline to post-treatment (i.e., eliminating the 3-month follow-up). The complete case analyses produced results consistent with the prior analyses, with the time-by-sex interaction remaining significant for daytime fatigue ($F = 6.21$, $p = 0.013$), overall daytime impairment ($F = 4.79$, $p = 0.029$), and depressive symptoms ($F = 4.60$, $p = 0.033$).

3.2. Responder analysis

Between-group rates of ISI scores <15 was investigated at post-treatment and 3-month follow-up, among patients with available ISI data. There was no difference in rates of sub-threshold insomnia between females and males at post-treatment (80.5% vs 78.7%; χ^2 (1) = 0.08, $p = 0.774$) or at 3-month follow-up (females 89.4% vs males 85.7%; χ^2 (1) = 0.513, $p = 0.474$).

3.2.1. Patient-therapist sex combinations

A secondary analysis was conducted on the combinations of patients' and therapists' sexes on changes in insomnia symptoms over time. There were no significant three-way interactions on any treatment outcomes, all $p>0.09$ (see the Supplementary File).

4. Discussion

This chart review examined differences between males and females on presentation of insomnia symptoms before treatment and changes in symptoms after treatment with CBT-I. Consistent with previous research [35], females had significantly more severe insomnia symptoms, daytime fatigue, and general daytime impairment at baseline than males. Males also showed significantly higher apnea-hypopnea indices and shorter sleep duration during the single-night polysomnography study prior to CBT-I than females [21]. Contrary to previous research [10–12], we observed significant differences between males and females in response to insomnia treatment. Males showed significantly less change from baseline on depression scores than females, however this was not significant after controlling for covariates. Females reported significantly greater reductions in daytime fatigue and overall daytime impairment across time compared to males, which remained significant after adjustment. Notably, substantial symptom improvements were seen after treatment in both males and females, and the observed differences at each timepoint were all small in magnitude. Interestingly, the sex of the therapist did not influence patient response to CBT-I, nor did it interact with participant sex. Moreover, and given the current issues with access to CBT-I, this finding promisingly suggests that therapist's sex need not be a consideration when referring patients for treatment.

Taken together, these findings demonstrate that CBT-I is effective for treating insomnia symptoms in both males and females. While significant differences were observed between males and females on the FFS, DFFS, and depression subscale of the DASS, all were small effects and likely not clinically meaningful (2 to 3-point differences in the change from baseline). Further, the responder analyses suggested that similar rates of clinically-meaningful treatment response were observed between males and females. Importantly, these findings suggests that the same treatment approach can be used to resolve insomnia symptoms in

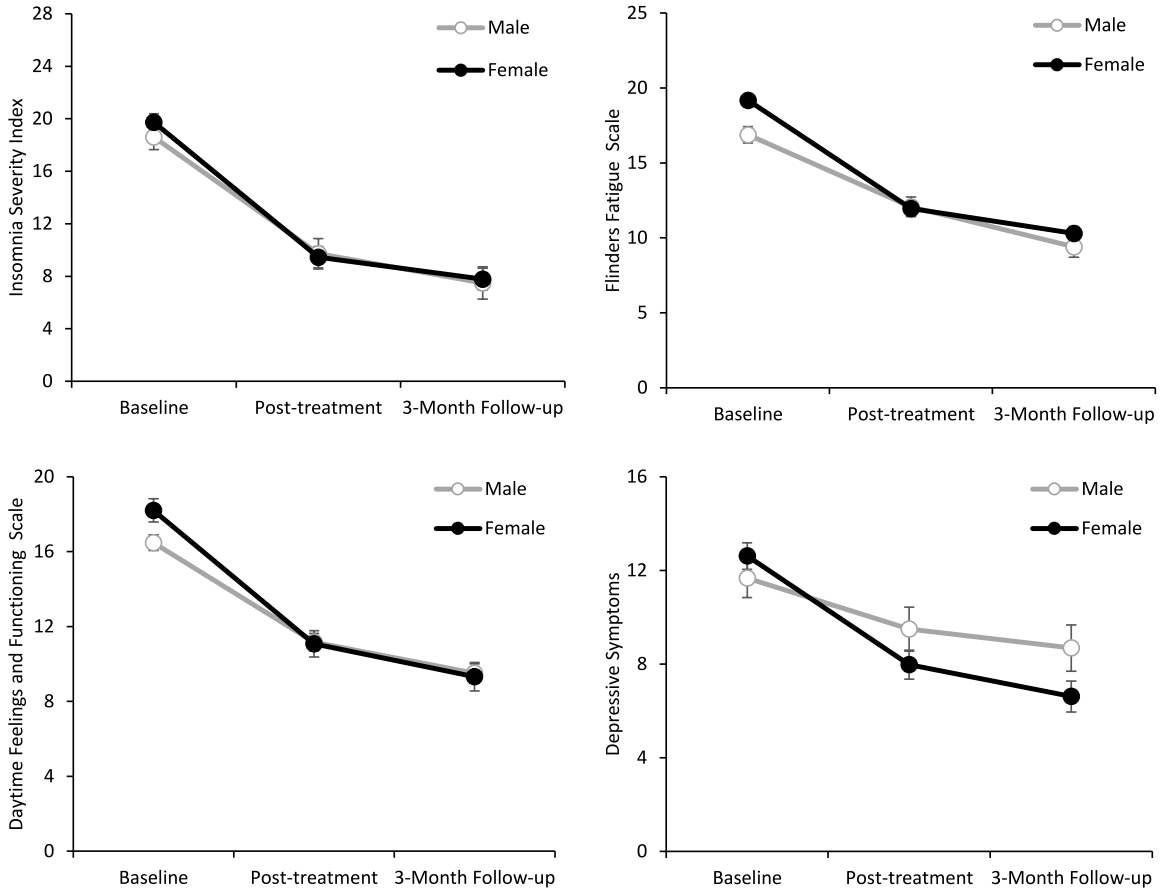

Fig. 1. Insomnia Severity Index (top left), Flinders Fatigue Scale (top right), Daytime Feelings and Functioning Scale (bottom left) and self-reported depressive symptoms (bottom right) on the Depression, Anxiety, Stress Scale from baseline to 3-month follow-up, separated by males and females. All values are EMM±SEM.

both males and females. Given that males are less likely to seek help for mental health conditions than females [36,37], this is an important message to promote amongst the community to support males to seek help for insomnia. Further, treating insomnia comes with many added benefits for mental health [38–40]: encouraging males to seek treatment for insomnia may further support them towards efforts to improve their mental health.

While this study had many strengths, there were some limitations worth considering. First, like in many real-world clinical programs, there were missing data across all timepoints: a common limitation with retrospective chart reviews. It is possible that patients who experienced greater benefits from treatment were more likely to complete post-treatment and follow-up questionnaires, thereby biasing toward a greater overall treatment-response. However, no significant between-group differences were observed in rates of missing data for any outcome across timepoints (see Supplementary File). Second, patient sex could only be explored as the binary male/female in this clinical cohort due to the limitations of data entry in public health records. Future research is warranted to explore whether patient sex other than male/female and patient gender influence insomnia presentation and response to treatment. Third, other important variables that could intersect with sex were not available for this study, such as ethnicity, race, and socioeconomic factors. In addition, hypnotic medication use or any information about other potential treatments was unavailable and could not be explored as a confound in the existing analyses. Data collection was limited to information needed for clinical purposes and these other variables were not routinely collected. Prospectively establishing clinical datasets for the investigation of these research topics is warranted to enable further research. Finally, studies with longer-term follow ups than three months are needed to examine any differences in sleep and daytime symptom improvements between sexes that may emerge, given that increases in total sleep time have been observed up to 12 months after treatment end [41].

5. Conclusion

The present study is amongst the first to demonstrate that, despite significant but small differences, insomnia symptoms are significantly reduced following CBT-I in both males and females. The observed post-treatment differences were small and do not by themselves warrant altered treatment approaches with either males or females. This is an important message for encouraging males, a group known to be less likely to seek help for mental health conditions, to seek treatment for insomnia. However, the idea that males, females, and non-binary people have differing needs with respect to CBT-I is still worth exploring, given the many sex-specific changes that occur throughout the lifespan during which targeted sleep interventions may be most beneficial. Future studies should thus still consider sex and gender, and the ways in which they may influence treatment experiences and treatment outcomes.

CRediT authorship contribution statement

Hannah Scott: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Conceptualization. **Alexandria Muench:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Sarah Appleton:** Writing – review & editing, Conceptualization. **Amy C. Reynolds:** Writing – review & editing, Writing – original draft,

Conceptualization. **Kelly A. Loffler:** Writing – review & editing. **Kelsey Bickley:** Data curation. **Jenny Haycock:** Writing – review & editing, Data curation. **Nicole Lovato:** Writing – review & editing, Conceptualization. **Gorica Micic:** Writing – original draft. **Leon Lack:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Alexander Sweetman:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Authors declare none.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2024.02.034.

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