

Management of Stress Based on IoT: Current Trends

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Abstract. In today's world stress has become a part of everyday life. The ongoing pandemic has contributed to increasing our everyday stress even further. If no timely action is taken it can become a bigger problem having an effect on physical and mental well-being of any individual. There is a gap in the number of people affected by stress and doctors and psychologists availability. Further with restrictions of social distancing and lockdowns the accessibility has further reduced. With advancements in human computer interaction and increased use of IoT, technology can help aid doctors in managing stress. A large variety of methods and approaches are available for stress management using HCI and IoT. This review aims to present a summary of the available techniques, with special focus on mobile apps. With mobile phones being omnipresent, apps are very popular amongst users of all ages. There is a huge number of such apps available, but there is no criterion for filtering out the useful ones from others. and highlight the useful apps from this enormous pool of resources. This paper attempts to examine some of them. They are reviewed analyzed and selected on the basis of techniques applied for stress management and ease of use and functionality.

Keywords: mHealth, eHealth, stress, IoT, IoMT

1 Introduction

Stress can have a huge impact on the health and well-being of an individual. Stress is growing not only amongst adults but also in teenagers. Economic Times states that 89% of the population in India are suffering from stress compared to the global average of 86%. According to the 2018 Cigna 360 Well-Being Survey – Future Assured stress levels are higher in Indians compared with other developed and emerging countries. People suffering from stress rarely seek out medical help. This is a direct consequence of the stigma attached with mental health and issues. There is a treatment gap between the prevalence of mental illnesses and the proportion of patients that get treatment. Due to stigma, lack of awareness, lack of professional medical help, resources etc most people go untreated. The Economic times also mentions that nearly 75% of respondents felt uncomfortable talking to a medical professional about their stress and cited cost as one of the barriers. [1]

The World Health Organization stated that of India's 135-crore population 7.5 per cent suffers from mental health issues, which approximates to over 10 crore people. As per a 2015 Ministry of Health report, for these 10 crore people, there were only 3,800 psychiatrists, 1,500 psychiatric nurses, 898 clinical psychologists, 850 psychiatric social workers and 43 mental health hospitals with a combined capacity of 20,000 beds in all of India. [2]

Thus the need of the hour is to find ways to deal with this problem in the wake of lack of infrastructure and resources to deal with this issue. In India today the use of smart phones has increased tremendously. With the development in the fields of mobile computing, and Human Computer Interaction (HCI) smart phones can play an important role in the field of healthcare. They can aid the doctors by being utilized to diagnose, prevent and even help the cure of mental health issues.

Internet of Things or IoT is defined as the "extension of network connectivity and computing capability to objects, devices, sensors and items not ordinarily considered to be computers".[27] With increased popularity and use of smartphones, wearable devices, artificial intelligence, IoT is becoming ubiquitous. IoT devices can be used for remote monitoring, diagnosis and treatment. This can help in expansion of individualized medical care and help in monitoring various aspects of mental health including stress

Mobile devices are increasingly being used in health care settings. This has further led to a rapid growth in the development of medical software applications (apps). Various apps are available for reference and information gathering; clinical decision-making; information and time management; communications and consulting; health record maintenance and access; patient management and monitoring; and medical education and training. All healthcare applications can be roughly categorized as professional apps and healthcare apps for patients. Professional Healthcare Apps include Doctor appointment & clinical assistance apps, Patient medical health tracking apps, Medical reference & database apps, Telehealth mobile apps (doctor-on-demand apps). Mobile Health Apps for Patients include Healthy lifestyle apps, Patient medical education apps, Dieting apps, Diagnosis apps for preventive purposes, Mental health apps, Reminder apps i.e. medical tracking apps or some health habit, Monitoring apps for chronic conditions, Women's health apps. The number of mobile health (mHealth) apps which are targeted at mental health will be cost-effective, help increase availability, quality of mental health treatment and may help the treatment gap. A 2015 World Health Organization (WHO) survey of 15,000 mHealth apps revealed that 29% focus on mental health diagnosis, treatment, or support.[3]

Smart phones provide a way to address the mental health provider shortage. But it is still not ensured that these apps are efficient or not. These are increasingly being used to aid psychiatric treatment, ensure adherence, and to aid self-management of mental health conditions. This review attempts to study and analyze the stress management apps available for students. This answers questions of how many of these apps are accurate and categorize them on the basis of approach used for stress management to provide an insight to the researchers in the field. It also attempts to find out the areas where improvement in this field is possible. It covers the apps available for Android users only.

2 Research method

2.1 Need for review

A methodical and exhaustive review is needed to find the gaps in existing methodologies and techniques. The first aim summarizes the various methodologies currently in trend for managing the issue of stress. As a second aim the paper intends to survey the existing apps available for stress management observe and analyze them. This study focuses on Android apps only. For this the Google Play Store was systematically searched. The apps with descriptions that matched the target intended audience were selected. They were then downloaded and evaluated across the domains of content, technique, availability and the ease of use.

Evidence synthesis: A total of 30 apps were identified. Of these, 24 met study criteria and were downloaded and evaluated. Of the strategies, the common ones were meditation, planning breathing and game based.

2.2 Study selection

For selecting techniques of IoT for stress management various digital libraries were searched for relevant research papers. The sources include Springer, ACM, Science Direct and IEEE libraries.

For study of apps, relevant apps were searched on play store. Initial filtering of apps at the first step was done on the basis of app name. Then on the basis of app description the search was refined and further selection was done. Based on the images of apps available and apparent ease of use of final selection was done.

2.3 Research questions

The purpose of this review is to find out if the apps available for teenagers for stress management are actually useful or not. The selection of papers was done according to the following research questions. The questions are as follows.

RQ1. What are the various approaches in IoT which can aid in stress management?

RQ2. What are the techniques used by apps for stress management?

RQ3. Are the interfaces of these apps user friendly?

RQ4. What are the research gaps in this field?

3 Discussion

The first objective is to outline the various ways IoT can aid in stress management. The various categories of IoT techniques which provide a solution to the problem of stress management can be categorized into Mobile Applications (Apps) & Algorithms, Smart Wearables, Artificial Intelligence (AI) and machine learning, Chatbots and E-Therapy.

With developments in fields of hardware sensors and other such devices are widely available at lower costs and integrated into almost every device. Zubair et al. [28] designed a smart band

device which could detect different conductance levels of the skin. This could predict whether individual is suffering from stress or not. In another work GSR Sensor Data was used for detection of stress patterns[29]. An An IoMT-Enabled Device was developed called Stress-Lysis[30]. It is a wearable, edge level processing device which used physical activities for automatic stress Level Detection.

Machine learning and AI has been effective in this field because of the data collected by the use of this IoT devices and apps. All these are generating data which can be analyzed by AI experts to gain insights and provide data to doctors also to manage stress.

Another objective of this review attempts to summarize techniques used by apps, and check their user-friendliness, engagement of user in effective stress reduction strategies, and enhancement of treatment adherence. Amongst all the devices used smart phones are the most popular ones amongst users. The techniques used by apps include Meditation, Game based, Activities, questionnaires, Planning and organizing, habit trackers, AI based, CBT and ACT based, self monitoring and so on. These apps also cover the categories of chatbots and e-therapy. Further they are also a huge source of data which can then be applied to various ML and AI algorithms to gain new insights into this field. Further this analyzed data can aid medical professionals in better stress management.

Meditation was the most used strategy with most of the apps using different techniques for meditation. Some provided audio clips for meditation in the form of lectures or music or voices of nature etc. Some recommended techniques of meditation and some provided books and materials. They focused on improving sleep, increasing concentration, anger management, reducing anxiety etc. Game based used games for distraction, relaxing and organizing. Planning apps mostly used planners for organizing work, schedules, reminders, trackers etc. AI based used chat-bots which could chat and provide help when stressed. Some also connected to others on closed social media groups or forums.

In terms of functionality and user interfaces nearly all apps were user friendly and easy to use and understand. They had fun pictures, colour codes and interactive menus. There were very few apps which were available for free and connected to any real doctor, psychiatrist or psychologist or offered immediate help in case of extreme conditions like suicide or panic attack etc. Most of them were not real time or live. They focused more on relaxing and reducing stress over a period of time with games, activities etc.

Table 1. Apps selected and categories

S.No	App	Cost	Category
1.	Stop, Breathe & Think	Free	Meditation
2.	Digipill	Free	Meditation
3.	Calm	Free	Meditation
4.	Headspace: Meditation & Sleep	Free	Meditation
5.	Tide	Free	Meditation
6.	Hypnosis for Anxiety, Stress Relief & Depression	Free	Meditation
7.	Abide: Christian Guided Meditation & Daily Prayers	Free	Meditation
8.	Serenity: Guided Meditation & Mindfulness	Free	Meditation
9.	NeuroNation - Brain Training & Brain Games	Free	Game based
10.	Antistress - relaxation toys	Free	Game based
11.	Monument Valley	Paid	Game based
12.	Lumosity	Free	Game Based
13.	Woe bot	Free	AI based
14.	Wysa	Free	AI based
15.	Youper- Emotional Health	Free	AI based
16.	Action For Happiness	Free	Planner
17.	Any.do	Free	Planner
18.	iStudiez Pro	Free	Planner
19.	Breathing Relaxation Exercises	Free	Breathing
20.	Moodpath - Depression & Anxiety Test	Free	Questionnaire
21.	Happify	Free	Activity based
22.	What's Up?	Free	CBT, ACT based
23.	Fabulous: Self Care	Free	Habit tracker
24.	Self-help Anxiety Management	Free	Self monitoring

Stop, Breathe, & Think[4] has won Webby Award and People's Voice award and has extremely high ratings. The focus is on medication and self-dwelling. It allows recording of thoughts and emotions before and after meditating. The app attempts to increase mindful thinking. It has a range of meditation techniques. It supports Mindfulness training which in turn promotes emotional and social intelligence.

iStudiez Pro[5] is designed specifically for students. It helps them to stay organized. It has multiple different options and features for schedule management. Track schedule, to-do lists, keep track of your grades, calculate GPA, prioritize tasks, know where you stand academically, are the features offered which can help reduce stress. Any.do[6] is based on planning and organization. It helps organize to-do list and manage tasks throughout the day, Organization is the key to relieving stress and feeling in control of your life. Digipill[7] is mediation based. It provides audio "pills" that are audio clips for half an hour. They address a wide range of issues

(from quitting smoking to getting a good night's sleep). These audio clips or pills are the work of mind coach Brian Colbert known worldwide. Happify[8] is dedicated to bringing happiness, using de-stress games, motivational articles, quotes and audio tracks. They are created by actual psychology coaches. Monument Valley[9] is game based. It has a puzzle game, where princess Ida is taken through various mazes and optical illusions. The visuals and music allow you to relax. While this is a paid app but the reviews are very good.

Other apps using meditation include Calm[10] for meditation and sleep with guided meditations, Sleep Stories, breathing programs, masterclasses, and relaxing music, Headspace[11]: Meditation & Sleep and Tide with Sleep Sounds, Focus Timer. Tide[12] has sounds from nature and guided meditation practices. Helps to reduce pressure, keep focus and clam, practice meditation, and have a better sleep.

Hypnosis[13] app contains audio affirmations and programs along with courses, and workshops to help reduce stress, reduce anxiety, overcome your phobias, get over fears, and stressful situations, , become more confident in social settings, and achieve relaxation. Abide[14] is based on meditations from Bible scriptures. Breathing Relaxation Exercises[15] has guidance for healthy and normal breathing and can be used during sophrology session or at the same time as your guided meditation. It has a module for Heart coherence which attempts to modify the cardiac rhythm by the respiratory control which will have the effect of rebalancing the sympathetic and parasympathetic nervous systems.

There are some apps based on AI in the form of chatbots which include Wysa[16] and Woebot[17]. Wysa is AI based and is a stress, sleep & mindfulness therapy chatbot. It is a well being tracker with daily spiritual meditation for women that improves women's mental health. It focuses on emotional health with mood tracking, finding optimism, reframing thoughts (CBT) in friendly chats to help you reduce sadness. Wysa provides personalized toolkit and tools to cope with depression, reduce anxiety, resolve sleep issues and provide support with grief. Woebot is a self-care expert in CBT & mindfulness which uses tools from Cognitive Behavioral Therapy (CBT). Intelligent mood tracking, Master skills to reduce stress and live happier, messaging for people with everyday stress and challenges such as symptoms of depression, anxiety, relationship problems, procrastination, loneliness, grief, addiction, pain management and more!

Fabulous[18] is a Self Care app which is Science-based. It provides motivation for fitness improvement & achieving weight loss goals, rebooting sleep cycle, and discovering mindfulness to reduce anxiety. It is not any habit tracker but also mindfulness app to help you relax and focus. What's Up? [19] Is based on CBT (Cognitive Behavioural Therapy) and ACT (Acceptance Commitment Therapy) methods to help cope with Depression, Anxiety, Anger, Stress etc. It has features for common negative thinking patterns, techniques to overcome them, metaphors to cope with negative feelings, comprehensive diary, catastrophe scale, ability to rate feelings on a scale out of 10, , grounding game, positive and negative habit tracker and simple breathing techniques for keeping calm and relaxed along with Forums to talk with people

NeuroNation[20] Is game based with Brain Training & Brain Games. It has won the "LEONARDO" award, the Health Award for Digital Prevention supported by the Federal Ministry of Health and Ministry of Education and Research. It contains fun exercises, Personalized and scientifically developed training, Precise peer-group insights, courses, Deep

insights into your personal strengths and potential and engaging gameplay. Moodpath[21] is a mental health assessment tool for Depression & Anxiety Test. It allows tracking and reflecting on your mood, break from negative thoughts and overwhelming emotions, assessing mental health, bi-weekly mental health assessment, Share your assessment with therapists, psychologists, and other healthcare professionals and track, monitor and reflect Lumosity[22] is game based with fun and interactive puzzle games to help you keep your mind active. It has daily brain exercises challenge core cognitive and academic abilities, including memory games, Problem solving games etc

Action For Happiness[23] is a daily companion for a happier life. It helps user receive simple, daily action ideas designed to help boost own wellbeing. The app allows sharing of own actions and ideas with others in the community. Self-help Anxiety Management(SAM)[24] is an app that offers a range of self-help methods for dealing with anxiety. Established methods of self-help have been combined with high standards of usability to provide an engaging, flexible, and practical resource. The key features of SAM are User guidance, External links, Self-monitoring of anxiety with graphical display, 25 self-help options covering: Information about anxiety, Thinking and anxiety, Physical relaxation, Mental relaxation, Health and Anxiety, Guidance on putting self-help into practice and a closed social network of SAM users

Antistress[25] - relaxation toys provides relaxation, diversion, distraction. The toys include A relaxing pond with lotus,A lot of different button to press, Physics wooden toys, Vibration feedback and Beautiful sounds. It includes an antistress Bamboo chime, a finger scale and some dirty windows to clean. Youper Emotional Health[26] is another app using artificial intelligence (AI) to personalize various techniques to fit user needs. It incorporates techniques from Cognitive Behavioral Therapy (CBT), Acceptance and Commitment Therapy (ACT), Mindfulness, and Meditation. KEY FEATURES include Quick conversations that can change your day, Mindfulness personalized to your moments, Effortless journal, mood tracker, Emotional insights on anxiety, depression, stress, panic, bpd, and more, Shareable reports and a Personality test.

Schneebergeraken[31] proposed a virtual stress management training which used interactive social agent as a trainer.It helped to cope with stressful situations. Biofeedback derived from the cardiovascular response of the heart rate variability (HRV) was used with an interactive social agent as biofeedback trainer.

Table 2: Detailed description of apps

S.No	App name	Approach
1.	Stop Breathe & Think	Morning meditation Guided meditation Breathe Mindfully. Tame Anxiety, Sleep Better, Strengthening Focus, Manage Depression, Meditation for Commuting Mindfulness techniques for College Life

2.	iStudiez Pro	online classes, regular schedule exams, due assignments and past classes, keep track of your homework and, track grades
3.	Any.do	calendars, reminders, daily planer
4.	Digpill	Prevent insomnia, Reduce stress, Gain confidence. Lose weight Increase motivation using a combination of psychoacoustics and NLP
5.	Happify	Science-based activities and games to help reduce stress improve emotional well-being overcome negative thoughts and build greater resilience
6.	Monument valley	A puzzle game in which you take princess Ida through various mazes and optical illusions. The visuals and music allow you to relax
7.	Calm	Lower stress less anxiety, and more restful sleep with guided meditations, Sleep Stories, breathing programs, master classes, relaxing music
8.	Headspace Meditation & Sleep	relaxation, meditation and guided meditation, mindfulness, and sleep app for focus, breathing staying calm
9.	Tide	Mental and physical health platform with sounds from nature and guided meditation practices.
10.	Hypnosis for Anxiety stress relief & depression	better sleep, Audio affirmations, courses and workshops to help you get over your fears, reduce stress and stressful situations, overcome your phobias, become more confident in social settings and relax more
11.	Abide	Background music, stories, nature sounds
12.	Breathing Relaxation exercises	The application can be used during your sophrology session, guided meditation breathing techniques, sleep faster, breathing pranayama for your yoga or simply a program to relax, rebalancing the sympathetic and parasympathetic nervous systems
13.	Wysa	Daily spiritual meditation for women, improves women's mental health, bond over family meditation, helps you stay emotionally healthy with mood tracking, reframing thoughts (CBT) , reduce sadness. It builds personalized toolkit with tools to cope with depression, calm anxiety, resolve sleep issues and support with grief, assess yourself symptomatically based on depression tests(e.g. P18Q9, tests for anxiety like GA)?
14.	Youper	Created by a team of doctors scientists and engineers. Utilizes artificial intelligence (AI) to personalize various. Incorporates techniques from Cognitive Behavioural Therapy (CBT), Acceptance and Commitment Therapy (ACT), Mindfulness, and Meditation, mood tracker Emotional , Personality test Integration with Google Fit
15.	Fabulous Self Care	Habit tracker, life coach motivator to focus on developing habits that reduce mental health, and improve daily productivity

16.	What's Up?	CBT (Cognitive Behavioral Therapy) and ACT (Acceptance Commitment Therapy) methods to help you cope with Depression Anxiety, Anger
17.	NeuroNation	Brain personalized training, using fun exercises and tailored courses, insights into personal strengths and potential, Precise peer group insights and engaging gameplay and exercises Games
18.	Moodpath A	mental health assessment, to track and reflect on your mood, take a break from negative thoughts. Bi-weekly Depression & Anxiety mental health assessment, Share assessment with therapists , psychologists, and other healthcare professionals, mood tracker and journal library Test with exercises based on cognitive behavioral therapy
19.	Lumosity	Brain Games & Cognitive Training App With Daily Brain Exercises, Puzzle Games Memory Games, Mindfulness Training.
20.	Serenity Meditation & Mindfulness	Guided Sleep guides, Stress relief, Quick meditations, Kids meditations
21.	The Action of Happiness	Daily companion, simple daily action ideas to help boost wellbeing.
22.	Self-help Anxiety	Self-help methods for people learning to manage their anxiety, User guidance, Self-monitoring of anxiety
23.	Antistress	For relaxation, diversion, collection of toys, play with wooden boxes, swipe gently your finger in the water tap buttons, draw with chalks, playing with a Newton's cradle
24.	Woebot	Self-care expert in CBT & mindfulness, intelligent mood tracking, reduce stress

4 Results

Over the years several IoT techniques have been used for monitoring health of the users. The most famous of these are using applications based on android or apple app store. The health tracking devices simply just track data and all the actual work is done by these apps. These applications fall under various categories. This paper has summarised these techniques and attempted to create classification of these categories and group them based on their approach. The figure below shows these several groups namely Game based, habit trackers, breathing exercises and meditating, chatbots, ACT and CBT based. Rest all fall under the miscellaneous category. This review paper has reviewed all these approaches and techniques used in them. The research questions posed at the beginning have been answered. The various approaches in IoT which can aid in stress management have been listed. The techniques used by apps for stress management have also been categorised. The interfaces of these apps have been analysed to see which are user friendly and which are not. The research gaps in this field have been identified. The apps fall short in the category that several of them may not be approved by doctors or psychiatrists or psychologists. There should be a criteria to give them some approval from authentic resource people in this field.

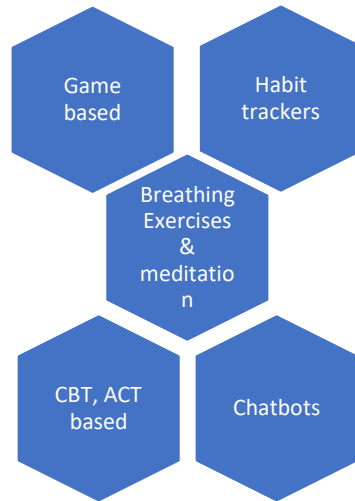


Fig 1: Categories of techniques used

5 Conclusion & Limitations

Findings from this review indicate that amongst all categories, smartphone apps are the most widely used technique for stress management. In this category, there are enormous number of apps available on the android play store for users. Many techniques have been utilized for stress management from medication, planning and organizing to activities, games and questionnaires and even AI based techniques. This field has a lot of potential. However, it is lacking in apps using real time data from users. This field can further be explored. There are certain limitations in this work as only the Google Play store was searched, and findings cannot be generalized to the other mobile OS users like iOS. This review may not have captured the entire population of stress management apps that are commercially available, or the full spectrum of effective strategies. Also, there are innumerable mHealth solutions but no criteria for filtering out the genuine apps from others.

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