Cost-Effectiveness Analysis of Face-to-Face Cognitive Behavior Therapy (CBT) vs Online CBT for Major Depressive Disorder Among Adults

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Abstract

Objective: This study aims to evaluate the cost-effectiveness of different depression treatment modalities for the US adult population., specifically online versus face-to-face cognitive behavioral therapy (CBT), from a societal perspective.

Methods: A cohort-based Markov model is employed to simulate Major Depressive Disorder (MDD) progression over 5 years, accounting for its recurrent nature. The model comprises five discrete health states: Depression, CBT, CBT + Medication, Remission, and Death, representing various stages of MDD and treatment responses. Using a monthly cycle length, our model captures dynamic transitions and assesses treatment cost-effectiveness.

Results: The cost-effectiveness analysis revealed that Online CBT was associated with lower total costs compared to Face-to-Face CBT over the 5-year time horizon. Specifically, individuals receiving Online CBT incurred $1345.74 less in annual costs compared to those receiving Face-to-Face CBT. Additionally, Online CBT resulted in a slightly higher total quality-adjusted life years (QALYs) gained compared to Face-to-Face CBT, indicating a favorable health outcome.

Conclusion: This study suggests that Online CBT is a cost-effective alternative to Face-to-Face CBT for the treatment of depression. It provides comparable health outcomes while reducing costs, thus offering a promising solution to improve access to effective depression treatment.

Introduction

Major Depressive Disorder (MDD) is an episodic and recurring condition that is common in the general population, with around 20% of adults suffering from either disorder at some time during their lives [1]. In the United States, an estimated 21.0 million adults, approximately 8.3% of the entire adult population, experienced at least one major depressive episode [2]. As a result, there is an increased demand for treatment, such as psychotherapy [3], putting a strain on the capacity of clinical psychologists. Cognitive behavioral therapy (CBT) has been shown to be an effective psychological treatment for people with depression [4]. CBT has been extensively used as an alternative or complement to pharmacological treatments, with some evidence of a more enduring impact when compared to drug treatments alone [5]. However, the United States faces a persistent challenge in providing prompt access to mental health services, including psychotherapy. Notably, the southern states, with Mississippi ranked at #47, Georgia at #48, Florida at #49, and Alabama at #50, exhibit the lowest levels of access to mental health care [6] and a higher prevalence of depression. Moreover, the economic burden for adults with MDD, including direct costs, suicide-related costs, and workplace costs, experienced a 37.9% rise, escalating from $US236.6 billion in 2010 to $326.2 billion in 2018 [7].

While evidence supports the effectiveness of face-to-face cognitive-behavioral therapy (FCBT), the need for alternative approaches is evident. This necessity arises with the goal of mitigating waiting times and improving overall accessibility to mental health services. For example, depressed patients in United States wait an average of 2 months for an in-person appointment [21]. Internet-based cognitive-behavioral therapy (ICBT) emerges as a promising solution, effectively bridging the gap in providing timely and less expensive mental health treatments. Minimizing wait times for mental health services has the potential to enhance patient stability, reduce the likelihood of relapse, lower crisis-related hospitalizations, and diminish both attempted and completed suicide rates [8].

Our study will evaluate the cost-effectiveness and health outcomes of the two different CBT delivery modes as the first line of treatment followed by a combination of CBT and treatment-as-usual (TAU) as second line of treatment for the US adult population above 18. We define TAU as second-generation antidepressant medications (ADMs), which is the recommended drug treatment for depressive disorders recommended by the American Psychological Association [9]. Various types of costs such as direct intervention costs, patient-related costs, technology and equipment costs, and follow-up and monitoring costs along with incremental costs. Our analysis aims to revisit this research, offering updated insights into evolving treatment costs and the growing significance of digital mental health platforms, particularly within the United States.

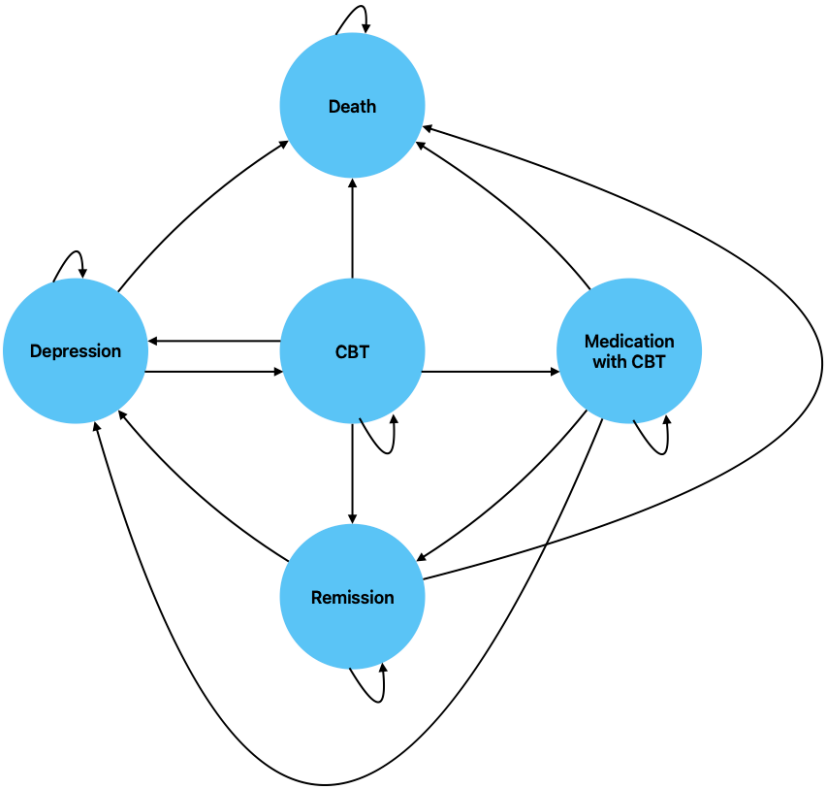
Methods

Model Structure

Major Depressive Disorder is characterized as a recurrent disease. To address this, we employed a cohort-based Markov model, enabling us to simulate the dynamic course of depression and treatment over time. Given the episodic nature of the disease, a longer time horizon is crucial to capture the potential for recurring episodes and evaluate the effectiveness of various treatment strategies comprehensively. We opted for a 5-year time horizon to simulate several depressive disorders and treatment attempts. We do not adopt a lifetime horizon because it would be associated with unrealistic assumptions about treatment alternatives and technological development. We chose a cycle length of 1 month, which is a reasonable time-period for patients to respond and transition to other states in the Markov model. A 1-month cycle length aligns with this clinical reality, allowing for frequent evaluation and potential modification of treatment strategies based on patient response and evolving needs.

Our Markov model comprises of discrete health states that represent various stages of depression and treatment response:

1. **Depression (D1)**: Individuals experiencing symptoms of depression without undergoing active treatment intervention
2. **CBT (C)**: Individuals undergoing Cognitive Behavioral Therapy (CBT), either through face-to-face or online mediums as first-level treatment
3. **CBT + Medication (M)**: Individuals receiving a combination of CBT and anti-depressants treatment as a second-level treatment
4. **Remission (R)**: Individuals who have successfully responded to treatment and are in a state of remission, characterized by the absence of depressive symptoms
5. **Death (D2):** Individuals who have died due to any cause



CBT: Cognitive Behavior Therapy (Online or Face-to-Face)
Figure 1: State-Transition Markov Model Structure

The model assesses the cost-effectiveness of two depression treatment interventions: Face-to-Face Cognitive Behavioral Therapy (CBT) and Online CBT. Our model can capture the delays in accessing in-person depression treatment through the transition probability from the depression state to the first-level treatment state (CBT). The model also reflects two stages of treatment for depression. In the initial population, individuals start in the depressed state. From here, depressed patients can choose to undergo the first stage of treatment: CBT (online or face-to-face treatment). This choice is represented by transition probabilities from the depression state to the CBT state. Patients who undergo CBT may experience remission after a successful first stage of treatment. However, in cases where CBT alone is ineffective for patients, antidepressant medication is prescribed in conjunction with continued CBT sessions. This combination therapy represents the second stage of treatment.

Throughout the model, all patients are at risk of all-cause mortality [26], with the associated risk factored into the transition probabilities between states as demonstrated in Table 1. We defined costs from a societal perspective, encompassing direct medical costs, and patient-related costs. Direct medical costs include the expenses associated with therapy sessions, medication, and healthcare utilization. Patient-related costs account for out-of-pocket expenses incurred by individuals seeking treatment. Health outcomes in the model are quantified in terms of Quality-

Adjusted Life Years (QALYs). QALYs are computed by multiplying the duration spent in each health state by the utility weight, reflecting the quality-of-life adjustment for that state. Utility and cost data are sourced from published studies reporting health state utilities from randomized control trials. Both costs and QALYs are discounted by 3% each year, adhering to standard practices in health decision modeling. All calculations and simulations were performed using the statistical software R, utilizing established libraries and packages such as *dampack* for Markov modeling and economic evaluation.

Model Parameters

Model Parameter	**Base Case Value**	**Reference**
Transition Probability		
Depression→Face to Face CBT	0.31	[22]
Depression→Online CBT	0.35	[22], [23]
Depression→Death	0.010438	[24]
Face to Face CBT→ Face to Face CBT + Medication	0.33640	[25]
Face to Face CBT→Remission	0.6090	[26]
Face to Face CBT→Depression	0.0145	[26]
Face to Face CBT→Death	0.010438	[24]
Online CBT→Online CBT + Medication	0.33640	[25]
Online CBT→Remission	0.5174	[26]
Online CBT→Depression	0.0201	[26]
Online CBT→Death	0.010438	[24]
Face to Face CBT + Medication→Depression	0.0858	[27]
Face to Face CBT + Medication→Remission	0.450	[28]
Face to Face CBT + Medication→Death	0.010438	[24]
Online CBT + Medication→Depression	0.0858	[27]
Online CBT + Medication→Remission	0.450	[25]
Online CBT + Medication→Death	0.010438	[24]
Remission→Depression	0.0064	[26]
Remission→Death	0.010438	[24]
Death→Death	1	
Cost Parameters		
Medical Costs		
Face-to-face cognitive behavioral therapy (per month)	$600	5 sessions a month recommended by APA [20]
Online cognitive behavioral therapy fee (per month)	$360	Monthly subscription includes: Live video session fee, CBT support materials, unlimited messaging [19]
Medication fee, second-generation anti-depressants (per month)	$76	[18]

Direct non-medical costs		
Cost of travelling to face-to-face therapy (per month)	$100	Estimate
Indirect costs		
Patient productivity loss (per month)	Taking $34/ hour: $204/ month for patients in remission $571/ month for patients in online based treatment $707/ month for patients in face-to-face based treatment $1142/month for patients in depression	[13], [14]
Healthy Utilities		
Depression	0.58	[16, 17]
CBT	0.72	[16, 17]
CBT + Medication	0.72	[16, 17]
Remission	0.85	[16, 17]
Death	0	

Table 1: Model Parameters

Measurement of Costs

In our analysis, we adopt a societal perspective to evaluate the economic impact of depression treatment interventions. By examining the costs and benefits associated with depression treatment from a societal viewpoint, our analysis will offer insights for policymakers and stakeholders seeking to optimize resource allocation and improve access to mental health treatments.

We assume that each patient has 4 CBT sessions each month, approximately 2 hours per session, for both modalities (i.e. online and face-to-face). Using a nationally representative observational study, we incorporated severity-dependent productivity losses of 1.5, 4.2, and 8.4 hours per week for patients in remission; undergoing treatment (both first-level and second-level treatment); and depression, respectively [13]. For patients undergoing face-to-face therapy, an additional 4 hours of productivity loss was added to account for the time spent travelling to therapy in a month. We have estimated the value of patients' time to be $34 per hour, which is the average U.S. hourly earnings based on the Bureau of Labor Statistics [14].

Health Utility

In our analysis, we are using utility values of 0.85, 0.72, and 0.58 for patients in remission; undergoing treatment (both first-level and second-level treatment); and depression, respectively. These values were derived from a prospective study of patients treated for MDD [15] and are consistent with utility estimates from clinical trials [16, 17].

Sensitivity Analysis

We conduct deterministic sensitivity analysis to analyze the impact of varying the values of various uncertain parameters on our model output as outlined in Table 4. The parameters that were selected for sensitivity analysis have a significant influence on the model outcomes with a degree of uncertainty and variability. The ranges used for were extracted from existing literature where we obtained the base case values as referenced in Tables 1 and 2.

We specifically examine the treatment effectiveness captured by the transition probabilities from CBT to remission and from depression to CBT. These transition probabilities represent critical aspects of the treatment pathway for MDD and directly influence the overall effectiveness of the interventions. The transition probability from CBT to remission reflects the likelihood of patients achieving a state of remission from depression after undergoing cognitive-behavioral therapy. A higher probability indicates a greater chance of successful treatment outcomes and improved patient well-being. Similarly, the transition probability from depression to CBT represents the treatment uptake rate, reflecting the proportion of individuals with depression who seek and receive cognitive-behavioral therapy. It also models the delays patients may encounter in accessing therapy due to factors such as waiting times for appointments and availability of mental health services. A higher probability implies more prompt initiation of treatment and reduced delays in accessing depression care. Additionally, we will explore the sensitivity of our model to changes in the costs associated with each treatment modality, including the cost of face-to-face cognitive-behavioral therapy (CBT) and the fee for online CBT. These cost parameters directly influence the economic burden of treatment and can affect the cost-effectiveness comparison between different interventions.

Results

Base Case Results

In the base case analysis, Face to Face CBT is associated with a cost of $10,361.52 and 1.54 QALYs. It is considered as the base strategy with a Non-Dominant (ND) status. Meanwhile, Online CBT costs $9,015.78 with an incremental cost compared to Face to Face CBT of -$1,345.74, indicating it is less costly than the status quo. The QALYs associated with Online CBT are 1.56. Therefore, Online CBT is found to be cost-saving and more effective compared to Face to Face CBT, with a Dominant (D) status. Hence, online CBT is the preferred option for treating depression from a cost-effectiveness perspective.

Strategy	Costs, $	Incremental Costs $	QALYs	Status
Face to Face CBT	10361.52	-	1.54	ND
Online CBT	9015.78	-1345.74	1.56	D

Table 2: Cost effective analysis results for treatment interventions for depression

To better understand the base outcomes, we plotted a cohort trace chart as shown in Figure 2. In the initial years, the steeper decline in the proportion of the population experiencing depression over time for Online CBT suggests that it was more effective in reducing depression symptoms compared to Face to Face CBT. This aligns with the higher uptake associated with Online CBT, possibly due to its accessibility and convenience. However, while Online CBT showed a faster reduction in depression symptoms, it also exhibited a slower progression to full remission compared to F2F CBT, indicating a lower efficacy rate. Interestingly, both treatments eventually lead to similar outcomes in terms of the proportion of the population in remission after 5 years, with Online CBT having a slightly higher proportion in remission (51.7%) than Face to Face CBT (51.1%). This suggests that while Online CBT may have a slower progression to remission, it still achieves comparable results to Face to Face CBT in the long term.

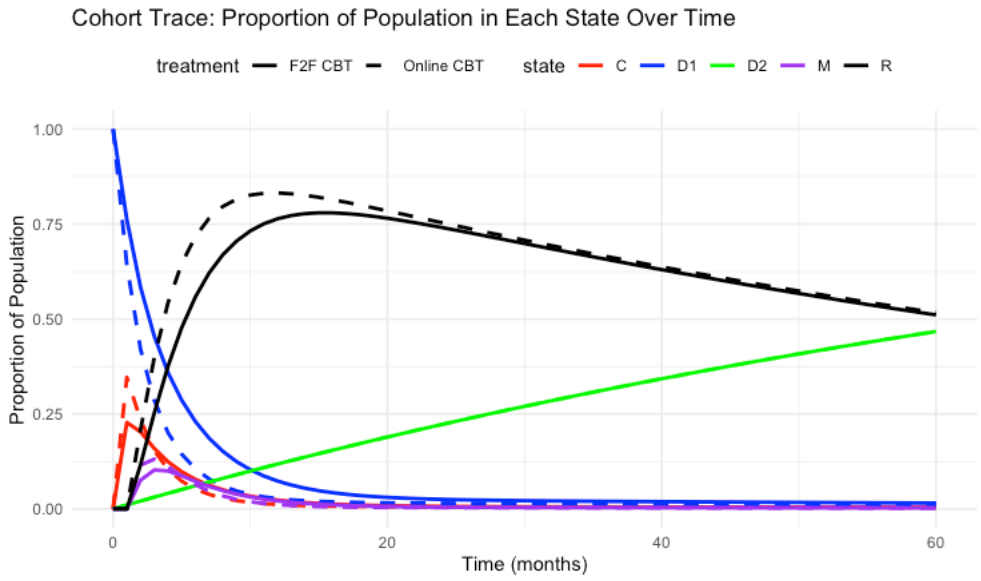


Figure 2: Cohort Trace Chart

Sensitivity Analysis Results

Parameter	Base Case	Low	Dominant Strategy	High	Dominant Strategy
Transition probability from depression to face-to-face CBT	0.31	0.23	Online CBT	0.39	No dominant strategy
Transition probability from depression to online CBT	0.35	0.26	No dominant strategy	0.44	Online CBT
Transition probability from face-to-face CBT to remission	0.6090	0.5311	Online CBT	0.687	Online CBT

Transition probability from online CBT to remission	0.5174	0.3878	Online CBT	0.647	Online CBT
Face-to-face cognitive behavioral therapy cost (USD/ month)	$600	$300	Online CBT	$960	Online CBT
Online cognitive behavioral therapy fee (USD/month)	$360	$120	Online CBT	$400	Online CBT

Table 3: Sensitivity Analysis

When the transition probability from depression to face-to-face CBT is at the higher end of the range, we observe that online CBT is no longer the dominant strategy and not cost-effective compared to face-to-face CBT. Similarly, when the transition probability from depression to online CBT is at the lower end of the range, online CBT is no longer cost-effective. This highlights the sensitivity of the model to changes in the transition probabilities from depression to treatment. Regarding treatment efficacy, as reflected in the transition probabilities to remission, and the therapy costs, the sensitivity analysis consistently shows that online CBT remains the dominant strategy. Even at the lowest probabilities of transitioning to remission for both face-to-face and online CBT, online CBT remains cost-effective. This suggests that online CBT can offer cost savings while being equally or more effective in achieving remission compared to face-to-face CBT.

Moreover, as transition probabilities increase towards the upper end of the range, online CBT continues to be cost-effective. Despite higher probabilities of transitioning to remission, online CBT maintains its dominance, indicating that it remains both more effective and less costly compared to face-to-face CBT. This underscores the robustness of online CBT as a cost-effective treatment option for depression. In terms of therapy costs, even at their highest values, online CBT remains dominant. This suggests that even if the costs of online therapy increase, it still provides cost savings compared to face-to-face CBT, while maintaining or improving efficacy. Therefore, the sensitivity analysis reinforces the earlier findings that online CBT is a viable and cost-effective alternative to face-to-face CBT for depression treatment.

Discussion and Future Work

MDD significantly impacts individuals' mental and physical health, leading to diminished quality of life and increased mortality risk. These implications incur substantial costs, prompting the urgent need for economic evaluations in health policy. Integrating cost-efficient and accessible treatments, such as internet-based programs, into primary healthcare could enhance resource utilization and reduce expenses efficiently. Numerous studies have investigated the effectiveness and cost-efficiency of internet-based interventions for depression, showing comparable outcomes to traditional face-to-face therapies worldwide. Our analysis revisits this research, providing updated insights considering evolving treatment costs and the burgeoning significance of digital mental health platforms, especially within the United States.

In our base case analysis, we found Online CBT to be associated with lower total costs compared to Face-to-Face CBT over the 5-year time horizon. This suggests that online interventions have

the potential to offer cost savings while maintaining or even improving treatment effectiveness. These findings align with previous research indicating the cost-effectiveness of online interventions for depression. However, it's important to note that the choice between online and face-to-face therapy should also consider individual preferences, access, and clinical needs. Our sensitivity analysis further explored the robustness of the results to variations in key parameters. Despite changes in transition probabilities and therapy costs, Online CBT consistently remained the dominant strategy, demonstrating its cost-effectiveness over a wide range of scenarios.

However, our study has several limitations that warrant consideration and suggest avenues for future research. Firstly, the time horizon of our analysis was confined to five years, potentially overlooking longer-term outcomes and costs associated with Major Depressive Disorder (MDD). Extending the time horizon could elucidate the sustainability of treatment effects and costs over a more extended period. This could include assessing the recurrence rates of depression over several years and evaluating the long-term cost-effectiveness of different treatment modalities. Secondly, the inherent uncertainty surrounding treatment uptake and efficacy rates, sourced from various randomized controlled trials (RCTs), introduces potential biases and limitations in our analysis. Future studies could incorporate more robust and updated data on treatment efficacy and uptake, possibly from larger and more representative samples, to improve the accuracy of the model.

Additionally, our study solely focused on the US adult population, limiting its generalizability to other demographics and geographical contexts. Future research could explore the applicability of our findings to diverse demographic groups, including adolescents and older adults, as well as different cultural and socioeconomic backgrounds. Understanding how various factors influence the effectiveness and cost-effectiveness of different treatment modalities could provide valuable insights for tailored intervention strategies. Furthermore, future research should investigate potential positive external effects of online CBT, such as optimizing therapists' resources by enabling them to treat more patients. Understanding how online CBT interventions can enhance therapists' capacity and improve access to care, especially for individuals with severe depression, warrants attention in subsequent research endeavors.

Lastly, exploring the cost-effectiveness of integrated care models combining online and face-to-face therapies could offer valuable insights into optimizing treatment delivery and resource allocation in mental healthcare. Investigating the comparative effectiveness and cost-effectiveness of such integrated approaches could help identify the most efficient and sustainable strategies for managing depression in real-world clinical settings.

Policy Implications and Conclusion

The findings of our study underscore the importance of considering online cognitive behavioral therapy as a cost-effective alternative to face-to-face CBT for depression treatment in the United States. Inspired by the success of Australia's online CBT platform, eTherapy, US policymakers should strongly consider investing in similar online therapy platforms. Given the existing disparities in access to mental healthcare across certain US states, especially those with limited resources, online CBT emerges as a viable solution to bridge this gap. By promoting the adoption of online therapy platforms, policymakers can significantly contribute to addressing

these disparities and ensuring that individuals in underserved areas have access to effective mental health treatments.

However, it is essential to accompany this investment with measures to ensure that therapists are adequately trained and equipped to deliver therapy effectively in an online setting. Policymakers should prioritize initiatives aimed at training and educating mental health professionals on delivering online therapy. By doing so, policymakers can maximize the impact of online CBT interventions and promote equitable access to mental healthcare nationwide. In conclusion, our study underscores the potential of online CBT to transform depression treatment, providing a cost-effective and accessible solution to enhance mental health outcomes for individuals across the United States.

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