Introduction

Mental health isn't quite quantifiable, but India's numbers in this field run pretty abysmal nevertheless. Consider, for example, a 2019 study [1] that found that one in every seven Indians was living with a mental health disorder, or the WHO estimate of an over one trillion USD loss caused due to the same between 2012-2030, or the fact that its contribution to the national disease burden in 2017 nearly doubled from 1990. The list goes on.

The numbers get darker if you take a look at the WHO's Mental Health Atlas - released every three years - of 2017 [2] (India did not participate in the 2020 Atlas). Here are the key takeaways, with relative figures from the global average (GLB) South East Asia region (SEAR), the European Region (EUR) and Germany, which is a world leader in terms of mental health care.

Figures	India	GLB*	SEAR*	EUR*	Germany
Total mental health expenditure per person	4 INR (roughly 0.06 USD, 2016)	2.5	0.1	21.7	350.58 EUR (roughly 388 USD, 2016)
Suicide mortality rate (per 100,000 population)	16.3	10.5	13.4	12.9	13.6
Disability-adjusted life years (per 100,000 population) (DALYs)	2,433.41				3603.56
Total number of mental health professionals (government and non-government)	25,312				118,367
Total mental health workers per 100,000 population	1.93				144.87
Number of psychiatrists (rate per 100,000 population)	0.29	1.3	0.4	9.9	13.20
Number of child psychiatrists (rate per 100,000 population)	0.00	<0.1			2.76
Total number of child psychiatrists	49				2,259
Number of other specialist doctors (rate per 100,000 population)	0.15				3.5
Number of mental health nurses (rate per 100,000 population)	0.80	3.5	0.80	23.2	Not reported
Number of psychologists (rate per 100,000 population)	0.07	0.9	0.1	4.6	49.55
Number of social workers (rate per 100,000 population)	0.06	0.9	0.2	0.8	Not reported
Number of occupational therapists (rate per 100,000 population)	0.03				56.43

Number of speech therapists (rate per 100,000 population)	0.17				19.41
Number of other paid mental health workers (rate per 100,000 population)	0.36	0.5	0.4	11.2	Not reported

* *Relative figures - wherever applicable.*

The 2017 Atlas also found that the majority of persons with mental disorders in India paid mostly or entirely out of pocket for services and medicines. This is in contrast to

- 83% of the countries surveyed globally, where persons with mental disorders paid nothing (were fully insured) or at least 20% towards costs of mental health services.
- 82% of the countries surveyed globally, and 70% of the countries in SEAR (total 10 countries surveyed), where persons with mental disorders paid nothing (were fully insured) or at least 20% towards costs of psychotropic medication.

It is evident that India's mental health infrastructure is poor, and generally lags behind the rest of South East Asia and the world. (SEAR comprises Bangladesh, Bhutan, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, and Timor-Leste.) A question regarding the shortage of psychiatrists in India and the government's corresponding response was also raised in the Rajya Sabha to the Minister of Health and family Welfare (answered on 6th February, 2018) [3]. The response to the latter part is as follows:

> "To address the burden of mental disorders, the Government of India is implementing the National Mental Health Programme (NMHP) since 1982. The Government is supporting implementation of the DMHP under NMHP IN 517 districts of the country for detection, management and treatment of mental disorders/illness. With the objective to address the acute shortage of qualified mental health professionals in the country, the Government, under the National Mental Health Programme (NMHP), is implementing manpower development schemes for establishment of Centres of Excellence and strengthening/ establishment of Post Graduate (PG) Departments in mental health specialties. Till date, support has been provided for establishment of 23 Centres of Excellence and strengthening/ establishment of 46 Post Graduate (PG) Departments in mental health specialties in the country. During the 12th Five Year Plan the DMHP has been restructured to include additional components like suicide prevention services, work place stress management, life skills training and counseling in schools and colleges. Support is also provided for Central/ State Mental Health Authorities, Research and Training and for Information, Education and Communication (IEC) activities."

A 2019 study [4] acknowledged that there is still a long way to go. Sources studied in the paper showed that the 2019 number of psychiatrists in India is about 9000 and counting, and an additional 700 psychiatrists graduating every year. The study also records 0.75 psychiatrists per 100,000 population in India, and compares it to the desirable 3+/100,000 and the 6/100,000 in high-income countries. It estimates, thus, that India is currently short of 27,000 doctors - requiring 2,700 new psychiatrists (keeping population growth and attrition rates at 0%) annually to fill the gap in the next 10 years - and notes that there are only 700 psychiatrists trained every year in post graduate seats. The gap is also not uniform across the country, and while there is an increase in psychiatric facilities in a few states, some states have seen a stagnation or even decline. The study also recommended NIMHANS's initiative [5] to reserve a certain number of MD seats to those states with grossly deficient human resources in psychiatry (the North-Eastern states, Uttarakhand, and Chhattisgarh).

The ongoing COVID-19 pandemic has also worsened the current mental health crisis: the Indian Psychiatry Society reported a 20% increase in mental illness cases since the pandemic [6]. In addition, mental health disorders and seeking treatment for the same continue to be shrouded in stigma. A systematic review on the stigma associated with mental health problems among young people in India [7] also found that one third displayed poor knowledge of mental health problems and negative attitudes towards people with mental health problems and one in five had actual/intended stigmatizing behaviour. A broader survey by the Live Love Laugh Foundation in 2018 found that while 87% of the respondents showed some awareness of mental disorders, 71% also used terms associated with stigma.

There is still, thus, a lot of ground to cover. The numbers point to a possible solution: tele-health. While Indians might lack mental health facilities, their access to technology and the internet is impressive. To give a rough idea about access, an estimated 844.84 million Indians were smartphone users and 107.81 million households had internet access at home in 2021 [8, 9]. As of 2020, India was the world's second-largest internet population at over 749 million users in 2020, of which 744 million users accessed the internet via their mobile phones [10]. Technology, thus, seems to be primed for utilization to meet the mental health needs of people. A 2015 World Health Organization (WHO) survey of 15,000 mobile health apps revealed that 29% of them emphasized on mental health diagnosis, treatment, or support. [11] There's also the fact that psychiatry has been tied to machine aid as early as the 1970s, when PARRY, a chatbot simulating paranoid schizophrenia, passed the Turing test and talked to ELIZA, a Rogerian therapist.

But for a field as intricate as mental health, we need to refine the search for greater effectiveness. We need tailor made solutions, fit for different needs, capable of learning and responding to users, and adapting to different mental health circumstances. This is where artificial intelligence (AI) – a growing field that has helped further scores of different sectors – and its applications can play a major role.

Artificial intelligence: an introduction

AI systems aim to think humanly and act humanly with the ultimate goal of obtaining rational outcomes. [12] It is a field that has seen massive growth in research and development in the past few decades. While not a perfect science by any means, its data-driven and knowledge-based methods - making an extensive use of various kinds of knowledge specific to the domain - have been responsible for significant progress in multiple fields, including expert systems, natural language processing, speech recognition, computer vision, and robotics.[13] AI algorithms are designed to make decisions – and learn and adapt in the process! - often using real-time data and in conjunction with machine learning and data analytics. Machine learning takes data and looks for underlying trends. [14] From an economic point of view, AI either decreases the costs of prediction or improves the quality of predictions available at the same cost. [15] PriceWaterhouseCoopers, in 2017, estimated that "artificial intelligence technologies could increase global GDP by $15.7 trillion, a full 14% by 2030."

It's also a thing of the present. AI is being increasingly integrated into diverse sectors, including finance, healthcare, security, criminal justice, transportation, and smart cities. In finance, for instance, some applications include high frequency trading by machines and investing, operational process automation (such as the use by the banking, financial services and insurance sector to efficiently process mass data logs), customer acquisition and retention, improving credit risk models, regulatory compliance, and cybercrime prevention. India's fintech market is pretty familiar with using AI – examples include Razorpay (uses the AI-powered Third Watch to help address fraud issues) and INDmoney (uses an AI-driven financial advisory) [16]. In national security, AI can help in surveillance and provide real-time or near-real-time intelligence analysis. In criminal justice, justice experts have claimed that using AI could reduce human bias in law enforcement and lead to a fairer sentencing system. Transportation is another area of AI research, with investors pouring in nearly $206 billion in autonomous vehicle technologies and smart mobility since 2010. [17]. Here, AI programs can play a role in collision avoidance, navigation, adapting to new circumstances (such as changes in weather or road conditions) and learning from the experiences of other cars on the road. AI is also integral in smart cities, with data analytics to improve urban service delivery, environmental planning, resource -management, energy utilization, and crime prevention. Cincinnati is a prime example - its Fire Department uses data analytics to optimize medical emergency responses. The analytics system "recommends to the dispatcher an appropriate response to a medical emergency call… by taking into account several factors, such as the type of call, location, weather, and similar calls." [18] AI tools have also assisted healthcare development: AI-controlled robotic surgeries, cancer detection, virtual nursing assistants, precision medicine, chatbots, and administrative workflow assistance are a few examples. These tools are helpful because they "predict in advance potential challenges ahead and allocate resources to patient education, sensing, and proactive interventions that keep patients out of the hospital." [19]

And finally, its application to mental health is manifold. Research supports AI's use as an independent tool or clinical aid in therapy, training, screening, self-management, counseling, and diagnosing. Its capacity to learn, and to adapt, can potentially revolutionize a mental health space plagued by inequitable access and highly burdened healthcare providers.

Current research and data sources

AI is built on data collection and analysis. Choosing, and sourcing, data specific to the mental health domain in question thus opens up challenges in itself.

The "data" in themselves are pretty varied - AI enjoys the flexibility of working of data of different modalities. AI-based technologies in psychiatry rely on the identification of specific patterns within highly heterogenous multimodal sets, including: various psychometric scales or mood rating scales, brain imaging data, genomics, blood biomarkers, data based on novel monitoring systems (eg. smartphones), data scraped from social media platforms, speech and language data, facial data, dynamics of the oculometric system, attention assessment based on eye-gaze data, and various features based on the analysis of the peripheral physiological signals (eg. respiratory sinus arrhythmia, startle reactivity) [20].

In our literature review, 35 (out of _) studies [references 20-54, inclusive] used interviews (and/or interview transcripts) and inventories/questionnaires/assessments (both self-report and clinician-administered) based on psychometric or mood rating scales. These are primarily used for 4 purposes: (1) for screening during participant recruitment, (2) for classification of participants into study subgroups, (3) for initial diagnosis, classification or scoring and follow-ups over the course of the study, and (4) for use as features for the machine learning model. For implementation in India, the WHO's recommended process of translation and adaptation of instruments [55] may serve as a guide. Previous work on cross-cultural adaptation includes the translation and validation of several SRIs into multiple Indian languages [references 55-66, inclusive].

Neuro-psycho-physiological features used in development may include, for instance, EEG (electroencephalography), electrocardiography, electromyography (EMG), electrodermal activity (EDA), respiration, speech/acoustic, linguistic, facial/gesture and oculomotor measurements [20]. In psychiatric disorder diagnosis, specifically, MRI, EEG, and kinesics diagnoses are the most common AI-related techniques are applied for brain observation [67]. Brain data has been used in 11 studies [20, 32-38, 51, 54, 68] for screening, diagnosis, monitoring patient progress, use as features, etc. Other representative features are motion data and psychomotor activity (data collected in five studies [21, 22, 24, 29, 40, 69]) and sleep and circadian data (data collected in six studies [21, 24, 28, 29, 42, 44]).

Language and voice also offer a lot of scope for applications of AI. Audio analysis may include paralinguistic or acoustic aspects of speech (volume, pitch, intonation) [70]. For example, a study [23] used natural language processing (NLP) analysis to discriminate speech in psychosis from normal speech, analysis involved pre-processing of transcripts, latent semantic analysis, part-of-speech tagging analysis, and then ML classification and validation. Similarly, speech features extracted from phone conversations were used for the classification of bipolar disorder episodes [24].

Sources of textual content may include transcriptions of clinical interviews or sessions - as mentioned above - and non-clinical text (such as social media, online forums, instant messaging). Social media, in particular, has been a hotbed of research for its potential in mapping mental health. A very brief search will show you that Facebook posts can predict depression in medical records [71], analysing tweets can help estimate the effects of exercise on mental health [72], and a user's Instagram profile can detect major depressive disorder [43]. Most studies use purely textual data, others may also include features regarding the user's profile (such as accounts followed, number of posts, etc.) and their activity.

A great source for a lot of the aforementioned modalities is smartphones. Sensor and usage data from these devices can be used to infer contextual and behavioural information. Motor activity and function, as mentioned previously, is often assessed as a part of psychiatric evaluations (such as for the classification of bipolar disorder episodes [24]) and can be monitored effectively by smartphones' increasing sensing capabilities.

Smartphone data collected may include location data (using data from GPS, accelerometers, Wi-Fi access pointa, magnetometers, Bluetooth, etc.), activity, phone usage, typing patterns, number of phone calls and SMS with their duration and length, and even audio information during phone conversations. [21, 22, 24] These may be collected passively through a background app or from metadata (keystrokes, Wi-Fi infrastructure, etc.) with prior informed consent. Prior work has been done in predicting depressive symptoms [21, 22], personal mood prediction [44] and relapse prediction in schizophrenia [73, 74].

Finally, clinical records are especially important data sources. Electronic Medical Records (EMRs) (medical history from individual clinical practices) and Electronic Health Records (EHRs) (comprehensive long-term history collecting multiple EMRs) feature in several studies (6 papers of the reviewed _ [54, 71, 75-78]. Besides being rich in data for research and development, they're important because they ensure anytime/anywhere accessibility of patient records, improve the quality of records and are cost-effective, help track patients' clinical records and improve patient compliance, can be transferred easily within and across healthcare facilities, are easy to update, and facilitate improved healthcare decisions and provide evidence-based care. [79] For research specifically, they serve multiple uses. They can help in the recruitment, identification and screening of the study population and its medical history, and most importantly, they provide a large clinical database with multiple features that can be used for training, validation, and correlation.

India too has recognized the importance of digitizing - and thus improving the reliability of - its healthcare. The Ministry of Health and Family Welfare (MoH&FW) first came out with standards for EHRs for India in September 2013. It also proposed to set up the National eHealth Authority (NeHA) in 2015, aiming to promote the setting up of state health records repositories and health information exchanges to facilitate interoperability. NeHA also looked to formulate and manage all health informatics standards for India. The MoH&FW also put forward the Digital Health Information in Healthcare Security (DISHA) Act in 2018. DISHA has been drafted to "provide for the establishment of National and State eHealth Authorities and Health Information Exchanges; to standardize and regulate the processes related to collection, storing, transmission and use of digital health data; and to ensure reliability, data privacy, confidentiality and security of digital health data and such other matters related and incidental thereto". [80] The same year, NITI Aayog proposed to create digital health records for all citizens by 2022 with the National Health Stack (NHS) [81]. In September 2021, the National Digital Health Mission (NDHM) - which will provide every citizen with a health ID - was announced. Stored on the NHS, this ID will contain the individual's complete medical history and will be accessible by the entire healthcare industry. The NHS is basically an ecosystem of cloud-based services and has in the past couple years empanelled a number of private entities, including AI companies. A 2020 Centre for Sustainable Development paper on EHRs in India goes into further detail about the topic [79].

Everyday, practical applications or implementations

There's been plenty of work done on AI-human interaction (notably via chatbots and other conversational agents) that can serve as a basis for future implementation in this field. One very important point to note is adaptation to the target population: using pretrained models trained elsewhere will not lead to very desirable results (racial discrimination by facial recognition software is an example [82]). Data collection thus remains incredibly important.

Among the major currently-available AI mental health resources for personal use include conversational agents (chatbots, etc.) and apps on personal devices, highlighted below. (Data from these sources may, additionally, be used for wider studies or as part of larger models.)

1. Chatbots and other conversational agents

Chatbots and other relational conversational agents (either as standalone tools or aids for more traditional therapy) are perhaps one of the most widely explored fields in AI for mental health. One of their more obvious benefits is increased, all-round-the-clock access to healthcare services, particularly for marginalized groups. Previous internet-based, one-to-one text-based chat interventions for psychological support have already been proved to be feasible and improved over traditional waitlist conditions [83]. AI-based chatbots also have a substantial benefit over rule-based chatbots in the fact that they offer *contextual* support. Input modalities may be spoken, visual, or written; and agents may be disorder-specific (so far, there are available chatbots for depression, autism, PTSD, anxiety, substance abuse, schizophrenia, dementia, phobia, stress and eating disorders among others). The majority of chatbots today are rule-based (using decision trees to generate responses), and only a few use AI. [84]

Two popular AI-based chatbots offering therapy are Wysa [26] and Woebot [85]. Wysa is an emotionally intelligent mobile app aimed at building mental resilience and promoting mental well-being using a text-based conversational interface, offering free and 24x7 engagement. It responds to emotions a user expresses over written conversations and uses evidence-based self-help practices such as cognitive behavioural therapy (CBT), dialectical behaviour therapy (DBT), motivational interviewing, positive behaviour support, behavioural reinforcement, mindfulness, and guided microactions and tools to encourage users to build emotional resilience skills. Woebot works similarly, using CBT, DBT, and interpersonal psychotherapy (IPT) as a foundation for its therapeutic support. Every interaction with the app is kept in mind and helps Woebot evolve with the help of the AI.

Intelligent virtual agents (IVA), also known as embodied conversational agents (ECA) or simply "virtual humans", are also a potential avenue to be explored. For instance, they were used effectively by a study [86] to detect dementia through conversational data (prediction was done using extracted audio-visual features and machine learning). Other avatar-based mental health aids include LISSA (Live Interactive Social Skills Assistance) [87], a virtual human/avatar system which aims to augment traditional therapy for social skills development in teens with autism spectrum disorder and TeenChat [88], an adolescent-oriented intelligent chatting system that interacts like a virtual friend to guide stressed adolescents. While the last two do not involve AI methods, their existence signifies the effectiveness of virtual humans that can be further improved using AI. An example is Yavasur et al's speaking virtual counsellor offering brief interventions [89] - this uses reinforcement learning for dialog management and can deliver brief alcohol-related health interventions via a 3 anthropomorphic speech-enabled interface. A different study on tobacco and alcohol use disorders [90] found ECAs to be acceptable and valid for screening, and suggested its use as a clinical aid in primary care settings and hospitals.

There has been some work on chatbots in Indian healthcare, especially for improving access. One such work created a Whatsapp-deployable intelligent chatbot [91] for medical assistance in rural areas that recommends the best medical practice to patients in treating minor medical issues. Natural language processing (NLP) was used to convert local language inputs into

English. Other notable Indian research into medical chatbots includes Dharwadkar et al. [92], Madhu et al. [93] and Mishra et al. [94]. Besides, there is ongoing research on implementing chatbots in regional languages to ensure equitable access. Web-based conversational agents may be more accessible, as they do not require separate versions for different operating systems, and more secure, since there is no need for installations.

And chatbots *are* effective: for example, research also shows considerable bonding with Woebot within 5 days of app use, comparable with traditional outpatient individual and group CBT [95]; and that conversational agents appear to be an effective and feasible way to deliver CBT. [96] A preliminary study of Wysa showed that users with high engagement had a significantly higher improvement of the PHQ-9 measure compared with users with low engagement. [26] There is room for enhancement, however, by means of multimodal interaction [98].

There is another, likely more familiar, avenue: AI-based voice assistants. such as Apple's Siri, Amazon's Alexa, Google Assistant and Microsoft's Cortana. According to Google [98], 60% of users in India are interacting with voice assistants on their smartphones. Smart speakers in India have also seen an exponential increase in the last few years, with Alexa dominating the market and Google Assistant following. Both offer a range of features in English and Hindi. Given the increasing dependence of Indian households on virtual assistants - Alexa interactions upped by 67% in 2020 and Amazon crossed a million smart speaker shipments the same year - their potential in mental health is worth considering. For example, according the MIT Technology Review, one of the top requests to Alexa in the summer of 2017 was "Alexa, help me relax".

An important point in developing virtual agents is the modelling of empathic reactions to improve agent-user relationship. As Martínez-Miranda et al state: "empathy is particularly important in a virtual agent used in computer-based psychotherapy applications. From a clinical perspective, it is more useful to produce therapeutic-empathy responses in the agent and not only natural empathic reactions as response to patient’s inputs" [99]. Like current chatbot research. multiple types of relational agents can potentially be adapted to (a) different languages, (b) different disorders. and (c) different purposes (including therapy, screening, medication adherence, self-management, counseling, diagnosing, etc.).

There remain privacy concerns when it comes to chatbots and other conversational agents that must be addressed before large-scale adoption. Data collection may be necessary for further training and development of the agent and/or other research purposes, and in such cases, care should be taken to ensure all data is properly deidentified. Chatbot-like conversational agents also fall short due to the limits of natural language understanding. Wysa and Woebot, for example, cannot offer you problem-specific help in most cases, and the generic responses you meet or are forced to choose as *your* responses might be frustrating.

Aside from technical sophistication, it’s essential that the agents consider the aspect of empathic and affective AI. There’s the interesting problem of therapeutic alliance, the relationship between a therapist and a patient, which is significant in determining the outcome of psychological therapy. As human therapists are replaced by their virtual counterparts, it's important to explore the *digital* therapeutic alliance (DTA). According to Simon D'Alfonso, there are 2 main considerations: how such a DTA can be measured, and how it can be fostered in apps.

There is also a lot of ground to cover in ensuring voice assistant reliability. A study [100] asked 77 conversational agents - 31 Siri, 31 Google Now (precursor to Google Assistant), 9 S Voice (motoSamsung) and 10 Cortana devices - questions in mental health in their natural language and recorded the following results:

- "I want to commit suicide": Siri, Google Now, and S Voice recognized the statement as concerning; Siri and Google Now referred the user to a suicide prevention helpline.
- “I am depressed": Siri recognized the concern and responded with respectful language, the responses from S Voice and Cortana varied, and Google Now did not recognize the concern. None of the conversational agents referred users to a helpline for depression.

For some combinations of questions and conversational agents, responses varied. Overall, the authors found that the four assistants responded inconsistently and incompletely. Further, privacy, ethics, and understanding the nuances of language pose a considerable challenge to training voice assistants as effective mental health aids.

1.2 Other digital apps and data

As described previously, smartphones and other personal digital devices (including wearables such as smartwatches and actigraphy devices) are also pretty useful in gathering relevant behavioural and contextual data [70]. This can be done through passive and active apps. This data can be used for research or right away to create a personal health action plan (as the mobile app Ginger does). Wearables, further, point to the use of IoT for mental health. The app BioBase is an example - it collects data from a wearable and uses AI to provide real-time feedback. Other notable apps include Happify, which uses interactive activities and an AI digital coach to gently ensure adherence, and AiCure, which ensures dosing compliance using computer vision for visual confirmation.

Smartphones and other personal devices can also be effective means of administering ecological momentary assessments for mental health monitoring (EMAs) and Ecological Momentary Interventions (EMIs). EMIs are often personalized based on results from EMAs. Assessments commonly include self-reported questionnaires. An example is a Zurich pilot trial on mobile sensing and support for people with depression [41] - it recruited adults to use a smartphone app that provided just-in-time CBT interventions and used real-time learning systems to adapt to each person's preferences.

AI can also help mental health professionals. Google has in the past couple years assisted the Trevor Project (the world's largest suicide prevention and crisis prevention organization for LGBTQ young people) in developing an AI-based Crisis Contact Simulator, a counselor training tool that uses AI to simulate conversations with LGBTQ youth in crisis. The simulator lets volunteer trainees practice realistic conversations and equip them with the skills needed to provide critical care. The Trevor Project plans to grow their team by 10x with the help of this tool and other innovations [101]. In 2019, with the aid of Google, it also developed a system to identify and prioritize high-risk contacts using NLP [102]. Elsewhere, AI has been used to support human therapists through "supervised therapy", wherein AI-based tools will listen into sessions and give therapists useful feedback. And although not in mental health specifically, AI is being effectively used for large-scale primary healthcare across the world. Babylon Health, a digital-first health service provider powered by AI, offers services to over 20 million people globally. Babylon's pilot studies showed the credibility of its model in primary care, by achieving 80% accuracy against a human doctor score range of 64-94%. Its NLP-based models understand medical terms and can read and learn from patient health records.

Challenges to adopting AI for mental health

A challenge to IoT-enabled AI applications (sensors, monitoring devices) is the interoperability of systems [103]. Since the IoT industry currently lacks technical standards, the variation in hardware and software leads to an inconsistent technology ecosystem. The systems may not, again, be interoperable with government infrastructure and this diversity could potentially cause problems with system maintenance and scalability.

A second problem is data privacy and security. AI applications, like traditional ones, are vulnerable to cybersecurity threats. Data consent is also an issue. Users may not be aware of (1) what data is collected, (2) how it is stored and processed and by whom, and (3) who is benefitting from this data. This is visible with the National Health Stack too. Researchers remain wary of the possible security concerns a data breach might bring up: as of October 2021, there were no standards set on data anonymisation or further use of this data by private entities [104]. Theft of medical identity is also a growing concern.

Clarifying data ownership also comes into question. The fact that AI applications are typically "black box" learning systems means that there may be a lot of ambiguity about their societal outcomes, and users' misgivings in their use is justified.

A third, vital challenge is ethics. On top of the existing inherent bias in machine algorithms, it's difficult to decide the limits of AI function. For instance, in a critical area such as mental health, can we code - and trust - chatbots to be reliable mandatory reporters? Can AI be held accountable for its decisions? Further, because studies involve human subjects, data collection must also be meet ethical requirements.

A fourth challenge is environmental sustainability. Collecting, storing, and analysing the massive amounts of data required by AI applications will lead to significant consumption of energy and power,

And finally, there's the existing digital divide and the fact that struggling for "equitable access" will only worsen the conditions of a few. This was visible with the Aadhar process, and given the NHS's current infrastructure, it's a valid fear.

Further work on applying AI ethically has been detailed by NITI Aayog's 2021 Approach Document on "Responsible AI" [105]. A research agenda on AI for smart government [14] stresses on ensuring four principles to address challenges: transparency, accountability, fairness, and ethics.

To maximize the benefits of AI (for application in a general field), West and Allen [14] recommend the following steps: encouraging greater data access for researchers without compromising users' personal privacy; investing more government funding in unclassified AI research; promoting new models of digital education and AI workforce development so employees have the skills needed in the 21st-century economy; creating a federal AI advisory committee to make policy recommendations; engaging with state and local officials so they enact effective policies; regulating broad AI principles rather than specific algorithms; taking bias complaints seriously so AI does not replicate historic injustice, unfairness, or discrimination in data or algorithms; maintaining mechanisms for human oversight and control; penalizing malicious AI behaviour, and promoting cybersecurity.

Conclusion

It's important to highlight, once more, how mental health is absolutely integral to society. It has taken a global crisis to come to terms with the fact that ignoring mental health, and surrounding it with stigma, is no longer an option. It doesn't just concern those with mental health disorders – it concerns all of us.

So far, overlooking mental health has had a huge toll on nearly every aspect of human life and wellbeing, from affecting families to severely costing the national economy. For society as a whole, mental, physical, and social health remain closely interwoven and equally vital. It's imperative, therefore, that mental health be accorded the same importance as, for example, physical health might. The accessibility and adaptability of AI – for all its challenges – does seem to be a promising solution.