PERCEPTION OF UNDERGRADUATE STUDENTS ON THE FEASIBILITY OF USING ARTIFICIAL INTELLIGENCE TO SELF-DIAGNOSE AND MANAGE DEPRESSION, IN THE UNIVERSITY OF IBADAN, OYO STATE.

BY

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CERTIFICATION

I certify that this study was carried out by GBAJABIAMILA OLASUNKANMI under my supervision in the Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria.

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DEDICATION

This research project is dedicated to everybody struggling mentally with one illness or another; hang in there, keep your chin up, more people are understanding better, proper help is coming.I am thankful to God for his grace, mercy and provision throughout my entire academic year.

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ABSTRACT

Poor mental health especially depression constitutes a significant source of morbidity in Africa, especially among undergraduate students. Early treatment reduces the risk of suicide, but this requires access to accurate and timely diagnosis. Unfortunately, most sufferers do not use formal health systems to seek diagnosis and follow-up for treatment thus accentuating thoughts of suicide. The use of Artificial Intelligence (AI) for students'self-diagnosis of depression is a promising alternative to the current low-level diagnostic approach. The objective of this study was to explore a novel approach in the use of artificial intelligence to improve self-diagnosis of depression among undergraduate students in Nigeria.

This cross-sectional study was conducted among 350 undergraduate students from the University of Ibadan, Nigeriausing both qualitative and quantitative methods. Multi-stage sampling technique was used to select the study participants. The assessment on students' perception and knowledge of AI and attitude to its use in self-diagnosing depression was conducted using self-administered questionnaires and interviews.Quantitative data was analysedusing inferential and descriptive statistics. Themanual qualitative thematic analysis method was used for the analysis of all transcribed interviews. Themes and categories were closely examined to identify common themes while subsequent information gathered were fitted into new categories.

Respondents'age was 20.6±2.4 years and 59.1% were females. Majority (82%) of the respondents were of Yoruba ethnicity. Over half (70.6%) of the respondents knew that depression is a state of sadness that extends over two weeks. Almost all (99.1%) of the respondents had good knowledge of depression with knowledge score of 8.8±0.8. More than half (59.4%) of the respondents said they are not at risk of depression while 52% confirmed to have been depressed while in the institution. Twenty (5.7%) respondents were previously diagnosed for depression. It took an average of 3 days for diagnosis to be done and result obtained across the 20 respondents. Of those diagnosed, treatment was obtained by 63.6% respondents with27.3% choosing their treatment type. Advice was the most (50%) received form of treatment for respondents. Poor access to professional mental health therapist was found to be a significant barrier to getting diagnosis(60.5%), followed by unavailability of mental health professional (50.3%) and stigmatization (50.0%).

Respondents had good knowledge about depression and artificial intelligence, respondents' knowledge was not significantly different across age and gender. Althoughthe perception of

respondents of AI was positive, it was however identified that data availability and addiction to the tool may pose an area of concern.

Based on findings from this study, it is recommended that advocacy should be made for the development of AI for students' self-diagnosis and management of depression in the university setting. Secondly, An AI tool that features complete diagnosis and recovery monitoring should also be designed. Thirdly, sensitization on stigmatisation should be carried out for mental health professionals working in tertiary institutions.

Keywords: Artificial Intelligence, Depression, Mental Health, Knowledge and Prevalence.

Word count: 450

Table of Contents

List of Tables

List of Figures

INTRODUCTION

1.0   BACKGROUND OF THE STUDY

Mental health is defined as a state of well-being in which every individual realizes his or her own potential, can cope with normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community (World Health Organisation (WHO), 2014). Three of the ten leading causes of disability in people between the ages of 15 and 44 are mental disorders and the rest are often associated with mental disorders (Yusoff, Abdul-Rahim, Baba, Ismail, Mat, &Esa, 2013).

Depression is a very common mental disorder that has increased in popularity and prevalence in recent times according to various research. The WHO explains it as; "a common mental disorder, characterized by persistent sadness and a loss of interest in activities that you normally enjoy, accompanied by an inability to carry out daily activities, for at least two weeks". People with depression normally have several of the following: a loss of energy; a change in appetite; sleeping more or less; anxiety; reduced concentration; indecisiveness; restlessness; feelings of worthlessness; guilt or hopelessness; and thoughts of self-harm and suicide. The seriousness of the disorder made WHO lead a one-year campaign in 2017, with the highlight being the World Health Day 2017. There was a significant increase of more than 18% in the number of people living with depression between 2005 and 2015 (WHO, 2017). This statistic support that depression is on the rise. To highlight its importance, it is one of the priority conditions covered by WHO's mental health Gap Action Programme (mhGAP). The programme aims to help countries increase services for people with mental, neurological, and substance use disorders through care provided by health care workers who are not specialists in mental health. A depressive episode can be categorised into mild, moderate, and severe based on the number and severity of symptoms.

The issue of students' mental health is a global problem that covers all developed and non-developed societies, both modern and traditional (Bayram&Bilgel, 2008). During their academic life young people face many contradictions and obligations to succeed, especially at university (Arslan, Ayranci, Unsal&Arslantas, 2009). The mental health problems of

1

students are widely studied at different educational levels, such as college and university (Bayram&Bilgel, 2008). A number of studies have indicated a high prevalence of mental health problems among students, including depression, compared to the rest of the population (Yusoff et al., 2013). More importantly, recent studies in this area indicate that the psychological and mental problems of students continue to increase (Field, Diego, Pelaez, Deeds & Delgado, 2012). For example, in the United States a national survey in 2005 mentioned that 86% of university counsellingcentres noted an increase in serious mental health and psychological problems among university students (Gallagher, Weaver-Graham &Tylor, 2005). One of the most prevalent problems of mental health is depression, which is a serious health problem among the student population (Ibrahim, Kelly, Adams &Glazebrook, 2013). Moreover, depression has a significant impact on academic performance, academic satisfaction and academic achievement (Arslan, Ayranci, Unsal, &Arslantas 2009). A study by Wechsler, Lee, Kuo and Lee (2000) reported that students with symptoms of depression achieve lower grades and are less active in the classroom relative to students who do not have these symptoms.

Kerr wrote for health line in 2017, 'A lack of sleep, poor eating habits, and not enough exercise are a recipe for depression among college students. The stress that comes with academia – including financial worries, pressure to get a good job after school, and failed relationships – is enough to force some student to leave college or worse'. These days, there are fewer job prospects after graduation than previous generations. These added concerns can lead to depressive episodes in undergraduates. The National Alliance on Mental Illness conducted a survey report on mental health in 2012. They found out that 64% of students who dropped out of college did so because of a mental health related reason. Half of those people who dropped out did not access mental health services and support. Some of them highlighted that connecting with mental health providers earlier, having peer-run support groups available, and accessing mental health services and support on campus, might have helped them stay in school.

Britannica defines Artificial Intelligence as the ability of a digital computer or computer controlled robots to perform tasks commonly associated with intelligent beings. According to Techopedia, Artificial Intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Some of the activities

2

computers with artificial intelligence are designed for include; speech recognition and learning.

Some few real life examples of Artificial Intelligence include self-driving cars, navigation dynamics, Chatbots, human versus computer games, Siri, Alexa, implantable medical devices, electronic trading and automation using robots. Machine learning is an application of artificial intelligence that gives machines the ability to learn and improve without the help of humans or new programming. A variety of machine learning algorithms, including Support Vector Machine, Maximum Likelihood, Neural Network, k-Nearest Neighbour, decision trees, Bayesian networks etc. have been developed. (Das, *et al.* 2015). Deep learning is part of a broader family of machine learning methods based on learning data representation as opposed to task specific algorithms. (Le Cun, *et al* 2015). Algorithms like machine learning, deep learning etc. drive these computer 'thoughts' by providing a conceptual framework for processing input and making decisions based on the data (One Hundred Year Study on Artificial Intelligence. Stanford University, 2016). AI lends itself to healthcare delivery very well. In fact, in the recent years there has been an exponential increase in the use of AI in clinical environments (Diprose&Buist 2016). With modern Medicine facing a significant challenge of acquiring, analysing and applying structured and unstructured data to treat or manage diseases, AI systems with their data-mining and pattern recognition capabilities come in handy. Medical AI is mainly concerned with the development of AI programs that help with the prediction, diagnosis and treatment or management of diseases (Sandeep Reddy, 2018). With an ever growing preference for convenience and Instant feedback, it is no wonder artificial intelligence is gaining more ground in the area of mental and behavioural health care (Jodi Clarke, for verywellmind.com, 2018).

1.1   STATEMENT OF THE PROBLEM

Depression is ranked by WHO as the single largest contributor to global disability (7.5% of all years lived with disability in 2015). Depression is also the major contributor to suicide deaths, which number is close to 800,000 per year. Suicide occurs throughout the lifespan and was the second leading cause of death among 15-29 year olds globally in 2015, a lot of undergraduates fall into this age bracket. Although the prevalence is quite high and looks to be on the rise among undergraduates, seeking for help to solve these mental illnesses such as depression is a major concern to this study.

3

Public stigma is one of the most influential barriers between mental health issues and treatment (Pederson et al., 2014). Pederson et al. (2014) define public stigma as the negative attitudes against people of a particular group, and in this instance, against those who seek treatment for mental health concerns, such as depression. However, there were other barriers, including the price of the services, availability of mental health professionals, the desire to solve problems alone, the shame of sharing problems with other people, and not knowing which services are best. In Colloway's (2008) study, it was found that one's fear of stigmatization, of treatment, and of being judged after expressing himself/herself hinder one from seeking and receiving psychological help.

1.2   JUSTIFICATION OF THE STUDY

University students globally are at higher risk to developing depression and suffer from its impact with varying levels of prevalence. The study conducted in African Universities showed that the prevalence of depression ranges between 16.2% and 67%.   This studyrevealed the status of students having a variety of depressive symptoms which provided needed data for planning interventions.The number of students in need of treatment for mental disorders such as depression far exceeds the resources of most counsellingcentres, resulting in substantial unmet need for treatment of mental disorders among college undergraduate students (Auerbach, Alonso, Axinn, Cuijpers, Green *et al;* 2016; Beiter, Nash, McCrady, & Rhoades *et al;* 2015). This study holds major promise for improving timely campus health services and mental policymaking through improvement of students' self-diagnosis of depression using AI.

Many patients want to have an opportunity to influence their treatment choices, but the reported numbers vary considerably. For example, Patel and Bakken (2010) surveyed 60 people who were seeking medical care for depression and reported that 98% of the sample wanted to be involved in the decisions. In another questionnaire survey with 94 depressed patients, Stacey et al (2008) found that half of the participants wanted to make the decisions alone, 40 percent wanted to share the decision and 10 percent wished to rely completely on the advice of physician or a relative. Moreover, Chewning et al (2012) found in a systematic review that up to 71 percent of patients with a range of conditions wanted to be involved in their treatment choices. Treatment for depression is considered as 'preference-sensitive',

4

since several options are recommended as adequate and effective (O'Connor et al., 2007). Therefore, this study has provided University administrators and other stakeholders the import of getting students involved in the co-creation of AI for self-diagnosis and management of depression.

In Nigeria, research has shown high levels of ignorance about mental illness and negative attitudes towards individuals with mental disorders (Dogra, Singh, Svirydzenka&Vostanis2012). Traditional healers and religious leaders are usually the first point of consultation for mental illness, with consequent prolongation of the pathway to appropriate care (Kabir, Iliyasu, Abubakar, Aliyu, 2004). The existing mental health policy for Nigeria was formulated in 1991 and it has not been updated. There were no family or patient associations in those areas and there are no mechanisms to protect patient's rights. Similarly, there is no provision for interactions between mental health providers and primary care staff. This study suggests that there should be a comprehensive review of how mental health service is provided and that there should be a plan for addressing any systemic issues. This study provided insight into how such plans could be instituted in the university setting through the use of AI.

Klein et al., explained in 2011 that some logistic barriers that may occur in treatment seeking for depression include healthcare costs, resources available, lack of mental health screening, and lack of care options available (Klein et al., 2011). The National Alliance on Mental Illness conducted a survey report on mental health in 2012. They found out that 64% of students who dropped out of university did so because of a mental health related reason. Half of those people who dropped out did not access mental health services and support. Some of them highlighted that connecting with mental health providers earlier, having peer-run support groups available, and accessing mental health services and support on campus, might have helped them stay in school.

'' *In a crisis that has become progressively dire over the past decade, digital solutions – many with artificial intelligence (AI) at their core – offer hope for reversing the decline in our mental wellness. New tools are being developed by tech companies and universities with potent diagnostic and treatment capabilities that can be used to serve large populations at reasonable cost*'' – ParieGarg, Harvard Business Review, 2018. This current study has revealed how depression among university students could be better investigated through the use of AI for self -diagnosis and management,thereby contributing to the design of mental

5

health promotion and prevention strategies for the prevention of the new incidences of depression and providing appropriate mental health treatment services for the affected students though removal of barriers. Moreover, this study has added value to filling scarcity of literature on Using AI for self diagnosis of depression among university students.

1.3   RESEARCH QUESTIONS
1. What is the students'level of knowledge about depression and Artificial Intelligence?
2. What is students' perception towards using Artificial Intelligence to self-diagnose and manage depression?
3. What is the students'level of knowledge about existing Artificial Intelligence tools to diagnose and manage depression?
4. How satisfied will the students be if there was an Artificial Intelligent tool to help self-diagnose and manage depression?
5. What will the students like to see incorporated into the Artificial Intelligent tool that could help self-diagnose and manage depression?

1.4   BROAD OBJECTIVE
To determine the perception of students about the use of Artificial Intelligence to self-diagnose and manage depression, and to help provide baseline information for whenever a one stop tool that can be used to self-diagnose and manage depression is to be create.

1.5   SPECIFIC OBJECTIVES ARE TO:
1. Assess the knowledge of undergraduate students on depression.
2. Assess the knowledge of undergraduate students onArtificial Intelligence and existing AI tools
3. Determine the perception of undergraduate students on self-diagnosis of depression and the use of Artificial Intelligence to self-diagnose and manage depression.
4. Assess respondents knowledge on existing use of Artificial Intelligence in depression diagnosis and management.
5. Determine how satisfied respondents are if Artificial Intelligence was used to self-diagnose and manage depression.
6. Determine what respondents would like to see in the tool if Artificial Intelligence was used to self-diagnose and manage depression.

1.6 RESEARCH HYPOTHESES

1. There will be no significant relationship between sex of the students and knowledge on depression.

2. There will be no significant relationship between the age of students and their knowledge on artificial intelligence.

LITERATURE REVIEW

2.0   Overview of Depression
Conceptual clarification: Depression

The World Health Organization refers to mental health disorders as one of the leading causes of disability globally. Three of the ten leading causes of disability in people between the ages of 15 and 44 are mental disorders, and the other causes are often associated with mental disorders (Yusoff, Abdul Rahim, Baba, Ismail, Mat and Esa, 2013).

Depression is a common mental disorder, characterized by persistent sadness and a loss of interest in activities that you normally enjoy, accompanied by an inability to carry out daily activities. It is an affective disorder that presents with depressed mood, loss of interest or pleasure, decreased energy, feelings of guilt or low self-worth, disturbed sleep or appetite, and poor concentration (Marcus, Yasamy, Mark, Dan and Shekhar, 2012; Yalemwork, 2015). Depression is also characterized by changes in mood status usually occurring as feelings of sadness which may fluctuate from slight hopelessness to severe feelings of disappointment (Ibrahim, Kelly, Adams and Glazebrook, 2013; Lotfi, Aminian, Ghomizadea and Zarea, 2010).

Depression is more than just sadness, it interferes with daily life and causes pain for the affected person and everyone who cares about that person. It's a common illness, but a very serious one (Anxiety and Depression Association of America, 2016). "Clinical depression" or a "depressive disorder" is a mood disorder that causes distressing symptoms that affect how an affected person feel, think, and handle daily activities, such as sleeping, eating, or working. To be diagnosed with depression, symptoms must be present most of the day, nearly every day for at least 2 weeks (National Institute of Mental Health, 2016).

According to the American Psychiatric Association (2000) the prevalence rate for a Major Depressive Disorder (MDD) in the United States is estimated at 7%, with most individuals experiencing the first episode of Major Depressive Disorder by their mid-20.

Differences between Depression and sadness or grief/bereavement

The deaths of a loved one, loss of a job or the ending of a relationship are difficult experiences for a person to endure. It is normal for feelings of sadness or grief to develop in

response to such situations. Those experiencing loss often might describe them as being 'depressed'

But being sad is not the same as having depression. The grieving process is natural and unique to each individual and shares some of the same features of depression. Both grief and depression may involve intense sadness and withdrawal from usual activities. They are also different in important ways:

o In grief, painful feelings come in waves, often intermixed with positive memories of the deceased. In major depression, mood and/or interests (pleasure) are decreased for most of two weeks.

o In grief, self-esteem is usually maintained. In major depression, feelings of worthlessness and self-loathing are common.

For some people, the death of a loved one can bring on major depression. Losing a job or being a victim of a physical assault or a major disaster can lead to depression for some people. Despite some overlap between grief and depression, they are different. Distinguishing them can help people get the help, support or treatment they need (American Psychiatric Association, 2013).

2.0.1   Epidemiology and prevalence

Depression is a common health problem, ranking third after cardiac and respiratory diseases as a major cause of disability (Ibrahim, Kelly, Adams and Glazebrook, 2013). Depression is a leading cause of disability and has been projected by the World health Organisation to become the most burdensome disease by the year 2020.

Epidemiological studies of the prevalence and incidence of psychiatric disorders like depression have been undertaken in a wide range of low-, middle- and high-income countries. These studies contribute immensely to our understanding of how common this disease is. According to the WHO, there were at least 350 million people living with depression globally. The WHO in 2017 also released the estimates below about depression for the year 2015:

- 4.4% is the estimated global proportion of the global population with depression.
- 322 million is the total number of people living with depression in the world.
- Depression is more common in females (5.1%) than males (3.6%).

9

- 18.4% is the total increase of estimated number of people living with depression between 2005 and 2015

- Nigeria has 7,079,815 cases, 3.9% of the population

- Depression is ranked as the single largest contributor to global disability and accounts for 7.5% of all years lived with disability

- Depressive disorders led to a global total of over 50 million Years Lived with Disability (YLD) in 2015.

- More than 80% of this non-fatal disease burden occurred in low- and middle-income countries.

Cases of depressive disorder (millions), by WHO Region

66.21
21%

52.98
16%

African Region
Eastern Mediterranean Region
European Region
Region of the Americas
South-East Asia Region
Western Pacific Region

29.19
9%

322 million

40.27
12%

85.67
27%

48.16
15%
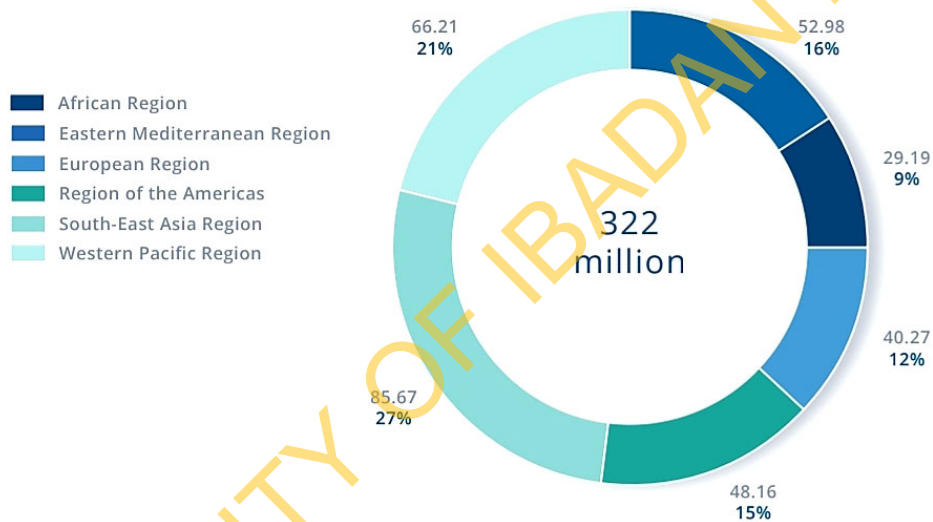
8

WORLD HEALTH ORGANIZATION

Figure 1: Causes of Depressive Disorder by WHO Region

Prevalence of depressive disorders (% of population), by WHO Region

Legend: ■ Female ■ Male ■ Both

Global prevalence of depressive disorders, by age and sex (%)

Legend: ■ Female ■ Male
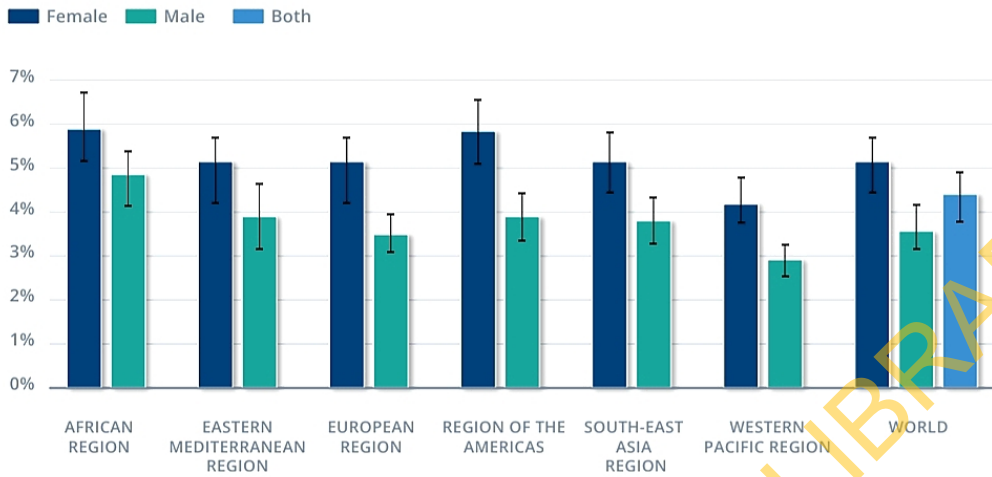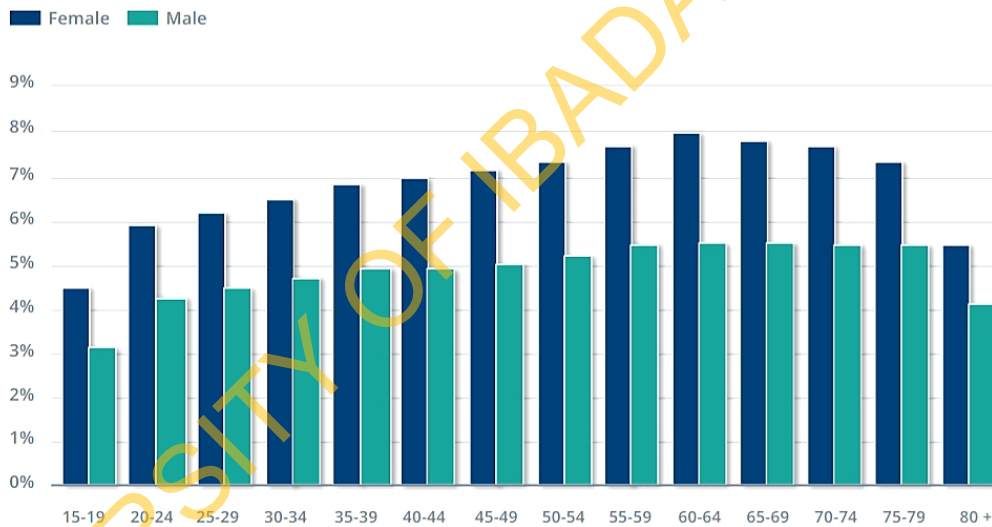
Source: Global Burden of Disease Study 2015 (*http://ghdx.healthdata.org/gbd-results-tool*)
Regional data shown are age-standardized estimates.

Figure 2: Prevalence of Depressive Disorder by WHO Region and Global Prevalence of Depressive Disorders, by Age and Sex

Depressive disorders	Total YLD (thousands)	YLD per 100,000	% of all YLDs	Rank cause
Low- and middle-income countries				
- African Region	7 229	731	7.9	2
- Eastern Mediterranean Region	4 049	685	6.9	2
- European Region	3 517	859	8.1	2
- Region of the Americas	5 106	844	9.3	1
- South-East Asia Region	13 967	724	7.0	2
- Western Pacific Region	10 525	640	7.2	2
High-income countries	9 608	839	7.9	2
World	54 215	738	7.5	1

Source: WHO Global Health Estimates (*http://www.who.int/healthinfo/global_burden_disease*)

Figure 3: Depressive Disorders

COUNTRY	Depressive Disorders		Anxiety Disorders	
	Total cases	% of popu-lation	Total cases	% of popu-lation
Algeria	1 683 914	4,5%	1 657 172	4,5%
Angola	892 128	3,6%	675 748	2,8%
Benin	411 695	3,9%	290 713	2,7%
Botswana	102 065	4,7%	68 954	3,1%
Burkina Faso	640 502	3,6%	471 618	2,7%
Burundi	448 822	4,2%	323 003	3,0%
Cameroon	886 273	3,9%	620 704	2,7%
Cape Verde	24 240	4,9%	15 175	3,1%
Central African Republic	202 081	4,2%	143 526	3,0%
Chad	478 228	3,5%	357 769	2,6%
Comoros	33 769	4,4%	23 946	3,1%
Congo	180 632	3,9%	129 558	2,8%
Côte d'Ivoire	843 736	3,8%	600 520	2,7%
Democratic Republic of the Congo	2 871 309	3,8%	2 113 267	2,8%
Equatorial Guinea	34 909	4,2%	24 147	2,9%
Eritrea	219 549	4,3%	156 599	3,1%
Ethiopia	4 480 113	4,7%	3 139 003	3,3%
Gabon	73 303	4,3%	50 501	3,0%
Gambia	74 821	3,9%	51 218	2,7%
Ghana	1 100 048	4,2%	744 217	2,8%
Guinea	474 541	3,9%	333 416	2,7%
Guinea-Bissau	71 467	4,0%	49 420	2,8%
Kenya	1 952 981	4,4%	1 375 341	3,1%
Lesotho	98 988	4,8%	63 601	3,1%
Liberia	155 406	3,5%	119 871	2,7%
Madagascar	1 041 000	4,4%	731 036	3,1%
Malawi	679 385	4,1%	501 153	3,0%
Mali	605 969	3,6%	446 852	2,6%
Mauritania	160 624	4,1%	109 873	2,8%
Mauritius	52 570	4,4%	42 559	3,5%
Mozambique	1 122 987	4,1%	819 845	3,0%
Namibia	104 001	4,4%	72 803	3,1%
Niger	653 348	3,4%	485 497	2,5%
Nigeria	7 079 815	3,9%	4 894 557	2,7%
Rwanda	425 516	3,8%	358 986	3,2%
Sao Tome and Principe	7 270	3,9%	5 085	2,7%
Senegal	560 991	3,9%	397 168	2,7%
Seychelles	3 722	4,0%	3 068	3,3%
Sierra Leone	243 895	3,9%	172 958	2,8%
South Africa	2 402 230	4,6%	1 768 851	3,4%
South Sudan	529 011	4,4%	369 254	3,1%
Swaziland	53 223	4,2%	37 984	3,0%
Togo	277 532	3,9%	194 844	2,8%
Uganda	1 747 769	4,6%	1 070 004	2,8%
United Republic of Tanzania	2 138 939	4,1%	1 551 036	3,0%
Zambia	636 819	4,0%	469 177	3,0%
Zimbabwe	603 529	4,0%	422 238	2,8%

Figure 4: Prevalence of Depressive Disorders and Anxiety Disorders

Depression affects an estimated one in 15 adults (6.7%) in any given year. And one in six people (16.6%) will experience depression at some time in their life. Depression can strike at any time, but on average, first appears during the late teens to mid-20s. Women are more likely than men to experience depression. Some studies show that one –third of women will experience a major depression episode in their lifetime. (American Psychiatric Association, 2013)

Depression often begins at a young age, can be chronic or acute, and when most severe, can lead to suicide (WHO, 2012). In Vietnam, depressive disorders have the second highest prevalence among mental disorders with about 36,000–40,000 people losing their lives to depression per year (Vuong, Ginneken, Morris, Ha, and Busse, 2011).

The prevalence of depression varies across different populations. Depression is particularly frequent among university students all over the world and their prevalence appears to be increasing (Adewuya, Ola, Olutayo, Mapayi and Oginni, 2006). Depression is a draining and harmful cluster of symptoms that may last for a period of weeks, months, or even years. The 'Turkey Mental Health Profile Project' reported that depression was among the most frequently seen mental illnesses, and the prevalence of depressive symptoms in Turkish university students varied between 10% and 40%. Another study in the mid-1990s specified the prevalence rate at 34.5%, indicating an increase in depression among young adults in Turkey in the second half of the 1990s (Ustun and Kessler, 2002). About 60% of university students left school without completing their studies because of depression, anxiety and maladjustment (Rubin, 2008). Keyes (2006) in a study revealed that the estimated rate of symptomatic expression of depression for individuals who do not meet criteria for a MDD is much higher, especially among undergraduates. In a study by Perez-Rojas, Lockard, Bartholomew, Janis, Carney and Xiao (2017) it was revealed that among 53,000 students, anxiety (56%) and depression (46%) were two of the most common conditions for which support in counselling centers was sought.

2.0.2 Types of depression
There are various forms of depression as explained by the National Institute of Mental health in a publication in 2016. Two of the most common forms of depression are:

- Major depression—having symptoms of depression most of the day, nearly every day for at least 2 weeks that interfere with your ability to work, sleep, study, eat, and

enjoy life. An episode can occur only once in a person's lifetime, but more often, a person has several episodes.

- Persistent depressive disorder (dysthymia)—having symptoms of depression that last for at least 2 years. A person diagnosed with this form of depression may have episodes of major depression along with periods of less severe symptoms.

Some forms of depression are slightly different, or they may develop under unique circumstances, such as:

- Perinatal Depression: Women with perinatal depression experience full-blown major depression during pregnancy or after delivery (postpartum depression).
- Seasonal Affective Disorder (SAD): SAD is a type of depression that comes and goes with the seasons, typically starting in the late fall and early winter and going away during the spring and summer.
- Psychotic Depression: This type of depression occurs when a person has severe depression plus some form of psychosis, such as having disturbing false fixed beliefs (delusions) or hearing or seeing upsetting things that others cannot hear or see (hallucinations).

Other examples of depressive disorders include disruptive mood dysregulation disorder (diagnosed in children and adolescents) and premenstrual dysphoric disorder. Depression can also be one phase of bipolar disorder (formerly called manic-depression). But a person with bipolar disorder also experiences extreme high—euphoric or irritable—moods called "mania" or a less severe form called "hypomania." The World Health Organisation in 2017 also explained that bipolar affective disorder typically consists of both manic and depressive episodes separated by periods of normal mood. Manic episodes involve elevated mood and increased energy, resulting in over-activity, pressure of speech and decreased need for sleep.

2.0.3 Depressive Symptoms
According to the WHO, 2017, depression symptoms can vary from mild to severe and can include:

- o Feeling sad or having a depressed mood
- o Loss of interest or pleasure in activities once enjoyed
- o Changes in appetite – weight loss or gain unrelated to dieting
- o Trouble sleeping or sleeping too much

15

- Loss of energy or increased fatigue
- Increases in purposeless physical activity (e.g., hand-writing or pacing) or slowed movement and speech (actions observable by others)
- Feeling worthless or guilty
- Difficulty thinking concentrating or making decisions
- Thoughts of death or suicide

The WHO 2015 further stated that people with depression usually experience several of the following: a loss of energy; a change in appetite; sleeping more or less; anxiety; reduced concentration; indecisiveness; restlessness; feelings of worthlessness; guilt or hopelessness; and thoughts of self-harm and suicide. Furthermore, patients with depression suffer from the loss of pleasure in usual activities, have sleep disturbances, loss of appetite or overeating, social withdrawal, and often think about suicide. Major depressive disorder or depressive episode, which involves symptoms such as depressed mood, loss of interest and enjoyment, and decreased energy; depending on the number and severity of symptoms, a depressive episode can be categorized as mild, moderate, or severe (WHO, 2017)

Symptoms must last at least **two weeks** for a diagnosis of depression. (WHO, 2017)

Also, medical conditions (e.g., thyroid problems, a brain tumour or vitamin deficiency) can mimic symptoms of depression so it is important to rule out medical causes.

2.0.4   Risk Factors for Depression
Depression can affect anyone-even a person who appears to live in relatively ideal circumstances.

Several factors can play a role in depression:

- **Biochemistry:** Differences in certain chemicals in the brain may contribute to symptoms of depression
- **Genetics:** Depression can run in families. For example, if one identical twin has depression, the other has a 70 percent chance of having the illness sometime in life.
- **Personality:** People with low self-esteem, who are easily overwhelmed by stress, or who are generally pessimistic appear to be more likely to experience depression.
- **Environmental factors:** Continuous exposure to violence, neglect, abuse or poverty may make people more vulnerable to depression

Barriers affecting the prevalence of Depression among University students

16

i. Lack of knowledge:In Nigeria, research has shown high levels of ignorance about mental illness and negative attitudes towards individuals with mental disorders (Dogra N, *et al.,* 2012).Lack of knowledge about depression and other mental illnesses has been identified as one of the major stumbling blocks and that can affect reporting. (Kabir M, Iliyasu Z, Abubakar IS, Aliyu MH, 2004). Given Nigeria's status as a low and middle income country, that in itself could be a contributing factor to depression among undergraduates in the country.

ii. Socio economic factors: A large cross-national study (Septoe, *et al.* 2007) on the relationship between symptoms of depression and socio-economic background of University students showed that family and personal income level, parental education, and family wealth, contributed to depression in students. Another study by Ibrahim *et al* in 2013, concluded that students from families with low level of income and parental occupation have a tendency towards depression.

iii. Inadequate mental health facilities and trained mental health care workers: Traditional healers and religious leaders are usually the first point of consultation for mental illness, with consequent prolongation of the pathway to appropriate care (Kabir M, Iliyasu Z, Abubakar IS, Aliyu MH, 2004). The WHO conducted a study on Nigeria's mental health services in 2005/2006. The report used the six states the country selected on the basis of her geopolitical distribution and location of the country's main psychiatric hospitals. The report showed that the mental health services in these areas are quite limited. Also, the existing mental health policy for Nigeria was formulated in 1991 and it has not been updated. There are no family or patient associations in these areas and there are no mechanisms to protect patient's rights. Similarly, there is no provision for interactions between mental health providers and primary care staff. This report suggests that there should be a comprehensive review of how mental health service is provided and that there should be a plan for addressing any systemic issues. Enough psychiatrists in the country could have given the country a boost in tackling mental health but the statistics released by WHO in 2001 doesn't give us much hope. The population ratio of psychiatrists is Nigeria 0.4:100 000, while for psychiatric nurses it is 4:100 000 (World Health Organization, 2001). Although depression happens to be a medical condition that can however be unfailingly

17

diagnosed and treated in primary care (Marcus, Yasamy, Mark, Dan and Shekhar, 2012).

iv.   Stigmatisation Nigeria has 7,079,815 cases of depression as at 2015 which was 3.9% of the population. Although, it can be argued that it could be higher given that it is highly sensitive issue in the country and most people do not want to be associated with it

v.   Transition from family environment to school environment:
Gaining admission and acceptance into university marks a transitional period for students, where by some students move away from their homes first time and lose the traditional adult supervision and the traditional social support. Adding to this, it might be the first time some of these students would face financial challenges. These changes have been known to contribute to risk factors for developing depression, which is linked with several severe problems in university students, especially academic achievement, suicidal ideation, substance abuse, and acute infectious illnesses (Yalemwork, 2015; Al-Busaidi, Bhargava, Al-Ismaily, Al-Lawati, Al-Kindi and Al-Shafaee, 2011; Lei, Xiao, Liu and Li, 2016). Also, trying to get familiar with the new change, maintain good grades in school, plan for the future, and be away from home often causes anxiety for a lot of students, and as a reaction to this stressful event, some students get depressed (Buchanan, 2012). They find that they cannot get themselves together. They may cry all of the time, skip classes, or isolate themselves without realizing they are depressed. Research has revealed that depression among university student is prevalent around the world (Eller, Aluoja, Vasar and Veldi, 2006), and the prevalence seems to be high (Reavley and Jorm, 2010).

In summary, a variety of events that pose challenges for youths transitioning to traditional university setting are associated to the increased rate of anxiety and depression symptoms in undergraduates. This transition often involves becoming isolated from lifelong social relationships and support mechanisms, incurring extensive financial burden, and realizing limitations to academic proficiency in a more rigorous learning environment (Vredenburg, O'Brien and Krames, 1988). These events often relate to stressors, triggering anxiety and depression which is more heightened as many undergraduates have not developed effective problem-

focused coping strategies to manage the perceived stressors (Downs and Ashton, 2011; Heller and Cassady, 2017).

vi. Physiological and psychological transition in youth development:

The youth phase is a time of contradictions when a person goes through many changes and experiences such as emotional, behavioral, sexual, economic, academic, and social, and as well as efforts of discovering one's identity with psycho-social and sexual maturation. Psychological morbidity in undergraduate students represents a neglected public health problem and holds major implications for campus health services and mental policymaking. In terms of life quality, understanding the impact of this neglected public health phenomenon on one's educational attainment and prospective occupational success is very important (Bayram and Bilgel, 2008).During this period, the mental health of university students constitutes one of the important components of social health (Ginwright and James, 2002).

2.0.5   Perception of Depression

People's perception and beliefs about the nature, diagnosis, causes, and consequences of depression may vary as a function of their own experiences with depression. For example, a study by Furnham and Kuyken (1991) revealed that people with a history of depression considered interpersonal difficulties more important in the onset of depression than did those who had never been depressed. Individuals who had experienced major depression rate their experiences of depression as having affected their lives in more distressing and debilitating ways than did those whose experiences of depression did not reach clinical levels (Coyne, Gallo, Klinkman, and Calarco, 1998).

Meanwhile, it can be difficult to detect depression in the older adult population because it can be confused with other diseases that surface later in life, such as dementia or memory loss. Also symptoms of depression are often confused with aging symptoms such as long face or a slouched posture (Evans and Mottram, 2000). About 11% of adults with depression go unnoticed and therefore do not get treated (Dorfman, 1995).

Studies have shown that stigma reduces the willingness of people to seek treatment for depression, let alone get diagnosis of it. Stuart and Arboleda-Florez, (2000) in a study revealed that individuals fear and avoid those diagnosed with mental illness. Of the many

stigmas, there are two types of stigma that arise from perceived and actual perceptions from inside the individual, or self-stigma and from society, or public-stigma (Latlova, Kamaradova&Prasko, 2014). Research has also shown that removing stigma from diseases, such as depression, can improve the quality of life for those living with it (Corrigan & Penn, 1999). Therefore, with the increasing population plagued with depression, much assistance will be needed to handle their symptoms. Lee and Dugan (2014) in a study discovered that out of 9,547 adults, 30% had inaccurate perceptions of their mood symptoms, while also revealing that adults are at risk of not seeking mental health care or receiving insufficient care. Garrido, Kane, Kaas and Kane (2011) in a study found that 65.9% of the respondents diagnosed with depression did not receive any mental health services within the previous 12 months. Depression if not properly diagnosed and treated, can increase the demand of caregivers, illness, and toll on health services, and this further necessitates the need for adoption of artificial intelligence into healthcare to aid in early diagnosis and treatment of depression (Evans &Mottram, 2000).

2.0.6 Diagnosis and Treatment of Depression

Depression is among the most treatable of mental orders between 80 percent and 90 percent of people with depression eventually respond well to treatment. Almost all patients gain some relief from their symptoms (American Psychiatric Association, 2013).

Before a diagnosis or treatment, a health professional should conduct a thorough diagnostic evaluation, including an interview and possibly a physical examination. In some cases, a blood test might be done to make sure the depression is not due to a medical condition like thyroid problem. The evaluation is to identify specific symptoms, medical and family history, cultural factors and environmental factors to arrive at a diagnosis and plan a course of action.

Medication: Brain chemistry may contribute to an individual's depression and may factor into their treatment. For this reason, antidepressants might be prescribed to help modify one's brain chemistry. These medications are not sedatives, upper or tranquilizers. They are not habit-forming. Generally antidepressant medications have no stimulating effect on people not experiencing depression.

Antidepressants may produce some improvement within the first week or two of use. Full benefits may not been seen for two to three months. If a patient feels little or no improvement after several weeks, his or her psychiatrist can alter the dose of medication or add or

20

substitute another antidepressant. In some situations other psychotropic medications may be helpful. It is important to let your doctor know if a medication does not work or if you experience side effects.

Psychiatrists usually recommend that patients continue to take medication for six or more months after symptoms have improved. Longer-term maintenance treatment may be suggested to decrease the risk of the future episodes for certain people at high risk.

Psychotherapy: Psychotherapy, or "talk therapy", is sometime used alone for treatment of mild depression; for moderate to severe depression, psychotherapy is often used in along with antidepressant medications. Cognitive behavioural therapy (CBT) has been found to be effective in treating depression. CBT is a form of therapy focused on the present and problem solving. CBT helps a person to recognize distorted thinking and then change behaviour and thinking.

Psychotherapy may involve only the individual, but it can include others. For example, family or couples therapy can help address issues within these close relationships. Group therapy involves people with similar illness. Depending on the severity of the depression, treatment can take few weeks or much longer. In many cases, significant improvement can be made in 10 to 15 sessions.

Electro Convulsive Therapy (ECT): is a medical treatment most commonly used for patients with severe major depression or bipolar disorder who have not responded to other treatments. It involves a brief electrical stimulation of the brain while the patient is under anaesthesia. A patient typically receives ECT two to three times a week for a total of six to12 treatment. ECT has been used since 1940s, and many years of research have led to major improvements. It is usually managed by a team of trained medical professionals including a psychiatrist, an anaesthesiologist and a nurse of physician assistant.

Self-help and coping

As part of treatment, there are a number of things people can do to reduce the symptoms of depression. For example many people, regular exercise helps create positive feeling and improve mood. Getting enough quality sleep on a regular basis, eating a healthy diet and avoiding alcohol (a depressant) can also help reduce symptoms of depression.

Although depression is treatable, less than half of those affected in the world (in many countries, less than 10%) receive the care and support they need (WHO, 2012). Inadequacy of resources, lack of psychiatric facilitates, social stigma, and lack of mental health literacy (MHL) constitute major barriers in accessing treatment for mental disorders in general and for depression in particular (WHO, 2012; Coles and Gibb, 2016; Jorm, 2011).

2.0.7 Consequences of Depression among Students

Depression is a psychological problem which has significant implications for students' lives, academic performance, and behavior. Higher institutions are beginning to understand the importance of attending to the psychological and emotional needs of undergraduate students, realizing that anxiety and depression gave significant negative impacts on student's ability to remember what they have been taught and overall academic performance (Casasady, Pierson and Starling, 2019).

Students who reported experiencing at least one period of depression-like symptoms were significantly more likely to experience academic problems than were those without symptoms, in terms of receiving a lower grade (Wechsler, Lee, Kuo, and Lee, 2000).Thus there is a negative relationship between depression and academic achievement. When depression is high, academic achievement is low and vice versa.

Hysenbegasi, Hass and Rowland (2005) conducted a study in Western Michigan University and found that depression has a strong impact on academic productivity among the students. According to their study, of the 121 depressed students who were diagnosed in the campus health center, 14.64% had missed a great number of classes, 5.45% missed assignments, and 1.36% and 0.74% of them missed examinations and dropped a number of courses (Yalemwork, 2015).Learning challenges linked with depression include diminished levels of interest in school, difficulty paying attention or concentrating on tasks, and struggling to engage in positive academic behaviors such as attending class and studying (Gaspar de Matos, Tome, Borges, Manso, Ferreira and Ferreira, 2008).

Study by Hagell and Westergren (2006) revealed that students reporting depression were significantly more likely to report less satisfaction with health-related quality of life (HRQoL) than students not reporting depression symptoms. Poor class-room performance is proportional to the daily frequency of students' depression symptoms. Students who were depressed had a major greater loss of healthy days compared to students who were not. If left untreated in the early age of occurrence, it can lead to different problems such as school

failure, conduct disorder, and delinquency, eating disorders such as anorexia and bulimia, school phobia, panic attacks, substance abuse, or even suicide (Yalemwork, 2015).

Furthermore, increased rates of comorbid anxiety symptoms are noted with depression (Anderson and Hope, 2008), with the presence of an anxiety disorder routinely being associated with heightened rates of diagnosed depression (Wittchen, Zhao, Kessler and Eaton, 1994; American Psychiatric Association, 2000; Gaspar de Matos et al., 2008; Horn and Wuyek, 2010).

Studies investigating the consequences of anxiety and depression has demonstrated that individuals who experience both conditions experience significantly lower levels of psychological health, increased rates of reoccurrence, longer durations of episodes with symptoms, greater resistance to treatment, and increased rates of suicidal attempts (Garber and Weersing, 2010; Rhebergen, Batelaan, deGraaf, Nolen, Spijker, &Beekman, 2011). The American Psychiatric Association (2000) has established that the effect of depression affects students to a great extent, including psychologically and academically. Students with depressive symptoms may experience difficulty sleeping, changes in weight, and an increased likelihood of suicidal thoughts in addition to problems with academic learning.

2.2   Knowledge of Depression among University Students

Knowledge of depression varies widely among students though literature is scanty on this issue. Jorm, Korten, and Jacomb (1997) in a study established that 39% (n = 1010) of Australians aged 18–74 had knowledge about depression. Jorm (2011) in another study carried out among 1016 Australians aged 15 and older discovered that 73.7% of the students know what depression is. Marcus and Westra (2012) in a study revealed that 80% of students aged 18-24 have knowledge about depression and 79% of young adults aged 25-64 also have knowledge about depression.

Mental health literacy (MHL) was studied in some Asian countries showing a lower percentage of respondents who knew about depression. Wang, Yanling, Qing, Jun, Weiling, Qingzhi, Juming, Xuejun, Jianxin and Qian (2013) in a study revealed that 34.6% (n = 1.953) of Shanghai residents are knowledgeable about depression. Another study among a multiracial population in Singapore revealed that 55.2% of this population (including

Chinese, Malay, Indian and others) were knowledgeable about depression (Chong, Abdin, Picco, Pang, Jeyagurunathan, Vaingankar, Kwok and Subramaniam, 2016).

Coles and Gibb (2016) in a study discovered that 40% of high school students aged 14–19 (n = 1104) in New York, USA were knowledgeable about symptoms of depression. A study in UK carried out by Klineberg, Biddle, Donovan and Gunnell (2011)showed that among 1125 young people aged 16–24, only 41.8% knew about depression. 74% of higher education students in Australia were knowledgeable about depression (Reavley, McCann and Jorm, 2012). Sayarifard, Ghadirian, Mohit, Eftekhar, Badpa and Rajabi (2015) carried out a study among 324 medical sciences students in Iran and the findings showed only 35.6% of the participants know about depression. Another study carried out by Amarasuriya, Jorm and Reavley (2015) among 4671 undergraduates revealed that only 17.4% of the respondents were knowledgeable about depression.

2.3   Artificial Intelligence

The ability to reason from collected knowledge to solve complex problems is generally considered intelligence. Artificial intelligence is the study and developments of intelligent machines and software that can reason, learn, gather knowledge, communicate, manipulate and perceive the objects. The term was coined by John McCarthy coined the term in 1956 as branch of computer science concerned with making computers behave like humans (Avneet, 2015). Artificial intelligence is also the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making and translation between languages (Dictionary.com). AI technologies have matured to the point in offering real practical benefits in many of their applications. Major Artificial Intelligence areas are Expert Systems, Natural Language Processing, Speech Understanding, Robotics and Sensory Systems, Computer Vision and Scene Recognition, Intelligent Computer- Aided Instruction, Neural Computing. From these Expert System is a rapidly growing technology which is having a huge impact on various fields of life. The various techniques applied in artificial intelligence are Neural Network, Fuzzy Logic, Evolutionary Computing, and Hybrid Artificial Intelligence (Avneet, 2015).

Artificial Intelligence has quite a diverse area. Some of the areas of AI include;

- Language understanding:AI has the ability to *understand* and respond to the natural language. To translate from spoken language to a written form and to translate from

24

one natural language to another natural language. Under this area is where we have (a) Speech Understanding (b) Semantic Information Processing (Computational Linguistics) (c) Question Answering (d) Information Retrieval (e) Language Translation.

- Learning and adaptive systems**:**The ability of AI to adapt to certain behaviours based on previous experience gotten from previous exposure, and to develop general rules concerning the world based on such experience. Under this area is (a) Cybernetics (b) Concept Formation.

- Problem solving**:** AI has theability to know when new information is needed and how to obtain it, the ability to formulate a problem in a suitable representation, and to plan for its solution. In this are there is the (a) Inference (Resolution-Based Theorem Proving, Plausible Inference and Inductive Inference), (b) Interactive Problem Solving, (c) Automatic Program Writing, and (c) Heuristic Search.

- Perception (visual):The ability of an artificial intelligence to analyse a sensed scene by relating it to an internal model which represents the perceiving organism's "knowledge of the world." The result of this analysis is a structured set of relationships between entities in the scene. In this area we have (a) Pattern Recognition (b) Scene Analysis

- Modelling**:**The ability of an artificial intelligence to develop an internal representation and set of transformation rules which can be used to predict the behaviour and relationship between some set of real-world objects or entities. (a) The Representation Problem for Problem Solving Systems (b) Modelling Natural Systems (Economic, Sociological, Ecological, Biological etc.) (c) Hobot World Modelling (Perceptual and Functional Representations)

- Robots**:**A combination of most or all of the above abilities with the ability to move over terrain and manipulate objects. (a) Exploration (b) Transportation/Navigation (c)Industrial Automation (e.g., Process Control, Assembly Tasks, Executive Tasks) (d) Security (e) Other (Agriculture, Fishing, Mining, Sanitation, Construction, etc.) (f) Military (g) Household

- Games**:**The ability to accept a formal set of rules for games such as Chess, Go, Kalah, Checkers, etc., and to translate these rules into a representation or structure which allows problem-solving and learning abilities to be used in reaching an adequate level

of performance. This area is used for intelligent games (Chess, Go, Bridge, etc.) that would usually require deep human thinking. (Avneet, 2015).

A variety of machine learning algorithms, including Support Vector Machine, Maximum Likelihood, Neural Network, k-Nearest Neighbour, decision trees, Bayesian networks etc. have been developed (Das, *et al.* 2015). Deep learning is part of a broader family of machine learning methods based on learning data representation as opposed to task specific algorithms (Le Cun, *et al* 2015). Algorithms like machine learning, deep learning etc. drive these computer 'thoughts' by providing a conceptual framework for processing input and making decisions based on the data (One Hundred Year Study on Artificial Intelligence(Stanford University, 2016).

2.4   Use of Artificial Intelligence in Health

The use of Artificial Intelligence (AI) has been on the rise in everyday lives spanning a broad variety of uses ranging from personal assistants, purchase reference and prediction, smart homes and cars, fraud detection, online customer support, 2health and even assisting personal relationships. This rising use of artificial intelligence is facilitated by the use of machine learning, computer modelling, and algorithmic creation enabled by ever bigger data sets combined with ever more capable technological capabilities driven by Moore's Law (Schaller, 1995) and Metcalfe's Law (Hendler and Golbeck, 2008).

Artificial Intelligence has the potential to advance the healthcare sector and it is also expected to affect various fields of medicine substantially (Topol, 2019). Medical students currently in school are likely to use artificial intelligence tools later in their career when they begin practice, and hence should be able to resolve any anxiety, confusion and questions that patients and the public may have about the application of artificial intelligence to medicine. They are also responsible for ensuring that artificial intelligence becomes a technology beneficial for patient care (Park, Kyung-Hyun, Kim, Park and Lim, 2019). Study by Rathi, Dishant, Rathi and Suresh (2019) revealed that out of 78 people surveyed, only 6 (7.69%), had knowledge about artificial intelligence, while about 62% had knowledge about the emergence of artificial intelligence in the field of medicine and healthcare.

2.5   AI & Healthcare

Theoretically, the application of AI can be extended to almost every aspect of healthcare. In fact, in the recent years the use of AI has seen an exponential increase in clinical environments (Diprose&Buist 2016). Modern medicine has faced significant challenge in the aspect of acquiring, analysing,

and the application of data to treat or/and manage diseases. AI systems are absolutely convenient to use instead at this time. Medical AI is mainly concerned with the development of AI programs that help with the prediction, diagnosis and treatment or management of diseases (Sandeep Reddy, 2018). $2.7 billion was raised between 2011 and 2017 by 121 health AI and machine learning companies; Rock health, a leading venture capital firm reported (Upendra, Rupa, 2018). Over the years robotics has been demonstrated to have the capabilities to assist the surgeons in complicated surgeries (Kanevsky*et al.,* 2016; Maeso*et al.,* 2010; Ishikawa *et al.,* 2007). When Robodoc, developed and demonstrated their robotic systems for orthopaedic surgeries i.e. hip and knee replacements, it was an over joyed moment. Since then use of robotics in various surgeries has been exploded. The Da Vinci robotic system provides a three-dimensional view, hand-tremor filtering, fine dexterity and motion scaling, and is suitable for narrow, inaccessible operative areas. The da Vinci system, developed by Intuitive Surgical for minimally invasive heart bypass surgery became a success story which later extended to other procedures including prostate cancer (Ishikawa *et al.,* 2007). In personalised medicine, AI has proved to be great support to the medical professionals in the clinics. Asides from its capabilities to analyse scientific literatures, create patterns to predict the diagnosis, it saves the health and medical professionals an ample amount of time and makes them better at their job by suggesting the most effective way to treat patients; ParieGarg and Sam Slick reported in October, 2018 for Harvard Business Review under its technology column. Technological advancement has allowed us to build the modern medical equipment by integrating AI technology, which helped us in clinical decision support, patient monitoring and coaching, automated devices to assist in surgery or patient care, and management of healthcare systems etc (Thompson, Parthasarathy, 2006).

Over the years robotics has been demonstrated to have the capabilities to assist the surgeons in complicated surgeries (Kanevsky*et al.,* 2016; Maeso*et al.,* 2010; Ishikawa *et al.,* 2007). It was ecstasy when*Robodoc*, developed and demonstrated their robotic systems for orthopaedic surgeries, hip and knee replacements. Ever since then, use of robotics in various surgeries has grown exponentially. Another is the Da Vinci robotic system which provides a three-dimensional view, hand-tremor filtering, fine dexterity and motion scaling, and is suitable for narrow, inaccessible operative areas. The Da Vinci system, developed by Intuitive Surgical for minimally invasive heart bypass surgery became a success story which later extended to other procedures including prostate cancer (Ishikawa *et al.,* 2007). It is now in its fourth generation and now considered to be the standard of care in multiple laparoscopic procedures.

It is the most common surgical robot and various modifications have been made for utilization in different types of surgeries including prostate, gynaecologic and cardiothoracic cases, Orthopaedic, gall bladder, hernia surgery, cancer and colon etc. This platform is considered as a revolution not because it is widely used in various procedures, rather serves as a data platform for studying the process of surgery (Kanevsky*et al.,* 2016; Maeso*et al.,* 2010; Ishikawa *et al.,* 2007). Robots also have shown great potential to facilitate other therapies including autism. Rudovic et al recently showed the efficacy of a personalized machine learning (ML) robot for autism therapy (Rudovic, *et al.,* 2018). AI has also been well integrated in to other areas of clinical practice. For example using "TeleLanguage" clinicians are now conducting multiple therapy sessions in multiple location simultaneously. The mobile computing revolution has galvanized the application of AI in many other areas of health care including in Geriatrics, Psychiatrics and Neurology. For example; psychiatrists now use AI programs to detect early signs of distressful behaviour in patients. This application collects data from a patient's smartphone and analyse their behavioural patterns and predicts and alerts the clinicians about their patients. Now there are at least couple of thousands mobile applications used in different areas of healthcare. Collecting biometrics from motion tracking devices (wearable devices) are widely used across the globe. AI has also been proved to play a major role in analysis of big data sets in genomics, which is important in drug discovery (Pastur, *et al.,* 2016). Moreover, advanced medical care for diseases like various cancers is heavily dependent on genotype-phenotype connections. After the completion of human genome sequencing project, the genome sequencing is becoming routine for each and every patient. It is merely impossible for humans to analyse the data quickly and comprehensively without the help of computers. Thereforeintegration of AI in these computers will enable them to analyse these data sets quickly and comprehensively and predict clinical conditions (Pastur, *et al.,* 2016). More importantly, as computers don't forget what they have learned and they don't have inherent biases, they are more likely to produce objective diagnoses which is key in advanced medical care (Dilsizian, Siegel, 2014).

The recent AI platform has also taken a big stride in healthcare research. For example; platform developed by Atomwise can predict, whether a particular drug will work or not (Upendra, Rupa, 2018). Similarly; Recursion Pharmaceuticals build a proprietary drug discovery platform that complements well with the high-throughput biology. Using their platform novel drugs can be identified for rare genetic diseases (Upendra, Rupa, 2018). Deep Genomics has developed the technology to predict the effects of a particular mutation in the

28

body based on its analyses of hundreds of thousands other mutations. Turbine has used AI to model cell biology to design personalized treatments for any cancer type or patient faster than any traditional healthcare service. As a result, the technology is already used in collaborations with Bayer, the University of Cambridge and top Hungarian research groups to find new cancer cures, speed up the time to market, and save the lives of patients suffering from currently incurable forms of the lethal disease (Zweig M). Another small company i.e. Zephyr Health uses machine learning to help life science companies to improve research and reduce the time it takes to bring their therapies to market (Zweig M). In recent years, Microsoft is also actively engaged to apply advanced machine learning algorithms to the mysteries of human biology (Rudovic, *et al.,* 2018).

2.6   AI & Mental Health

Researchers from Lawson Health Research Institute in Ontario, Canada and The Mind Research Network in Albuquerque, New Mexico developed a new artificial intelligence (AI) algorithm that could help predict whether a patient will successfully respond to medication for a mood disorder (Health Imaging, August 08, 2018). The AI algorithm can analyse brain scans to better classify mood disorders and predict medication in patients. This AI algorithm classified mood disorders with 92.4% accuracy, according to the researchers. Tristan Green wrote in an article for TNW in August, 2017; she explained that part of the problem is the stigma attached to seeking help for emotional problems. We need to address these issues seriously, we need a way of bringing inexpensive on-demand therapy to people and not making them seek help. So far since 2017, there has been an increase in the collaboration of AI and mental health. This can be seen by the continually increase in AI start-up companies that have picked up interest in solving aspects of mental health issues. An example of this start-up is Mindstrong. The aim of Mindstrong is to turn our smartphones into an emotional diagnostics device. The founders believe that people need a personal way to measure their mental health. The idea is to monitor the way our devices are used since we use our devices differently when we are upset and when we are just hanging out.

ParieGarg and Sam Slick reported in October 22, 2018 for Harvard Business Review under its technology column *'' In a crisis that has become progressively dire over the past decade, digital solutions – many with artificial intelligence (AI) at their core – offer hope for reversing the decline in our mental wellness. New tools are being developed by tech companies and universities with potent diagnostic and treatment capabilities that can be used to serve large populations at reasonable cost*'' The article further explained that there is a

shortfall in psychiatrists and other mental health specialists. This was also highlighted earlier with the ratio of patient to psychiatrists in Nigeria. The article explains that those who are fortunate enough to live in areas with sufficient access to mental health services often can't afford them because therapists don't accept insurance. The article further discussed how AI solutions makes humans better even at their most basic level by helping psychiatrists and other mental health professionals do their jobs better. They collect and analyse reams of data much more quickly than humans and could then suggest effective ways to treat patients.

A typical example is the Ginger.io's virtual mental services which includes a video and text based therapy and coaching sessions. Through analysing past assessment and real-time data collected using mobile devices the app can help specialists track patients' progress, identify times of crisis, and develop individualized care plans. In a year-long survey of Ginger.io users, 72% reported significant improvements in symptoms of depression. They also help anticipate problems by supplementing mental health issues using machine-learning tools, which automatically expand their capabilities based on experience and new data. An example of this is Quartet health, which screens patient medical histories and behavioural patterns to uncover undiagnosed mental health problems. Quartet can flag possible anxiety based on whether someone has been repeatedly tested for a non-existent cardiac problem. It can also recommend pre-emptive follow-up in cases where patients may become depressed or anxious after receiving a bad diagnosis or treatment for a major physical illness. Quartet has reduced emergency room visits and hospitalizations by 15 to 25% for some of its users.

Another example is Woebot a Chatbot developed by clinical psychologists at Stanford University in 2017. It treats depression and anxiety using a digital version of the 40-year-old technique of cognitive behavioural therapy – a highly structured talk psychotherapy that seeks to alter a patient's negative thought patterns in a limited number of sessions. In a study of students suffering from depression, those using Woebot experienced close to 20% improvement in just two weeks, based on PHQ-9 scores – a common measure of depression. One reason for Woebot's success with the study group was the high level of participant engagement. At a low cost of $39 per month, most were talking to the bot nearly every day – a level of engagement that simply does not occur with in-person counselling.

Woebot launched in the summer of 2017 and is referred to as an automated conversational agent. It is designed to offer convenient care to those struggling with depression. As listed on the company's website, Woebot offers the following features

- Tracks your mood
- Gives you insight
- Teaches you stuff
- Helps you feel better
- Be there 24/7
- Learn from you over time.

Wysa is described on the company's website as an artificial intelligence-based ''emotionally intelligent'' bot that is able to help you manage your emotions and thoughts. Just like Woebot, Wysa is designed with influences from CBT to help you challenge and change unhelpful thoughts and behaviours. In addition to CBT, Wysa incorporates addition influence from dialectical behavioural therapy (DBT), meditation practices, and motivational interviewing. As with other AI-based programmes, Wysa continues to collect data as you chat in order to more accurately read and meet your mental health needs.

Tess is another artificial intelligence platform used for mental health care, Tess is described as a ''Psychological AI that administers highly personalized psycho-education and health-related reminders on demand''. Tess is used through text-based messaging conversation, like the others. The programme can be accessed through Facebook Messenger, texting, web browsers, and other platforms convenient for the user.

2.7   Perception of the Use of Artificial Intelligence in Health

Since science and technology has developed and observed the advancement in the ability of machines using artificial intelligence to understand and manipulate data using algorithms, many fields, especially the medicine and healthcare would in no doubt benefit from deep learning, an aspect of artificial intelligence that uses neural networks and data (Miller & Brown, 2018). Currently, people perceive that artificial intelligence is able to offer concrete and ingenious applications that have gradually become intertwined within our daily lives. We can cite the example of targeted advertisements on the Internet, the proposition of films and series which should please us by Netflix according to what we have seen before, the identification of credit-card fraud on the Internet, mobile applications that connect patients to doctors virtually, etc. These applications have already proven their efficiency in various areas, leading to growing fascination among the public. Thus, many countries, such as the United States and China, have invested rapidly in these techniques (Diebolt, Azancot and Boissel, 2018; Pauwels and Vidyarthi, 2015).

31

Another perception is that artificial intelligence appears to have already briskly inserted itself everywhere into patient healthcare, starting a few years ago. It could be argued that this may just be the result of a mere trend. However, it appears that the will to develop its application within the healthcare system is still very strong (Miller & Brown, 2018; Topol, 2019; Bibault, Giraud, Housset, Durdux, Taieb, & Berger, 2018; Erlich, Shor, Pe'er and Carmi, 2018). For example, the journal Nature published an article in 2017 in which machine learning (an artificial intelligence technique) was able to diagnose skin cancer as efficiently as dermatologists (Esteva, Kuprel, Novoa, Ko, Swetter, Blau, 2017). In 2018, another scientific article claimed that AI was even able to do it better than dermatologists (Haenssle, Fink, Schneiderbauer, Toberer, Buhl and Blum, 2018). In addition, the FDA (Food and Drug Administration) in the USA authorized the first artificial intelligence device to diagnose diabetic retinopathy without a physician's help in April 2018 (Reuters, 2019).

In a study by de Saint-Laurent (2018), majority of the respondents perceived that artificial intelligence may not provide enough security and privacy to health data, and thus established that there is a need to find a balance between access to data and their protection. Majority of respondents in study by Lai, Brian and Mamzer (2020) believed that artificial intelligence tools could have an impact on the organization of the healthcare system, as they are not intended to be developed only in the care setting, and could also enable the public take advantage of these tools (e.g. self-screening). The participants also believed that artificial intelligence has the capacity to bring positive benefits to patients, revolutionize healthcare and bring breakthroughs. The participants perceived artificial intelligence tools developed by industrialists as those with the capacity to be able to save time for the doctor, carry out watchful and alert work, better monitor the population, alleviate some deficiencies related to medical deserts, and even improve management difficulties in the healthcare sector (especially at the hospital). Artificial intelligence could therefore be a means to enter an era of more effective medicine, improving care and reducing costs, while increasing patient safety (Lai, Brian and Mamzer, 2020).

Currently, health care systems in many countries are beginning to rely on storage of patient data to provide better health care services. Due to the growing technological developments, health care information technology solutions provide the capacity to store enormous volumes of patient data; however, appropriate utilization of this data is essential to enhance health care quality, improve decision making, and reduce costs (Lovis, 2019; van Hartskamp, Consoli, Verhaegh, Petkovic and van de Stolpe, 2019). People believe that artificial intelligence has

provided significant advancements in this regard over the past decade (Yu, Beam and Kohane, 2018).

Artificial intelligence technologies were developed to offer practical benefits in different areas including health care applications (Pannu, 2015; Wu, Chan, Zhang and Ming, 2019). A common feature of artificial intelligence is the reproduction of human intellectual functions. From the health care perspective, artificial intelligence brings a "paradigm shift to health care, powered by increasing availability of health care data and rapid progress of analytics techniques" (Jiang, Jiang, Zhi, Dong, Li and Ma, 2017). Regardless of its promise, health sector employees have mixed perceptions regarding the implementation of artificial intelligence technologies (Fan, Liu, Zhu, &Pardalos, 2018; Oh, Kim, Choi, Lee, Hong and Kwon, 2019).

In a study by Sarwar, Dent, Faust, Richer, Djuric and Ommeren (2019) to explore perspectives of artificial intelligence implementation in clinical practice among medical respondents, it was revealed that majority of the respondents had generally positive attitudes toward artificial intelligence, with approximately 75% of them reporting excitement or interest in artificial intelligence as a diagnostic tool for improving quality and efficiency in healthcare. Similarly, study by Alamanova (2018) investigated the perceptions of artificial intelligence among human resource (HR) professionals in the fields of leadership, consultancy, and recruitment. The results showed that HR professionals have different feelings about artificial intelligence than they do about other new technologies, as they were excited about reducing manual workloads while remaining cautious about adding excessive functionality to computing machines.

Maskara, Bhootra, Thakkar and Nishkalank (2017) in a study investigated current and future applications of artificial intelligence as well as employee acceptance of artificial intelligence in the medical field. The findings revealed that most respondents were aware of artificial intelligence interventions in use in their field and some were already harnessing artificial intelligence themselves; however, while doctors were aware of the advantages of artificial intelligence, they also perceived disadvantages in the high cost and lack of human touch. This corresponds in study by Oh, Kim, Choi, Lee, Hong and Kwon (2019) as they explored the awareness of artificial intelligence among doctors and assessed their attitudes toward medical artificial intelligence applications. The study revealed that doctors have positive attitudes

toward artificial intelligence implementation in the medical field. Majority of the surveyed physicians assumed that their roles will not be replaced by artificial intelligence.

Study by Sit, Srinivasan and Amlani (2020) among Canadian medical students revealed that the majority of the students were less likely to consider radiology as a career due to fear of replacement by artificial intelligence, while a minority of German students believed that artificial intelligence would replace radiologists. 88% of students believed that artificial intelligence will play an important role in healthcare, and 49% reported they were less likely to consider a career in radiology due to artificial intelligence. 89% of students believed that teaching in artificial intelligence would be beneficial for their careers, and 78% agreed that students should be trained on how to use artificial intelligence tools as part of their medical degree. Only 45 students received any teaching on artificial intelligence; none of the students received such teaching as part of their compulsory curriculum. Statistically, the study showed that students that did receive teaching in artificial intelligence were more likely to consider radiology (p = 0.01) and rated more positively to the questions relating to the perceived competence in the post-graduation use of artificial intelligence (p = 0.01–0.04); despite this, majority of students who have been taught artificial intelligence reported a lack of confidence and understanding required for the necessary use of healthcare artificial intelligence tools (Sit, Srinivasan and Amlani, 2020).

A significant proportion of students believed that taking courses on how to use artificial intelligence tools would be beneficial for their careers with 88.8% of students responding either strongly agree (35.1%) or agree (53.7%); 9.7% of the students were neutral about learning how to use artificial intelligence and its benefit to their careers. 1.2% of students disagreed with this statement. Along this line of questioning, majority of the students (78.1%) also agreed with the statement that all medical students should take courses on how to use artificial intelligence tools as part of their medical degree; 28.1% and 50% of students selected strongly agree and agree, respectively. Neutral responses were recorded by 16.1% of students, and only 5.6% of students responded negatively when asked if all students should take courses on how to use artificial intelligence tools. While majority of students reported that they would not feel ready to work with artificial intelligence tools by the end of their degree, only 10.4% of students agreed that they would be confident in using artificial intelligence tools if required, and the same number of students agreed that they would possess a basic understanding in the methods used to assess artificial intelligence performance. 11.3%

of students felt they would possess the knowledge needed to work with artificial intelligence in routine clinical practice (Sit, Srinivasan and Amlani, 2020).

2.9   Theoretical and Conceptual Framework

The health belief model is selected as the most appropriate model for this study. The Health Belief Model (HBM) is a model at the individual level that has been used to explain change, predict and maintenance of health related behaviour. It will be used as a guiding framework for health education work, especially during any health behaviour interventions.

The health belief model has four major concepts. It assumes that people will take action to prevent or to control ill-health if they regard themselves as being susceptible to the condition (perceived susceptibility). They will take action if they believe that the condition will have potential serious consequences for them (perceived severity). They will take action if they perceive that the effectiveness of various actions available to reduce will the threat of illness or disease (or to cure illness or disease) (perceived benefits). They also need to believe that the anticipated barrier to taking to action are outweighed by its benefits (perceived barriers). Cue to action talks about the stimulus needed to trigger the decision-making process to accept a recommended health action. These cues can be internal or external. Finally, self-efficacylooks at the level of a person's confidence in his/her ability to successfully perform a behaviour. This construct was added to the model in mid 1980s and it can be used to provide training and guidance in taking action, reduce anxiety, demonstrate desired behaviours, use progressive goal setting, and give verbal reinforcement.

Individual perceptions	Modifying factors	Likelihood of action

Perceived Benefits
Prevention of depression,
self-diagnosis of
depression, confidentiality
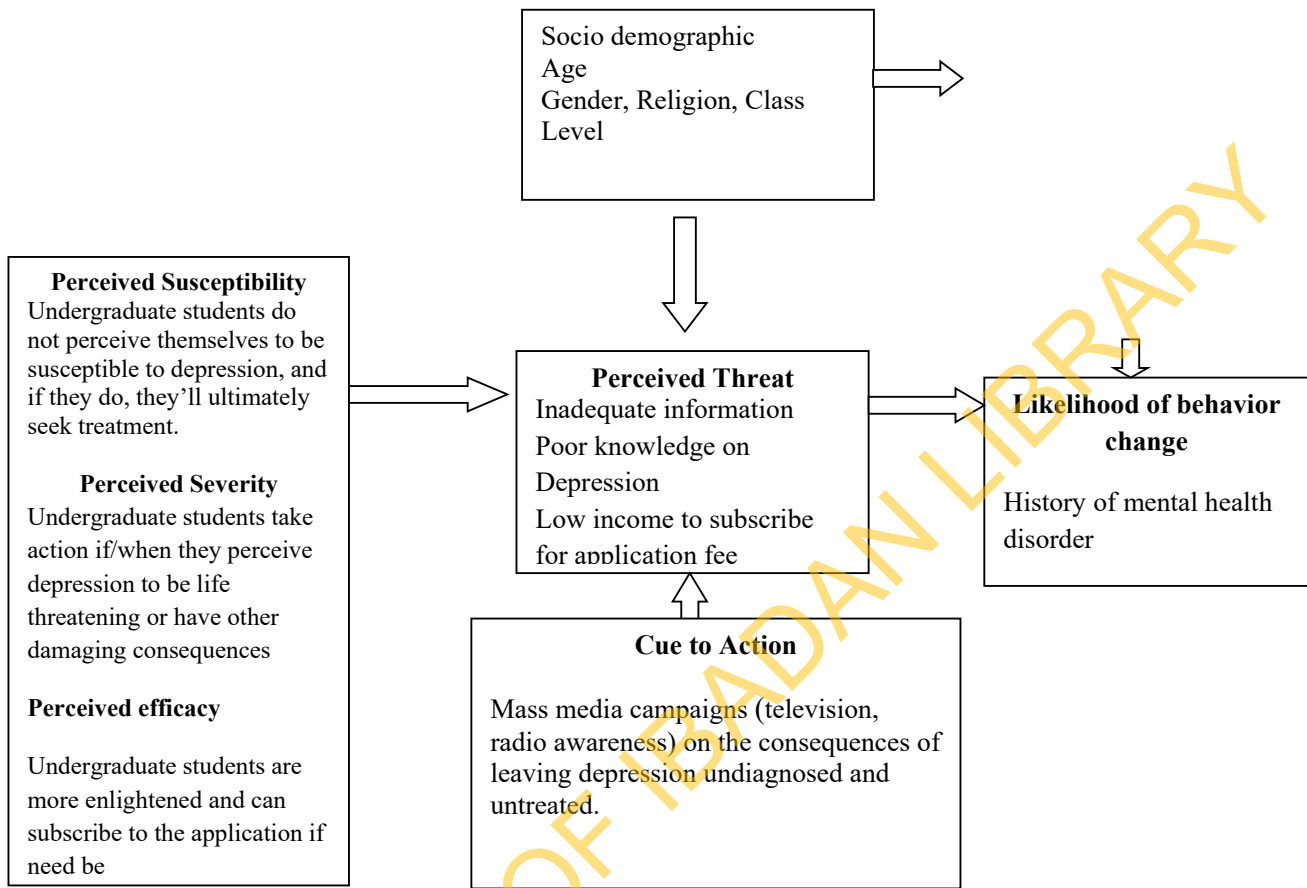
Figure 2.0: Health Belief Model as applied to the study

CHAPTER THREE

METHODOLOGY

3.1 Study Design

The study is cross-sectional survey in design,and used to assess the perception of undergraduate students about the feasibility of using artificial intelligence to self-diagnose and manage depression, in the University of Ibadan, Oyo state. The study utilised mix-methods comprising qualitative and quantitative research method.

3.2 Study Area

The area selected for this study is University of Ibadan, Ibadan, Oyo state. The institution occupies over 1,032 hectares of land and is located in Ibadan North Local Government Area. The University was originally established in 1948 on the 17th day of November as an external college of the University of London. It was then called the University of Ibadan in 1962 with just a little over 2000 students (University of Ibadan, 2002).

Faculties of Arts; Law; Basic Medical Sciences; Clinical Sciences; Pharmacy; Public Health; Dentistry; Veterinary Medicine; Technology; Agricultural Sciences; and the Social sciences make up the 13 faculties the institution has. There are 12 halls of residence within the institution, although majority housing the undergraduate students, they also accommodate the post graduate students too. Students generally experienced depressive symptoms, sometimes resulting from the dissolution of a romantic relationship, and they sometimes seek help from peers.

3.3 Study Population

The respondents of the survey were undergraduate students of the University of Ibadan, Oyo state.

3.4 Eligibility/Inclusion

For the purpose of this study, respondents suitable for this study will be undergraduates of the University of Ibadan, Oyo state. Respondents in all levels (100-600) were considered for the study.

3.5 Exclusion Criteria

Undergraduates eligible but not willing to participate in the study were excluded from the study.

3.6 Determination of Sample Size

The Leslie Kish's formula was used to calculate the sample size for this study.

$$n = \frac{z^2 \times (P \times 1 - P)}{d^2}$$

$$N= \frac{Z^2pq}{d^2}$$

N= Minimum sample size

Z= Standard normal deviation set at 1.96 normal interval

p= Proportion estimated to be obtained in the target population {prevalence of depression among university students found that reported prevalence rates ranged from 10% to 85%, with a weighted mean prevalence of 29.3% (Ibrahim, Kelly, Adams, &Glazebrook, 2013).

q= Proportions that does not have the characteristics being investigated

$\qquad$ (q=1-p) q= 1 – 0.293= 0.707

d= Degree of accuracy set at 0.05 (precision set at 5% significant)

Therefore, the sample size N= $\frac{(1.96)^2 \times 0.293 \times 0.707}{0.05^2}$

$\qquad$ N= $\frac{0.79579}{0.0025}$

$\qquad$ N= 318

A non-response rate of 10% of 318 = 32

Hence, 33 was added to the sample size calculated to make the sample size 350 in order to address loss or incompleteness of questionnaire.

3.7 Sampling Technique

The calculated sample size for the study is 350 undergraduate students.

Multi-stage sampling technique was employed for the selection of undergraduate students.

Stage 1: A record review was conducted in the institution to determine the total number of faculties in the University of Ibadan. All the faculties were selected.

Stage 2: A record review was conducted in the institution to determine the total population of undergraduates in each faculty, and the total population of males and females in each faculty at the University of Ibadan.

Stage 3: A record review was conducted in the institution to determine the number of departments in each faculty, total population of undergraduates in each department from each faculty, the total number of undergraduates in each level and the total population of males and females in each department.

Stage 4: Proportionate random sampling technique was used to determine the percentage of respondents that would be selected from each department in each faculty to ensure equality of respondents selected across each level, department, and faculty.

38

3.8 Study Instrument

The study comprised both qualitative and quantitative research method.

Qualitative Method

The qualitative method this study employed was Focus Group Discussion (FGD). A Focus group discussion guide was constructed for this study. Focus group discussion was used because of the need to hear unrestricted views, the perception and take of the undergraduate students on the feasibility of using artificial intelligence to self-diagnose and manage depression, the possible development of the AI tool, the inputs they would like, and features that they will like to see added therein.

Quantitative method

The quantitative method involved the use of structured, self-administered questionnaire which will be divided into six sections to collect relevant information. Section A (Socio-Demographic Characteristics), followed by Section B (Level of knowledge of undergraduate students on depression), Section C (Level of knowledge of undergraduate students on Artificial Intelligence), Section D (Perception of undergraduate students on self-diagnosis of depression), Section E (Perception of undergraduate students on the use of Artificial Intelligence to self-diagnose and manage depression) and Section F (Level of knowledge of undergraduate students on existing use of Artificial Intelligence in depression diagnosis and management).

3.9 Validity and Pre-Testing of Research Instrument

To establish validity of the study instruments, appropriate literatures were reviewed to acquire knowledge and concepts needed to develop the questionnaire. The questionnaires were cross-checked to ensure completeness and proper recording of the data. The questionnaires were then pretested among respondents with similar characteristics at Federal University of Agriculture Abeokuta (FUNAAB) to test for its validity. The research instrument was administered by the investigator and the trained assistants.

3.10 Reliability of Instrument

To ensure reliability, the instrument was pre-tested on 10% of the total sample size. This figure amounts to 32 of the students of the Federal University of Agriculture Abeokuta

(FUNAAB). This population was chosen because of the similar characteristics inherent in the target population.

Data was checked for completeness, sorted and cleaned and a coding guide developed and used to facilitate the entry of the data into the computer. Subsequently, the data was analysed using descriptive statistics. The data was then subjected to Cronbach alpha statistical test. Cronbach alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. In this test, a result showing a correlation coefficient greater than 0.70 is said to be reliable and the closer the value of the reliability test to 1, the more reliable is the instrument. A co-efficient of 0.7-1.0 was obtained

3.11   Data Collection Procedure
Questionnaire

Sequentially numbered self-administered questionnaire were employed to recover data for this study. The data was collected by the investigator and research assistants who were trained and ready prior to the time of data collection. The possible challenges that may have ensued during the course of the study were explained to the research participants. Permission to conduct the study was sought from the management. The investigators guided the participants through on how to fill the questionnaires.Regular supervision was made by the data collection supervisor to ensure that all necessary data were properly collected After the questionnaires were filled, the principal investigator checked for completeness and errors before leaving the field.

Focus Group Discussion

Respondents were consented for a session of focus group discussion, which were recorded on audio tapes. FGD sessions were conducted in after selecting a preferred time and locations, the sessions captured different groups. The sessions were conducted at a convenient time for participants. The data was obtained using an audio recorder and, notes taken during the discussions and sessions

3.12   Data Management, Analysis and Presentation
The questionnaires were assigned serial numbers to foster easy entry and recall. A coding guide was constructed along with the data collection tool in order to facilitate the data analysis. Cleaning, recording and coding of data for analysis were carried out. The data collected was entered into the statistical software and analysed using descriptive statistics and

inferential statistics such as Chi-square. The results obtained from the Statistical Package for Social Science (SPSS) version 20, are summarized and presented in tables and charts. The knowledge of the participants regarding AI was assessed based on a 6-point scale categorized as poor (0-3) and good (>3-6), while the knowledge of participants regarding depression was assessed based on an 11-point scale categorized as poor (0-5) and good (>5-11). The perception of the participants regarding the use of AI to self-diagnose and manage depression was done on a 6-point scale categorized as poor (0-3) and good (>3-6).

All recorded data from the FGDswere played again to ensure that it was well saved. The data collected was transferred from the audiotape recorder to the computer system for better audio presentation. The audio tape was played and replayed several times for clarity after which full verbatim transcription was done. After the transcription, the researcher typeset and read it to get familiar with the data by reading through the entire transcripts many times; to obtain a sense of totality; significant statements were underlined and extracted. Significant sentences that have similar opinions, as well as varying opinions of the participants, were labelled by the researcher. Different parts of the text that contained significant statements were marked with appropriate labels for further analysis. The manual qualitative thematic analysis method was used for the analysis of all transcribed interviews. Themes and categories were closely examined to identify common themes while subsequent information gathered were fitted into new categories. Each opinion was put in italics including the means of identification and for easy comprehension by the speaker.

3.13   Ethical Considerations

Ethical approval was obtained from the Ethical Review Committee of the University of Ibadan, before going to the field for data collection. Informed consent was obtained from each participant after explaining the purpose of the study to them. No names were recorded on the questionnaire to ensure confidentiality. Study participants had the right to decline or withdraw from the study at any point in time. They were also be assured that refusal to participate or withdrawal from the study would not attract any penalty.

Qualitative findings

Respondents' viewpoints on Artificial Intelligence

Viewpoints on Artificial Intelligence (AI) was assessed based on respondents' awareness of existence, ways it can improve health, use in mismanagement of depression and possibility of the use in Nigeria. Awareness of AI's existence was chorused among respondents, all of them claimed to have heard of AI, many of them could explain what AI correctly. Below are some of the views expressed by some of the discussants:

> *"Yes. What I know about artificial intelligence is basically using machine intelligence instead of human intelligence, like imputing into computers to help you solve problems."* (Discussant8)

> *"It's more like a robot"* (Interviwee4)

Benefits of AI were enthusiastically expressed by discussant:

> *"Yes. They are. For example, when you talked about Google maps… If you're in a place where you're finding it difficult to move around or you need direction, you could easily just use Google map to find your way and it does not even require lots of time. It's convenient"* (Discussant8)

Most discussant were able to explain AI adaptability to health, while highlight different existing AI tools already used in health care. Below are some of their views:

> *"For example, there is an app- period tracker, for females alone. Someone that can't keep track of their menstrual cycle, they use the app"* (Discussant2)

> *"what about those watches that can check bp and pulses?"* (Discussant5)

> *"and there's a medical app that can errm… input your… in case of emergency, can input your… maybe the person is diabetic of asthmatic or has any health issue, in case of emergency, there are some things that*

the doctor has to know to be able to help the person… That you can input
your health history to them" (Discussant7).

Two discussants claimed to have access to psychiatrists (Discussant3 and 4). More than half of the discussants admitted to have been depressed; however none of the discussants had confirmed diagnosis of depression. Some discussants expressed reasons for this:

"we don't have access to psychiatrists" (Discussant1)

"The thinking of "I'd get over it soon" (Discussant 6)

Discussing on the acceptability of a self-diagnosing AI tool for depression especially for students, the statement was met with positive responses, some discussant shared their reasons:

"even for people that are ashamed to talk with their friends."
(Discussant3)

"Exactly, instead of people using sniper" (Discussant1)

"Economically, humans need it, and to an extent it can work for at least
70% of what they will get and it will help in one way or the other."
(Discussant8)

Most discussant perceived the AI tool as a must have for students, reason were shared for this:

"it's a need because it's based on a variety of reasons and I'm very sure
it'll be cost effective when compared with other conventional methods"
(Discussant7)

"some are even depressed and don't know they're depressed."
(Discussant2)

"there are some people that are not depressed now but could be in
future… everybody needs the app." (Discussant5)

"and do you know that if the app is friendly enough to chat with, it can
even prevent depression. If you have someone to talk to…" (Discussant8)

43

The app interface was also explored, discussing the content and usability, different discussant shared their opinion on the AI assistant:

> *"one thing again, the app should have opening or starting questions like "do you want me- like your app, to be a female or a male?" I might want my AI to be a female, I'm a guy. Because I prefer talking to females, do you understand?"* (Discussant5)

> *"so like if the AI is a male, some people might not feel comfortable talking to it, like "why I go dey follow guy talk?" that kin thing (something like that). Do you get it?"* (Discussant6)

> *"so if the app can be like "do you want me to be a male or a female?" that's just the bomb."* (Discussant 2)

Discussing the content of the app, discussants had the following viewpoints:

> *"how to get in touch with other psychiatrists. Something that would make you want to talk."* (Discussant2)

> *"couple of games."* (Discussant1)

> *"depression questions"* (Discussant7)

> *"A few jokes"* (Discussant5)

> *"okay, so what I would like to see on the app is ... you know how we have care groups and all, there should be like an interactive session where you can talk to other depressed people... like a forum"* (Discussant8)

> *"and also, a part where you'd get extended education about depression"* (Discussant6)

Below are some of the barriers to the app usage made by discussants:

> *"people might not have access to internet and..."* (Discussant5)

> *"no smart phones"* (Discussant2)

When asked about the perceived effects of the AI tool, the effects it will have on depression and then sustainability? The discussants had the following to say:

> *"addiction… you could actually get too used to it and then find it hard to connect with other people. I understand that it has to be available all the time, but there should also be like a time lap…"* (Discussant4)

> *"that's where having a chat forum comes… if there's a forum in chats with other people, it won't totally disconnect you from other people."* (Discussant8)

> *"it will reduce the population of people depressed."* (Discussant1)

> *"and some people are not really depressed, they just need… they're just sad, lonely, that kind of thing… it gives you a companion…"* (Discussant5)

> *"and also increase people's knowledge on depression"* (Discussant3)

Quantitative Findings

4.1   Socio demographics

There were three hundred and fifty (350) respondents recruited for this study. The mean age of respondents was 20.6±2.4 Majority of the respondents were of Yoruba ethnicity (82%) compared to the Ibo (12%) and Hausa (2.3%). Christianity (78.3%) accounted for majority of respondents' religion with almost all (84%) identifying their families at average socio-economic level. The faculties of Education (20.9%), Arts (14.3%), Sciences (12%) and Social sciences (10%) had significantly higher proportion of the respondents and more than a third (40.9%) in the 200 level of higher education. The Android OS accounted for 89.1% of the phone ownership, WhatsApp (81.1%) was the most commonly used app by respondents, being used every day by most of the respondents (90.6%) (Tables 1a & 1b).

Table 4.1a: Socio-demographics characteristics

Variable	Frequency (N=350)	%
Sex		
Male	143	40.9
Female	207	59.1
Ethnicity		
Yoruba	287	82.0
Hausa	8	2.3
Ibo	42	12.0
Edo	9	2.6
Igbira	2	0.6
Efik	1	0.3
Religion		
Christian	274	78.3
Islam	75	21.4
Traditional	1	0.3
Socio-economic status of families		
Low	21	6.0
Average	294	84.0
High	35	10.0
Faculty		
Pharmacy	31	8.9
Education	73	20.9
Arts	50	14.3
Law	21	6.0
Sciences	42	12.0
Social sciences	35	10.0
Basic Medical Sciences	32	9.1
Public Health	10	2.9
Clinical sciences	12	3.4
Agric& Forestry	8	2.3
Technology	24	6.9
Engineering	12	3.4

Table 1b: Socio-demographics characteristics

Variable	Frequency (N=350)	%
Educational level		
100 Level	65	18.6
200 Level	143	40.9
300 Level	43	12.3
400 Level	51	14.6
500 Level	48	13.7
Type of phone		
Android	312	89.1
IOS	36	10.3
Windows	1	0.3
Most used Application		
WhatsApp	284	81.1
Instagram	12	3.4
Twitter	14	4.0
Linked in	1	0.3
Facebook	9	2.6
YouTube	1	0.3
Google	18	5.1
Bible	2	0.6
Any books	5	1.4
DSTV	2	0.6

47

4.2 Knowledge on Depression

There were two hundred and forty even (247) respondents (70.6%) who knew that depression is the state of sadness that extends over two weeks, more than half of the respondents (55.4%) did not know that depression is a general term for sadness. Almost all of the respondents (90.6%) knew that depression is a mental health condition while about two third (63.7%) had incorrect knowledge attributing depression as overthinking (Table 2). Sadness (41.9%), Isolation (30.4%), Withdrawal from social activities (29.8%), mood swing (26%), loss of interest in activities (25.7%) and overthinking (17.1%) were the most common symptoms identified by respondents for depression (Table 3).

Loss of loved one (26.2%), poverty (23.2%), Heartbreak (23.8%), failure (32.9%), financial crisis (17.1%) and family crisis or issues (15%) were the prominent causes of depression mentioned by respondents (Table 4).

Overall, respondents' knowledge score was 8.8±0.8 from a possible score of 11 points, indicating a high level of knowledge exhibited by respondents with almost all (99.1%) having good knowledge of depression.

Table 2: Knowledge of depression

What is Depression?	Yes (%)	No (%)
Depression is the state of sadness that extends over two weeks	247 (70.6)*	100 (28.6)
Depression is a general term for sadness	149 (42.6)	194 (55.4)*
Depression is a mental health condition	317 (90.6)*	30 (8.6)
Depression is overthinking	223 (63.7)*	120 (34.3)

* *correct responses*

49

Table 3: list of symptoms of depression

Symptoms	Responses	Percent of Cases
Mood swing	88	26.0
lost in thought	40	11.8
Sadness	142	41.9
Withdrawal from people and social activities	101	29.8
Suicidal thoughts or attempts	45	13.3
Unstable state of mind	42	12.4
weight loss	33	9.7
Isolation of oneself	103	30.4
Insomnia	32	9.4
Frequent sleep	16	4.7
Paranoia	7	2.1
Feeling of emptiness or hopelessness	17	5.0
Loss of interest in activities	87	25.7
Loss of appetite	42	12.4
excessive crying	17	5.0
Excessive eating	14	4.1
Overthinking	58	17.1
Pessimism	14	4.1
Fatigue	34	10.0

High blood pressure	4	1.2
Overreaction	10	2.9
Lack of concentration	2	0.6

* *Multiple choices*

Table 4: list of causes of depression

Causes	Responses	Percent of Cases
relationship status	17	5.0
Loss of a job	30	8.8
low self esteem	36	10.6
inferiority complex	18	5.3
Financial crisis	58	17.1
Loss of a loved one	89	26.2
Overthinking	46	13.5
Poverty	79	23.2
Heartbreak	81	23.8
Difficulty or bad experiences	5	1.5
Poor standard of living	18	5.3
Low or bad grades	1	0.3
Emotional or psychological trauma	35	10.3
Loneliness	19	5.6
Poor health condition	16	4.7
Failure	112	32.9
Conflict	2	0.6
Abuse	18	5.3
Unemployment	3	0.9
Family crisis or issues	51	15.0
Poor Academic performances	23	6.8
Sexual life problems	1	0.3
Stigmatization	14	4.1
unmet needs	15	4.4
Victimization	3	0.9
Stress	16	4.7
Sickness	9	2.6
Disappointment	37	10.9
Spiritual Attack	1	0.3
Body size	2	0.6
Pressure	23	6.8

Unexpected negative events	30	8.8
Genetics	17	5.0
Certain medications	22	6.5
Trauma	10	2.9

* *Multiple choices*

4.3   Prevalence of depression

More than half of the respondents (59.4%) said they are not at risk of depression while 52% confirmed to have been depressed while in the institution (Fig. 1). In respect of self-diagnosis of depression, more than half of the respondents (51.9%) rated their level of depression as mild, compared to 2.1% who rated as severe (Fig 2).

There were 20 (5.7%) respondents who were previously diagnosed for depression, 8 (36.4%) were diagnosed by a mental health professional while 11 were diagnosed by other health professional instead. It took an average of 3 days for diagnosis to be done and result obtained across the 20 respondents. Treatment was obtained by 14 (63.6%) respondents with 6 respondents (27.3%) choosing their treatment type. Advice (50%) was the most received form of treatment for respondents.

Poor access to professional mental health therapist (60.5%) was found to be a significant barrier to getting diagnosis, followed by unavailability of mental health professional (50.3%) and stigmatization (50%) (Fig 3).
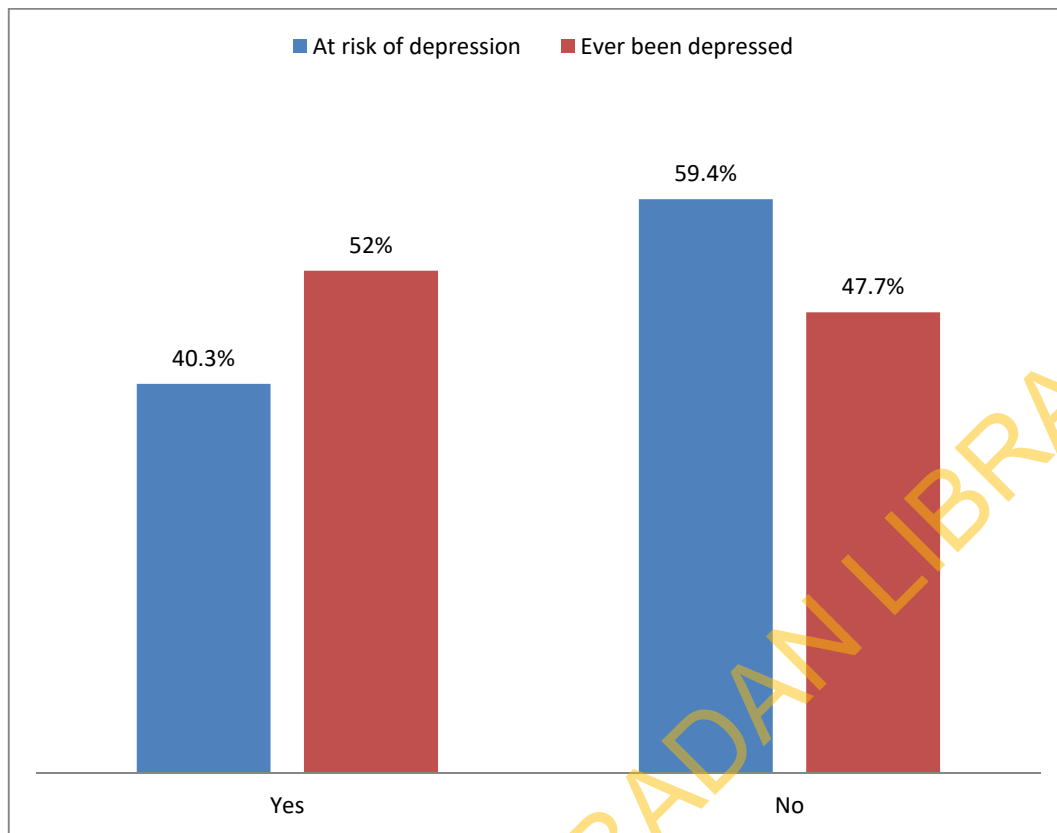
Figure 5: Prevalence of depression among respondents
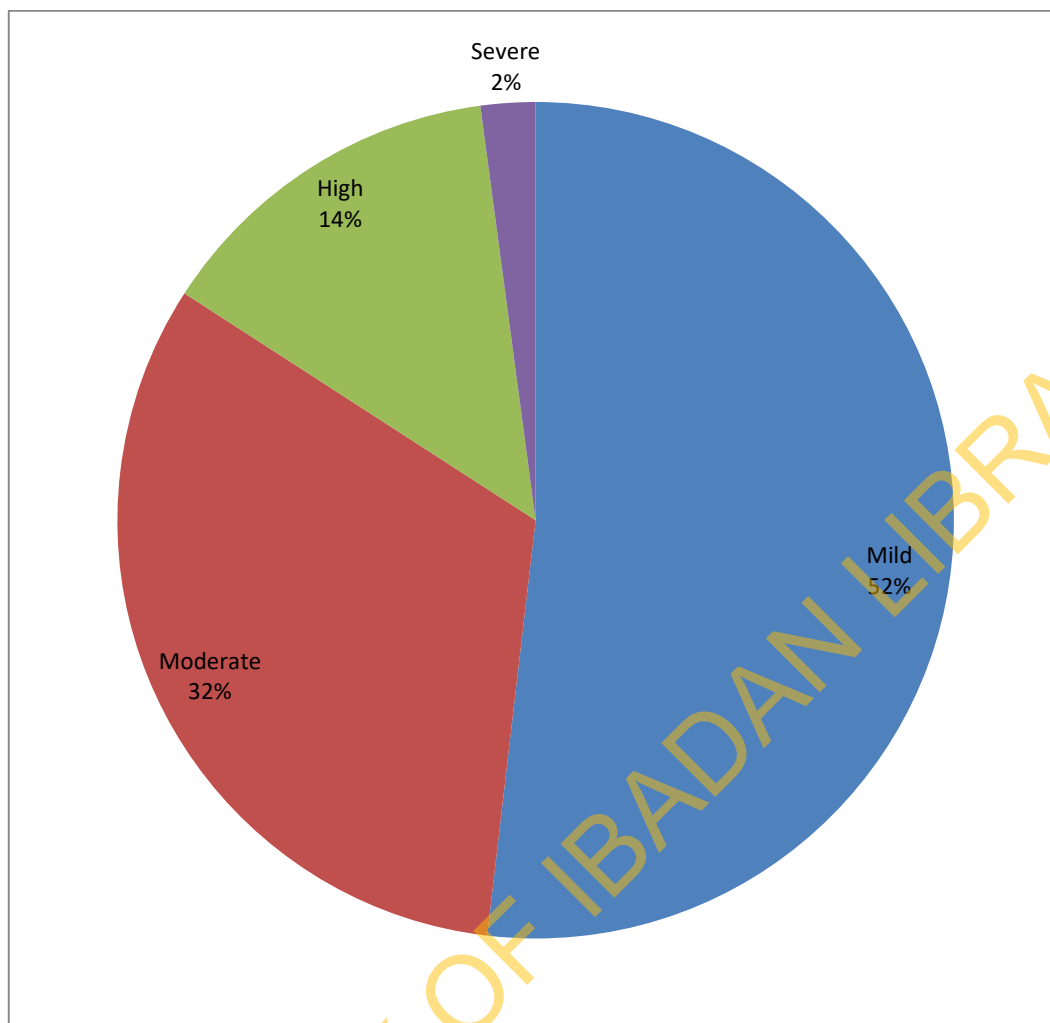
Figure 6: Level of depression among respondents
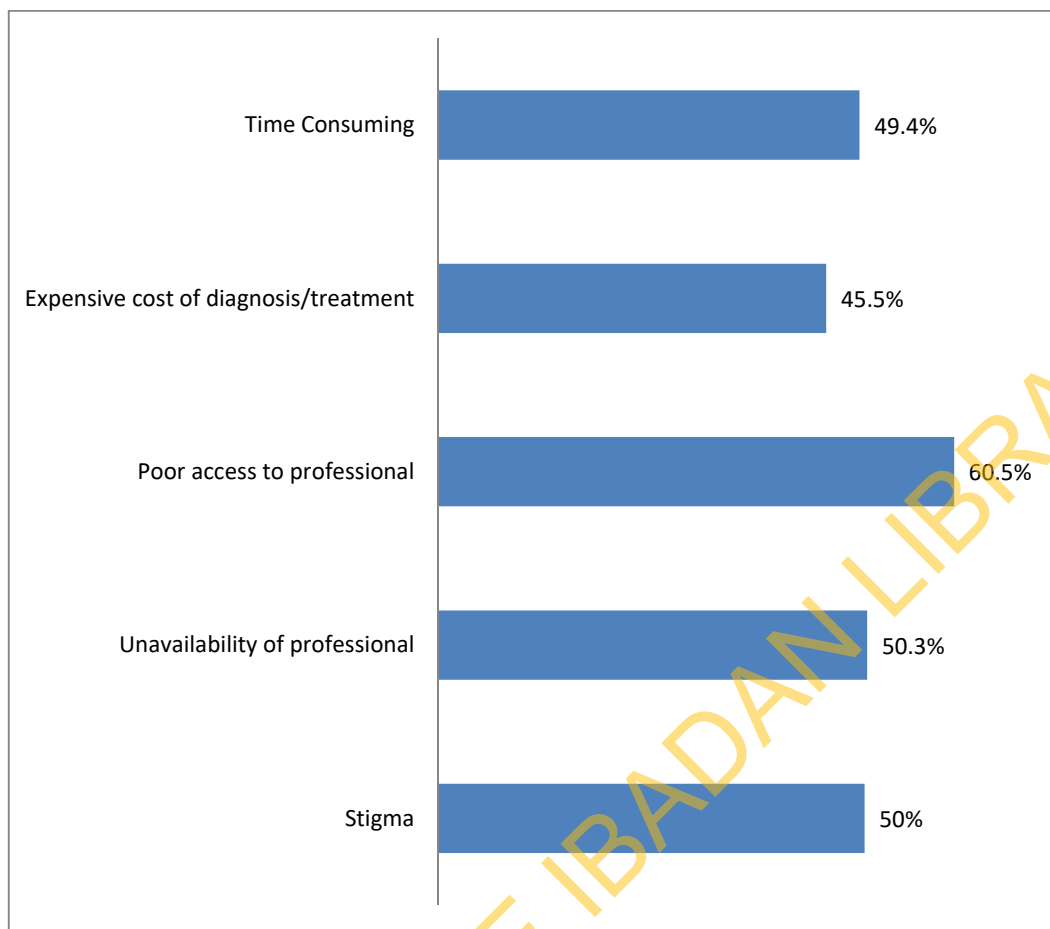
Figure 7: Barriers to getting diagnosis for depression among respondents

There were 40 (11.4%) respondents who in the past few weeks have wished they were dead, 7.7% have in the past week, felt that they or their family would be better off if they were dead, 8% have in the past few weeks, had thoughts about killing themselves and 9.4% have ever tried killing themselves (Table 5).

Table 5: Depression Diagnosis

Questions	N (%)
In the past few weeks, have you wished you were dead?	40 (11.4)
In the past few weeks, have you felt that you or your family would be better off if you were dead?	27 (7.7)
In the past few weeks, have you had thoughts about killing yourself?	28 (8.0)
Have you ever tried to kill yourself?	33 (9.4)

4.4   Knowledge on Artificial Intelligence (AI)

The statement "Artificial intelligence (AI) is the theory and development of computer systems able to perform tasks normally requiring human intelligence" was considered to be true by almost all of the respondents (97.4%). A further 90.3% of the respondents considered **Strong AI** can only imitate characteristics that resemble human intelligence to be true and about two third of the respondents (68.3%) considered **Weak AI** can successfully imitate human intelligence as false (Table 6).

Google (46.6%) was the most popular AI options mentioned by respondents, followed by Siri (28.7%), Facebook (24.7%), Google maps (21.8%) and Google assistant (16.1%) (Table 7).

Overall, respondents' knowledge score was 3.4±1.5 from a possible score of 6 points, indicating an average level of knowledge exhibited by respondents with 38.6% having good knowledge (Fig 4).

60

Table 6: Knowledge on AI

Questions	True (%)	False (%)
Artificial intelligence (AI) is the theory and development of computer systems able to perform tasks normally requiring human intelligence	341 (97.4)	8 (2.3)
Strong AI can only imitate characteristics that resemble human intelligence	316 (90.3)	32 (9.1)
Weak AI can successfully imitate human intelligence	105 (30.0)	239 (68.3)

Table 7: Possible AI options

	Responses	Percent of Cases
Siri	50	28.7%
Google maps	38	21.8%
Emotional intelligence	14	8.0%
Flo tracker	14	8.0%
Google	81	46.6%
Cortana	14	8.0%
Netflix	11	6.3%
Facebook	43	24.7%
Weka	4	2.3%
Twitter	24	13.8%
Youtube	7	4.0%
Speech recognition app	10	5.7%
Handwriting recognition app	3	1.7%
Facial recognition app	1	0.6%
Swift keyboard	6	3.4%
Robin	3	1.7%
Google assistant	28	16.1%
Snapchat	18	10.3%
Instagram	19	10.9%
IBM Watson	3	1.7%
Talking Tom	1	0.6%
Replika	1	0.6%
Prisma	1	0.6%
ELSA	5	2.9%
Wysa	1	0.6%
Youper	1	0.6%
Alexa	2	1.1%
Bixby	2	1.1%

Multiple choices
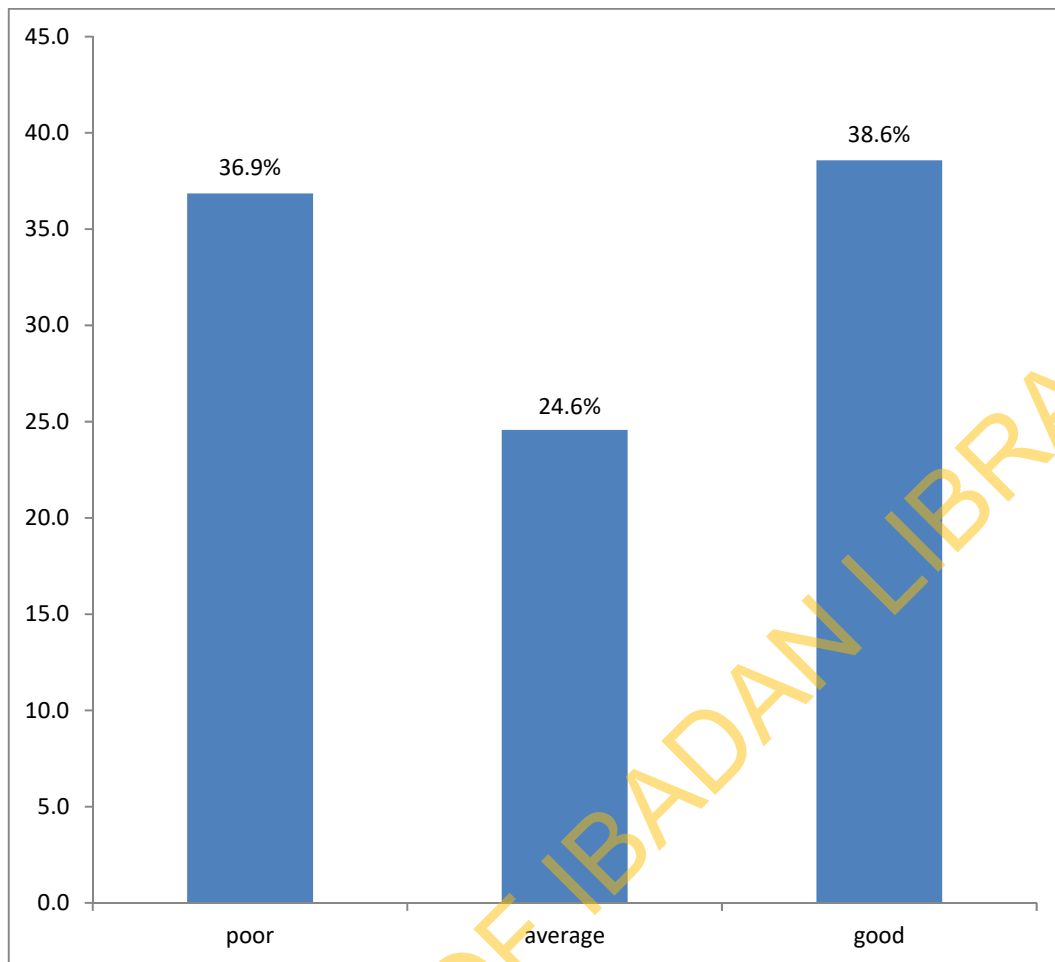
Figure 8: Respondents AI knowledge distribution

4.5   Experience with the Use of Artificial Intelligence Enabled Apps

More than half of the respondents (52.6%) knew of AI enabled tools/Apps, 51.4% claimed to have not used any AI enabled tool/App while most of the respondents (86.9%) did not know any AI app that can be used to diagnose depression. Almost all of the respondents (94%) have not used any AI tool used in diagnosing or/and managing depression. There were 95.4% and 97.4% of the respondents who have not heard of or used Woebot, Youper or Wysa before respectively (Table 8).

Table 8: Experience with the Use of Artificial Intelligence Enabled Apps

Questions	Yes (%)	No (%)
Do you know any Artificial intelligence enabled tool/App?	184 (52.6)	162 (46.3)
Do you use any Artificial intelligence enabled tool/App?	169 (48.3)	180 (51.4)
Do you know any AI app that can be used to diagnose depression?	44 (12.6)	304 (86.9)
Do you use any AI tool used in diagnosing or/and managing depression?	19 (5.4)	329 (94.0)
Have you heard of Woebot, Youper, or Wysa?	15 (4.3)	334 (95.4)
Have you used Woebot, Youper, or Wysa?	8 (2.3)	341 (97.4)

4.6   Perception on the Use Of Artificial Intelligence To Self-Diagnose And Manage Depression

One hundred and sixty nine (48.3%) respondents agreed that AI provides timely and accurate diagnosis of depression while about two third (63.7%) also agreed that it will help reduce the pressure on mental health professionals. Stigma reduction was attributed to AI by more than half of the respondents (57.4%). Also 56.9% and 54.9% of the respondents agreed that AI will help reduce the stigma associated with depression drastically and help reduce suicide due to depression respectively (Table 9).

Addressing features that will be preferred to be in the AI diagnosing app, majority of respondents (over 70%) believe that the tool/App should "prompt you with questions to assess your mood, prompt you with questions to assess your anxiety level, prompt you with questions to assess your depressive symptoms, prompt you with questions to assess your depressive status, have the ability to keep record of your sessions, provide you with depression management tools, language compatible with you, user friendly, show you the depressive symptoms analysed and provide you with educational tools on depression" (Table 10).

Perception score of respondents was 3.41 ± 2.27 from a possible score of 6, indicating positive perception. More than half of the respondents (55.1%) had positive attitude towards AI tool (Fig 5).

Table 9: Perception on the Use of Artificial Intelligence to Self-Diagnose and Manage Depression

Statement for consideration	Agree (%)	Disagree (%)	Undecided (%)
Provides timely and accurate diagnosis of depression	169 (48.3)	48 (13.7)	130 (37.1)
It will help reduce the pressure on mental health professionals	223 (63.7)	40 (11.4)	87 (24.9)
The tool will help reduce the stigma associated with depression drastically	201 (57.4)	45 (12.9)	102 (29.1)
It will help with choice of treatment and autonomy	211 (60.3)	31 (8.9)	107 (30.6)
Overtime it will help reduce the prevalence of depression	199 (56.9)	32 (9.1)	118 (33.7)
It would help reduce suicide due to depression	192 (54.9)	50 (14.3)	107 (30.6)

Table 10: AI self-diagnosing app

Would you like to see these features in the AI enabled app used for self-diagnosis of the depression	Yes (%)
Tool/App should prompt you with questions to assess your mood	297 (84.9)
Tool/App should prompt you with questions to assess your anxiety level	283 (80.9)
Tool/App should prompt you with questions to assess your depressive symptoms	283 (80.9)
Tool/App should prompt you with questions to assess your depressive status	280 (80.0)
Tool/App should prompt you with questions on your bio data and personality type	256 (73.1)
Tool/App should prompt you with questions on your interests, activities, frequency of participation, etc	270 (77.1)
Tool/App should be subjective to your personality type	224 (64.0)
24/7 availability of the tool to you	271 (77.4)
Confidentiality of information shared/ Tool-client protection	277 (79.1)
Tool/App should have the ability to keep record of your sessions	280 (80.0)
Tool/App should provide you with depression management tools	289 (82.6)
Tool/App should be language compatible with you	295 (84.3)
Tool/App should have the ability to sense complex cases and provide options for referral	279 (79.7)
Tool/App should have the ability to successfully sense your recovery	274 (78.3)
Tool/App should be user friendly	300 (85.7)
Tool/App should show you the depressive symptoms analyzed	289 (82.6)
Tool/App should provide you with educational tools on depression	295 (84.3)
Tool/App should be transparent in result of diagnosis generation	298 (85.1)
Tool/App results should very accurately predict my level of depression	280 (80.0)
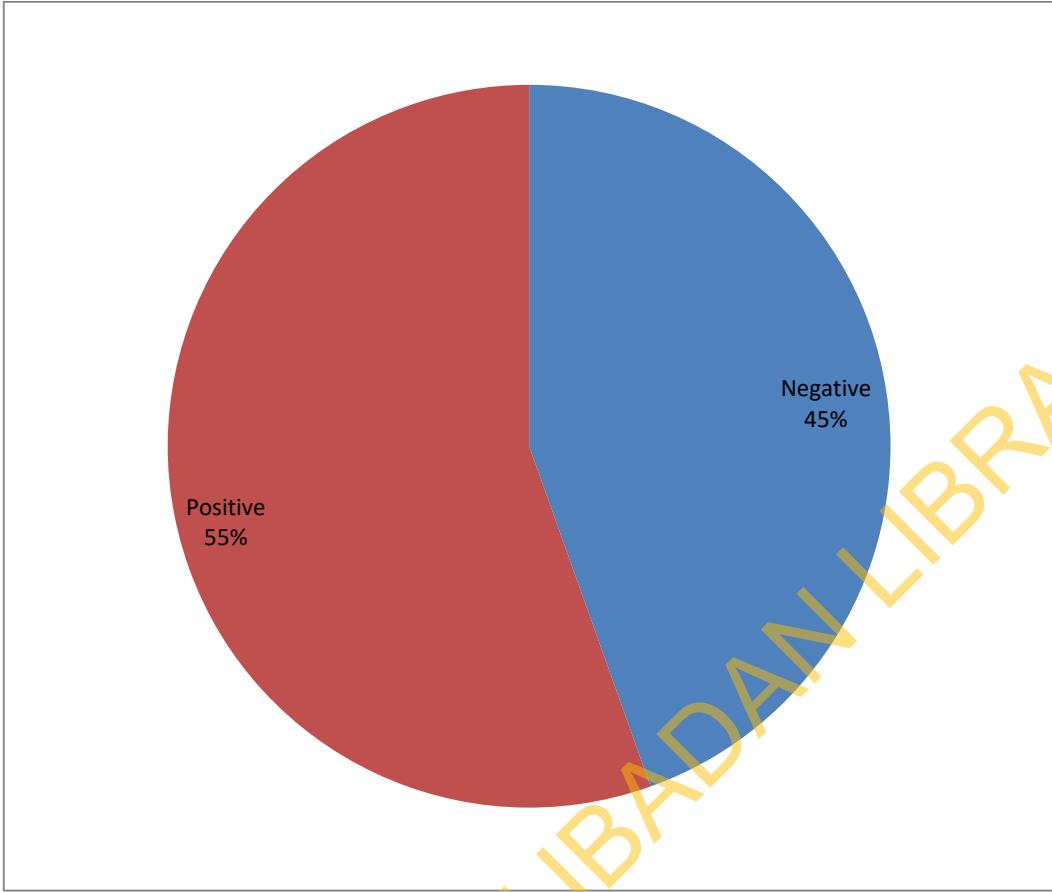
Figure 9: Respondents' perception distribution

4.7 AI usage intention

Findings showed that 42.6% of the respondents are very likely to download AI applications, this was reflected in the 44% of the respondents who admitted to very likely to install the app and 40.6% who admitted to very likely to use the app for self-diagnosis of depression (Table 11).

However, there was a small proportion of respondents (13.4%) who would trust the generated result to a large extent, likewise 13.7% who would generally accept generated results. Acting on the generated results however would be done by 19.1% of the respondents to a large extent (Table 12).

In the event of positive result however, more than half of the respondents (55.7%) would visit a health worker or counsellor while 37.7% would talk to a friend (37.7%). Majority of the respondents (86.9%) would recommend the app to someone else (Table 13).

Table 11: Intention to use AI

If the app was available, how likely are you in taking the following actions:	Very likely (%)	Likely (%)	Not likely (%)
Downloading the App	149 (42.6)	140 (40.0)	60 (17.1)
Installing the App	154 (44.0)	137 (39.1)	57 (16.3)
Using the App for self-diagnosis of depression	142 (40.6)	142 (40.6)	65 (18.6)

Table 12: AI Use

To what extent will you:	To a large extent (%)	To some extent (%)	Not at all (%)
Trust the generated results	47 (13.4)	275 (78.6)	27 (7.7)
Generally accept generated results	48 (13.7)	263 (75.1)	38 (10.9)
Act on generated results	67 (19.1)	238 (68.0)	43 (12.3)

Table 13: AI usage

	Frequency	Percentage
Which of the following are you most likely to do in the event of a positive result for depression?		
Visit a health worker or counsellor	195	55.7
Talk to a friend	132	37.7
I prefer to smoke	3	0.9
Withdraw and deal with it	2	0.6
Talk to God about it	5	1.4
Talk to Family	3	0.9
Nothing	4	1.1
Uncertain	2	0.6
Talk to a loved one	1	0.3
Will you recommend this app to someone else		
Yes	304	86.9
No	45	12.9

4.8 Perceived barriers to AI use

Assessing respondents' perceived barrier to AI use, data availability (37.1%), poor service connection (32.2%), lack of internet enabled phone (28.6%), cost of app (20.1%), illiteracy (18.2%) and size of applicable (15.2%) were the most prominent barriers to use perceived by respondents (Table 14). Family members and health professional were prominent referral points identified by respondents (Table 15).

Table 14: Perceived barrier to AI use

	Responses	Percent of Cases
Update of the application	13	4.0%
Size of the application	50	15.2%
Poor service connection	106	32.2%
Data availability	122	37.1%
Lack of internet enabled phones	94	28.6%
Illiteracy	60	18.2%
Cost of the app	66	20.1%
Public awareness of the App	43	13.1%
Accuracy of the App/results	49	14.9%
Level of sensitivity	15	4.6%
Significant solutions	5	1.5%
Ignorance	25	7.6%
Inaccurate results	13	4.0%
Data insecurity	11	3.3%
Data consumption	21	6.4%
Time consumption	16	4.9%
Battery consumption	12	3.6%
Availability of apps on phones	32	9.7%
Trust with the app	42	12.8%
App Malfunction	9	2.7%
Inability of tool to perceive emotion	6	1.8%
Computer literacy	11	3.3%
Knowledge of the app usage	26	7.9%
Power failure	18	5.5%
Reluctance to use the app	14	4.3%
Traditional mindset or mentality	5	1.5%
My Faith	4	1.2%
Fear of diagnosis result	8	2.4%
Anxiety	4	1.2%
Complexity of the app	11	3.3%
Inadequate information on the usage of the app	3	0.9%

User friendliness	2	0.6%
In-app purchases	4	1.2%
Unwillingness to admit depression	2	0.6%
Abandonment of actual health care	4	1.2%
Lack of interpersonal relationship	1	0.3%
It is prone to hack	1	0.3%

* Multiple choices

Table 15: Referral

	Responses	Percent of Cases
Mother	232	67.8%
Father	116	33.9%
Friend	143	41.8%
Cousin	57	16.7%
Brother	71	20.8%
Sister	108	31.6%
Counsellor	100	29.2%
Health worker	123	36.0%
Neighbour	2	0.6%
Husband	1	0.3%
Wife	1	0.3%
Girlfriend	4	1.2%
Boyfriend	5	1.5%
Mental health professional	4	1.2%
Other family members	4	1.2%
Aunt	1	0.3%
Uncle	4	1.2%
Religious leader	6	1.8%
Mentor	12	3.5%
Colleagues	2	0.6%
Jesus	4	1.2%

* *Multiple choices*

HYPOTHESES TESTING

1. There will be no significant difference between sex of the students and knowledge on depression.

Independent sample t-test was used in testing this hypothesis, it was found that there is no significant difference in the level of knowledge of depression between the male and female respondents (F=1.748; t=-1.553; P=0.121) (Table 16).

2. There will be no significant relationship between the age of students and their knowledge on artificial intelligence.

Chi-square statistical analysis was used to test this hypothesis, it was found that there is no significant relationship between the age of students and their knowledge on artificial intelligence X^2 (2, N=350) =2.417, P=0.297 (Table 17).

Table 16: Independent sample t-test

Sex	N	Mean	Std. Deviation	Std. Error Mean	F	t	P-value
Male	143	8.7483	.86780	.07257	1.748	-0.1553	0.121
Female	207	8.8889	.80786	.05615			

Table 17: Chi-square analysis

Age	AI knowledge				Chi-square		
	Poor	Average	Good	Total	X^2	Df	P-value
Below 20 years old	70	38	72	180	2.417	2	0.297
	38.9%	21.1%	40.0%	100.0%			
20 years old and above	59	48	63	170			
	34.7%	28.2%	37.1%	100.0%			

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1   Discussion

This study explores the perception of undergraduates in the use of artificial intelligence to self-diagnose and manage depression. The demographic characteristics of the respondents, their knowledge on depression and AI, their perception on the self-diagnosis and management of depression was investigated. The implication of the findings of this study to health promotion and education was discussed and recommendations were made at the end of this report.

5.1.1   Respondents' Socio-Demographic Characteristics

The average age of respondents was 20 years old with majority (82%) of the participants of Yoruba ethnicity. The reason for the dominant ethnic group could be because the study was carried out in the southwest geopolitical zone of Nigeria which is largely dominated by the Yoruba tribe. While Islam and Christianity are the two major religions in Nigeria, most of the participants were Christians (78.3%). WhatsApp is the most used application (81.1%), understandably so too as it is a generally acceptable platform used to share information and communicate. There are more users of Android OS phones than any other model, however all the respondents but 1 have at least one working smartphone of any kind of Operating System.

5.1.2   Respondents' Knowledge of Depression

In Nigeria, research has shown high levels of ignorance about mental illness and negative attitudes towards individuals with mental disorders. However, data gathered from this study highlights different things associated with depression by respondents including: extended state of sadness, a mental health condition, overthinking, result of disappointment, an emotional state of being unhappy, a state of not being mentally healthy, low self-esteem and suicidal thoughts, a state of the mind when you feel so down and extremely sad, loss of understanding of who you are due to the surrounding circumstances. Respondents' high level of knowledge of depression in this study is in tandem with findings from Jorm (2011) where 73.7% of the students know what depression is and likewise in another study by Marcus and Westra (2012) where 80% of students aged 18-24 have knowledge about depression and 79% of young adults aged 25-64 also have knowledge about depression. However, there are substantial amount of studies documenting contrary findings with low level of knowledge of depression among students (Coles and Gibb, 2016; Klineberg, Biddle, Donovan and Gunnell, 2011; Sayarifard, Ghadirian, Mohit, Eftekhar, Badpa and Rajabi, 2015; Amarasuriya,

Jormand Reavley, 2015), this might be attributed to the higher level of education of respondents in this study.

5.1.3 Respondents' Knowledge on Artificial Intelligence (AI)

In this study, respondent's knowledge of AI was found to be above average with less than one-third exhibiting good knowledge of AI. Google, Siri, Facebook, Google maps and Google assistant were identified by respondents as AI. Categorizing AIs, it was stated by respondents that Strong AI can only imitate characteristics that resemble human intelligence and Weak AI cannot successfully imitate human intelligence. This finding is contrary to that of Rathi, Dishant, Rathi and Suresh (2019) who revealed that out of 78 people surveyed, only 6 (7.69%), had knowledge about artificial intelligence.

5.1.4 Respondents' Perception on use of AI for Depression Diagnosis

Findings from this study indicated positive perception of AI by respondents, highlighting timely and accurate diagnosis of depression and reduction of the pressure on mental health professionals. While respondents in a study by Lai, Brian and Mamzer (2020) believed AI has the capacity to bring positive benefits to patients and revolutionize healthcare, a major concern shared was that artificial intelligence tools could have an impact on the organization of the healthcare system, as they are not intended to be developed only in the care setting, and could also enable the public take advantage of these tools (e.g. self-screening). Furthermore, in a study by de Saint-Laurent (2018), majority of the respondents believed that artificial intelligence may not provide enough security and privacy to health data. Concerns also shared in this study include addition to the AI tools: *"addiction… you could actually get too used to it and then find it hard to connect with other people. I understand that it has to be available all the time, but there should also be like a time lap…"*.

5.1.5 Respondents' use of AI enabled Apps to Self-diagnose and Manage depression

This study revealed that almost all the respondents (94%) have not used any AI in the diagnosis or the management of depression. While more than half of the respondents (52.6%) know of generally AI enabled tools there were (95.4%) who have never heard of Woebot, Youper, or Wysa which are all AI tools that have been created to help with mental health disorders in one way or the other. This finding showed that the idea is relatively new to the respondents and at the time this research was conducted no tool has been built for Africa by Africans.

5.1.6 Respondents' satisfaction with an AI tool to Self-diagnose and Manage depression

In this study, the respondents clearly agree that an AI tool to help with self-diagnosis and management is more of a need than it is a want

"it's a need because it's based on a variety of reasons and I'm very sure it'll be cost effective when compared with other conventional methods"

"there are some people that are not depressed now but could be in future… everybody needs the app.". Although a few concerns were raised like addiction to the tool, lack of data to browse, there's a sense of general satisfaction and yearn for the need when presented with the possibility. '*'it will reduce the population of people depressed''* one respondent concluded with certainty.

5.1.7 What Respondents would like to see in the AI tool

According to the result of this study, a high proportion respondents (more than 80%) would like the tool to be user friendly, prompt them with questions to assess their mood, anxiety level, depressive status, and depressive symptoms. They would also like the tool to have the ability to keep record of sessions, provide educational tools on depression, and very accurately predict the level of depression and be transparent with the diagnosis generation. This finding suggests that students' preference for AI for self-diagnosis and management of depression is high. This might be attributed to the high degree of familiarity with the use Android mobile phones and computers and the feeling that such AI tool will limit stigmatisation and improvement in healthy status with subsequent impact on theiracademic achievement.

5.1.8 Implication of findings for Health Promotion and Education

From findings gathered from this study, it is evident that students have a good knowledge of depression and have a positive attitude towards AI use for self-diagnosis of depression. While this is positive, the barriers to help seeking for mental health illnesses like depression has been clearly highlighted. Stigma, lack of access to mental health professionals, and high cost of treatment rank high. Working strategies could be developed, adopted, or adapted to help sensitize people on stigma associated with mental health illnesses. Advocacy should be carried out for better access to mental health professionals and affordable treatment plans. Using information from this study, Health Promotion and Education can go further to develop a one stop AI tool that not only helps with self-diagnosis but management and treatment too.

This would help to reach more people, young people nonetheless, promote and prolong life and reduce the number of years lived with disability.

5.2   Conclusion

This study investigated the perception of students about the use of Artificial Intelligence to self-diagnose and manage depression. Findings showed that respondents had an overall good knowledge on depression and artificial intelligence, respondents' knowledge was not significantly different across age and gender; although the perception of respondents of AI was positive, it was however identified that the fear of addiction to the tool may pose an area of concern. Respondents welcome the idea of AI diagnostic tool for depression and are looking forward to it. This is vital in the provision of options to affected students with depressive symptoms who are unable to reach out for help or incapable of doing so, because of difficulty in accessing mental health care or due to barriers of cost, location, or unavailable mental health professionals. Thus, incorporating AI diagnostic tool for depression in the university will result in substantial unmet need for treatment of mental disorders amongundergraduate students. This approach in exploring the use of artificial intelligence to improve self- diagnosis of depression amongundergraduate students in Nigeria has contributed to understanding the opportunities of improving the use of AI to assist students to produce results that help them realise their present mental health status and informative posts from time to time thus helping them increase knowledge of their mental health.

5.3   Recommendations

Based on findings from this study, the following recommendations were made

1. Introduction to mental health should be compulsorily taught at entry levels of universities. This will not only help with improvement of knowledge on the subject matter but create a safer, stigma free environment which will in-turn help improve help seeking behaviours of sufferers.
2. An AI tool that could help self-diagnose and manage depression and anxiety should be developed. The tool will not only serve diagnostic purposes but also help connect mental health professionals and provide users with variety of management and care options.
3. The developed tool should be recommended to undergraduate students in the University of Ibadan and across the country.

4. More mental health professionals should be trained and at least 2 should be in every University.

5. A mental health department should be incorporated into the already existing school clinic.

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APPENDIX I

QUESTIONNAIRE

Greetings, I am a Master of Public Health student of the Department of Health Promotion and Education, Faculty of Public Health, College of Medicine; University of Ibadan. I am writing my research project on perception of undergraduate students on the feasibility of using artificial intelligence to self-diagnose and manage depression, in the University of Ibadan, Oyo state.

The questions won't take much of your time.There are no right or wrong answers and under no circumstances will your responses be divulged to a third party. I will be grateful if you can spend some time answering these questions honestly. All the information provided will be kept confidential.

THANK YOU.

Survey identification number …………

SECTION A: SOCIO-DEMOGRAPHIC DATA

Please tick as appropriate

1. Sex: 1. Male ☐ 2. Female ☐
2. Age (in years as at last birthday) …………
3. Ethnic group: 1. Yoruba ☐ 2. Hausa ☐ 3. Igbo ☐ 4. Others …
4. Religion: 1. Christianity☐ 2. Islam☐ 3. Traditional☐4. Others…
5. How would you rate the socio economic level of your family 1. Low ☐ 2. Average ☐ 3. High ☐
6. Faculty…………………………………….
7. Level …………….
8. Phone ownership: 1. Yes ☐ 2. No ☐
9. Type of phone owned: 1. Android ☐ 2. IOS ☐ 3. Others ☐
10. Type of Apps familiar with ………………………….
11. Most frequently used App ………………………….
12. Frequency of use: 1. Everyday ☐ 2. Thrice or more in a week but not everyday ☐ 3. Less than thrice in a week ☐ 4. Others …………..

SECTION B: KNOWLEDGE ON DEPRESSION Instruction: please tick the answer you feel as appropriate for each question

S/N	Questions		
13.	**What is Depression?**	Yes	No
i.	Depression is the state of sadness that extends over two weeks		
ii.	Depression is a general term for sadness		
iii.	Depression is a mental health condition		
iv.	Depression is overthinking		

v. Others…………………….………………………………………………….

S/N	Questions
14.	**State 3symptoms of depression?**
i.	
ii.	
iii.	

S/N	Questions
15.	**State 3causes of depression?**
i.	
ii.	
iii.	

Instruction: please tick the answer you feel as appropriate for each question

95

16. Do you think you are at risk of being depressed?   Yes ☐   No ☐
17. Have you ever been depressed?   Yes ☐   No ☐

Instruction: If your answer to Q17 is NO please skip the following questions and continue from Q32. If not, please continue with the questions and tick as appropriate.

18. How would you rate your level of depression?   1. Mild ☐ 2. Moderate ☐   3. High ☐   4. Severe ☐
19. Have you been previously diagnosed for depression?   Yes ☐   No ☐

Instruction: If your answer to Q19 is YES please answer the following questions, if not please skip to Q26

20. Were you diagnosed by a mental health professional?   Yes ☐   No ☐
21. Were you diagnosed by other health professionals instead?   Yes ☐   No ☐
22. How long did it take for diagnosis to be done and result obtained?   1 day ☐   less than a week ☐   one week ☐   two weeks ☐   others ………..
23. Were you treated or was the condition at least managed?   Yes ☐   No ☐
24. Were you allowed to choose your treatment type?   Yes ☐   No ☐
25. What treatment were you given?   ………………………………..

Instruction: If your answer to Q19 is NO please answer the following questions, what were the barriers to getting a diagnosis?

26. Stigma associated with mental illnesses (depression)   Yes ☐   No ☐
27. Unavailability of mental health professional   Yes ☐   No ☐
28. Poor/little/no access to mental health professional   Yes ☐   No ☐
29. Expensive cost of diagnosis/treatment   Yes ☐   No ☐
30. Time consuming   Yes ☐   No ☐
31. Others …………………………………

Instruction: please tick the answer you feel as appropriate for each question

S/N	Questions	Yes	No
32.	In the past few weeks, have you wished you were dead?		
33.	In the past few weeks, have you felt that you or your family would be better off if you were dead?		
34.	In the past few weeks, have you had thoughts about killing yourself?		
35.	Have you ever tried to kill yourself?		

SECTION C: KNOWLEDGE ON ARTIFICIAL INTELLIGENCE(AI)

Instruction: please tick the answer you feel as appropriate for each question

S/N	Questions	True	False
36.	Artificial intelligence (AI) is the theory and development of computer systems able to perform tasks normally requiring human intelligence		
37.	**Strong AI** can only imitate characteristics that resemble human intelligence		
38.	**Weak AI** can successfully imitate human intelligence		

39. Mention 3 Applications (Apps) you know that uses artificial intelligence

    i. ………………………………….
    ii…………………………………..
    iii. ………………………………

SECTION D: EXPERIENCE WITH THE USE OF ARTIFICIAL INTELLIGENCE ENABLED APPS

Instruction: please tick the answer you feel as appropriate for each question

S/N	Questions	Yes	No
40.	Do you know any Artificial intelligence enabled tool/App?		
41.	Do you use any Artificial intelligence enabled tool/App?		
42.	Do you know any AI app that can be used to diagnose depression?		
43.	Do you use any AI tool used in diagnosing or/and managing depression?		
44.	Have you heard of Woebot, Youper, or Wysa?		
45.	Have you used Woebot, Youper, or Wysa?		

SECTION E: PERCEPTION ON THE USE OF ARTIFICIAL INTELLIGENCE TO SELF-DIAGNOSE AND MANAGE DEPRESSION

Instruction: please tick the answer you feel as appropriate for each question

S/N	Perceived benefits of using Artificial Intelligence (AI) Apps for self-diagnosis of depression	Agree	Disagree	Undecided
46.	Provides timely and accurate diagnosis of depression			
47.	It will help reduce the pressure on mental health professionals			
48.	The tool will help reduce the stigma associated with depression drastically			
49.	It will help with choice of treatment and autonomy			
50.	Overtime it will help reduce the prevalence of depression			
51.	It would help reduce suicide due to depression			

52. Others …………………………………………..

What would like to see in the tool/app if artificial intelligence was used to self-diagnose and manage depression; features, characteristics, technical inputs

Instruction: please tick the answer you feel as appropriate for each question

S/N	Would you like to see these features in the AI enabled app used for self-diagnosis of the depression	Yes	No	Not necessarily
53.	Tool/App should prompt you with questions to assess your mood			
54.	Tool/App should prompt you with questions to assess your anxiety level			
55.	Tool/App should prompt you with questions to assess your depressive symptoms			
56.	Tool/App should prompt you with questions to assess your depressive status			
57.	Tool/App should prompt you with questions on your bio data and personality type			
58.	Tool/App should prompt you with questions on your interests, activities, frequency of participation, etc			
59.	Tool/App should be subjective to your personality type			
60.	24/7 availability of the tool to you			
61.	Confidentiality of information shared/ Tool-client protection			
62.	Tool/App should have the ability to keep record of your sessions			
63.	Tool/App should provide you with depression management tools			
64.	Tool/App should be language compatible with you			
65.	Tool/App should have the ability to sense complex cases and provide options for referral			
66.	Tool/App should have the ability to successfully sense your recovery			
67.	Tool/App should be user friendly			
68.	Tool/App should show you the depressive symptoms analyzed			
69.	Tool/App should provide you with educational tools on depression			
70.	Tool/App should be transparent in result of diagnosis generation			
71.	Tool/App results should very accurately predict my level of depression			

72. Others …………………………………………………………

Instruction: please tick the answer you feel as appropriate for each question

S/N	If the app was available, how likely are you in taking the following actions:	Very likely	Likely	Not likely
73.	Downloading the App			
74.	Installing the App			
75.	Using the App for self-diagnosis of depression			
S/N	To what extent will you:	To a large extent	To some extent	Not at all
76.	Trust the generated results			
77.	Generally accept generated results			
78.	Act on generated results			

79. Which of the following are you most likely to do in the event of a positive result for depression? 1.Visit a health worker/counsellor☐   2. Talk to a friend☐   3. Other (specify)…………………………….

80. Will you recommend the app to someone else? e.g. a friend   Yes ☐   No ☐

81. Mention 3 perceived barriers or constraints to use of the AI tool/App for self-diagnosing depression
    - i. ……………………………………..
    - ii. ……………………………………..
    - iii. ……………………………………..

82. In the event of a positive diagnosis for depression, who are the 3 people you will like the results be shared with for support? (E.g. mother, father, cousin, counsellor, health worker, sister, etc.)
    - i. ……………………………………..
    - ii. ……………………………………..
    - iii. ……………………………………..

APPENDIX II

Informed Consent

PERCEPTION OF UNDERGRADUATE STUDENTS ON THE FEASIBILITY OF USING ARTIFICIAL INTELLIGENCE TO SELF-DIAGNOSE AND MANAGE DEPRESSION, IN THE UNIVERSITY OF IBADAN, OYO STATE.

I am a masterof public health postgraduate student at the department of Health Promotion and Education, Faculty of Public Health, College of Medicine University of Ibadan. I am conducting research on the "**PERCEPTION OF UNDERGRADUATE STUDENTS ABOUT THE FEASIBILITY OF USING ARTIFICIAL INTELLIGENCE TO SELF-**

99

DIAGNOSE AND MANAGE DEPRESSION, IN THE UNIVERSITY OF IBADAN, OYO STATE"The purpose of this study is to determine the perception of students on the use of Artificial Intelligence to self-diagnose and manage depression, and to improve the overall mental wellbeing of the students by using information from this research to create a one stop tool that can be used to self-diagnose and manage depression.The study is focusing on undergraduate students in the University of Ibadan.

The discussion will not take more than an hour, and your participation is voluntary, you may wish to refuse to answer any question or withdraw from the study, there will be no penalty to you and you will not lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with the researcher or the institutions. The information you give us is completely confidential, and we will not associate you with anything you say in the focus group discussion.We would like to tape the discussion so that we can make sure to capture the thoughts, opinions, and ideas we hear from the group. No names will be attached to the focus groups. We understand how important it is that this information is kept private and confidential. We will ask participants to respect each other's

For any questions, concern, or complaint about this research study you may contact the principal investigator Mr. OlasunkanmiGbajabiamilaon 08135232578 or olasunkanmigbajabiamila@gmail.com for questions about your rights as a participant in this study, to discuss other study-related concerns or complaint with someone who is not part of the research team or in case of any physical or psychological harm/discomfort as a result of participating in this study you may contact and lodge your complains with any member from the University of Ibadan Health Research Ethics Committee. Please check the space below and sign to show you agree to participate in this focus group.

Signing the consent form

I have read (or someone has read and explained this form to me) and I am aware that am being asked to participate in this research study. I have had the opportunity to ask questions and had them answered to my satisfaction. I voluntarily agree to participate in this research study.

Name of Subject……………………………….

Signature & date…………………………………..

Investigator/ Research assistants

I have explained the research to the participants before requesting the signature above. A copy of this form has been given to the participant.

Name of person obtaining consent………………………………………

Signature& Date……………………………………………………

FOCUS GROUP GUIDE

Good morning, trust you had a good day; it's really a pleasure meeting you today for the discussion. My name is OlasunkanmiGbajabiamila, and together with my secretary and research assistants that will be assisting me in conducting the program. You were selected because you fulfilled the criteria for this study and also you agreed to participate in the conduct of the study.

I would like to use this opportunity to remind us that there is no right or wrong answers in this discussion, therefore one should feel free and share her opinion regardless of whether you agree or disagree with what we are discussing. It is of paramount importance that we hear all your opinions. Your ideas will be highly respected and appreciated if shared, as we are more concerned with what each of you think or feel is worth sharing regarding the issue to be discussed.

101

Your comments should not be repeated outside of this group, therefore as you don't want anybody to tell anyone about your opinion or comments, please do not tell anyone about someone else's opinion. Let us start by giving you codes.

1. Sex: 1. Male ☐   2. Female ☐
2. Age (in years as at last birthday) …………
3. Ethnic group: 1. Yoruba ☐   2. Hausa ☐   3. Igbo ☐   4. Others …
4. Religion: 1. Christianity☐   2. Islam☐   3. Traditional☐ 4. Others…
5. Level …………….

QUESTIONS TO INVESTIGATE PARTICIPANTS' VIEW ON SELF-DIAGNOSIS AND MANAGEMENT OF DEPRESSION USING ARTIFICIAL INTELLIGENCE

1. Viewpoints on Artificial intelligence

   - Probe for definition

   - ways AI be used to improve health

   - use in the diagnosis of depression (perceived advantages, perceived disadvantages).

   - use in the management of depression

- Existing knowledge on similar tools

- views on such tools

- The possibility of the use of such tools among students in Nigeria and Africa

2. Extent to which students are likely to be satisfied with the use of an Artificial Intelligent tool that helps self-diagnose and manage depression?

Probe for:

   - Gender differences

   - Trust with the tool

   - Accuracy of results

   - Preference when compared to conventional methods of diagnosis and management

   - What it is considered as; a need or a want and reasons for answers

3. Ideas about things that students' will like to see incorporated into the tool that help self-diagnose and manage depression?

   - Product (simplicity,

   - Content- Issues to be incorporated ;Number of question items

102

- Type of results expected

- Deployment to students -Mechanism

- Training need

- Regulation

- Facilitators for use

- Barriers

4. Perceived effects of the tool?

- On Depression

- Sustainability

Any more things you might like to add?

That concludes our discussion. Thank you so much for coming and sharing your thoughts and opinions with us. We have a short evaluation form that we would like you to fill out if you have time. If you have additional information that you did not get to say in the focus group, please feel free to write it on this evaluation form.

ETHICAL APPROVAL

INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IAMRAT)
College of Medicine, University of Ibadan, Ibadan, Nigeria.

Director: **Prof. Catherine O. Falade**, MBBS (Ib), M.Sc., FMCP, FWACP
Tel: 0803 326 4593, 0802 360 9151
e-mail: cfalade@comui.edu.ng lillyfunke@yahoo.com

UI/UCH EC Registration Number: **NHREC/05/01/2008a**

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

Re: Perception of undergraduate students on the feasibility of using artificial intelligence to self-diagnose and manage depression, in the University of Ibadan, Oyo State.

UI/UCH Ethics Committee assigned number: UI/EC/19/0425

Name of Principal Investigator: **Olasunkanmi Gbajabiamila**

Address of Principal Investigator: Department of Health Promotion and Education
College of Medicine,
University of Ibadan, Ibadan

Date of receipt of valid application: 26/09/2019
Date of meeting when final determination on ethical approval was made: **N/A**

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and *given full approval by the UI/UCH Ethics Committee.*

This approval dates from **04/12/2019** to **03/12/2020**. If there is delay in starting the research, please inform the UI/UCH Ethics Committee so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the UI/UCH EC assigned number and duration of UI/UCH EC approval of the study.* It is expected that you submit your annual report as well as an annual request for the project renewal to the UI/UCH EC at least four weeks before the expiration of this approval in order to avoid disruption of your research.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the UI/UCH EC. No changes are permitted in the research without prior approval by the UI/UCH EC except in circumstances outlined in the Code. The UI/UCH EC reserves the right to conduct compliance visit to your research site without previous notification.
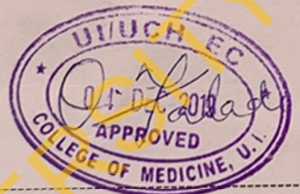
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