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Moderators of outcome in self-guided internet-delivered cognitive-behavior therapy for obsessive-compulsive disorder

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ABSTRACT

Internet-delivered cognitive behavioural therapy (ICBT) is an effective treatment for obsessive-compulsive disorder (OCD). Currently there is limited research examining the predictors and moderators of outcome in ICBT for OCD. This study examined moderators of treatment outcome in a sample of 216 individuals who commenced a self-guided ICBT intervention for OCD (*M*age = 34.00; *SD* = 12.57; 72.7% female). The results indicated that those with higher baseline OCD severity, depression severity, and neuroticism had less improvement at post-treatment and follow up (resulting in 40%, 24% and 12% higher symptom severity for every standard deviation increase on the measure at post-treatment and 33%, 17% and 20% higher symptoms at follow up respectively). However, participants with higher baseline treatment expectancy and readiness to reduce rituals and compulsions had better outcomes at post-treatment and three-month follow up (resulting in a 5% and 7% lower symptom severity for every standard deviation increase on the measure at post-treatment and 12% and 12% lower symptoms at follow up respectively). The results have important implications for who may respond best to self-guided ICBT.

Obsessive-compulsive disorder (OCD) is a common psychological condition (Kessler et al., 2012) that is characterised by intrusive and distressing thoughts, images, and urges, as well as repetitive and time consuming compulsions (American Psychiatric Association, 2022). OCD is a chronic condition, with little chance of spontaneous remission (Melkonian et al., 2022). Cognitive behavioural therapy (CBT) is an effective treatment for OCD with large effect sizes seen in multiple meta-analyses (Olatunji et al., 2013; Reid et al., 2021). However, there are barriers to accessing CBT for many patients, including those related to direct and indirect costs, difficulties accessing a qualified clinician and stigma (Gentle et al., 2014; Marques et al., 2010).

Internet-delivered CBT (ICBT) reduces many of these barriers and is an effective treatment for OCD with results from clinical trials (Andersson et al., 2012; Mahoney et al., 2014; Wootton et al., 2019) and effectiveness studies (Luu et al., 2020; Wootton et al., 2021) demonstrating significant reductions in OCD symptoms. More recent evidence also suggests that ICBT is non-inferior to face-to-face CBT for OCD, with both treatment approaches resulting in large within-group and small between-group effect sizes (Lundström et al., 2022). Thus, individuals with OCD now have multiple evidence-based options when accessing CBT for OCD. However, our understanding of who responds best to ICBT for OCD is under-researched.

A number of reviews have now investigated predictors and/or moderators of outcome in CBT for OCD (e.g., Keeley et al., 2008; Knopp et al., 2013; Olatunji et al., 2013; Reid et al., 2021), however inconsistent findings are typically found. These inconsistent findings may be explained by differences in samples (e.g., diagnosed versus undiagnosed OCD), as well as the version of DSM used to make diagnoses. That is, prior to DSM-5 symptoms of hoarding disorder were classified as OCD, and this disorder is now classified as an independent disorder (American Psychiatric Association, 2022) that is characterised by significant co-morbidity (Frost et al., 2011). Thus, samples of individuals with OCD who had high proportions of patients who would now be diagnosed with hoarding disorder may not be appropriate and may introduce significant noise into the data.

The most recent review of predictors of outcome was conducted by

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McDonald et al. (2023) who examined the predictors of outcome in eight studies that only included participants who were diagnosed with a structured diagnostic interview and met diagnostic criteria for DSM-5 OCD (i.e., those with hoarding symptoms were not included). This study found that some pre-treatment variables including baseline OCD severity, past treatment, and levels of avoidance may predict a poor outcome, as did 'during treatment' variables of poor working alliance and treatment adherence (McDonald et al., 2023). All of the review studies conducted to date that have examined the predictors of outcome in CBT for OCD have included those receiving face-to-face CBT or a mix of face-to-face and internet-delivered CBT. It is possible that the predictors of outcome may differ between face-to-face CBT and ICBT. For instance, despite the intervention materials being similar, the information is presented in very different formats, and this may affect predictors of outcomes. Similarly, there is a much smaller amount of therapist contact in ICBT when compared to face-to-face CBT. For these reasons it is possible, for example, that patients may require higher levels of motivation to complete ICBT compared with face-to-face CBT. Thus, further research investigating predictors of outcome specifically in ICBT is required.

To date three studies have examined predictors of outcome in clinician-guided ICBT for OCD. In clinician-guided ICBT participants are supported by a clinician as they work their way through the online materials. Firstly, in a large study (N = 101), Andersson et al. (2015) found that higher baseline OCD severity, higher levels of disgust, and lower scores on the Working Alliance Inventory (Horvath & Greenberg, 1989) predicted worse treatment outcome. Secondly, in a smaller study (N = 24), baseline OCD severity did not predict outcome, however increased readiness to reduce avoidance and higher attendance at adjunct telephone therapy sessions did predict improved outcome (Diefenbach et al., 2015). Finally, in another smaller study (N = 30) Wheaton et al. (2021) found that higher baseline OCD severity, higher levels of avoidance, and past CBT for OCD predicted worse outcomes.

While a profile of who may respond better in clinician-guided ICBT is emerging (i.e., those who are treatment naïve, have lower OCD severity, lower disgust severity, lower levels of avoidance, higher adherence to treatment and higher perceived working alliance) there is very little information on predictors of outcome in self-guided ICBT for OCD. Self-guided ICBT interventions do not involve any direct contact with a clinician, and thus may have different predictors of outcome to clinician-guided interventions. For instance, engaging in a self-guided intervention may require higher levels of motivation or personality traits such as conscientiousness. Similarly, individuals who have higher levels of depression may respond better to ICBT programs that include clinician support. A previous study conducted by our team investigating preliminary predictors of outcome in a large sample (N = 157) of participants who commenced a self-guided ICBT intervention for OCD found that higher baseline OCD severity, younger age, experiencing higher contamination or symmetry symptoms, and a history of past treatment significantly predicted higher post-treatment OCD severity, while younger age, and a history of previous treatment predicted participants who were less likely to obtain a clinical response (Wootton et al., 2024).

Given the small amount of literature examining who responds best to self-guided ICBT for OCD the aim of the current study was to replicate our previous study in a new sample and extend the literature by examining moderators of outcome in a large international sample of individuals who commenced a self-guided ICBT intervention for OCD. We examined variables that have previously shown to be related to treatment outcome in in-person CBT, as well as variables related to outcome in ICBT for OCD, such as demographic, baseline severity of symptoms, level of disgust, past treatment, motivation to change, treatment adherence, symptoms duration, type of obsession (autogenous or reactive) (Lee & Kwon, 2003) and type of compulsion (harm avoidance or incompleteness) (Summerfeldt et al., 2014). We also examined variables that may yet be unstudied or be relevant based on the nature of ICBT (e.g., personality factors, attitudes towards professional help seeking, perfectionism, and treatment expectancy). Given the limited literature on this topic this study was designed as exploratory.

1. Method

1.1. Design

This was a secondary data analysis of an open trial examining the efficacy of self-guided ICBT for individuals with OCD using a large international sample (Wootton et al., 2023). The original study was pre-registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12620000146998) and ethical approval was provided from the Human Research Ethics Committee at Macquarie University (REF No: 5201701075).

1.2. Participants

Participants included 216 individuals who commenced a self-guided ICBT intervention (*M*age = 34.00; *SD* = 12.57; range 18–78; 72.7% female). The demographic characteristics of the sample are outlined in Table 1. Participants were recruited between February 18, 2020 and December 7, 2021. Reported recruitment source included 1) internet search (82/216; 38.4%), 2) International OCD Foundation website (30/216; 13.9%), 3) Email from the eCentreClinic (4/216; 1.9), 4) Friend, family member, or support group (22/216; 10.2%), 5) health practitioner or service (21/216; 9.7%), 6) social media advertisement 54/216; 25.0%), and 7) 'Other' (2/216; 0.9%). To be included in the original study participants were required to be English speaking (which was self-reported in the demographic questionnaire), be aged 18 years or older, have regular access to the internet, to be at low risk of suicide (i.e., no suicidal plans or intentions or recent history of suicide attempts or deliberate self-harm), demonstrate OCD symptoms by scoring at least 7 on one of the subscales of the Dimensional Obsessive-Compulsive Scale (DOCS; Abramowitz et al., 2010), at least 14 on the self-report version of the Yale-Brown Obsessive-Compulsive Scale (YBOCS; Goodman et al., 1989), and meeting criteria on the OCD module of the Diagnostic Interview for Anxiety, Mood, Obsessive-Compulsive and other Neuropsychiatric Disorders (DIAMOND; Tolin et al., 2018), which was administered in a self-report format.

1.3. Measures

1.3.1. Demographic variables

The following demographic information was used for this secondary data analysis: 1) age; 2) gender; 3) location (country); 4) geographical location (urban or rural); 5) medication status; and 6) whether the participant had previously received psychological treatment for OCD.

Table 1
Demographic characteristics of the sample (N = 216).

Variable		Mean (SD)	N (%)
Age		34.01 (12.57)	–
Gender	*Female*	–	157 (72.7)
	Male	–	53 (24.5)
	Other	–	6 (2.8)
Location	*Oceania*	–	66 (30.6)
	North America	–	87 (40.3)
	United Kingdom	–	24 (11.1)
	Asia	–	20 (9.3)
	European Union	–	15 (6.9)
	Other	–	4 (1.9)
Geographical location	*Capital city*	–	138 (63.9)
	Other urban	–	35 (16.2)
	Rural or remote	–	43 (19.9)
Medication (% yes)		–	94 (43.5)
Previous treatment (% yes)[a]		–	122 (56.5%)

[a] Indicates N = 171 (data collected at post-treatment).

1.3.2. Diagnostic tool

The OCD module of the Diagnostic Interview for Anxiety, Mood, Obsessive-Compulsive and other Neuropsychiatric Disorders (DIAMOND; Tolin et al., 2018) was administered to examine whether the participant was likely to meet diagnostic criteria for OCD. The DIAMOND OCD module demonstrates good psychometric properties when administered in a clinician-administered format: 'very good' interrater reliability (κ = .62), 'excellent' test retest reliability (κ = .83), and excellent convergent validity with the Obsessive Compulsive Inventory – Revised (OCI-R; Foa et al., 2002) (Tolin et al., 2018). In the current study the OCD module was administered in a self-report format.

1.3.3. Baseline severity of OCD symptoms

The baseline severity of OCD symptoms was measured using multiple measures. Firstly, the self-report version of the *Yale-Brown Obsessive Compulsive Scale (YBOCS)* (*Goodman* et al., *1989*) was used. The YBOCS is a commonly used 10-item scale of OCD symptom severity. The total score, as well as the obsessions and compulsions subscale scores were calculated for this measure. The internal consistency in this sample was .821 (Wootton et al., 2023). Secondly, the total score and subscale scores on the *Dimensional Obsessive Compulsive Scale (DOCS)* (*Abramowitz* et al., *2010*) were also calculated. The DOCS is a 20-item self-report measure assessing the severity of four OCD symptom subtypes including 1) contamination obsessions and washing/cleaning compulsions; 2) responsibility for harm, injury, or bad luck obsessions and checking/-reassurance seeking compulsions; 3) unacceptable obsessional thoughts with mental or neutralizing compulsions; 4) symmetry, incompleteness and exactness obsessions with ordering/arranging or repeating compulsions (Abramowitz et al., 2010). The internal consistency in this sample was .878 (Wootton et al., 2023). Finally, the baseline score on the self-report version of the *Clinician Global Impression Scale* (CGI; Guy, 1976) was used. This is a single item measure of OCD severity on a 7-point scale ranging from 1 (normal) to 7 (extreme problem).

1.3.4. Baseline severity of depressive symptoms

Baseline depressive symptoms were measured with the nine-item Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001). The PHQ-9 is a commonly used brief measure of depressive symptoms and a score ≥10 typically indicates clinically significant symptoms of major depressive disorder (Kroenke et al., 2001; Levis et al., 2019). The internal consistency in the current sample was .856 (Wootton et al., 2023).

1.3.5. Other clinical variables

Readiness to change was assessed with the *Readiness Ruler (RR)* (Simpson et al., 2010), a two-item measure that assesses how ready the participant is to 1) stop rituals and compulsions and 2) stop avoiding situations that triggers obsessions or compulsions on a scale of 0 (not ready) to 10 (already trying). *Length of symptoms* was self-reported by participants at baseline. Early improvement was measured with the self-report CGI (Improvement) scale (CGI; Guy, 1976), administered at mid-treatment.

1.3.6. Type of obsession and compulsion

Type of obsession was measured with the *Type of Obsession Questionnaire*, a two-item purpose-built scale that aims to determine the type of obsession experienced by the patient based on the conceptualization of obsessions by Lee and Kwon (2003). On a 0 (strongly disagree) to 10 (strongly agree) scale participants are asked to respond to the following question to assess reactive obsessions *"My obsessions are generally triggered by something happening in my day/surroundings"* as well as the following question to assess autogenous obsessions *"My obsessions generally pop up out of nowhere rather than being triggered"*. Similarly, reasons for engaging in compulsions were assessed with the *Reason for Compulsion Questionnaire*, a two-item purpose build measure that aims to determine the patient's reason for engaging in compulsions based on the conceptualization of compulsions by Summerfeldt et al. (2014). On a 0 (strongly disagree) to 10 (strongly agree) scale participants are asked to respond to the following question to assess harm avoidance "*I mostly complete my compulsions in order to prevent or reduce feelings that something bad might happen to myself or others"* and *"I mostly complete my compulsions in order to prevent or reduce feelings of 'incompleteness' or things 'not being quite right"* to assess incompleteness.

1.3.7. Treatment variables

Treatment variables examined include 1) the number of lessons commenced (collected automatically by the ICBT platform) and 2) time spent on the program (in minutes), which was self-reported by the participants at mid-treatment (*"On average, how many minutes have you spent per day working on the skills described in the Course in the last four weeks")*.

1.3.8. Other variables

Disgust was measured with the *Disgust Propensity and Sensitivity Scale - Revised* (DPSS-R) (Fergus & Valentiner, 2009), a 12 item measure of disgust (internal consistency was .909 in this sample). Perfectionism was measured with Clinical Perfectionism Questionnaire (CPQ) (Fairburn et al., 2003), a 12-item measure of perfectionism (internal consistency was .808 in this sample). Attitudes towards professional help seeking for a mental health condition was measured with the 10-item Attitudes Towards Seeking Professional Psychological Help – Short Form (ATSPPH-SF) (Fischer & Farina, 1995). On the ATSPPH-SF higher scores increase more favourable attitudes towards seeking professional help. Internal consistency of the ATSPPH-SF was .760 in this sample. The Big-5 personality variables were measured with the Big Five Inventory 10-item (BFI-10) (Rammstedt & John, 2007), a 10-item scale designed to measure the personality traits of extraversion, agreeableness, conscientiousness, emotional stability and openness (2-items each). Treatment expectancy was measured with the 6-item Credibility and Expectancy Questionnaire (CEQ) (Devilly & Borkovec, 2000).

Scores on each of the variables of interest are outlined in Table 2. All

Table 2
Clinical characteristics of the sample (N = 216).

Variable		Mean (SD)
Baseline severity	*YBOCS total score*	23.35 (4.99)
	YBOCS obsessions total	11.80 (2.65)
	YBOCS compulsions total	11.55 (2.98)
	DOCS total	31.28 (13.27)
	DOCS contamination total	7.01 (6.07)
	DOCS harming total	9.31 (5.26)
	DOCS thoughts total	8.88 (5.54)
	DOCS symmetry total	6.08 (5.21)
	CGI (severity)[a]	4.35 (0.93)
	PHQ-9 total	11.52 (6.19)
Clinical variables	*Readiness to stop rituals/compulsions*	7.44 (2.64)
	Readiness to stop avoidance	6.97 (2.70)
	Length of symptoms (years)	16.73 (12.18)
	Mid-treatment improvement (CGI-I) [a]	3.52 (0.93)
	Autogenous obsessions	5.96 (2.91)
	Reactive obsessions	7.18 (2.57)
	Harm reduction	7.65 (2.90)
	Incompleteness	6.03 (3.42)
Treatment variables	*Number of lessons commenced*	3.61 (1.64)
	Time spent on practicing skills (mins) [b]	40.49 (41.84)
Other variables	*Pre-treatment DPSS-R total*	30.19 (10.44)
	Pre-treatment CPQ total	30.69 (6.51)
	Pre-treatment ATSPPH total	22.62 (4.61)
	Pre-treatment extroversion	5.48 (2.35)
	Pre-treatment agreeableness	6.22 (2.01)
	Pre-treatment neuroticism	8.62 (1.62)
	Pre-treatment openness	7.76 (1.87)
	Pre-treatment conscientiousness	7.23 (2.03)
	Pre-treatment CEQ [c]	35.24 (9.89)

[a] Indicates N = 143 (collected at mid-treatment).
[b] Indicates N = 123 provided useable data.
[c] Indicates N = 215.

measures were administered via the secure eCentreClinic platform.

1.4. Treatment

The intervention was delivered via the eCentreClinic platform (www.ecentreclinic.org) and all participants logged in with a unique username and password. The ICBT intervention is a 5-module program that is delivered over 8-weeks according to a pre-determined timeframe and participants are not able to access modules outside of this timeline. The intervention has previously been shown to be effective in this sample (Wootton et al., 2023) as well as other samples when delivered in a self-guided format (Wootton et al., 2014, 2019). The content of the 5-modules includes: 1) psychoeducation; 2) behavioral experiments; 3); behavioral activation/arousal reduction; 4) exposure and response prevention and 5) relapse prevention. Participants did not have any contact with a clinician at any point during the assessment or treatment in this study. All participants completed the same intervention despite their geographical location. The system automatically notifies participants via email when a module is available and when they have missed a module. The system also monitors participant interaction with the intervention, such as when they commenced a module and the amount of time they spent reading the module.

1.5. Statistical analysis

The statistical testing of the moderators of outcomes was conducted with several incremental steps. Initially, we utilized a series of weighted, longitudinal, generalized estimation equation models (Liang & Zeger, 1986) in the first step to quantify the rate of symptom change over time from the pre-treatment to post-treatment window and then from pre-treatment to three-month follow-up. In these analyses, we examined the association of 35 demographic, baseline severity, treatment variables, clinical variables, and other covariates for their relationship with varying rates of symptom change over time. The model was fitted using generalized estimating equations (GEE) with a gamma distribution and a log-link function. An unstructured working correlation matrix with robust standard errors was specified (Karin et al., 2018). The estimation of the change over time parameter was structured to capture the average percentage change in symptoms from pre-treatment to post-treatment, reflecting the typical therapeutic effect, and then extending to follow-up. These models incorporated a time-by-covariate interaction, designed to illustrate the degree to which a covariate alters the treatment outcomes from pre-treatment. In our output, we configured these estimates to illustrate the moderation of treatment outcomes as either a percentage increase (e.g. relatively increased outcome symptoms when exp(β) parameters are positive) or a percentage decrease (e.g. relatively decreased outcome symptoms when exp(β) parameters are negative) in post-treatment YBOCS scores, while accounting for all other variables.

In the second step, we analysed participant symptom outcomes through a multivariate analysis at both post-treatment and three-month follow-up. Here, we utilized artificial neural network algorithms (Szalisznyó & Silverstein, 2021), specifically designed to accommodate the numerous high-dimensional combinations of variables and the potential for more multivariate and personalized model predictions. Neural networks are based on a non-greedy and non-parametric assembly algorithm that can effectively capture the multiple, joint, and potentially non-parametric influences of various predictors and their impact on outcome prediction. The main assessment drawn from this multivariate viewpoint is the R square metric, showcasing the potential for our selected variables to create a highly adaptable, albeit less immediately interpretable, multivariate prediction. This multivariate metric serves as a benchmark to compare against various univariate models.

In the third step, we integrated the pattern of results into a comparative and comprehensive graphic, taking into account both metrics of change over time and the magnitude of association with treatment outcomes. To achieve this, we utilized a cumulative bar chart, which aggregates the contribution of each predictor to the modification of the average treatment effect (time * covariate moderation), the prediction of outcomes (R squared), and both these outcomes at both post-treatment and three-month follow-up.

1.5.1. Statistical weighting for initial YBOCS symptom severity

Throughout our models, we applied a sampling weighting function, employing inverse probability weighting, a common propensity score weighting adjustment method (Rosenbaum & Rubin, 1983). Propensity score methods are well-regarded for their usefulness in causal inference and discovery of treatment effects (Mao et al., 2019), particularly in clinical trials where certain crucial attributes of the sample exhibit limited variance and dispersion, such as the under sampling of patients with mild and severe baseline symptoms. This oversampling technique promotes synthetic balance in the distribution of initial symptom scores, thereby equalizing the likelihood of observing a participant within each of the minimal, mild, moderate, and severe symptom ranges. Consequently, weighting enables us to approximate treatment efficacy in a manner that generalizes to a broader spectrum of patients with various initial symptom presentations, rather than disproportionately representing patients with moderate symptoms.

1.5.2. Missing data

In our handling of missing data, we initially tested assumptions regarding systematic dropout and bias. This examination led to the identification of a single dominant effect (Incremental lesson completion, Wald Chi Square = 101.9, Nagelkerke R Square ~ 59.6%), suggesting a conditional missing at random assumption. This result is consistent with previous findings in the ICBT literature (Karin et al., 2021). However, considering the variety of models we evaluated and the potential for uncertain, and potentially artificial, moderation between missing data imputations and the range of covariates, we opted for replacing missing data under the Full Information Maximum Likelihood (FIML) assumption. This decision reflects the diverse range of covariates and statistical weighting incorporated in each model, rather than relying on a common imputation method.

1.5.3. Gauging the magnitude of effect moderation

In our evaluation of all predictors and their influence on treatment outcomes, we primarily focused on the moderation of change over time as the key measure of progress, indicative of the therapeutic process. However, we acknowledge that in non-randomized samples (e.g., multifaceted and stratified samples), outcomes can be assessed by either estimating change metrics, such as assessing the rate of pre-treatment to post-treatment change over time, or by comparing the outcome scores of patients at post-treatment (e.g., prediction accuracy and variance explained; Chicco et al., 2021). Therefore, in line with established practice (Chicco et al., 2021), we estimated the magnitude of treatment effect moderation in two ways: first, by examining how each covariate could moderate the rate of symptom change from pre-treatment to post-treatment and three-month follow-up (e.g. time*group effects); and second, by assessing the percentage of variance explained (R-squared) by the predicted model values at post-treatment and 3-month follow up. However, we de-prioritized the interpretation of the latter metric due to its susceptibility to misrepresentation of outcomes under conditions of no change (e.g., a stationarity effect). For example, if symptom scores remain unchanged from pre-treatment to post-treatment, they would perfectly predict outcomes at post-treatment (100%), potentially creating a misleading impression. While we do not assume such an outcome, we present both metrics and emphasize the time by covariate interaction coefficients as the primary indicator of effect modification. To facilitate the interpretation of the magnitude of change across a wide range of outcomes, we standardized all the continuous variables considered. By doing so, the relationship between continuous covariates and the rate of YBOCS symptom change is expressed *per* 1 standard deviation of each covariate, and is consequently comparable irrespective

of differing scales and score ranges.

1.5.4. Sensitivity analysis

Finally, in accordance with guidelines for observational studies (STROBE; von Elm et al., 2007), we conducted sensitivity analyses to compare our models. This included comparing the use of propensity score-weighted models with unweighted models and with models that weighted for the propensity score of each covariate rather than YBOCS baseline symptoms (doubly robust models). Our reporting of covariate analyses prioritized weighted models, while unweighted predictor models are provided in Supplementary Table S1.

Statistical analyses were conducted using SPSS version 27, with an alpha level set at 0.05. This threshold was chosen to balance the possibility of a type I error within multiple contrasts and the need to detect potential marginal trends within more nuanced subgroups, as well as higher-order interactions.

2. Results

2.1. Overall results

The overall results from the various moderators of treatment change are presented in a tornado bar chart in Fig. 1. The predictors are organised into the following categories and are displayed in the following order: 1) demographics, 2) baseline severity, 3) clinical variables, 4) treatment variables, and 5) 'other' variables. The results in each category are further discussed below.

2.2. Demographic variables

The univariate moderation test for each of the demographic variables at post-treatment and at 3-month follow up is provided in Table 3. Age emerged as a moderator of overall effect explaining approximately 5% of the variance in post-treatment outcome. For every standard deviation increase in age, OCD symptoms decreased 3.1% on the YBOCS, indicating that older participants had lower scores at post-treatment. However, this was no longer significant at 3-month follow up (see Table 3). Similarly, gender emerged as a moderator of overall effect, explaining approximately 5% of the variance in post-treatment outcome on the YBOCS. The results indicate that males have 7.5% higher symptoms on the YBOCS at post-treatment compared with females. However, this finding was no longer significant at 3 month follow up (see Table 3).

Participant location was also a moderator of overall effect, however explained less than 1% of the overall variance in post-treatment outcome. When compared with 'Oceania' participants, participants in Asia, United Kingdom, and North America had higher symptoms on the YBOCS at post-treatment (18%, 14%, and 9% respectively) and participants classified in 'other' countries had 32% lower symptoms on the YBOCS at post-treatment. At 3-month follow up participants in Asia, United Kingdom and 'other' all had significantly lower symptoms when compared with 'Oceania' participants (25%, 14%, and 68% respectively).

Finally, those who had previously received treatment had 6% higher symptoms on the YBOCS at post-treatment compared with those who were treatment naïve, and this variable explained 8% of the variance in post-treatment outcome, however this was no longer significant at 3-month follow up. Rurality of the participant and medication use did not moderate treatment outcomes on the YBOCS at post-treatment, however medication use did moderate treatment outcome at 3-month follow up. When compared with participants who were not taking medication, participants who were medicated had symptoms that were 29% higher on the YBOCS at 3 month follow up (see Table 3).

2.3. Baseline severity

The univariate moderation test for each of the baseline severity variables at post-treatment and at 3 month follow up is outlined in Table 4. All baseline OCD severity measures moderated post-treatment effects on the YBOCS, explaining a significant proportion of the variance (range: 13% for the DOCS symmetry subscale to 74.5% for the YBOCS total score). For the YBOCS total score, for every standard deviation increase in baseline scores participants had 40% higher symptoms on the YBOCS at post-treatment. For the DOCS total score, for every standard deviation increase in baseline score on the DOCS participants had 23% higher symptoms on the YBOCS at post-treatment and for the CGI-S, for every standard deviation increase in baseline score participants had 35% higher scores on the YBOCS at post-treatment. A similar result was found for the PHQ-9, where for every standard deviation increase in baseline PHQ-9 score participants had 24% higher OCD symptoms on the YBOCS at post-treatment. Similar results were found at 3-month follow up (see Table 4) with all OCD severity measures and depressive symptom measures continuing to moderate treatment outcome on the YBOCS.

2.4. Clinical variables

The univariate moderation test for each of the clinical variables at post-treatment and 3-month follow up is outlined in Table 5. Readiness to reduce rituals/compulsions and readiness to stop avoiding triggers were significant moderators of outcome (post-treatment YBOCS score) explaining 10% and 3% of the variance respectively. For every standard deviation in readiness to reduce rituals/compulsions at baseline participants had 7.3% lower OCD symptoms on the YBOCS at post-treatment. A similar result was found for readiness to reduce avoidance. With every standard deviation increase in readiness to reduce avoidance at baseline participants had 4% lower symptoms on the YBOCS at post-treatment. These results indicate that participants who were more motivated at baseline are more likely to be improved at post-treatment. Similar results were seen at 3-month follow up (see Table 5) with the reduction in symptoms increasing to 12% and 15% for readiness to reduce rituals/compulsions and readiness to reduce avoidance respectively.

Type of obsession and reason for compulsions were also significant moderators of outcome. For every standard deviation increase on the measure of reactive obsessions participants had 9% higher symptoms at post-treatment on the YBOCS (explaining 8% of the variance). At 3-month follow up there was a 13% increase in symptoms on the YBOCS for those who had higher baseline scores on the reactive obsession measure. For every standard deviation increase on the measure of autogenous obsessions at baseline participants had 4% higher symptoms on the YBOCS at post-treatment (explaining 11% of the variance). However, at 3-month follow up higher baseline scores on the autogenous obsessions measure predicted 6% lower symptoms at 3-month follow up. This indicates that at 3-month follow up participants with higher autogenous obsessions had better outcomes on the YBOCS (i.e., lower scores) than those who had higher scores on the reactive obsessions measure.

For every standard deviation increase in the measure designed to assess whether compulsions are completed to reduce harm participants had 12% higher scores on the YBOCS at post-treatment and 20% higher scores on the YBOCS at 3-month follow up (explaining 16% and 7% of the variance respectively). For every standard deviation in the measure designed to assess whether compulsions are completed to reduce a sense of incompleteness at baseline participants had 4% lower OCD symptoms on the YBOCS at post-treatment and 3-month follow up (explaining 7% and 3% of the variance respectively) indicating that individuals that are higher on incompleteness at baseline responded better to the treatment.

Mid-treatment improvement also emerged as a moderator of overall effect explaining approximately 7% of the variance in post-treatment outcome on the YBOCS and 2% of the variance in 3-month follow up outcome on the YBOCS. For every standard deviation increase in CGI-I scores at mid-treatment, participants had 33% higher scores at post-

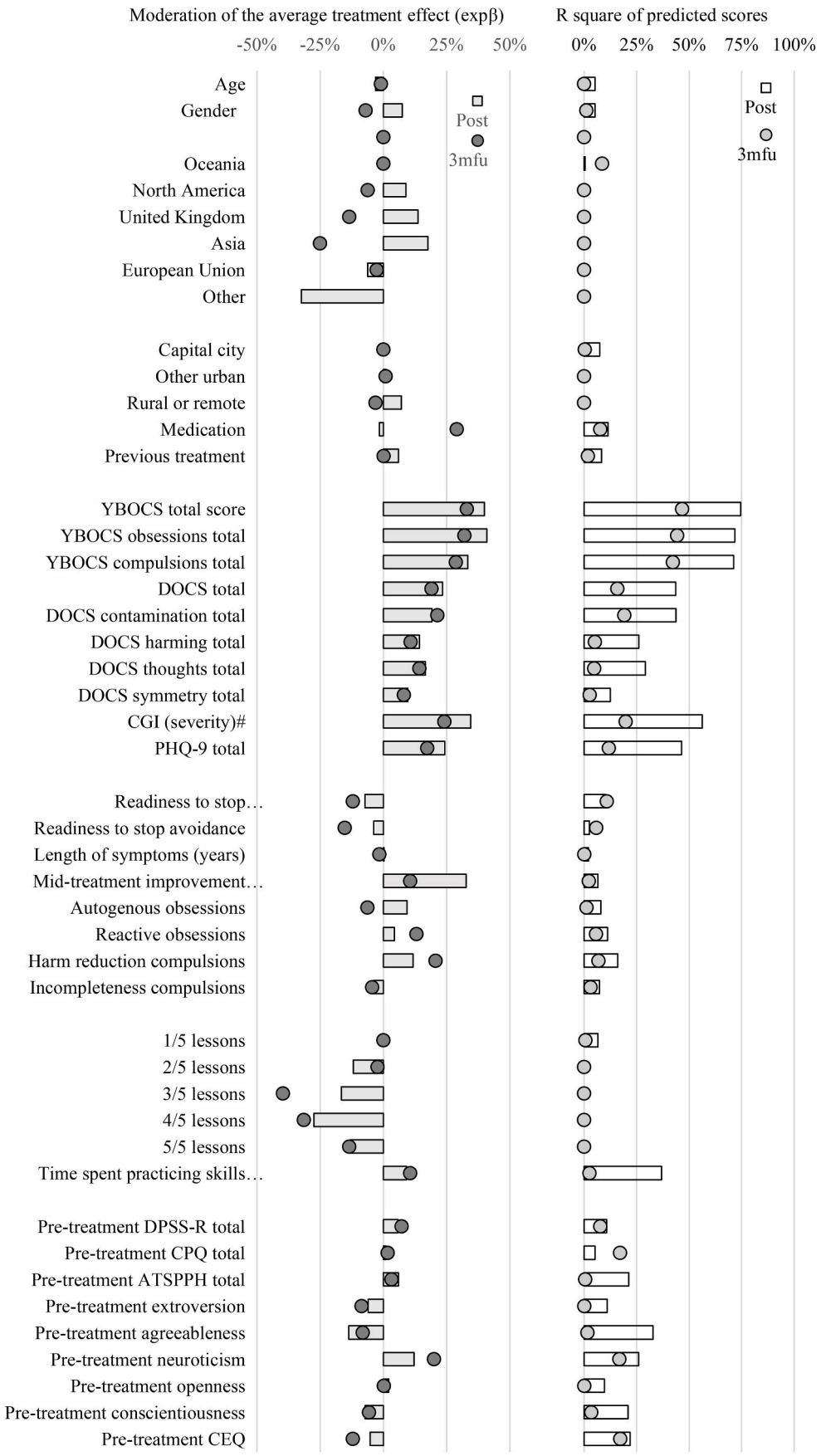

Fig. 1. Tornado chart synthesis illustrating the relative ability of each predictor to predict and account for YBOCS outcome variance, at post-treatment (Bars) and at three months follow-up (dots).

Table 3
Univariate moderation test of symptom change (YBOCS) over time for demographic variables.

	Global test of moderation		Post-treatment			Follow up		
	Time*Covariate (Wald χ^2)	p value	Post Tx expβ (% of effect)	p value	R square	3 month follow up expβ (% of effect)	p value	R square
Age	33.9	<.001	−3.1% (−5.5 to −0.6)	.016	5.2%	−1% (−3.9 to 2)	.524	<0.1%
Gender ^	65.9	<.001	7.5% (1.4–14)	.015	5.2%	−7% (−14.2 to 0.7)	.075	1%
Location								
Oceania	411.0	<.001	–	–	0.5%	–	–	8.5%
North America	–	–	8.9% (3.7–14.4)	.001	–	−6.2% (−12.1 to 0)	.050	–
United Kingdom	–	–	13.7% (7–20.8)	<.001	–	−13.5% (−20.9 to −5.3)	.002	–
Asia	–	–	17.6% (7.5–28.6)	<.001	–	−25.1% (−31.4 to −18.1)	<.001	–
European Union	–	–	−6.2% (−15.8 to 4.3)	.237	–	−2.7% (−17.7 to 15.1)	.750	–
Other	–	–	−32.4% (−39.6 to −24.4)	<.001	–	−67.6% (−76.1 to −56.1)	<.001	–
Geographical location								
Capital city	42.7	<.001	–	–	7.4%	–	–	0.3%
Other urban	–	–	1.2% (−5.5 to 8.4)	.724	–	0.9% (−14.6 to 19.1)	.918	–
Rural or remote	–	–	7.1% (−13.5 to 32.6)	.527	–	−3.1% (−55.8 to 112.6)	.937	–
Taking medication	116.2	<.001	−1.6% (−5.8 to 2.8)	.468	11.4%	29% (22.1–36.4)	<.001	7.7%
Had previous treatment	7.1	.068	6% (0.8–11.4)	.022	8.3%	0.1% (−5.6 to 6.3)	.961	1.8%

Note. ^ indicates that 'other' gender category was collapsed with female for this analysis due to insufficient variance.
Significant and positive expβ indicate percentage increase in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. Significant and negative expβ indicate percentage decrease in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable.

Table 4
Univariate moderation test of symptom change (YBOCS) over time for baseline severity measures.

	Global test of moderation		Post-treatment			Follow up		
	Time*Covariate (Wald χ^2)	p value	Post Tx expβ (% of effect)	p value	R square	3 month follow up expβ (% of effect)	p value	R square
YBOCS total	18921.7	<.001	39.9% (36.6–43.2)	<.001	74.5%	33% (28.7–37.5)	<.001	46.60%
YBOCS obsessions	3230.4	<.001	40.9% (38.1–43.8)	<.001	71.8%	32% (27–37.1)	<.001	44.20%
YBOCS compulsions	7193.5	<.001	33.3% (29–37.7)	<.001	71.2%	28.6% (24.5–32.8)	<.001	42.20%
DOCS total	945.6	<.001	23.4% (20.5–26.3)	<.001	43.6%	19% (14.9–23.2)	<.001	15.80%
DOCS contamination	591.8	<.001	19.2% (15.3–23.2)	<.001	43.7%	21.3% (17.2–25.6)	<.001	19.10%
DOCS harming	168.8	<.001	14.2% (10.6–17.9)	<.001	26.1%	10.8% (6.4–15.3)	<.001	5.10%
DOCS thoughts	130.0	<.001	16.6% (12.9–20.5)	<.001	29.2%	14.2% (9.9–18.7)	<.001	4.80%
DOCS symmetry	251.1	<.001	9.7% (6.3–13.2)	<.001	12.5%	8.1% (4.1–12.3)	<.001	2.60%
CGI (severity)#	1404.9	<.001	34.5% (31–38)	<.001	56.2%	24.1% (19.8–28.5)	<.001	19.70%
PHQ-9 total	272.0	<.001	24.3% (20.8–27.9)	<.001	46.4%	17.3% (13.2–21.5)	<.001	11.70%

Note. Significant and positive expβ indicate percentage increase in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. Significant and negative expβ indicate percentage decrease in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. YBOCS: Yale-Brown Obsessive Compulsive Scale; DOCS: Dimensional Obsessive-Compulsive Scale; CGI: Clinician Global Impression Scale; PHQ-9: Patient Health Questionnaire (9-item).

Table 5
Univariate moderation test of symptom change (YBOCS) over time for other clinical variables.

	Global test of moderation		Post-treatment			Follow up		
	Time* Covariate (Wald χ^2)	p value	Post Tx expβ (% of effect)	p value	R square	3 month follow up expβ (% of effect)	p value	R square
Readiness to stop rituals/ compulsions	171.5	<.001	−7.3% (−9.9 to −4.6)	<.001	10.3%	−12.1% (−14.6 to −9.6)	<.001	10.8%
Readiness to stop avoidance	201.9	<.001	−3.8% (−6.6 to −0.8)	.012	2.5%	−15.3% (−17.8 to −12.7)	<.001	5.7%
Length of symptoms (years)	15.3	.004	0.3% (−2.2 to 2.9)	.811	2.1%	−1.6% (−4.5 to 1.3)	.268	<0.1%
Mid-treatment CGI-I	345.4	<.001	32.7% (28–37.5)	<.001	6.6%	10.6% (7.1–14.2)	<.001	2.2%
Autogenous obsessions	107.9	<.001	9.3% (4.7–14.1)	<.001	8.0%	−6.3% (−11.2 to −1.1)	.018	1.1%
Reactive obsessions	86.1	<.001	4.4% (1.6–7.3)	.002	11.2%	13.1% (9.4–16.9)	<.001	5.6%
Harm reduction compulsions	183.9	<.001	11.7% (8.5–15)	<.001	16.0%	20.6% (16.2–25.3)	<.001	6.8%
Incompleteness compulsions	25	<.001	−3.9% (−7.2 to −0.6)	.022	7.3%	−4.4% (−7.6 to −1)	.010	3.1%

Note. Significant and positive expβ indicate percentage increase in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. Significant and negative expβ indicate percentage decrease in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. YBOCS: Yale-Brown Obsessive Compulsive Scale; DOCS: Dimensional Obsessive-Compulsive Scale; CGI: Clinician Global Impression Scale (Improvement); PHQ-9: Patient Health Questionnaire (9-item).

treatment on the YBOCS and 11% higher scores at 3-month follow up, indicating that the less improved participants are at mid-treatment the less likely they are to be improved at post-treatment and 3-month follow up. Symptom length did not moderate treatment outcomes at post-treatment or 3-month follow up on the YBOCS.

2.5. Treatment variables

The univariate moderation test for each of the treatment variables at post-treatment and at 3-month follow up are outlined in Table 6. All participants (216/216; 100%) commenced Lesson 1, while 177/216 (81.9%) commenced Lesson 2, 143/216 (66.2%) commenced Lesson 3, 130/216 (60.2%) commenced Lesson 4 and 113/216 (52.3%) commenced all five lessons. Number of lessons commenced, moderated treatment outcome and explained approximately 7% of the variance in post-treatment outcome on the YBOCS. When compared with participants who commenced one of the five lessons, participants who completed two of the five lessons had 12% lower symptoms, participants who completed three of the five lessons had 17% lower symptom, participants who completed four of the five lessons had 28% lower symptoms and participants who completed all modules had 13% lower symptoms on the YBOCS at post-treatment. Average amount of time (in minutes) working on the skills at mid-treatment also moderated treatment effects. For every standard deviation increase on this measure at mid-treatment participants had 9% higher scores at post-treatment on the YBOCS (explaining 37% of the variance) indicating that increased practice of the skills at mid-treatment results in increased symptomatology at post-treatment. These results remained consistent at 3-month follow up (see Table 6).

2.6. Other variables

The univariate moderation test for each of the 'other' variables at post-treatment and 3 month follow up are outlined in Table 7. As outlined in Table 7, for each standard deviation increase in total scores on the DPSS-R at baseline participants had 6% higher scores on the YBOCS at post-treatment and 7% higher scores on the YBOCS at 3 month follow up. Total score on the ATSPPH also moderated treatment outcomes and explained approximately 21% of the variance. For each standard deviation in total score on the ATSPPH participants had 6% higher symptoms on the YBOCS at post-treatment. However, this finding was no longer significant at 3-month follow up.

Extroversion, agreeableness, neuroticism and conscientiousness also moderated treatment outcome. For every standard deviation increase in symptoms of extroversion, agreeableness and conscientiousness at baseline participants had 6%, 14% and 7% lower scores respectively on the YBOCS at post-treatment and 9%, 8%, and 6% lower scores respectively at 3-month follow up. For neuroticism participants had 12% higher scores on the YBOCS at post-treatment (explaining 26% of the variance) and 20% higher scores at 3-month follow up (explaining 17% of the variance). Treatment expectancy, as measured by the CEQ, also moderated treatment outcomes. For every standard deviation increase in CEQ scores at baseline participants had 5% lower symptoms on the YBOCS scores at post-treatment and 12% lower symptoms at 3 month follow up. Perfectionism and openness to experience did not moderate treatment outcome on the YBOCS at post-treatment or 3 month follow up.

2.7. Multivariate analysis

The neural network model reveals that both post-treatment and follow-up outcome prediction have the potential to involve a complex interplay of multiple variables. In these neural network (NN) models, the input variables contributed to performance metrics of R-squared of 64.5%, with mean squared error (MSE) of 4.47 YBOCS points and a slightly diminished prediction performance at follow-up, with an R^2 of 50.5% and MSE of 5.3%. These metrics however also suggest that the explanatory power of a complex and multilayer model is not substantially improved than models that considered baseline variables alone ($R^2_{postTx} = 74.5\%$, $R^2_{3mfu} = 46\%$).

3. Discussion

The aim of the current study was to replicate and extend the literature by examining the moderators of outcome in a large sample of participants who commenced a self-guided ICBT intervention for OCD. The study was designed as exploratory given the limited existing literature available. Overall, the results of the current study indicated that a large number of variables moderated treatment outcome at post-treatment and 3-month follow up. These outcomes are discussed below.

3.1. Symptom severity

Variables of pre-treatment OCD severity contributed the largest amount of variance in post-treatment and 3 month follow up outcomes, with higher pre-treatment severity resulting in less improvement on the YBOCS. These results are consistent with a recent systematic review that examined predictors of outcome in face-to-face CBT and ICBT studies for OCD, which found that higher baseline OCD symptoms predicted poorer outcome (McDonald et al., 2023). Similarly, the results of the present study are also consistent with some studies examining the predictors of outcome in clinician-guided ICBT for OCD (Andersson et al., 2015;

Table 6
Univariate moderation test of symptom change (YBOCS?) over time for treatment variables.

	Global test of moderation		Post-treatment			Follow up		
	Time*Covariate (Wald χ^2)	p value	Post Tx expβ (% of effect)	p value	R square	3 month follow up expβ (% of effect)	p value	R square
Number of lessons commenced								
1/5 lessons	185.6	<.001	–	–	6.6%	–	–	0.6%
2/5 lessons	–	–	−11.9% (−21.3 to −1.5)	.026	–	−2.3% (−12 to 8.5)	.665	–
3/5 lessons	–	–	−16.6% (−25.1 to −7.1)	.001	–	−39.7% (−47.1 to −31.1)	<.001	–
4/5 lessons	–	–	−27.5% (−35.1 to −19.1)	<.001	–	−31.5% (−39.3 to −22.7)	<.001	–
5/5 lessons	–	–	−13.1% (−19.1 to −6.7)	<.001	–	−13.5% (−20.5 to −5.8)	.001	–
Time spent practicing skills (mins)	90.7	<.001	9.2% (4.9–13.7)	<.001	36.9%	10.6% (7.1–14.2)	<.001	2.5%

Note. Significant and positive expβ indicate percentage increase in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable. Significant and negative expβ indicate percentage decrease in post-treatment or 3-month follow up scores for every standard deviation increase in the relevant variable.

Table 7
Univariate moderation test of symptom change over time for other variables.

	Global test of moderation		Post-treatment			Follow up		
	Time*Covariate (Wald χ^2)	p value	Post Tx expβ (% of effect)	p value	R square	3 month follow up expβ (% of effect)	p value	R square
DPSS-R total	88.5	<.001	5.8% (2.6–9)	<.001	10.8%	7.2% (3.8–10.8)	<.001	7.7%
CPQ total	1.3	.854	1.1% (−2.1 to 4.4)	.512	5.2%	1.7% (−2.3 to 5.8)	.414	17.1%
ATSPPH total	28.6	<.001	6% (2.7–9.3)	<.001	21.2%	3.2% (−0.7 to 7.4)	.112	0.5%
Extroversion	99.2	<.001	−6% (−8.7 to −3.3)	<.001	11.0%	−8.6% (−11.6 to −5.4)	<.001	0.1%
Agreeableness	130	<.001	−13.7% (−16.2 to −11.2)	<.001	32.8%	−8.2% (−11.2 to −5.1)	<.001	1.6%
Neuroticism	172.5	<.001	12.1% (8.7–15.5)	<.001	26.0%	20% (15.3–24.9)	<.001	16.7%
Openness to experience	9.5	.050	2.1% (−0.8 to 5.1)	.157	9.7%	0.2% (−2.4 to 2.8)	.896	0.1%
Conscientiousness	78.9	<.001	−7.3% (−10.4 to −4.1)	<.001	20.9%	−5.7% (−8.4 to −2.9)	<.001	3.4%
CEQ	69.6	<.001	−5.2% (−8.5 to −1.8)	.003	21.9%	−12.1% (−14.9 to −9.2)	<.001	17.1%

Wheaton et al., 2021), but inconsistent with Diefenbach et al. (2015) who found that baseline OCD symptom severity was unrelated to outcome. Finally, the results of this study are consistent with the only other study examining predictors of outcome in self-guided ICBT (Wootton et al., 2024), which also found that higher baseline OCD severity significantly predicted post-treatment OCD severity. While the available literature demonstrates that baseline OCD symptom severity is likely related to outcome, it is not yet clear what level of severity may result in suboptimal outcomes. This is an important avenue for future research as it will inform treatment planning for individuals with OCD.

3.2. Depression severity

Baseline depressive symptoms also moderated treatment outcome with those with higher baseline depressive symptoms performing less well at post-treatment and 3 month follow up. This is the first study to find a relationship between baseline depressive symptoms and outcomes at post-treatment and follow up in ICBT for OCD. Previous research has not found such a relationship (Diefenbach et al., 2015; Seol et al., 2016; Wheaton et al., 2021; Wootton et al., 2024). However, this may be due to the inclusion criteria in other studies, which primarily restrict entry to participants who have lower levels of depression. For example, the participants in Wootton et al. (2024) study were required to have a score of less than 22 on the PHQ-9 (Kroenke et al., 2001) to enter the study. In the current study there were no restrictions on depressive symptoms, and indeed scores on the PHQ-9 ranged from 0 to 27 ($M = 11.52$; $SD = 6.19$), indicating participants on average had moderate depressive symptoms. It is also possible that depressive symptoms may be more important in self-guided ICBT than clinician-guided ICBT interventions given self-guided interventions may potentially require more motivation than clinician-guided interventions due to the absence of the therapist support.

3.3. Demographics

In terms of demographic predictors, age and gender were significant predictors of outcome at post-treatment, but not 3-month follow up. At post-treatment those who were older and those who were female had better treatment outcomes. The finding related to age is consistent with the only other study examining the predictors of outcome in self-guided ICBT for OCD (Wootton et al., 2024), however is inconsistent with previous research examining predictors of outcome in clinician-guided ICBT studies that found no relationship with age (Wheaton et al., 2021), and also the opposite effect, that individuals who were younger were more likely to respond to the treatment (Seol et al., 2016). These results may indicate that age might be important variable to consider, but potentially only in self-guided ICBT interventions. In terms of gender, women responded better to self-guided ICBT for OCD in this study. However, gender has not emerged as a significant predictor in other studies (Wheaton et al., 2021; Wootton et al., 2024), thus future research is needed to explore the relationship between gender and outcome.

The country the participants was located in during treatment also moderated treatment outcome, with those in Asia, the United Kingdom and North American having significantly higher symptoms at post-treatment and those from 'Other' countries having significantly lower post-treatment scores. At 3-month follow up those from Asia, United Kingdom, and 'other' all had significantly lower OCD symptoms when compared with 'Oceania' participants. This is the first study to examine treatment outcome in different countries, thus comparisons with the existing literature are difficult. Australia is a world leader in the provision of ICBT and it is possible that participants in other countries were more engaged with the treatment because it is more of a novel approach to treatment in that country, whereas participants in Australia have multiple options for accessing ICBT for OCD. As self-guided ICBT is disseminated in more countries it will be important to examine whether participants respond differently, and the reasons why this may occur.

3.4. Previous treatment

Previous treatment also emerged as a significant moderator of outcome at post-treatment, with those who were treatment naïve having larger reductions in symptoms than those who had previous treatment for OCD. However, at 3-month follow up this variable no longer moderated outcome. Exposure to previous treatment has been found to be a significant predictor in other studies (McDonald et al., 2023; Wheaton et al., 2021; Wootton et al., 2024). This finding may indicate that self-guided ICBT is a more appropriate intervention for individuals who are treatment naïve, and that individuals who have previously received treatment may be better suited to a higher intensity intervention. However, it is common for participants with OCD to receive non evidence-based interventions in the community (Schwartz et al., 2013) and individuals who have been provided with such treatment may still benefit from self-guided ICBT, which has been found to be an efficacious treatment (Lundström et al., 2022; Wootton et al., 2019, 2023). The previous treatment received by participants in this study was not examined, thus it is unclear if participants who indicated that they received previous treatment had received an evidence-based treatment in the past.

3.5. Motivation to change

Motivation to change using the readiness ruler was found to predict treatment outcome with the results indicating that participants that were more motivated at baseline are more likely to do well at post-treatment and follow up. This finding is somewhat consistent with Diefenbach et al. (2015) who found that increased readiness to reduce avoidance resulted in improved outcomes after receiving clinician-guided ICBT for OCD. Similarly, Wheaton et al. (2021) found that higher levels of baseline avoidance predicted worse outcomes at

post-treatment. It is possible that a brief motivational enhancement adjunct treatment could be provided to participants with lower levels of motivation at baseline to enhance their response to self-guided ICBT for OCD, however this requires examination in future research.

3.6. Mid-treatment variables

Mid-treatment improvement also surfaced as a moderator of the overall effect at post-treatment and follow-up, with those indicating improvement at mid-treatment having lower post-treatment and follow up scores. This is the first study to examine how mid-treatment improvement affects treatment outcome. Another variable examined at mid-treatment was amount of time practicing the skills. The results of this study also found that individuals who report a larger amount of time practicing the skills at mid-treatment had higher symptoms at post-treatment and 3 month follow up. This is the first study to examine this variable as a predictor of outcome, and these are contrary to what would be expected. It is important to consider these results as preliminary as data for this variable was not available for the full sample.

3.7. Type of obsession and compulsions

While type of obsession moderated treatment outcome, the results indicated that there was no difference in treatment response for those with higher scores on the autogenous obsessions questions versus the reactive obsession question. That is, participants with higher scores on these measures both performed less well at post-treatment. This finding is inconsistent with the research of Burhan et al. (2023) who found that those with reactive obsessions have better outcomes. However, for type of compulsion participants with incompleteness compulsions achieved better outcomes at post-treatment and follow up than individuals who complete compulsions to avoid harm. This is inconsistent with the research of Cervin and Perrin (2021) who found that higher levels of incompleteness results in less improvement. The items to assess these variables were single item, purpose built, and unvalidated, thus results should be interpreted with caution. It will be important for future research to determine whether participants with different types of obsessions and compulsions respond different to ICBT and CBT treatments more generally.

3.8. Treatment engagement

Unsurprisingly, the number of lessons commenced moderated treatment outcome, with those who commenced at least 4 of the 5 lessons having 28% lower symptoms at post-treatment. Participants to complete at least 4/5 lessons have received the active treatment components, and this may be another variable to inform future stepped care treatments. That is, individuals who do not commence lesson 4 (which is delivered in week 5 of the 8-week program) may be better served by being referred on to a higher intensity intervention, such as in-person treatment. This finding is consistent with other studies that have found treatment adherence predicts treatment outcome (Diefenbach et al., 2015; McDonald et al., 2023).

3.9. Disgust, attitudes towards psychological treatment, and personality variables

Finally, consistent with previous research (Andersson et al., 2015; Cervin & Perrin, 2021), higher levels of baseline disgust predicted less improvement at post-treatment. Those with higher scores on the ATSPPH, indicating more favourable opinions on psychological treatment, also predicted less improvement at post-treatment. Higher scores on three of the Big-5 personality variables at pre-treatment (extroversion, agreeableness and conscientiousness) resulted in improvements in outcome at post-treatment. However, higher scores on neuroticism at pre-treatment, resulted in worse outcomes at post-treatment. Openness to experience was unrelated to outcome. Treatment expectancy also moderated treatment outcomes, with those with higher levels of treatment expectancy at baseline have improved scores at post-treatment and follow up. This is the first study to examine many of these variables as possible predictors of outcome and thus results should be considered preliminary and replicated in future research.

3.10. Limitations

While the current study provides important contributions to the literature on the moderators of outcome in self-guided ICBT there are some limitations that should be acknowledged. First, this was an open trial of self-guided ICBT for OCD and thus there was no control group to examine treatment change in an untreated group. However, research has indicated that OCD is a chronic condition, and that symptoms of OCD rarely spontaneously remit without treatment (Melkonian et al., 2022). Thus, it is likely that treatment change is a result of the intervention provided, rather than spontaneous remission of symptoms.

Second, concurrent treatment was not consistently monitored in this study and participants were not excluded from the study if they were using concurrent treatment. Thus, treatment improvement and moderators of improvement may be related to other potential adjunctive treatments. However, it is worth highlighting that these treatment has been demonstrated to be effective in multiple other trials (Wootton et al., 2013, 2014, 2019, 2021), thus the potential for the improvement to be related to adjunctive treatments is likely to be minimal.

Third, some of the measures used may have been suboptimal in measuring the variables of interest. For instance, the measure of type of obsession and reason for compulsion was an unvalidated measure and this may have impacted the results. Future research should aim to replicate these findings using validated measures. Similarly, one of the important variables of interest, previous treatment with a health professional, was only assessed at post-treatment and this may have impacted outcomes in our study. While this variable was found to be a significant moderator of outcome at post-treatment, it was not significant at follow up. Future research may wish to examine the relationship between previous treatment and response to ICBT in the future.

Fourth, a positive screen on the DIAMOND (Tolin et al., 2018) OCD module was required for study entry and the DIAMOND has not previously been validated in a self-report format. However, in addition to a positive screen on the DIAMOND OCD module, participants needed to score at least 7 on one of the subscales of the Dimensional Obsessive-Compulsive Scale (DOCS; Abramowitz et al., 2010) and at least 14 on the self-report version of the Yale-Brown Obsessive--Compulsive Scale (YBOCS; Goodman et al., 1989). Thus, it is unlikely that participants who did not have OCD were accepted into the study.

Finally, given the limited literature on this topic, the study was designed as exploratory and thus moderator variables were not selected *apriori.* As the literature grows it will be important for future studies to select moderators *apriori* which will allow for specific hypotheses to be generated and tested. It will also be important to examine other potential moderators of outcome that were not measured in this study, such as sexual orientation, income, and racial identity, which may be related to treatment outcome in self-guided ICBT for OCD.

3.11. Clinical implications

Despite these limitations the study has a number of important clinical implications. Firstly, the results indicate that pre-treatment OCD severity and pre-treatment depressive symptoms seem to be related to treatment outcome in self-guided ICBT for OCD. Thus, it is important to consider these variables when assessing whether a patient may benefit from self-guided ICBT for OCD. Secondly, while some demographic variables were significant, the variance accounted for by these variables was small. This indicates that self-guided ICBT for OCD may be beneficial for patients with various demographic profiles, including patients

who are older. Finally, self-guided ICBT may be an important first step into treatment for individuals who are treatment naïve, however may be less helpful for patients with a long history of previous psychological or pharmacological treatment for the OCD symptoms. Similarly, self-guided ICBT may be helpful for participants who have an expectancy that the treatment will be beneficial for them, and for participants who are ready to stop their compulsions, thus it is important to assess participants' expectation for change and readiness to commence treatment prior to referring to a self-guided ICBT intervention.

4. Conclusions

In conclusion, this study demonstrates that there may be a number of variables that impact treatment outcome for those who engage in self-guided ICBT for OCD. However, of the pre-treatment variables examined in this study, OCD severity, depression severity, treatment expectancy, and neuroticism explained the most variance in post-treatment and follow up outcomes. It will be important for future research to replicate these results and also investigate whether there are different predictors and moderators of treatment outcome in self-guided and clinician-guided ICBT for OCD, and also when alternative ICBT interventions are used.

CRediT authorship contribution statement

Bethany M. Wootton: Writing – original draft, Validation, Supervision, Software, Project administration, Methodology, Investigation, Funding acquisition, Data curation. **Eyal Karin:** Writing – original draft, Validation, Funding acquisition, Formal analysis. **Maral Melkonian:** Writing – review & editing, Project administration, Investigation, Data curation. **Sarah McDonald:** Writing – review & editing, Software, Project administration, Investigation, Data curation. **Nickolai Titov:** Writing – review & editing, Supervision, Software, Funding acquisition, Conceptualization. **Blake F. Dear:** Writing – review & editing, Supervision, Software, Methodology, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2024.104643.

Data availability

The data that has been used is confidential.

References

Abramowitz, J. S., Deacon, B. J., Olatunji, B. O., Wheaton, M. G., Berman, N. C., Losardo, D., Timpano, K. R., McGrath, P. B., Riemann, B. C., Adams, T., Björgvinsson, T., Storch, E. A., & Hale, L. R. (2010). Assessment of obsessive-compulsive symptom dimensions: Development and evaluation of the dimensional obsessive-compulsive scale. *Psychological Assessment, 22*(1), 180–198. https://doi.org/10.1037/a0018260

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders* (5th Text Revision ed.). American Psychiatric Association.

Andersson, E., Enander, J., Andrén, P., Hedman, E., Ljótsson, B., Hursti, T., Bergström, J., Kaldo, V., Lindefors, N., Andersson, G., & Rück, C. (2012). Internet-based cognitive behaviour therapy for obsessive-compulsive disorder: A randomized controlled trial. *Psychological Medicine, 42*(10), 2193–2203. https://doi.org/10.1017/S0033291712000244

Andersson, E., Ljótsson, B., Hedman, E., Enander, J., Kaldo, V., Andersson, G., Lindefors, N., & Rück, C. (2015). Predictors and moderators of Internet-based cognitive behavior therapy for obsessive-compulsive disorder: Results from a randomized trial. *Journal of Obsessive-Compulsive and Related Disorders, 4*, 1–7. https://doi.org/10.1016/j.jocrd.2014.10.003

Burhan, H.Ş., Şafak, Y., Karadere, M. E., Turgal, E., Özdel, K., & Türkçapar, M. H. (2023). Factors predicting the effectiveness of cognitive-behavioral group therapy in the treatment of obsessive–compulsive disorder. *Journal of Rational-Emotive and Cognitive-Behavior Therapy, 41*(1), 115–127. https://doi.org/10.1007/s10942-022-00456-0. Article.

Cervin, M., & Perrin, S. (2021). Incompleteness and disgust predict treatment outcome in pediatric obsessive-compulsive disorder. *Behavior Therapy, 52*(1), 53–63. https://doi.org/10.1016/j.beth.2020.01.007. Article.

Diefenbach, G. J., Wootton, B. M., Bragdon, L. B., Moshier, S. J., & Tolin, D. F. (2015). Treatment outcome and predictors of internet guided self-help for obsessive-compulsive disorder. *Behavior Therapy, 46*(6), 764–774. https://doi.org/10.1016/j.beth.2015.06.001

Fairburn, C. G., Cooper, Z., & Shafran, R. (2003). *The Clinical Perfectionism Questionnaire.* Oxford, Unpublished scale.

Fergus, T. A., & Valentiner, D. P. (2009). The disgust propensity and sensitivity scale-revised: An examination of a reduced-item version [article]. *Journal of Anxiety Disorders, 23*(5), 703–710. https://doi.org/10.1016/j.janxdis.2009.02.009

Foa, E. B., Huppert, J. D., Leiberg, S., Langner, R., Kichic, R., Hajcak, G., & Salkovskis, P. M. (2002). The obsessive-compulsive inventory: Development and validation of a short version. *Psychological Assessment, 14*(4), 485–496. https://doi.org/10.1037//1040-3590.14.4.485

Frost, R. O., Steketee, G., & Tolin, D. F. (2011). Comorbidity in hoarding disorder. *Depression and Anxiety, 28*(10), 876–884. https://doi.org/10.1002/da.20861

Gentle, M., Harris, L. M., & Jones, M. K. (2014). The barriers to seeking treatment for obsessive-compulsive disorder in an Australian population. *Behaviour Change, 31*(4), 258–278. https://doi.org/10.1017/bec.2014.20

Goodman, W. K., Price, L. H., Rasmussen, S. A., Mazure, C., Fleischmann, R. L., Hill, C. L., Heninger, G. R., & Charney, D. S. (1989). The Yale-Brown obsessive compulsive scale. I. Development, use and reliability. *Archives of General Psychiatry, 46*(11), 1006–1011.

Horvath, A. O., & Greenberg, L. S. (1989). Development and validation of the working alliance inventory. *Journal of Counseling Psychology, 36*(2), 223–233. https://doi.org/10.1037/0022-0167.36.2.223. Article.

Karin, E., Crane, M. F., Dear, B. F., Nielssen, O., Heller, G. Z., Kayrouz, R., & Titov, N. (2021). Predictors, outcomes, and statistical solutions of missing cases in web-based psychotherapy: Methodological replication and elaboration study [Article]. *JMIR Mental Health, 8*(2). https://doi.org/10.2196/22700. Article e22700.

Karin, E., Dear, B. F., Heller, G. Z., Gandy, M., & Titov, N. (2018). Measurement of symptom change following web based psychotherapy – statistical characteristics and analytical methods for measuring and interpreting change. *JMIR Mental Health, 5*(3). https://doi.org/10.2196/10200

Keeley, M. L., Storch, E. A., Merlo, L. J., & Geffken, G. R. (2008). Clinical predictors of response to cognitive-behavioral therapy for obsessive-compulsive disorder. *Clinical Psychology Review, 28*(1), 118–130. https://doi.org/10.1016/j.cpr.2007.04.003. submitted for publication.

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H. U. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research, 21*(3), 169–184. https://doi.org/10.1002/mpr.1359

Knopp, J., Knowles, S., Bee, P., Lovell, K., & Bower, P. (2013). A systematic review of predictors and moderators of response to psychological therapies in OCD: Do we have enough empirical evidence to target treatment? *Clinical Psychology Review, 33*(8), 1067–1081. https://doi.org/10.1016/j.cpr.2013.08.008. submitted for publication.

Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Lee, H. J., & Kwon, S. M. (2003). Two different types of obsession: Autogenous obsessions and reactive obsessions. *Behaviour Research and Therapy, 41*(1), 11–29.

http://www.scopus.com/inward/record.url?eid=2-s2.0-0037213798&partnerID=40&md5=e4529a392a51501c3cc8ac2c6421eb50.
Levis, B., Benedetti, A., & Thombs, B. D. (2019). Accuracy of Patient Health Questionnaire-9 (PHQ-9) for screening to detect major depression: Individual participant data meta-analysis. Article *BMJ, 365*. https://doi.org/10.1136/bmj.l1476. Article l1476.
Liang, K. Y., & Zeger, S. L. (1986). Longitudinal data analysis using generalized linear models. *Biometrika, 73*(1), 13–22.
Lundström, L., Flygare, O., Andersson, E., Enander, J., Bottai, M., Ivanov, V. Z., Boberg, J., Pascal, D., Mataix-Cols, D., & Rück, C. (2022). Effect of internet-based vs face-to-face cognitive behavioral therapy for adults with obsessive-compulsive disorder: A randomized clinical trial. Article *JAMA Network Open*. https://doi.org/10.1001/jamanetworkopen.2022.1967. Article e221967.
Luu, J., Millard, M., Newby, J., Haskelberg, H., Hobbs, M. J., & Mahoney, A. E. J. (2020). Internet-based cognitive behavioural therapy for treating symptoms of obsessive compulsive disorder in routine care [Article]. *Journal of Obsessive-Compulsive and Related Disorders, 26*. https://doi.org/10.1016/j.jocrd.2020.100561. Article 100561.
Mahoney, A. E. J., Mackenzie, A., Williams, A. D., Smith, J., & Andrews, G. (2014). Internet cognitive behavioural treatment for obsessive compulsive disorder: A randomised controlled trial. *Behaviour Research and Therapy, 63*, 99–106. https://doi.org/10.1016/j.brat.2014.09.012
Mao, H., Li, L., & Greene, T. (2019). Propensity score weighting analysis and treatment effect discovery. *Statistical Methods in Medical Research, 28*(8), 2439–2454. https://doi.org/10.1177/0962280218781171. Article.
Marques, L., LeBlanc, N. J., Wegarden, H. M., Timpano, K. R., Jenike, M., & Wilhelm, S. (2010). Barriers to treatment and service utilization in an internet sample of individuals with obsessive-compulsive symptoms. *Depression and Anxiety, 27*(5), 470–475. https://doi.org/10.1002/da.20694
McDonald, S., Melkonian, M., Karin, E., Dear, B. F., Titov, N., & Wootton, B. M. (2023). Predictors of response to cognitive behavioural therapy (CBT) for individuals with obsessive-compulsive disorder (OCD): A systematic review. *Behavioural and Cognitive Psychotherapy*, 1–18. https://doi.org/10.1017/s1352465823000103
Melkonian, M., McDonald, S., Scott, A., Karin, E., Dear, B. F., & Wootton, B. M. (2022). Symptom improvement and remission in untreated adults seeking treatment for obsessive-compulsive disorder: A systematic review and meta-analysis. *Journal of Affective Disorders, 318*, 175–184. https://doi.org/10.1016/j.jad.2022.08.037. submitted for publication.
Olatunji, B. O., Davis, M. L., Powers, M. B., & Smits, J. A. J. (2013). Cognitive-behavioral therapy for obsessive-compulsive disorder: A meta-analysis of treatment outcome and moderators. *Journal of Psychiatric Research, 47*(1), 33–41. https://doi.org/10.1016/j.jpsychires.2012.08.020
Reid, J. E., Laws, K. R., Drummond, L., Vismara, M., Grancini, B., Mpavaenda, D., & Fineberg, N. A. (2021). Cognitive behavioural therapy with exposure and response prevention in the treatment of obsessive-compulsive disorder: A systematic review and meta-analysis of randomised controlled trials. submitted for publication *Comprehensive Psychiatry, 106*. https://doi.org/10.1016/j.comppsych.2021.152223. Article 152223.
Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects [Article]. *Biometrika, 70*(1), 41–55. https://doi.org/10.1093/biomet/70.1.41
Schwartz, C., Schlegl, S., Kuelz, A. K., & Voderholzer, U. (2013). Treatment-seeking in OCD community cases and psychological treatment actually provided to treatment-seeking patients: A systematic review. *Journal of Obsessive-Compulsive and Related Disorders, 2*(4), 448–456. https://doi.org/10.1016/j.jocrd.2013.10.006. submitted for publication.
Seol, S. H., Kwon, J. S., Kim, Y. Y., Kim, S. N., & Shin, M. S. (2016). Internet-based cognitive behavioral therapy for obsessive-compulsive disorder in Korea [Article]. *Psychiatry Investigation, 13*(4), 373–382. https://doi.org/10.4306/pi.2016.13.4.373
Simpson, H. B., Zuckoff, A. M., Maher, M. J., Page, J. R., Franklin, M. E., Foa, E. B., Schmidt, A. B., & Wang, Y. (2010). Challenges using motivational interviewing as an adjunct to exposure therapy for obsessive-compulsive disorder. *Behaviour Research and Therapy, 48*(10), 941–948. https://doi.org/10.1016/j.brat.2010.05.026. Article.
Summerfeldt, L. J., Kloosterman, P. H., Antony, M. M., & Swinson, R. P. (2014). Examining an obsessive-compulsive core dimensions model: Structural validity of harm avoidance and incompleteness [Article]. *Journal of Obsessive-Compulsive and Related Disorders, 3*(2), 83–94. https://doi.org/10.1016/j.jocrd.2014.01.003
Szalisznyó, K., & Silverstein, D. N. (2021). Computational predictions for OCD pathophysiology and treatment: A review. *Frontiers in Psychiatry, 12*, Article 687062. https://doi.org/10.3389/fpsyt.2021.687062. submitted for publication.
Tolin, D. F., Gilliam, C., Wootton, B. M., Bowe, W., Bragdon, L. B., Davis, E., Hannan, S. E., Steinman, S. A., Worden, B., & Hallion, L. S. (2018). Psychometric properties of a structured diagnostic interview for DSM-5 anxiety, mood, and obsessive-compulsive and related disorders [article]. *Assessment, 25*(1), 3–13. https://doi.org/10.1177/1073191116638410
von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). The strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Lancet, 370*(9596), 1453–1457. https://doi.org/10.1016/S0140-6736(07)61602-X [Article].
Wheaton, M. G., Patel, S. R., Andersson, E., Rück, C., & Simpson, H. B. (2021). Predicting treatment outcomes from internet-based cognitive behavior therapy for obsessive–compulsive disorder. *Behavior Therapy, 52*(1), 77–85. https://doi.org/10.1016/j.beth.2020.02.003. Article.
Wootton, B. M., Dear, B. F., Johnston, L., Terides, M. D., & Titov, N. (2013). Remote treatment of obsessive-compulsive disorder: A randomized controlled trial. *Journal of Obsessive-Compulsive and Related Disorders, 2*(4), 375–384. https://doi.org/10.1016/j.jocrd.2013.07.002. Article.
Wootton, B. M., Dear, B. F., Johnston, L., Terides, M. D., & Titov, N. (2014). Self-guided internet administered treatment for obsessive-compulsive disorder: Results from two open trials. *Journal of Obsessive-Compulsive and Related Disorders, 3*(2), 102–108. https://doi.org/10.1016/j.jocrd.2014.03.001
Wootton, B. M., Karin, E., Dear, B. F., Staples, L., Nielssen, O., Kayrouz, R., & Titov, N. (2021). Internet-delivered cognitive-behaviour therapy (ICBT) for obsessive-compulsive disorder when delivered as routine clinical care: A phase IV clinical trial. *Journal of Anxiety Disorders, 82*, Article 102444. https://doi.org/10.1016/j.janxdis.2021.102444. Article.
Wootton, B. M., Karin, E., Titov, N., & Dear, B. F. (2019). Self-guided internet–delivered cognitive behavior therapy (ICBT) for obsessive-compulsive symptoms: A randomized controlled trial. *Journal of Anxiety Disorders, 66*, Article 102111. https://doi.org/10.1016/j.janxdis.2019.102111. Article.
Wootton, B. M., McDonald, S., Karin, E., Titov, N., & Dear, B. F. (2024). Predictors of outcome in self-guided internet-delivered cognitive-behavior therapy for obsessive-compulsive disorder: A preliminary investigation. *Journal of Clinical Psychology*.
Wootton, B. M., McDonald, S., Melkonian, M., Karin, E., Titov, N., & Dear, B. F. (2023). Efficacy and acceptability of a self-guided internet-delivered cognitive-behavioral educational program for obsessive-compulsive symptoms with international recruitment. *Cognitive Behaviour Therapy*. https://doi.org/10.1080/16506073.2023.2279492. Article.