

Mindfulness Exploratory Data Investigation

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Abstract

The use of apps to deliver mindfulness training is becoming more popular with each passing year. More and more patients are turning to apps as an affordable and convenient method for self-improvement in the mental health sphere. As more research is being done into how mental health affects physical health, the general population becomes increasingly aware of how to improve themselves and others around them. However, some apps may be more credible than others. In this paper, the app “Headspace”, created by the mental healthcare provider Headspace Health, is examined for its effectiveness at delivering mindfulness training in an app to a generalized adult population. To determine how well users understand mindfulness and are consequently affected by the app, four psychometric scales will be used in this study: the Satisfaction with Life Scale, the Perceived Stress Scale, the Wagnild Resilience Scale, and the General Health Questionnaire. Participants in this study were asked to self-report their scores on these four scales at the initial phase of the study, a 10-day intervention period, and a 30-day intervention period. The reported scores are investigated to determine the effectiveness of the Headspace app only; no other mindfulness training apps are analyzed in this study.

Keywords: mindfulness, app-based training, app efficacy, Satisfaction with Life Scale, Perceived Stress Scale, Wagnild Resilience Scale, Global Health Questionnaire

Mindfulness Exploratory Data Investigation

Personalized mindfulness training is a relatively recent phenomenon that has gained popularity with the increased use of smartphone apps. A quick internet search for the phrase “mindfulness app” yields plenty of SEO websites and blogs listing the various mindfulness apps that developers have created within the past decade. This approach seems to be working for patients too, as instead of visiting a therapist, individuals can pay a subscription fee close to the price of their lunch some of the most popular apps on the market.

Mindfulness is defined as the “thought to create a witnessing or observant stance toward the ongoing emotional and other psychological experiences, the results of which appears, from the present results, to promote a balanced to even-kneeled emotional life (Brown & Ryan, 2003). It is because of this reason that there are “both short and long term negative and positive affect associated with physiological indicators in natural settings” (Diener & Chan, 2011). To put it another way, mindfulness has the potential to have a profound effect on one’s physical and emotional state. To be mindful of oneself is to reduce the risk of physical illness and increase one’s longevity.

Mindfulness App-Based Training

Online interventions are becoming more popular in recent years due to their ease of access and lower prices compared to a traditional in-person therapist (Geraghty et al., 2013). In addition, mindfulness is a “habit and mind-training skill that requires regular practice and sustained effort to be effective (Kabat-Zinn, 2003). Therefore, there is a growing market for the web-based delivery of mindfulness training, even more so for mobile-based app delivery (Mani et al., 2015). Many apps contain timers and reminders, while others provide progressive and program-based mindfulness (Mani et al., 2015). It is important to note however, that mindfulness

encompasses meditation, breathing exercises, and relaxation, which may be offered in parts in certain “mindfulness” apps only (Mani et al., 2015). Other apps may offer introductory lessons to the principles and address common misconceptions behind mindfulness, which aids users into improving their engagement with the mindfulness exercises (Mani et al., 2015). Therefore, in order to assess the effectiveness of mindfulness programs delivered through mobile applications, the results must be assessed through a means other than anecdotal evidence (i.e., user ratings and reviews).

Research Directions

This exploratory data investigation will use the R language to determine how mindfulness training delivered through the “Headspace” mobile app may affect the emotional and cognitive states of patients in an adult population. The effectiveness of the “Headspace” app is determined by the changes in scores for the following questionnaires: Satisfaction with Life Scale, Perceived Stress Scale, and the Wagnild Resilience Scale. Scores will be assessed in relation to the percentage of users that report high and low scores for each test, which are then compared to a waitlisted group (a group that does not utilize the app) to see if the app improves any category. This author hypothesizes that there will be an overall increase in the Satisfaction with Life Scale and the Wagnild Resilience Scale, and a decrease in the Perceived Stress Scale for the entire population, regardless of the intervention period. A one-time score taken from the General Health Questionnaire will also be provided as a reference point to compare to, as it is able to measure life factors other than psychological well-being (i.e., physiological well-being). This hypothesis is believed to be true since mindfulness should in theory, increase life satisfaction as a higher-level need, and increase resilience to adverse events and trauma. The

amount of perceived stress should in theory decrease since a primary benefit of mindfulness is decreasing elevated cortisol levels which may be present as a result of stress.

Methods

Participants

Participant data was given by the course instructor. In the dataset provided, participants were randomized in a controlled trial. The first group of participants ($n = 29$) engaged with a self-guided mindfulness meditation app for a certain amount of time. After intervention periods of 10 days and 30 days, they were asked to self-report their scores from the Satisfaction With Life Scale (SWLS), Perceived Stress Scale (PSS), and Wagnild Resilience Scale (WRS). The second group of participants ($n = 33$) engaged in traditional peer-reviewed mindfulness lectures taught in person; these participants are considered to be a waitlist control. A one-time assessment of General Health Questionnaire (GHQ) was given to participants at the beginning of the study. A total of 25 males and 37 females participated in this study ($n = 42$). Participant ages ranged from 25 – 59 years of age (mean = 39.13, sd = 5.70).

Measures

Headspace App. According to the company's website, the Headspace app (referred to as Headspace from this point forward) "was started with one mission: to improve the health and happiness of the world" (Headspace Health, 2022). Headspace is developed by Headspace Health, a mental healthcare provider that claims to be the most accessible and comprehensive provider in the world. Their services include partnering "with over 2,500 companies and health plans to provide access to mediation, mindfulness, coaching, therapy, and psychiatry to their members and employees. Headspace Health makes the claim that they are used in 190 countries around the world, with 70 million members and 600,000 user reviews (Headspace Health, 2022).

Some key members of Healthspace Health include Russell Glass (CEO), Christine Evans (Chief Marketing and Strategy Officer) and Karan Singh (Chief Clinical Operating Officer) as of December 2022.

Headspace provides users with two pricing plans: \$69.99 USD/year (\$5.83 USD/month) + 14 days free, or \$12.99 USD/month + 7 days free (Headspace Health, 2022). The company claims that patients show a 19% decrease in anxiety symptoms after 8 weeks, a 32% decrease in stress after 30 days, a 29% decrease in depressive symptoms after 8 weeks, a 22% increase in focus after 1 session, and an 11% increase in resilience after 30 days with the app (Headspace Health, 2022).

Satisfaction With Life Scale. The Satisfaction With Life Scale (SWLS) was developed in 1984 to measure the subjective well-being of participants. It is “a good measure of life satisfaction” when compared to other general life satisfaction questionnaires (Larsen et al., 1985). According to the researchers, the “multi-item scales tended to show modest reliabilities” while the SWLS, as a “cognitive life satisfaction measure, showed high temporal reliability.” The scale is a 5-item questionnaire that asks participants to rate their subjective well-being on an Likert-type 7 point scale, with 1 = strongly disagree and 7 = strongly agree (Diener et al., 1985). Ratings are “summed in an unweighted way to yield a domain satisfaction composite score” (Diener et al., 1985).

Perceived Stress Scale. The Perceived Stress Scale (PSS) is a psychometric tool that finds a balance between previous objective and subjective measures of stress. The PSS “measures the degree to which situations in one’s life are appraised as stressful” (Cohen et al., 1983). Objective measures are placed inside of the scale to estimate the risk associated with easily identifiable events, but its weakness lies with the fact that stressful events are presumed to

be the “precipitating cause of pathology and illness behavior” (Cohen et al., 1983). Subjective measures, while very personalized, are very difficult and time consuming to conduct, not to mention the fact that “the illness process is affected by a person’s global stress level, not just by his/her response to a particular event” (Cohen et al., 1983). This makes subjective stress difficult to study as there is “evidence that people often misattribute their feelings of stress to a particular source when the stress is actually due to another source” (Cohen, 1985). The PSS is a 14-item questionnaire, with answers reported with a Likert scale of 0 = never in the past month to 4 = very often in the past month. Questions 4-10 and 13 are scored in the reverse direction to foster content validity. Participant responses are summed to determine an individual’s perceived stress from an quantifiable standpoint.

Wagnild Resilience Scale. The Wagnild Resilience Scale (WRS) is a questionnaire developed in 1987 that attempts to understand adult resiliency in adverse circumstances (Wagnild & Young, 1993). Before the development of this tool, “adaptive outcomes [were] described as evidence of resilience, usually in the realm of social and psychological competence” (Wagnild & Young, 1993). There are 25 items that participants are asked to rate themselves on, with 1 = disagree and 7 = agree. Items 1-17 on the WRS describe an individual’s self-reported personal competence, and items 18-25 describe an individual’s acceptance of self and life. Questions were specifically designed as “constructs linked with resilience and outcomes of resilience” (Wagnild & Young, 1993).

General Health Questionnaire. The General Health Questionnaire (GHQ) was designed in 1969 for the purposes of identifying psychiatric illnesses in general practice patients (Goldberg & Blackwell, 1970). The questionnaire consists of 60 items, and aims to provide information “about the present mental state of the participant rather than the probability of falling

ill in the future” (Goldberg & Blackwell, 1970). Responses are scored on a Likert scale, with 0 = better than usual, 1 = same as usual, 2 = worse than usual, and 3 = much worse than usual.

Depression is a major component for this assessment, as the GHQ is able to discriminate between “reactive depression” and “endogenous depression” (Goldberg & Blackwell, 1970).

Reactive depression is defined as presenting depression symptoms in response to an external stressor, while endogenous depression refers to the presentation of depression symptoms without stress or trauma. As the GHQ effectively discriminates between the two types of depression, mindfulness and well-being studies are particularly suited for this questionnaire.

Approach

The dataset is collected from the “mindfulness.RData” dataset, obtained from the course instructor. This dataset contains information on whether a subject used Headspace for mindfulness lessons, or placed on a waitlist for app usage while receiving traditional in-person lessons. Age and sex were the only demographics provided of the participants. The dataset also contains the baseline scores, a 10-day intervention score, and a 30-day intervention score for the SWLS, PSS, and WRS. A GHQ score was provided as a one-time measure. Finally the dataset includes the number of days the app was used.

This data investigation will involve splitting the participants into two categories, those who used Headspace and those who did not. Participants will then be divided into further subcategories, separating them by their sex. Comparisons will be made between the baseline scores and the 10-day interventions, baseline scores and the 30-day interventions, and 10-day interventions with 30-day interventions for the tests that have them. GHQ scores will be categorized based on their frequency in both app and non-app users, and associated with the various ages of the participants.

Results

Satisfaction with Life Scale Data Investigation

Of the male population that used Headspace to learn about and practice mindfulness ($n = 16$), 7 (43.8%) reported an improvement in life satisfaction by the 10-day intervention, and 10 (62.5 %) reported an improvement in life satisfaction by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 7 (43.8%) reported an improvement in life satisfaction, although some subjects in this population may overlap with those found in the previous two conditions.

Of the female population that used Headspace ($n = 13$), 8 (61.5%) reported an improvement in life satisfaction by the 10-day intervention, and 10 (77.0%) reported an improvement in life satisfaction by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 10 (77.0%) reported a continued upward trend in life satisfaction, although this some subjects in this population may overlap with those found in the previous two conditions.

Of the male population that were waitlisted in order to engage with traditional mindfulness practices instead ($n = 9$), 3 (33.3%) reported an increase in their life satisfaction by the 10-day intervention, and 2 (22.2%) reported an increase in their life satisfaction by the 30-day intervention. Between the 10-day intervention and the 30-day intervention 5 (55.5%) reported a continued trend in life satisfaction; all subjects were found to overlap with the previous two conditions.

Of the female population that was waitlisted ($n = 24$), 13 (54.2%) reported an increase in their life satisfaction by the 10-day intervention, and 11 (45.8%) reported an increase in their life satisfaction by the 30-day intervention. Between the 10-day intervention and the 30-day

intervention 11 (45.8%) reported a continued trend in life satisfaction, although some subjects in this population may overlap with those found in the previous two conditions.

Perceived Stress Scale Data Investigation

Of the male population that used Headspace to learn about and practice mindfulness (n = 16), 3 (18.8%) reported an increase in perceived stress by the 10-day intervention and 6 (37.5%) reported an increase in perceived stress by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 4 (25.0%) reported an increase in perceived stress, although some subjects in this population may overlap with those found in the previous two conditions.

Of the female population that used Headspace (n = 13), 1 (7.7%) reported an increase in perceived stress by the 10-day intervention and 0 (0.0%) reported an increase in perceived stress by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 1 (7.7%) reported an increase in perceived stress, with the same subject being present in the first condition.

Of the male population that were waitlisted in order to engage with traditional mindfulness practices instead (n = 9), 2 (22.2%) reported an increase in perceived stress by the 10-day intervention and 5 (55.5%) reported an increase in perceived stress by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 7 (77.7%) reported trends of increased stress; this population entirely overlaps with those found in the previous two populations.

Of the female population that was waitlisted (n= 24), 9 (37.5%) reported an increase in perceived stress by the 10-day intervention and 15 (62.5%) reported an increase in perceived stress by the 30-day intervention. Between the 10-day intervention and the 30-day intervention,

17 (70.8%) reported trends of increased stress, although some subjects in this population may overlap with those found in the previous two conditions.

Wagnild Resilience Scale Data Investigation

Of the male population that used Headspace to learn about and practice mindfulness (n = 16), 10 (62.5%) reported an improvement in their resilience by the 10-day intervention, and 11 (68.8%) reported an improvement in their resilience by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 9 (56.3%) reported an improvement in their resilience, although some subjects in this population may overlap with those found in the previous two conditions.

Of the female population that used Headspace (n = 13), 7 (53.8%) reported an improvement in their resilience by the 10-day intervention, and 10 (77.0%) reported an improvement in their resilience by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 11 (84.7%) reported an improvement in their resilience, although some subjects in this population may overlap with those found in the previous two conditions.

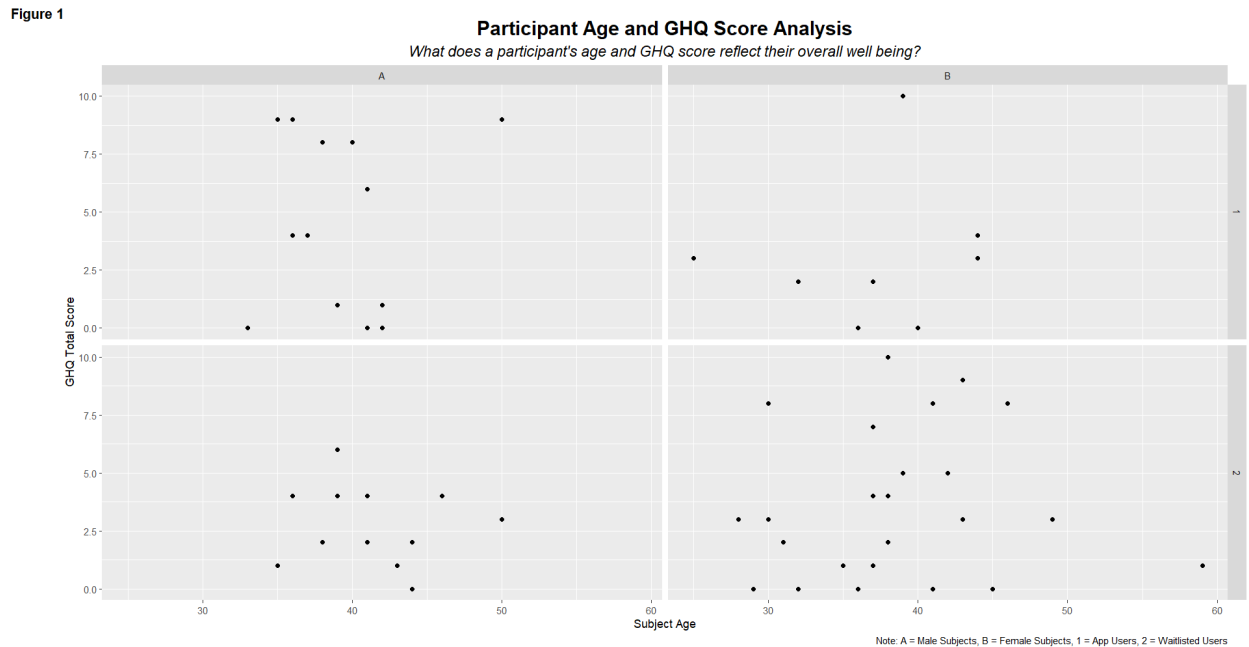
Of the male population that were waitlisted in order to engage with traditional mindfulness practices instead (n = 9), 4 (44.4%) reported an improvement in their resilience by the 10-day intervention, and the same 4 (44.4%) also reported an improvement in their resilience by the 30-day intervention. Between the 10-day intervention and the 30-day intervention, 4 (44.4%) reported an improvement in their resilience, although this population exactly matches individuals found in the previous two conditions.

Of the female population that was waitlisted (n = 24), 16 (66.7 %) reported an improvement in their resilience by the 10-day intervention, and 13 (54.1%) reported an improvement in their resilience by the 30-day intervention. Between the 10-day intervention and

the 30-day intervention, 9 (37.5%) reported an improvement in their resilience, although some subjects in this population may overlap with those found in the previous two conditions.

General Health Questionnaire

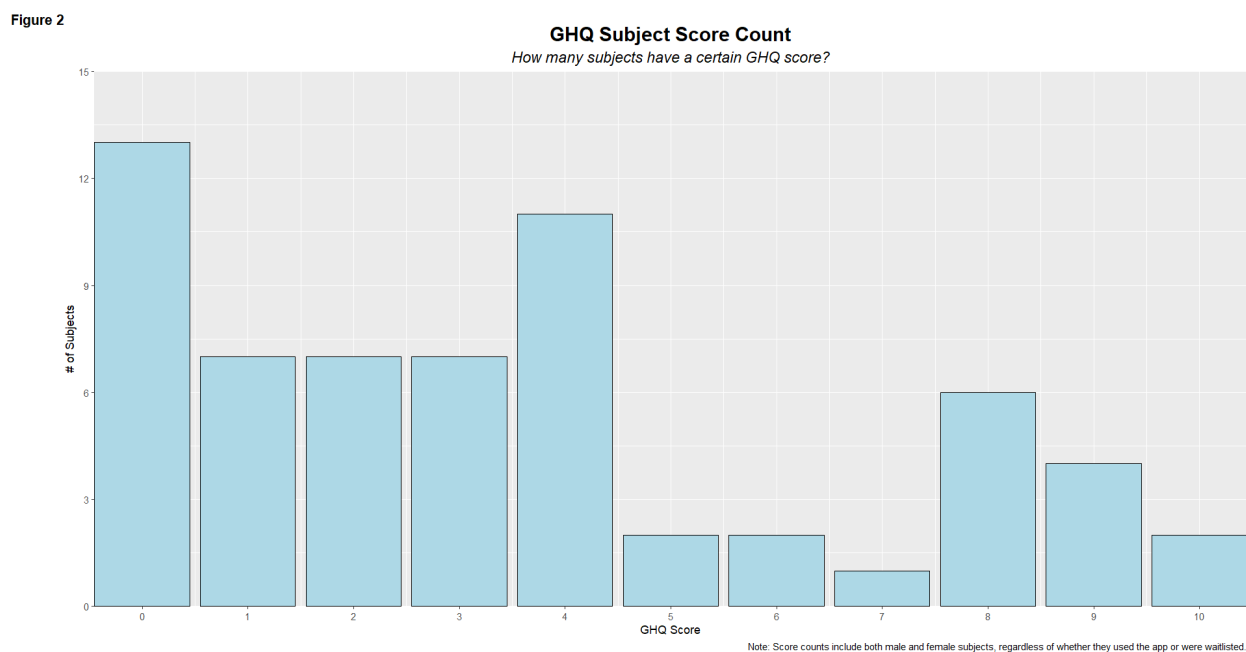
Subjects were categorized based on their age and GHQ scores. A visual summary of the results can be found in Figure 1.



Here, it can be shown that the data in the upper left corner contains the information related to the male Headspace users. This population's GHQ score (mean = 4.44, sd = 3.70) ranges from 0 to 9 points and the age (mean = 39.25, sd = 3.92) ranges from 33 to 50 years. The upper right corner contains information related to the female Headspace users. This population's GHQ score (mean = 2.85, sd = 1.68) ranges from 0 to 6 points and the age (mean = 41.31, sd = 4.13) ranges from 35 to 50 years. The lower left corner contains information related to waitlisted male subjects, of which the GHQ score (mean = 2.66, sd = 3.12) ranges from 0 to 10 points and the age (mean = 37.44, sd = 6.00) ranges from 25 to 44 years. The lower right corner contains

information related to waitlisted female subjects, of which the GHQ score (mean = 3.63, sd = 3.20) ranges from 0 to 10 points and the age (mean = 38.5, sd = 7.11) ranges from 28 to 59 years.

The GHQ scores were also investigated by their frequencies, that is, how often each result appeared in subjects. The results are summarized in Figure 2.



Here, it can be shown that the GHQ scores (mean = 3.53, sd = 3.08) appear to resemble a bimodal distribution. The highest mode for reported GHQ scores is 0, and the second highest mode reported is 3. The median GHQ score also happens to be 3, while the 25% quartile and the 73% quartile are 1 and 5, respectively. It is important to note that these scores are presumed to be baseline GHQ scores before any mindfulness training has occurred at all (either through Headspace or the waitlist) and contains data from both male and female participants.

Discussion

Key Findings

The results from this study indicate the hypothesis that delivery of mindfulness training through the use of a mindfulness app is somewhat effective. Scores on multiple measures

indicate the Headspace's efficacy in delivering content despite its significantly reduced price compared to a traditional therapist. Users will most likely opt for the \$69.99 USD/year subscription plan, rather than \$100/session, depending on the US state as of 2022 (Lauretta, 2022). The popularity of Headspace is indicated by the low GHQ scores evidenced in Figure 2. Those seeking to improve their general health may want to start with improving their mental health first, and the average GHQ score of 3.53 was found to be very low compared to the maximum of 10.

Based on the analysis of the population that benefited from the app, subject scores on the SWLS indicate that there is an improvement in life satisfaction after 10 days with Headspace, even more so after 30 days. For this analysis, the difference between percentages for Headspace users and waitlisted subjects will be taken to determine the overall change. In the male population, there was a 10.5% increase in life satisfaction after 10 days, and a 40.3% increase in life satisfaction after 30 days. However, some users may not benefit from extended use of Headspace, as evidenced by the -11.8% decrease in improvement from the 10-day to 30-day intervention periods in male subjects when using Headspace compared to the waitlist. For the female population, similar trends appear. 7.3% of female users reported an increase in their SWLS scores after 10 days with the app, and 31.2% reported an increase in their SLWS scores after 30 days with Headspace. 31.7% of female users reported an increase in life satisfaction between the 10-day and 30-day intervention periods when using the app compared to the waitlist, suggesting that the novelty of Headspace may wear off for a very small proportion of men as evidenced by the negative percentage change within the same time period.

Using a similar analysis of taking the difference from the waitlisted users and app users for the PSS, 3.4% of male users reported a decrease in stress symptoms (i.e., fewer male users

reported increased stress symptoms when using Headspace when compared to the waitlist) after 10 days. 17.8% of male users reported a decrease in stress symptoms after 30 days with Headspace, and 52.7% of male subjects maintained decreased levels of stress between the 10 day and 30 day intervention periods if they were using Headspace when compared to the waitlist. A similar trend occurred with female Headspace subjects, as 29.8% reported a decrease in stress after the 10-day period and 62.5% reported a decrease in stress after the 30-day period. 63.1% of female subjects reported a decreasing trend of stress when using Headspace compared to the waitlist between the 10-day and 30-day intervention period. Overall, it appears that Headspace works to decrease perceived stress in both sexes regardless of the timeframe.

This process was once again used to determine the changes in WRS scores, however, the approach for the WRS is similar to the SWLS as the difference is taken from the app users by the waitlisted users (and not the other way around, as was done with the PSS to facilitate for an easier interpretation). For male Headspace users, 18.1% reported an increase in resilience after a 10 day period, and 24.4% reported an increase in resilience after a 30 day period. 11.9% of male subjects were able to maintain their trend of increased resilience if they were using Headspace (when compared to the waitlisted group) between the 10-day and 30-day intervention period. In the female population of app users, -12.9% of users reported increased resilience after a 10 day period, and 22.9% of users reported increased resilience after a 30 day period. 47.2% of female subjects were able to maintain their trend of increased resilience if they were using Headspace (when compared to the waitlisted group) between the 10-day and 30-day intervention period. The negative percentage change reported with female users suggests that it may take some time for the app to build resiliency within patients who may or may not have preexisting conditions.

Limitations

The primary limitation of this study comes from how the data was acquired. As this study is an investigation into a dataset, analysis is only limited to the information provided. There was no other information about the participants, which could influence the results of the analysis. For example, there is no information on the preexisting conditions of the subjects, or whether the subjects have had trauma before. Factors such as these could have the potential to greatly influence the baseline scores, as not all subjects may have a similar background. Should there be a guarantee that all subjects come from a similar environment, then there would be greater certainty for the effectiveness of the Headspace for mindfulness.

In addition, while the subjects were randomly segregated into the app and waitlist conditions, there were not equal populations of males and females for each. This presents a limitation to the analysis of this dataset, as the effect on the scores (and therefore emotional/cognitive states) could be said with greater certainty in some populations rather than others. When the delivery of app-based mindfulness training is limited, some populations would be more likely to seek it than others, which is most likely to be reflected in user ratings and reviews. The timespan of the study is not given, so nothing can be said about the years the data was collected from (environmental factors may change initial baseline scores).

Future Directions

The delivery of mindfulness training through apps such as Headspace has been proven to be effective given a small sample size in both male and female populations. As more users continue to seek out app-based training due to its convenience and affordability, more research must be done into other apps as developers try to cash in on the market. To determine the efficacy of these apps, there must be research performed on the design and user interface in order to learn how long users stay on the app (after all, mindfulness training does require consistency

and dedication). Failure to maintain training could result in type II errors (false negatives) when determining how popular and/or effective an app really is. Furthermore, research should be performed in populations other than standardized adults, as there may be different needs for achieving a state of mindfulness.

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