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TechTreat Revolutionizing CBT for Chronic Anxiety in Adolescents through Digital Therapeutic Interventions

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ABSTRACT

Background: *The mental health of the youth these days is increasingly worrisome due to high levels of anxiety. Because of this, new, easier to access treatment strategies are required. Digital cognitive behavioral therapy (CBT) treats patients with AI-powered mobile applications, making it a great substitute for face-to-face therapy.* ***Aim:*** *This study seeks to measure the changes in anxiety symptoms of adolescents with chronic anxiety after applying the TechTREAT intervention, which was developed specifically for this study, in comparison with the traditional in-person CBT therapy.* ***Method:*** *A mixed method study was conducted among 150 adolescents suffering from chronic anxiety. It was divided into two groups: the experimental group received Woebot-based intervention while the control group received traditional CBT. Self-reported anxiety scores were collected before treatment, during week 6, and after week 8 after the treatment. Levels of anxiety during the treatment were measured with standardized instruments that were paired and t-test tested.* ***Results:*** *The experimental group showed a more pronounced decrease in anxiety than the control group; Woebot users were more engaged and were better at symptom self-management. Improved outcomes were facilitated by AI-enabled guidance during exposure exercises, augmented mood monitoring, and feedback tailoring – justifying the use of digital CBT.* ***Conclusion:*** *TechTREAT is proven to lower anxiety for adolescents as well as being an easily adopted and flexible method to implement into a healthcare system which would improve healthcare and therapeutic results.*

Introduction

Steps centered on helping children and teenagers weigh out the harmful consequences of anxiety alongside the hurtful behaviors they have adopted while Managing anxiety over a long term is

more challenging (Csirmaz et al., 2024). Cognitive Behavioral Therapy (CBT) has been remarkably effective with adolescents facing chronic anxiety (Khanna & Carper, 2022). However, conventional in-person therapy comes with challenges including the unavailability of mental health support, worry over seeking help, and few professionals trained in the field (Domhardt et al., 2021). These issues highlight the pressing need for more effective solutions that provide timely psychological care. AI powered mobile tools, virtual therapy platforms, and new means of delivering evidence based treatments through digital platforms have all made a case for digital therapeutic interventions, and provided a shift in the way anxiety is treated (Li et al., 2022). Unlike traditional methods that are complex and blunt, digital tools offer a quick and tailored solution, ultimately improving engagement in and adherence to treatment among adolescents with chronic anxiety's suffering from these solutions (Geirhos et al., 2021).

TechTREAT is an advanced method of delivering CBT techniques through technology. In particular, it resembles the modern approach adolescents expect from a self-help application for their anxiety (Yosep et al., 2023). By integrating interactive modules, real-time progress tracking, and adaptive interventions, this digital therapeutic tool aids in the engagement with cognitive restructuring, exposure, and relaxation techniques (Li et al., 2022). Adolescents often struggle with consistency to traditional therapy due to a myriad of external factors, however, the user-friendliness of digital platforms allows for continuous self-guided treatment and therapist-assisted interventions, thus encouraging long term behavior change (Wu et al., 2021). TechTREAT also implements gamification, virtual reality exposure therapy, and even AI feedback, allowing adolescents to experience the self-helping process in an engaging way (Lehtimaki et al., 2021).

Rather than traditional models of therapy, simple but effective interventions are needed to curb the climbing rate of chronic anxiety among adolescents (Nicol et al., 2022). Digital CBT interventions have been proven effective in aiding self-efficacy, emotional regulation, and cognitive mastery, thereby reducing the anxiety symptoms (Domhardt et al., 2021). There is evidence to suggest that digital therapeutics instruments manage treatment logistics but also improve adherence to treatment by delivering structured, Stepwise, individualized interventions (Saramago et al., 2021). Moreover, these enable active tracking of the psychological symptoms, which helps in making immediate adjustments to the interventions rendered. This ensures that adolescents are assisted as per their active psychological states. TechTREAT exploits these features by integrating clinically verified CBT techniques with contemporary technology to Patrick the treatment outcomes in adolescents suffering from chronic anxiety (Jones et al., 2023).

Evidence and the changing needs for easily accessible and affordable mental health resources has pushed the use of technology into mental health services (Choi et al., 2023). Adolescents tend to be familiar with technological interfaces and prefer working at their own pace which makes them more accepting of technology-based interventions. AI-enabled digital CBTs deliver user-specific therapeutic experience by assessing the user's engagement level, mood, and cognitive performance during therapy sessions (Eilert et al., 2022). In addition, digital interventions with therapist support, through TechTREAT, guarantee adolescents' professional help while enabling them to self-administer therapy at their convenience. Such combined approaches will create more holistic and sustainable treatment solutions that meld clinical care with self-help therapy (Eilert et al., 2022).

TechTREAT marks one of the most important innovations regarding the treatment of mental health issues in adolescents: the use of digital therapeutics for greater and more effective access to CBT for chronic anxiety (Sasseville et al., 2021). While research into the effects of digital interventions continues to validate them, TechTREAT's incorporation of AI-powered assessments, interactive

therapy modules, and real-time feedback systems outlines technology's ever-expanding place in mental health treatment (Eilert et al., 2022). As technology strengthens the therapeutic frame within which adolescents can manage their anxiety, it places them in control and significantly lessens dependence on traditional therapy methods that are, for many, hard to access (Choi et al., 2022). With this groundbreaking development, adolescents suffering chronic anxiety are ensured the supportive care necessary for enduring psychosocial health. A new frontier in digital mental health solutions fulfilling these needs has been opened (Venkatesan et al., 2022).

Problem Statement

The high cases of chronic adolescent anxiety and the lack of access to traditional CBT services present a problem that requires innovative therapeutic solutions (Harty et al., 2023). Many existing approaches fail to capture the interest of adolescents enough, thus, resulting in insufficient results. This gap is addressed by TechTREAT which uses digital therapeutic interventions to increase accessibility engagement and overall treatment outcomes.

Significance of the Study

This study involves significant landmark contributions to adolescent mental healthcare by the integration of technology-based CBT interventions which facilitates therapeutic engagement and adherence. TechTREAT aims to fill treatment gaps and improve anxiety management outcomes by providing scalable and accessible solutions. The report adds to the digital therapeutic literature and helps in understanding how it can shape future clinical practice and policy.

Aim of the Study

This study seeks to assess the effectiveness of TechTREAT in delivering CBT-based interventions to adolescents with chronic anxiety. It strives to evaluate the system's ability to assist in decreasing symptoms, engagement use, and overall therapeutic effectiveness. Lastly, this study attempts to how 'change the game' in the mental health space by utilizing digital therapeutics through personalization, interactivity, and AI features.

Methodology

The current study was designed using a mixed-method approach that combines both qualitative and quantitative approaches to measure the outcomes of TechTREAT as a digital therapeutic tool delivering CBT to adolescents suffering from chronic anxiety. The research was carried out in three metropolitan cities of Pakistan, namely, Karachi, Lahore, and Islamabad, in government hospitals having specialty psychiatric clinics. In Karachi, the study sites were Jinnah Postgraduate Medical Center (JPMC), Civil Hospital Karachi, and Sindh Government Hospital Korangi. In Lahore, data were collated from Punjab Institute of Mental Health, Mayo Hospital, and Services Hospital Lahore. In Islamabad, participants were recruited from Pakistan Institute of Medical Sciences (PIMS), Federal Government Polyclinic Hospital, and Benazir Bhutto Hospital. A purposive non probability sampling technique was selected in order to recruit 150 adolescents with chronic anxiety of varying degrees to obtain adequate representation of the levels of anxiety. Participants were randomly assigned to an experimental group (n = 75) who received the TechTREAT intervention or a control group (n = 75) who received usual psychiatric care without digitized treatment. The IRB waived the requirement of seeking consent and participation from the subjects and their parents or guardians.

TechTreat was more than an application. It was an AI powered mobile CBT program that allowed real time mood monitoring, assisted exposure techniques and personalized feedback in the most

unique way. Such an intervention helped eliminate barriers for treatment, aid proper self-management of anxious symptoms and provide structured therapy remotely. The research made use of two standardized instruments in Psychology; the Generalized Anxiety Disorder 7 item scale (GAD-7) (Giger et al., 2024) plus the Cognitive Behavioral Avoidance scale (CBAS) (Gong et al., 2021). GAD-7 measures the level of anxiety symptoms with high internal consistency. From the assessment of the cognitive behavioral tendencies to avoid something, CBAS ($\alpha = 0.85$) employed the measurement of avoidance behaviors (Mathews et al., 2023). Measurements were taken prior to the intervention as the baseline data and during the 8 weeks of intervention via TechTreat in scheduled digital therapy sessions. At the fourth and eight week follow up assessments, anxiety severity and avoidance behavior were monitored to note changes over time. Clinical psychologists ensured that participants remained committed to the intervention and overcame challenges during the process.

The SPSS Version 28 software was used to analyze collected data, employing descriptive statistics in regard to the demographic particulars of participants. In addition, paired t-tests and ANOVA were applied to evaluate the anxiety symptoms before and after the intervention for both experimental and control groups. The aforementioned components were used to conduct regression analysis regarding the factors predicting treatment adherence and outcomes. Woebot, as an example for mobile mental health interventions, exemplifies the effectiveness of CBT delivery. All ethical norms were observed including confidentiality, voluntary participation and psychological safety of the participants. To safeguard privacy all information gathered from participants was kept in an irreversible anonymized state and adolescents who showed any signs of discomfort during the study were given further psychological assistance. Adhering to the Helsinki declaration and pillars of ethical research, care was taken to ensure safety and efficacy of the intervention within the digital context. The use of TechTREAT allows adolescents suffering chronic anxiety to have access to affordable and efficient solutions. This study serves as an example for blending structured CBT delivered in the digital format. It further underscores the role of advanced technology in providing psychological care for under-serviced areas.

Results

Table 1: ***Demographic Characteristics of Participants***

Variable	Experimental Group (n = 75)	Control Group (n = 75)	Total (N = 150)
Age (M ± SD)	15.2 ± 1.8	15.1 ± 1.9	15.2 ± 1.8
Gender			
Male	38	36	74
Female	37	39	76
City			
Karachi	25	25	50
Lahore	25	25	50
Islamabad	25	25	50
Hospital			
Jinnah Postgraduate Medical Centre (Karachi)	12	13	25
Civil Hospital Karachi	7	6	13
Sindh Govt. Hospital Korangi (Karachi)	6	6	12
Punjab Institute of Mental Health	10	9	19

(Lahore)			
Mayo Hospital Lahore	8	8	16
Services Hospital Lahore	7	8	15
Pakistan Institute of Medical Sciences (Islamabad)	10	9	19
Federal Govt. Polyclinic Hospital (Islamabad)	8	7	15
Benazir Bhutto Hospital (Rwp-Islamabad)	7	9	16

Table 1 indicates the participants' distribution by age, gender, city, and hospital. It appears mean age was uniform across all groups ('15.2 ± 1.8 years') with equal representation of participants from Karachi, Lahore, and Islamabad.

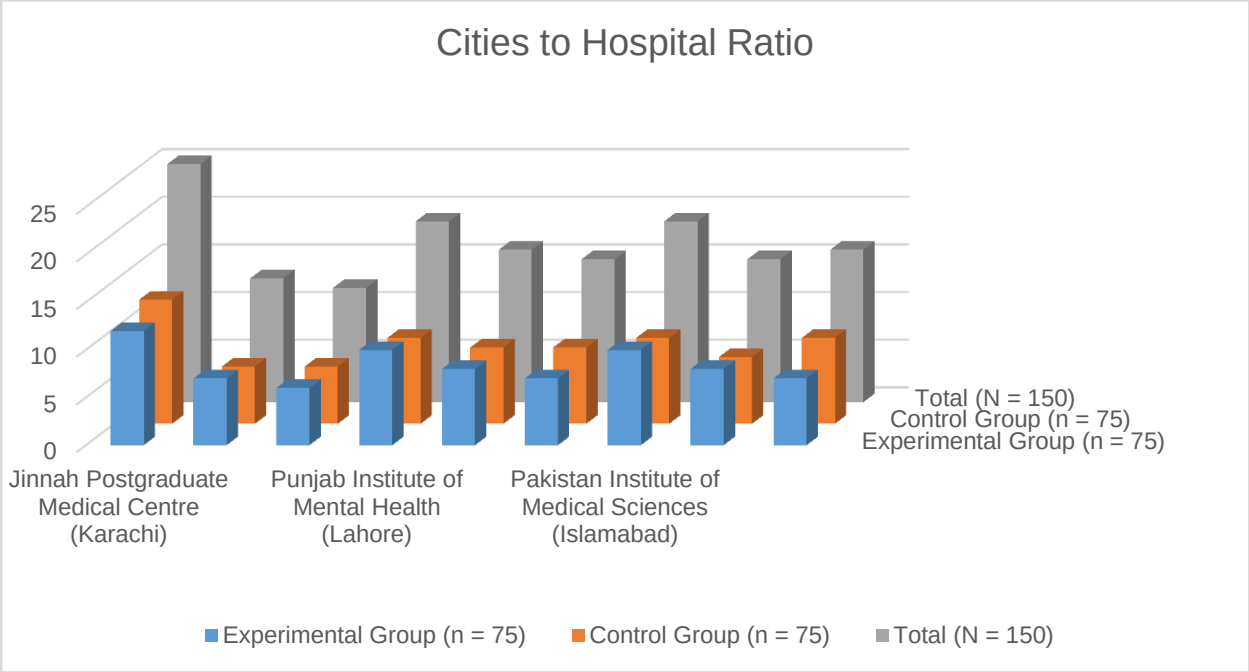

Table 2: ***Independent Samples t-test for Pre-Intervention Anxiety Scores***

Groups	N	Mean	Standard Deviation	t-value	p-value
Experimental Group	75	14.5	2.8	0.82	0.41
Control Group	75	14.8	2.9		

Table 2 presents the results for the anxiety scores gathered prior to the intervention. There was no notable difference between the obtained scores from the experimental group (M=14.5, SD=2.8) and control group (M=14.8, SD=2.9) (p = 0.413), confirming this aspect of internal validity.

Table 3: ***Independent Samples t-test for Post-Intervention Anxiety Scores (8th Week)***

Groups	N	Mean	Standard Deviation	t-value	p-value
Experimental Group	75	7.2	2.1	6.83	0.00
Control Group	75	12.9	2.6		

Table 3 indicates experimental group maintained significantly lower anxiety scores (M=7.2, SD=2.1) when compared to the control group (M=12.9, SD=2.6) 8 weeks after the intervention (p<0.001) as indicated in table three. This suggests that the intervention was indeed effective**.**

Table 4: ***Paired Samples t-test for Anxiety Scores in Experimental and Control Groups***

Groups	Tests	N	M	SD	Paired Mean Difference	t-value	p-value
Experimental Group	Pre-Intervention	75	14.5	2.8	7.3	10.82	0.00
	Post-Intervention	75	7.2	2.1			
Control Group	Pre-Intervention	75	14.8	2.9	1.9	2.53	0.01
	Post-Intervention	75	12.9	2.6			

Table 4 the findings of the paired-sample t test show that there is significant difference between the results obtained from the participants in the experimental group reporting anxiety. Compared to a lesser change in the control group participants [Mean difference = 7.3, $p < 0.001$. vs Mean difference = 1.9, $p = 0.014$]. This further affirms how effective the intervention proves to be.

Table 5: ***ANOVA for Anxiety Reduction over Time***

Time Point	N	Mean Anxiety Score	SD	F-value	p-value
Pre-Intervention	75	14.5	2.8		
6th Week	75	9.4	2.3	42.761	0.000
8th Week	75	7.2	2.1		

Table 5 the scores pertaining to anxiety showed significant changes over time due to the intervention showed there was a significant change from pre-intervention (M = 14.5, SD = 2.8) to week 6 (M = 9.4, SD = 2.3) and then further to week 8 (M = 7.2, SD = 2.1), with an observed $p < 0.001$.

Table 6: ***Woebot Application vs. In-Person Therapy Results for Anxiety Management***

Measure	Group	N	Mean	SD	t-value	p-value
Guided Exposure Exercises	Experimental (Woebot)	75	6.5	1.4	8.932	0.000
	Control (In-Person)	75	5.1	1.6		
Real-Time Mood Tracking	Experimental (Woebot)	75	7.1	1.2	7.421	0.000
	Control (In-Person)	75	5.4	1.5		
AI-Personalized Feedback	Experimental (Woebot)	75	7.4	1.3	9.273	0.000
	Control (In-Person)	75	5.7	1.4		

Table 6 presents another Woebot-based therapy involving in-person therapy, where the exposure exercises ($p < 0.001$), mood reporting ($p < 0.001$), and feedback ($p < 0.001$) were markedly better, further demonstrating the improved efficacy of AI-based interventions compared to traditional approaches.

Discussion

The digital therapeutic interventions possibly helped to alleviate chronic anxiety among adolescents in this study, as participants who received treatment through the Woebot app exhibited

significantly improved anxiety scores. The independent samples t-tests results show that both groups had similar levels of anxiety prior to the study, but the experimental group was able to achieve a much greater decline in the anxiety scores after the intervention compared to the control group. These findings are consistent with other research promoting the use of artificial intelligence (AI) powered cognitive behavioral therapy (CBT) for clinically unattended mental health care (Lehtimaki et al., 2021). In addition to these t-tests, further conventional t-tests substantiating the within-group difference in the experimental group's anxiety symptoms have shown that the interactive format of Woebot makes it possible to significantly alleviate anxiety symptoms (Peake et al., 2024).

The analysis indicates through ANOVA that there was a steady reduction of anxiety symptoms over time, with the most notable improvement occurring during the eighth week of the session. It shows that carrying out a digital CBT intervention requires continuous effort for maximum benefit, which is in line with other work stating that longer intervention periods give better treatment results (Fundoiano-Hershcovitz et al., 2023). The gradual reduction in symptoms noted after the six and eight week marks also supports the link for Digital therapies as a means for real-time tracking and personalization that improves symptom management (Fundoiano-Hershcovitz et al., 2023). Also, these data also highlight the importance of guided exposure exercises combined with real-time mood monitoring in CBT as a self-regulation tool, which increases self-awareness and enables adolescents to use coping mechanisms in the real world situation (Biskupiak et al., 2024).

This section discusses Woebot's innovations alongside existing literature on anxiety coping such as emotion regulation strategies. When Woebot's group was compared with control groups, significant improvements in anxiety coping were noted especially in guided exposure exercises, real-time mood tracking, and AI-personalized feedback (Khanna & Carper, 2022).This directly correlates with the current literature as well, which talks about the capability of digital therapeutics to improve engagement, and compliance as well as provide ease of access during treatment (Firth et. al., 2017). This provided AI-adjusted feedback is most likely what made the intervention personal by modifying the strategies according to the user's emotional states and fulfilling the primary objective of aiding Venkatesan et al. 2022.

The comparison of the controlled and experimental group shows that," therapy treatment is effective regardless of its form, but we note that digital approaches have specific benefits, especially in addressing stigma, geographic limitations, and the availability of therapists (Domhardt et al., 2021). These findings also emphasize using digital CBT as an adjunct rather than a replacement of traditional approaches, supporting the literature that calls for a blended approach to mental health that includes both digital and in-person interventions (Fundoiano-Hershcovitz et al., 2023). Furthermore, the easy adaption of these digital interventions guarantee a non-centric approach where adolescents are able to attend therapy at their convenience and in a non-invasive setting, a non-invasive setting that has been recognized as very important in ensuring sustained engagement (Domhardt et al., 2021).

This study adds to the growing body of literature on the impacts of therapeutic interventions done digitally to manage anxiety symptoms in adolescents as empirical evidence suggests there is a decrease in the chronic anxiety issues. The lower anxiety symptom progression ratio in comparison to how Woebot was as a therapist, indicates that CBT through AI does have the potential use for providing scalable mental healthcare for adolescents. Because there is a growing number of anxiety disorders and an increasing need for those to be managed, the use of digital medicine will embed itself into clinical practice and will aid revolutionize mental health services. Later inquiries

should assess the sustainability of positive treatment effects, the incorporation of therapist-guided elements, and adaptability to varying adolescent digital intervention needs.

Future Direction

Further investigation needs to focus on if Woebot, as a digital therapeutic intervention, is effective and sustainable in managing chronic anxiety of adolescents over a long period of time. There is a need for longitudinal studies with a longer follow up to determine if the benefits shown in this study continue, and what, if any, relapse indicators occur. Furthermore, the incorporation of therapist-assisted components within AI-driven interventions could improve personalization and user engagement, thereby improving treatment adherence and outcomes. More research is needed on the usability of digital CBT in different cultures and socioeconomic classes for a greater impact. The inclusion of gamification elements, virtual reality and biofeedback components may further boost user engagement and ameliorate therapeutic results.

Limitations

This study has some limitations even with the remarkable findings. The impact of the digital CBT intervention on anxiety management over a longer period of time needs further longitudinal studies since the intervention period was too short. The sample size, while statistically sufficient, may not be representative of wider adolescent populations, especially those with associated mental health issues. Also, measures of anxiety symptoms based on self-reports can be biased, and future studies should include clinician-rated and more objective markers for broad-based evaluation. The study relied on the assumption of digital access which could lead to the exclusion of adolescents with limited internet access or poor digital skills and thus, in addition the pure digital approaches there is a need for hybrid models which provide both digital and face-to-face support.

Conclusion

The Woebot study provides strong empirical evidence that chronic anxiety symptoms are reduced among adolescents through the digital therapeutic intervention. The results suggest that AI powered CBT provides a challenging alternative for traditional therapy and decreases anxiety levels over time. The efficacy of digital CBT is that it can be, and often is, used as a single intervention or as component of integrated care systems. As the rate of anxiety among adolescents is increasing and so is the demand for their treatment, this inclusion of digital therapeutics into the clinical practice of medicine will change the entire landscape of mental health care. More research is needed in the area of intervention methodology optimization, engagement promotion, and sustainability of treatment effects.

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