



Digital Therapy: The Impact of Goodville Game on Anxiety Reduction

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SUMMARY. The study investigates the effectiveness of the Goodville game in reducing anxiety levels among its players. Using data collected from April 2021 to September 2022, the study involved 1600 participants, predominantly female (88.5%), from the United States (71%) and the United Kingdom (29%), with ages ranging from 18 to 76 and an average age of 41.67 years.

Participants' anxiety levels were initially assessed using the Generalized Anxiety Disorder-7 (GAD-7) scale, revealing that 47.9% had mild anxiety, 33.1% moderate anxiety, and 19% severe anxiety. The research methodology focused on analyzing changes in GAD-7 scores over a six-week period, considering factors like gender, age, and gaming frequency.

Results indicated a significant overall decrease in anxiety levels, with average GAD-7 scores dropping from 10.585 to 8.3931. The most significant reduction was observed in the first week. Particularly notable was the impact on those with severe anxiety at baseline, who experienced an average score decrease of 4.914 points, compared to a mean change of 2.351 points in the moderate group and 1.007 points in the mild group. There were no significant correlations found between the changes in GAD-7 scores and demographic factors such as gender, age, or gaming frequency.

The study concludes that playing Goodville can effectively reduce anxiety, particularly in individuals with higher initial anxiety levels. This underscores the potential of digital interventions in mental health care and the importance of tailored digital mental health strategies based on individual symptom severity. The findings advocate for further research into the factors influencing treatment outcomes and the long-term effects of such digital therapeutic interventions.

Key words: anxiety, digital therapy, Goodville,

Anxiety disorders rank among the most widespread mental health issues, affecting approximately 4% of the global population, or about 301 million individuals (Javaid et al., 2023). The growing ubiquity of these disorders poses a significant threat to the overall well-being and quality of life of the population (Javaid et al., 2023; Racine et al., 2021). From 1990 to 2019, the number of individuals impacted by anxiety surged by over 55% (Javaid et al., 2023). The onset of the COVID-19 pandemic in 2020 further exacerbated the situation, leading to a marked worldwide escalation in the frequency of anxiety symptoms, with a reported prevalence rate of around 30% (Brooks et al., 2020; Salari et al., 2020). If left unaddressed, chronic anxiety may lead to a range of other health complications, such as hypertension (Pan et al., 2015), cardiovascular diseases (Celano et al., 2016), and dementia (Gulpers et al., 2016).

Current treatment approaches often employ a combination of medication and psychotherapy (Sartori & Singewald, 2019). However, timely and adequate treatment remains almost inaccessible for over half of those affected by anxiety disorders (Werlen et al., 2020). Existing data further reveal that only about 10% of individuals affected by anxiety receive effective treatment (Alonso et al., 2018). Factors such as structural limitations within healthcare systems, lack of awareness, prohibitive treatment costs, and the stigma associated with mental health contribute to this shortfall in access to care (Alonso et al., 2018; Clement et al., 2015). Consequently, there is an urgent need for innovative and effective strategies to assist individuals in managing stress and anxiety (Pallavicini et al., 2021).

In this context, video games emerge as a significant technological asset in developing techniques for stress and anxiety relief (Granic et al., 2014). Increasingly, video games are being applied in mental health fields as supportive tools, extending beyond their traditional role as entertainment (Carras et al., 2018; T. M. Fleming et al., 2017; Jones et al., 2014). Empirical studies confirm the capability of video games in enhancing cognitive functions, such as attention, memory, and cognitive flexibility, particularly among adults and the elderly (Palaus et al., 2017; Reynaldo et al., 2021). Additionally, video games have shown potential in reducing stress and anxiety (Fish et al., 2014; Kowal et al., 2021; Pine et al., 2020; Russoniello et al., 2017; Stanhope et al., 2015) and in improving emotional regulation (Villani et al., 2018).

Over the past decade, the popularity of casual video games on smartphones has soared. As of 2023, the mobile gaming industry has significantly evolved, with nearly 6.92 billion smartphone users worldwide, comprising 85.88% of the global population (How

Many People Have Smartphones Worldwide (Sep 2023), n.d.). Forecasts suggest a continued increase in smartphone usage, expecting a growth of 10.71% from 2024 to 2028 (*Global: Number of Smartphone Users 2013-2028 | Statista*, n.d.). Currently, there are close to 800,000 mobile games available across various app stores, drawing in over 3 billion users in 2023 alone (*How Many People Play Mobile Games in 2023? 3 Billion! - The Small Business Blog*, n.d.; *Mobile Game Statistics 2023*, n.d.)

This widespread adoption and substantial user engagement offer significant opportunities for incorporating mobile games into mental health interventions (Birk & Mandryk, 2016). While numerous studies have investigated the effectiveness of gamification in mental health-focused mobile applications (Cheng et al., 2022; T. M. Fleming et al., 2017; Pine et al., 2020; Six et al., 2021) research specifically assessing the impact of mobile games on individuals with anxiety, stress, or depression remains scarce. Noteworthy examples include Cheng et al.'s study (Cheng et al., 2022) on the effects of playing Pokémon Go on depression and Kim et al.'s research (Kim et al., 2016) on anxiety reduction among breast cancer patients through smartphone-based multiplayer mobile games.

This paper aims to contribute to the existing research on the therapeutic effects of mobile games by evaluating the efficacy of Goodville farm game in reducing anxiety levels among its players. Goodville is a casual farming game designed for smartphones and tablets. Developed by Stork Limited using Unreal Engine 4, it is downloadable on both Android and iOS platforms from the Play Store and App Store. The protagonist, Jane, is a novice farmer whom players guide in developing her farm. She sows and harvests crops, constructs buildings, and completes orders. The game advances through various levels and locations at a leisurely pace, enhanced with diverse sound effects and vibrant 3D graphics. Players are rewarded with in-game energy and other rewards for task completion. Beyond its gaming aspects, Goodville includes elements that aim to improve emotional well-being. Dr. Sokool, an in-game character, has a laboratory where he offers advice and recommendations for mental health, addressing anxiety, depression, and sleep issues. He periodically engages with the protagonist, Jane, proposing participation in psychoeducational programs. Additionally, another in-game character, Florence—endorsed by the World Health Organization (WHO) due to a collaboration with the Goodville development team and researchers—offers advice and recommendations for improving mental and physical health. Goodville players can also monitor their emotional states through integrated self-assessment surveys within the game, evaluating

depressive and anxious symptoms as well as stress levels in a gamified format. Completing these surveys earns players extra in-game energy. The results are provided verbally and graphically, allowing players to track their emotional state over time. Included in 'Goodville' is the GAD-7 questionnaire, a tool for assessing anxiety levels. The anxiety self-assessment using GAD-7 is conducted anonymously, without requiring personal data. Users have the option to provide their gender and age before taking the survey.

The research aimed to measure changes in anxiety levels among Goodville players during their gameplay. The study utilized a database of self-assessment data on anxiety levels from Goodville players in the United States and the United Kingdom, collected from April 2021 to September 2023. Anxiety assessments were conducted using the GAD-7 questionnaire integrated into the Goodville platform.

Methods

The Generalized Anxiety Disorder-7 (GAD-7) is a seven-item scale that reflects the diagnostic criteria for Generalized Anxiety Disorder (GAD) as outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (Spitzer et al., 2006). The GAD-7 has become increasingly popular in research and clinical practice in recent years due to its excellent psychometric properties, brevity, and ease of administration (Johnson et al., 2019). It includes seven questions that probe the frequency of various anxiety symptoms experienced by the patient in the past week, with response options of “not at all”, “several days”, “more than half the days”, and “nearly every day”, scored as 0, 1, 2, and 3, respectively. The GAD-7 scoring defines cut-off points for mild (5-9), moderate (10-14), and severe (15 or more) anxiety levels (Spitzer et al., 2006)

The initial database contained anxiety self-assessment results from 2,860 respondents who completed the GAD-7 weekly for six weeks following the installation of the Goodville game. Analysis of the results indicated that 1,260 users (44%) reported no significant anxiety symptoms and were thus excluded from the dataset. The remaining 1,600 users (56%) had their self-assessment results further analyzed in alignment with the research goals. Among the participants, 1,132 (71%) were from the USA and 468 (29%) from the UK. There were 1,416 female and 184 male participants. The ages ranged from 18 to 76, with a mean age of 41.67 and a standard deviation of 13.251.

The study assessed changes in anxiety levels using repeated measures ANOVA, taking into account factors like sphericity and the chosen method. Post hoc tests, which

included pairwise comparisons, were carried out to pinpoint significant differences at specific time intervals. The level of statistical significance was established at $p < 0.05$, with adjustments for multiple comparisons applied as needed. The study also examined the relationship between the degree of change in anxiety levels during gameplay and the initial anxiety levels of participants. The data samples were categorized into three groups based on their initial GAD-7 scores, indicating mild, moderate, or severe anxiety symptoms. For each participant, the difference between their initial and final GAD-7 scores was calculated.

To select a suitable statistical analysis method, the normality of the distribution of the GAD-7 score differences was tested using the Shapiro-Wilk test. In instances where normality was not assumed, the Kruskal-Wallis test was utilized to compare the score differences across the three groups. Should the Kruskal-Wallis test indicate significant differences, post hoc analysis with the Dunn test—a non-parametric method for pairwise comparisons—was employed to identify distinct group differences regarding the change in anxiety symptoms. The significance threshold was maintained at $p < 0.05$ for all statistical tests.

Additionally, the study investigated the relationship between the changes in GAD-7 scores during gameplay and variables such as gender, age of participants, and the number of active gaming days within the study period, using correlation analysis.

All statistical analyses were performed with the R statistical language and MedCalc statistical software.

Results

Table 1 presents the distribution of Goodville players by the severity of their anxiety as determined by their initial GAD-7 scores.

Table 1. Distribution of Goodville Players by Severity of Anxiety According to the Results of the Initial GAD-7 assessment (N=1600)			
GAD-7 cut-off scores	Severity level	Distribution of players	
		abs.	percentage
5 - 9	mild	767	47.9
10 – 14	moderate	530	33.1
15 or more	severe	303	19

The evaluation of the table data indicates that more than half of the respondents reported noticeable anxiety at the initial assessment, with nearly one-fifth exhibiting severe anxiety symptoms.

The methods used to assess sphericity in ANOVA for repeated measures, Greenhouse-Geisser ($\epsilon = 0.816$) and Huynh-Feldt ($\epsilon = 0.819$), yielded similar values, indicating that the assumption of sphericity was satisfactorily met. Analysis of within-subject effects showed that the sum of squares for the three corrections (Sphericity assumed, Greenhouse-Geisser, Huynh-Feldt) was identically valued at 5495.617, with degrees of freedom ranging from 4.899 to 4.916. The mean square varied between 915.936 and 1121.848, and the F-value (89.79) was statistically significant at $P < 0.001$ for all corrections. These findings demonstrate that there was a significant change in GAD-7 scores during gameplay. Trend analysis revealed significant linear ($t = -14.4260$, $P < 0.0001$), quadratic ($t = 9.3922$, $P < 0.0001$), and cubic ($t = -5.4147$, $P < 0.0001$) trends, suggesting that the changes in anxiety levels over time were complex and not strictly linear or quadratic.

Throughout the six-week period of gameplay, GAD-7 scores significantly decreased from an initial mean score of 10.585 (CI: 10.3714 to 10.7986) to 8.3931 (CI: 8.1003 to 8.6859) by the study's end. The graph in Figure 1 illustrates the temporal dynamics of the average GAD-7 scores, indicating that the most pronounced reduction in anxiety levels occurred in the first week.

Pairwise comparisons, as detailed in Table 2, highlight the significance of the changes in anxiety levels between each time point. The data show that the most substantial decreases in anxiety levels were between the first and third time points, aligning with the initial two weeks.

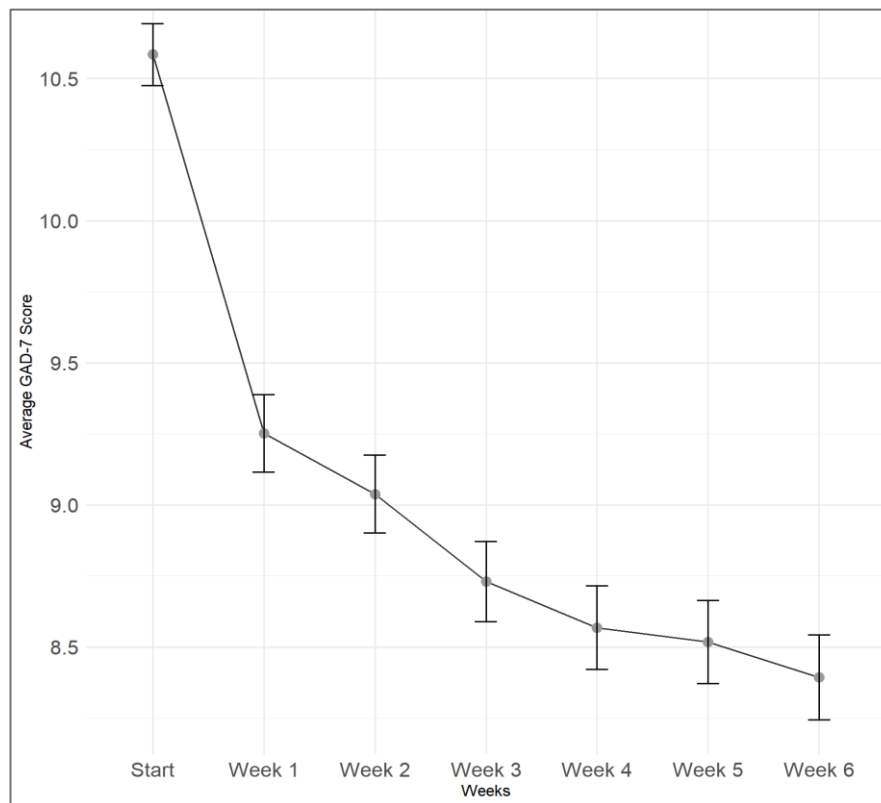


Figure 1. Temporal dynamics of average GAD-7 scores during 6 weeks of Goodville gameplay

Time points		Mean difference	Std. Error	P	95% CI
Start	Week 1	1.333	0.113	<0.0001	0.988 to 1.678
	Week 2	1.547	0.121	<0.0001	1.180 to 1.914
	Week 3	1.854	0.123	<0.0001	1.479 to 2.229
	Week 4	2.016	0.130	<0.0001	1.621 to 2.411
	Week 5	2.067	0.132	<0.0001	1.665 to 2.469
	Week 6	2.192	0.138	<0.0001	1.771 to 2.613
Week 1	Week 2	0.214	0.102	0.7811	-0.0981 to 0.526
	Week 3	0.521	0.110	<0.0001	0.186 to 0.855
	Week 4	0.683	0.116	<0.0001	0.331 to 1.035
	Week 5	0.734	0.119	<0.0001	0.372 to 1.095
Week 2	Week 6	0.859	0.126	<0.0001	0.475 to 1.242
	Week 3	0.307	0.0985	0.0392	0.0072 to 0.607
	Week 4	0.469	0.107	0.0003	0.143 to 0.796
	Week 5	0.520	0.114	0.0001	0.174 to 0.886
Week 3	Week 6	0.645	0.121	<0.0001	0.277 to 1.013
	Week 4	0.163	0.0941	1.0000	-0.124 to 0.449
	Week 5	0.213	0.0981	0.6306	0.0855 to 0.512
Week 4	Week 6	0.338	0.108	0.0379	0.00899 to 0.667
	Week 5	0.0506	0.0914	1.0000	-0.227 to 0.329
Week 5	Week 6	0.176	0.102	1.0000	-0.134 to 0.485
	Week 6	0.125	0.0907	1.0000	-0.151 to 0.401

Impact of Initial Anxiety Severity

The Shapiro-Wilk test revealed that the paired differences in GAD-7 scores between the initial and final assessments did not follow a normal distribution ($W = 0.993$, $p < 0.001$). Consequently, the non-parametric Kruskal-Wallis test was employed to explore the relationship between the initial anxiety symptom severity and the degree of change in these symptoms. Significant differences were observed across the three categorized groups—mild, moderate, and severe—regarding the extent of anxiety symptom changes ($K = 71.042$, $p < 0.0001$). Post hoc pairwise comparisons conducted using the Dunn procedure with a Bonferroni adjustment are summarized in Table 3, showing marked differences in GAD-7 score changes between each of the depression severity groups.

Severity group	n	Average Rank	Different ($p < 0.05$) from group
Mild	767	881.27	(2)(3)
Moderate	530	787.561	(1)(3)
Severe	303	881.27	(1)(2)

The violin plot depicted in Figure 2 showcases the distribution of GAD-7 anxiety scores among Goodville users over a six-week period of gameplay, grouped by baseline anxiety severity: mild, moderate, and severe. Users with initially mild anxiety levels typically showed minimal change in their anxiety scores, suggesting that the gameplay had a neutral effect on this group. The average decrease in anxiety levels for this cohort was 1.007 points, with a standard deviation of 4.943. In the moderate anxiety group, a slightly greater variability was observed, indicating a range of individual responses to the gameplay. The mean change in GAD-7 scores for this group was 2.351 points, with a standard deviation of 5.443. In contrast, users with initially severe anxiety experienced a significant reduction in their scores, with an average decrease of 4.914 points and a standard deviation of 6.085, implying that gameplay in Goodville may be more beneficial for users with more substantial baseline anxiety levels.

There were no significant correlations found between changes in GAD-7 scores and participants' gender, age, or the frequency of active days playing Goodville during the six-week period.

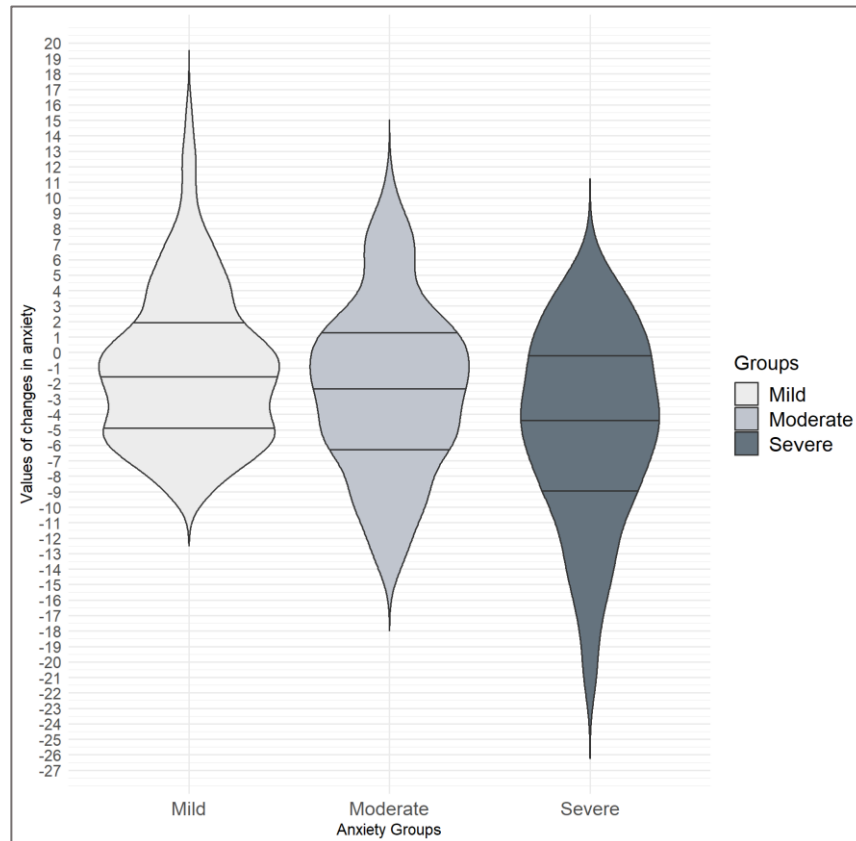


Figure 2. Variations in Anxiety Scores Among Goodville Users by Initial Anxiety Level

Discussion and Conclusion

The primary goal of this study was to evaluate the impact of playing Goodville on users' anxiety levels over a six-week period. Goodville is more than just a casual mobile farming game; it incorporates features designed to enhance players' emotional well-being and includes a mechanism for users to monitor their emotional states. We utilized self-reported anxiety data from users in the United States and the United Kingdom, employing the Generalized Anxiety Disorder (GAD-7) scale, which was integrated into the Goodville game interface. The assessment spanned six weeks, with evaluations occurring weekly from the point of the game's installation. The study excluded users with minimal non-significant anxiety symptoms (GAD-7 scores under 5), focusing on a sample of 1,600 users displaying a range of anxiety levels from mild to severe.

A repeated measures ANOVA showed a significant decrease in anxiety levels among users throughout the gameplay period. Considering the substantial size of our sample, these findings imply that the Goodville game may exert a therapeutic influence. This is in line with prior studies that have identified a beneficial effect of video and mobile games on mental health (Birk & Mandryk, 2016; Cabot Scott and Wilkinson, 2016; Kowal

et al., 2021; Pine et al., 2020). The trends we noted both linear and cubic suggest that ongoing engagement with the game leads to a consistent alleviation of anxiety symptoms. However, individual variability in response to the game and other external factors likely play a role in these dynamic changes.

We observed the most substantial reduction in anxiety levels during the initial week, with a steady and significant decline thereafter. This immediate effect might reflect the initial therapeutic engagement with the game, with the intensity of this effect tapering off yet maintaining through the sixth week. The more substantial anxiety reduction early on bolsters the argument that Goodville's influence is significant. Its engrossing, yet soothing gameplay may provide players with a sense of agency and relief from stress, aligning with existing literature on the mental health benefits of gaming (Abd-Alrazaq et al., 2022; Dewhirst et al., 2022; T. Fleming et al., 2023; T. M. Fleming et al., 2017; Six et al., 2021) and underscoring the value of digital interventions as a supplement to traditional therapy.

The study findings also reveal that the therapeutic impact of Goodville varies with the initial anxiety severity. Users with more severe anxiety at baseline experienced more marked improvements, suggesting a potentially greater benefit for those facing significant anxiety. However, the game appeared less effective for users with milder anxiety symptoms. This highlights the importance of initial symptom severity in gauging the effectiveness of digital interventions for anxiety and suggests that Goodville, with its immersive and engaging nature, may be particularly suited for those with higher stress levels and psychological distress.

Our analysis found no significant correlations between changes in GAD-7 scores over the six-week period and factors such as gender, age, or frequency of gameplay. This suggests that the game's therapeutic potential may be broadly applicable across different demographics and does not require consistent play to be effective, offering a flexible option for those managing anxiety.

Future research should investigate additional factors that may influence treatment outcomes, such as individual gaming preferences or behaviors, to enhance our understanding of how gaming can support mental well-being and its potential clinical applications.

Limitations and Future Directions

It is important to acknowledge several limitations within our study. It was limited to the effects of the Goodville game in isolation, without accounting for variables such as medication, psychological support, or comorbid conditions. The six-week study duration also precludes insights into the long-term effects of gameplay. Additionally, while we considered certain demographic variables, a broader range of factors, like socioeconomic status or educational background, could potentially affect the results and warrant further investigation.

To validate our findings, subsequent studies should aim for replication with larger and more diverse samples, considering cultural and geographic diversity to assess Goodville's universal applicability.

A significant constraint of our research was its anonymous and remote nature, which precluded access to participants' diagnostic information. Future studies could include diagnostic evaluations to understand how Goodville might differentially benefit various mental health conditions.

By addressing these limitations in subsequent research, we can refine our comprehension of Goodville's therapeutic effects and extend its relevance and credibility in addressing mental health outcomes.

In summary, our research provides evidence for the positive effect of the Goodville game on anxiety reduction, underscoring the game's potential as a tool for emotional improvement. The incorporation of digital solutions like Goodville into mental health strategies offers a promising avenue for enhancing treatment outcomes. The study underlines the necessity of tailoring digital interventions to individuals' symptom severity, suggesting that Goodville might be particularly beneficial for reducing severe anxiety symptoms. These insights are valuable to the burgeoning field of personalized digital interventions for mental health, highlighting the need for targeted approaches based on symptom severity.

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