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mHealth for Mental Health

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Abstract. An individual's physiological and social wellbeing shapes their mental health. Mental health is indicative of one's cognitive behaviour and emotional wellbeing. Everything around us is connected through virtue of a network - Internet. The Internet is a tool for information, communication and connectivity. It has been predicted that three-quarters of internet users will access internet solely via smartphones in the coming years. This brings an opportunity to monitor healthcare using smartphone technology. mHealth holds enormous untapped potential in the near future, especially, in the arena of personalized healthcare and eventually personalised medicine. With data-intensive diagnostics and imaging coming into play, a gigantic amount of data is being collected and stored. In this paper, we have mentioned the importance of mental health, it's characteristics and how mHealth devices (smartphone, smart devices, bio-sensors etc.) can play a key role in managing and coping with mental health problems. We have further analysed the behavioural patterns of active smartphone and smart device users globally as opposed to the active users in a particular region. An analysis of the percentage of population suffering from different mental health problems has been undertaken and a solution to these using mHealth architecture and data analytics proposed. We have also highlighted how mHealth sensory system with its 5 potential P's (Preventive, Personalised, Predictive, Participatory, Psycho cognitive) can revolutionize the mental health landscape.

Keywords: mHealth, Mental Health, Health Care, Data Analytics, Health, Personalised Medicine.

1 Introduction

Increasing population indicates the increasing demands and problems of the people. One majorly ignored problems is the mental health among people. Around 75% of adolescents face some kind of mental health problem, which is about 1-in-every 5 individuals[1, 2]. This situation is increasing at an alarming rate as there has been no proper channel set for the routine diagnosis of the mental illness as it is done for the physical conditions[3].

Mental health is often been not taken into notice until the symptoms become serious and evident[4]. Mental problems are different for different people i.e. they might suffer from same disorder, but foundation and reactions of the disorder can be completely different. At some point or the other, every stratum of population has been suffering from some amount of stress levels[1, 4]. Be it due to interpersonal-professional life,

financial insecurity, emotional instability or any other. This stress levels can be categorised into positive stress and negative stress.

The positive stress to particular level may push person towards life goal. However, after a certain threshold, it might turn into negative stress. Feeling of being burdened and unable to cope with stress, there are chances one might suffer from some mental health issue in near future if not counselled at the right time[5]. Everyone has a unique identity and perspective as we have acquired in ourselves throughout the course of life. Therefore personalised information about each individual is the key to treat one's mental health.

Keeping daily routine in check is quite a lot considering the metropolitan lifestyle: thus, there comes need for technology which could help one, monitor themselves even without their actual involvement.

mHealth refers to Mobile Health[6]. mHealth can share data continuously, not for a limited time but for longer duration in order to see the difference between the statistics and the behavioural patterns of an individual. This will allow users to track their activities themselves better in person and call for help if necessary. mHealth will not only note the change in behaviour due to the external factors but will also monitor frequency of it via numerous embedded sensors i.e. GPS, accelerometer, microphone, light sensor (and other sensors mentioned in the diagram), which will make it easier for user as well as their medical practitioner to analyse them and define the problem[7-11].

Most adults today have a mobile device to keep track of their day to day life be it a reminder for meeting or the contact details of people, social media application or emails from work[10].

Sensors are available in various wearable technologies such as smartwatches, smart jewellery, fitness trackers, implants, bands, patches, clips, head and hand accessories etc.[12] Sensors when are incorporated with mobile devices will help individual track minute to minute activity in real-time to keep monitoring them every single minute. We already have a great dependency on mobile device thus with its smart sensor technology combined with other wearable bio-sensor technology, is a smart way to analyse daily routine to keep up with good mental health[12, 13].

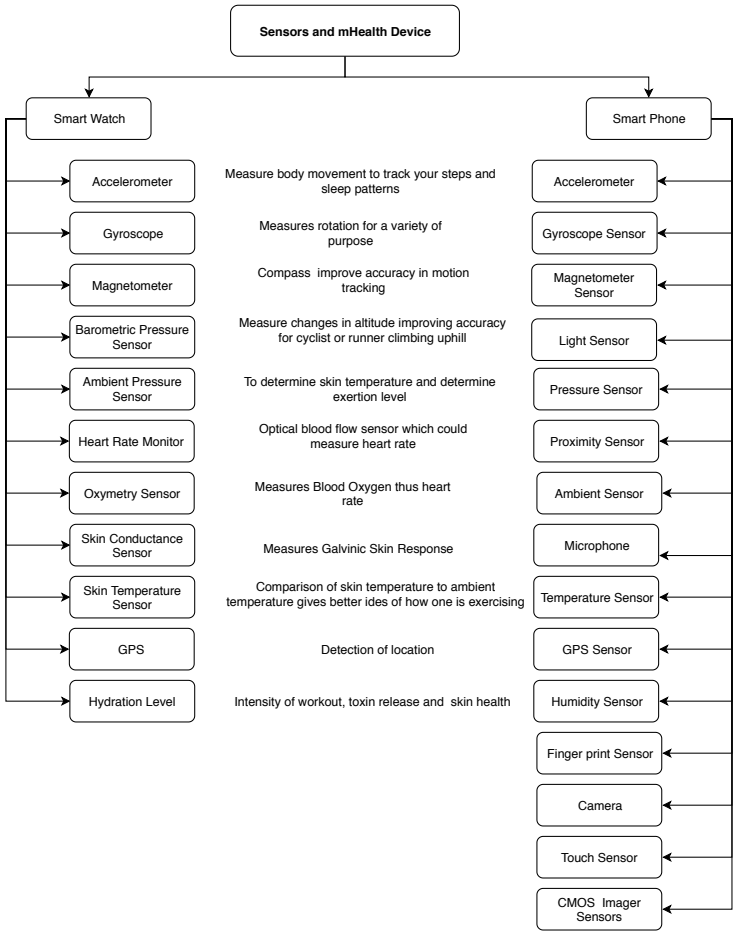


Fig 1. Bio-sensors and their corresponding roles in smart phones and smart watches.

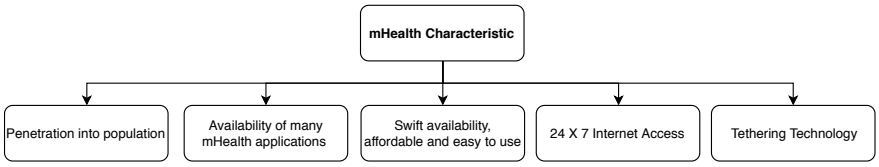


Fig 2. Characteristic of mHealth for Mental Health

Data from these sensors could be collected passively with user's smartphone, which coupled with the user's phone usage information such as SMS pattern, call history, and application usage which may potentially be used to digitally phenotype an individual's behaviour and access user's mental health[12].

For instance, user's emotional state or stress measure can be predicted from their voice while on a call being recorded by microphone sensor. Meanwhile, other sensors can help collect different information about the user (in the figure) even without interfering with their schedule and could be tracked and monitored whenever required[12]. Monitoring motion of the body, heart rate, body position, body posture, circadian rhythm or the sleep cycle, and even tremors when accounted for, data science can provide actionable insights about a body[7]. As these details can actually tell a lot about a person's mental health as the body and mind function in a cooperative manner smartphone along with other sensory devices enables a less intrusive and much more precise alternative to the traditional self-reporting approach, which may be very useful in assessing the mental wellbeing of an individual[1].

There are several measures that can be taken by the patient to help themselves to cope with their state. Social isolation should be avoided by the concerned person, communication should be improved in relationships, people should try to be more open about their illness, proper medications should be taken.

Fig 3. Role of mHealth in improving Mental Health

mHealth is user-friendly and affordable which makes it a more feasible option for penetration into daily life complimenting site capture data and forming a complete dataset about the changes related to mental health[14].

2 Review of Literature

A lot of research has been done in mobile health and sensor technology in terms of health[15]. There are many researchers who have developed techniques using combinations of sensory devices that have been approximately accurate, which is very close to dedicated instrument (for instance a heart rate monitor- Electro Cardio Graph) without any insertional operation on the body[2, 16, 17]. In this section, we have mentioned a few instances we came across while framing this article.

Zhu et al. worked on the prediction model based on the Markov-chain Monte Carlo method and achieved an accuracy of 70% in mood prediction. A relation between

mobility and sleep duration with respect to daily stress levels was found. They also found duration of speech, geospatial activity, sleep rhythm and kinaesthetic activity to be associated with mental health status. Another team of researchers lead by Norman et al. used data from Bluetooth, GPS sensor and consumption of battery information of the smartphone which helps in tracking an individual's social interactions and activities. There, they found that the data from these sensors are significantly correlated with their depressive and manic symptoms. In addition to this, Ben-Zeev et al. conducted studies on the feasibility and acceptance of passive sensing by smartphone sensors among the people with mental disorder like schizophrenia. People with schizophrenia were mostly found open to sensing with smartphones and two-thirds expressed interest in receiving feedback, but a third expressed concern was privacy. The GPS location information was exploited to recognize outdoor activities among people with schizophrenia and thereby to infer social functioning[18, 19].

Wang et al. proposed a system called CrossCheck that used data from the GPS, accelerometer, light sensor and microphone as well as call history, application usage, and Short Messaging Service (SMS) patterns to predict the change in mental health among patients with schizophrenia.

Resources for Parents|Autism & Beyond Recently, Apple Inc.'s ResearchKit initiative launched a mobile application called "Autism and Beyond". This application captures images of the facial expressions of the users in response to standardised stimuli by the iPhone's front-facing camera and analyzes these images using algorithms designed for emotion recognition[8, 20]. This application can potentially identify individuals who are at risk of autism and other developmental disorders.

3 Methodology

When a person's mind is in a disturbed state, it directly affects the body. These can be regarded as the symptoms or a reflection of the mental state which are often ignored but these actions are noted by the sensors that are specifically designed for recording these activities which might be a potential cause of mental anxiety or stress. i.e. working on the principle of combining and comparing the statistics and information about the history of the patient and the current records. This will provide valuable information about the time and extent of deterioration of the conditions, helping in taking proper measures according to user's personal condition. All these records are be stored on the cloud so that they can be accessed hassle-free[21, 22].

In the extreme cases, for the patient in the critical condition, these devices and sensors can also be programmed to send a direct alert notification to the doctors[23]. This way, if a patient is unable to provide the information about his condition or is unable to contact the doctor, the sudden fluctuations in the conditions of the body can immediately notify the concerned doctor.

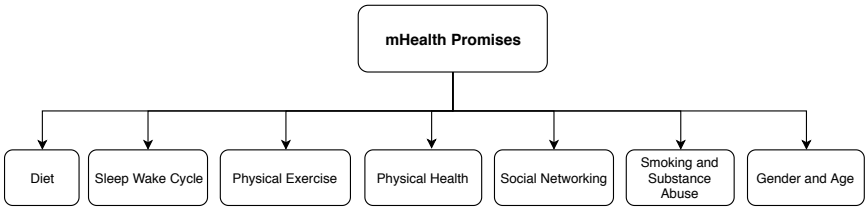


Fig 4. Promises of mHealth for Mental Health

mHealth will record the normal eating habit of an individual, and whenever there is a sudden change in the habit and is very frequent the person can be notified to consult a doctor. This approach can shorten the time where a person is unaware of the fact that he might be mentally ill or approaching towards serious mental illness because till the time a person is diagnosed with any kind of disorder, it has already led to a stage where it needs to be treated with special measures.

mHealth can also be used to keep a check on the prescribed medication routine[24], thus controlling the attacks and keeping in check the anxiety of the person.

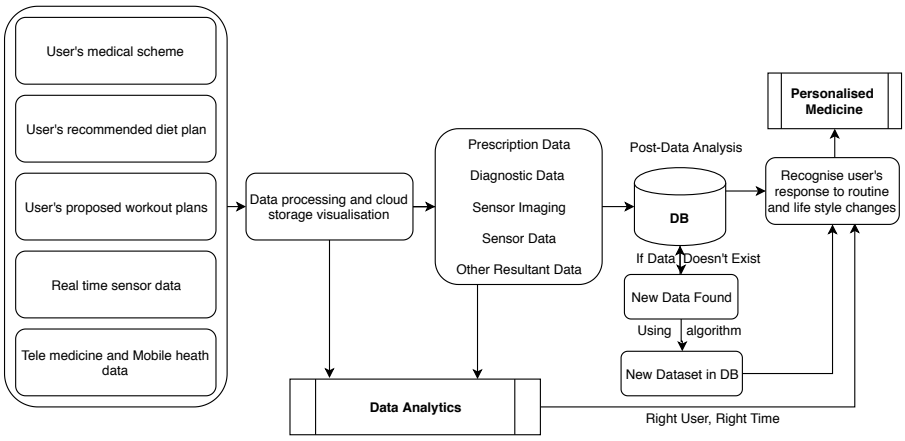


Fig 5. Roadmap of data analytics and mhealth architecture for mental health potentially paving way for personalised medicine.

In this paper, we have proposed an architectural framework for the roadmap of data analytics and mhealth architecture for mental health. Real time data management (through body sensors and chips via health and tele health), individualised medical scheme, recommended diet plan, workout plan, optimal medical procedures and various other personal needs etc. Stored data through data analytics can recognise the pattern of response of a particular stimulus in the user which results in personalised healthcare paving way for personalised medicine[25, 26]. Data after collection is moved to a data base. If the database has the existing details of the patient, the information is updated in the data source and if data does not exist for the patient, it

creates a new domain for the patient via some algorithm and analyse it using data analytics to recognise the response of the patient to the particular stimulus thus offers personalised healthcare[27, 28].

The architecture in the figure explains the roadmap and flow of information from real time data collection to the processing to offer personalised healthcare to the user.

4 Result

Mental health risks have been increasing at an alarming rate. Comparative studies from World Bank (WB), World Health Organisation (WHO), and United Nations (UN) have shown that the total population is approximately 7.5 billion, in which 9.3% males and 11.9% females of the total population are suffering from one or the other mental health disorder. Depression being one of the most common mental disorders in the world has about 2.7% males and 4.1% females. However, around 2.8% of men and 4.7% women are affected by anxiety disorder. Schizophrenia on the other hand, has 0.26% males and 0.25% females suffering, Mental and substance use disorder has some of the highest numbers with 12.6% males and 13.3% females. Paradoxically, alcohol use and drug use have 2% and 1.3% males and 0.8% and 0.6% respectively.

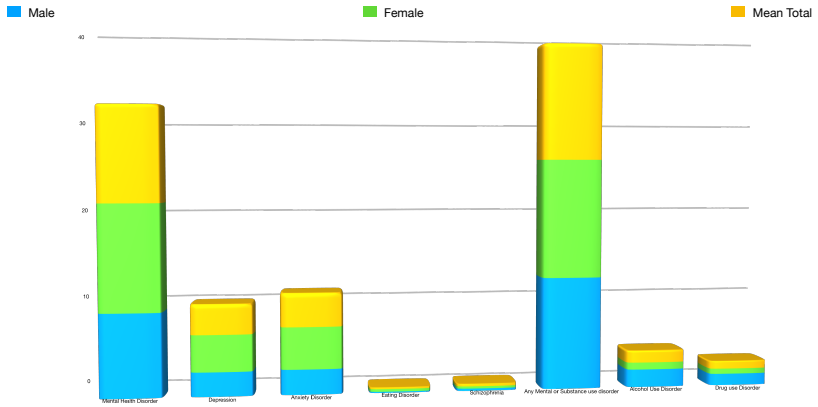


Fig 6. Number of people affected by different mental health issues

The revolutionary change in technology initiated in the year 2015. Sensory devices created a buzz in several regions like the Asia Pacific, Central and Eastern Europe, Latin America, Middle East and Africa, North America and Western Europe by 2016, there was a boom in the demand for sensory devices like smartphones and smartwatches(much higher for smart phones). Since then, it is observed that the usage of sensory devices has been increasing throughout. The years 2020, 2021 and 2022 shows the predictive calculations of this upward trend.

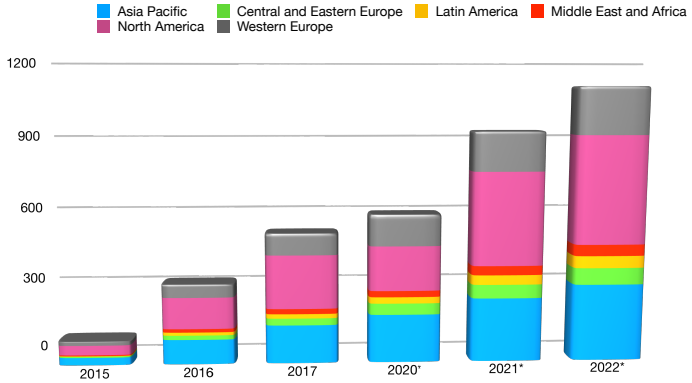


Fig 7. Use of sensory devices by various regions over the years

Over the years, smartphone users have shown an increasing trend in their use. The data received by WHO illustrates that the number of smartphone users in the United States of America (USA), Europe, India and others in 2016, the USA shows around 0.208 billion people using smartphones, whereas, Europe, India and others are 0.25 billion, 0.251 billion and 1.791 billion respectively. In 2017, the change in the number of people shows a significant shift being 0.246 billion in the USA, 0.252 billion in Europe, 0.299 billion in India and 1.903 billion for others. 2018 and 2019 show the same progressing trend in the statistics and the years 2020 and 2021 show the potential predicted numbers.

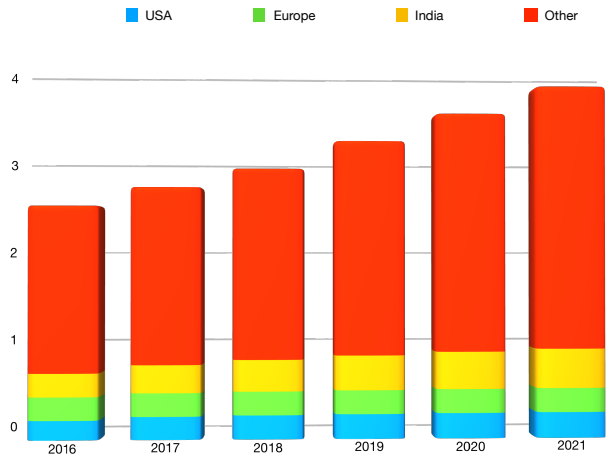
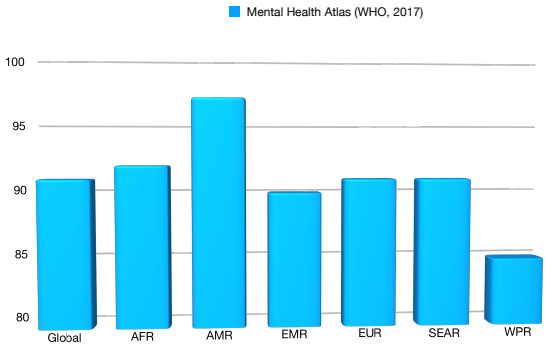


Fig 8. Number of smartphone users in billion

According to WHO, in 2017 the statistics of mental health has been a major cause of concern not only regionally but also globally. Around 91% of people all over the world suffered from some kind of mental health issues. When considering regions, in the African Region (AFR) the population with mental health issues was calculated to be

92%. In the American Region (AMR), it peaked to 97% which was the highest amongst all the regions. The Eastern Mediterranean Region (EMR), European Region (EUR) and South East Asian Region (SEAR) had approximately 90%, 91% and 91% respectively. Lastly, Western Pacific Region (WPR) has the least numbers amongst all which is around 85%.



	Global	AFR	AMR	EMR	EUR	SEAR	WPR
N	117/194	43/47	34/35	19/21	48/53	10/11	23/27

Fig 9. mental health atlas in different regions (WHO, 2017)

The following illustration is about the shooting trend of smart health care monitoring system. It is seen that over the years, a large number of the population started using wearable smart devices which supports our assumption of using smart phone with smart health care monitoring system to cope with mental health problems.

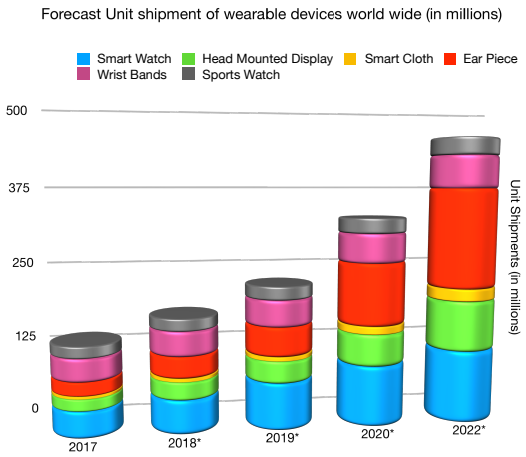


Fig 10. Number of wearable devices over the year worldwide

5 Conclusion

There is a tremendous increase in the percentage of population suffering from some mental health disorder or the other. With the advancement of technology and reduction in the cost of smart gadgets and bio-sensors, there is at our disposal a way to penetrate deep into the population beyond the socio-economic barriers. A careful analysis of real-time sensory data from both smart phones and sensory devices could prove to be just the tool needed to cope with these ever-increasing mental health issues. Basis the trend analysis in the results section of this paper, an increased penetration of mobile phone and smart device holds the potential to reduce mental stress, if the user were to follow 6 simple strategies mentioned in the figure. This mHealth sensory system with 5 potential P's (Preventive, Personalised, Predictive, Participatory, Psycho cognitive) can pave way to personalised mental healthcare and someday to personalised medicine. Additionally, certain steps need to be undertaken so as to improve one's mental health - one of which is not just realizing the superficial symptoms but also understanding the root cause. Trying new things can also greatly affect one's mental health and lastly, the individual should be open to receiving help.

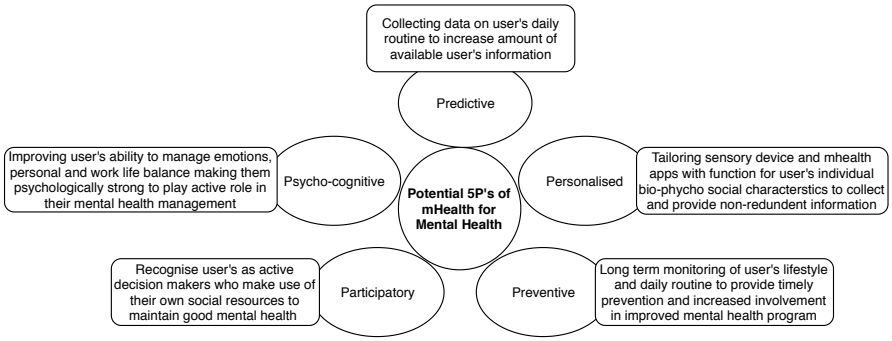


Fig 11. P5 approach for mental health in mHealth

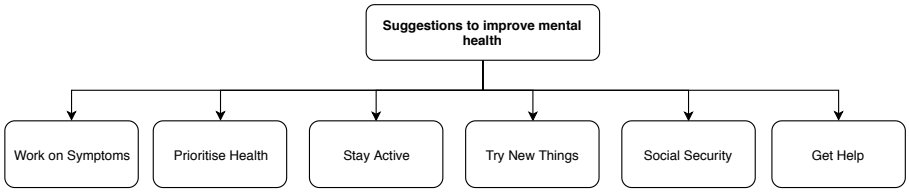


Fig 12. Suggestions to improve mental health

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