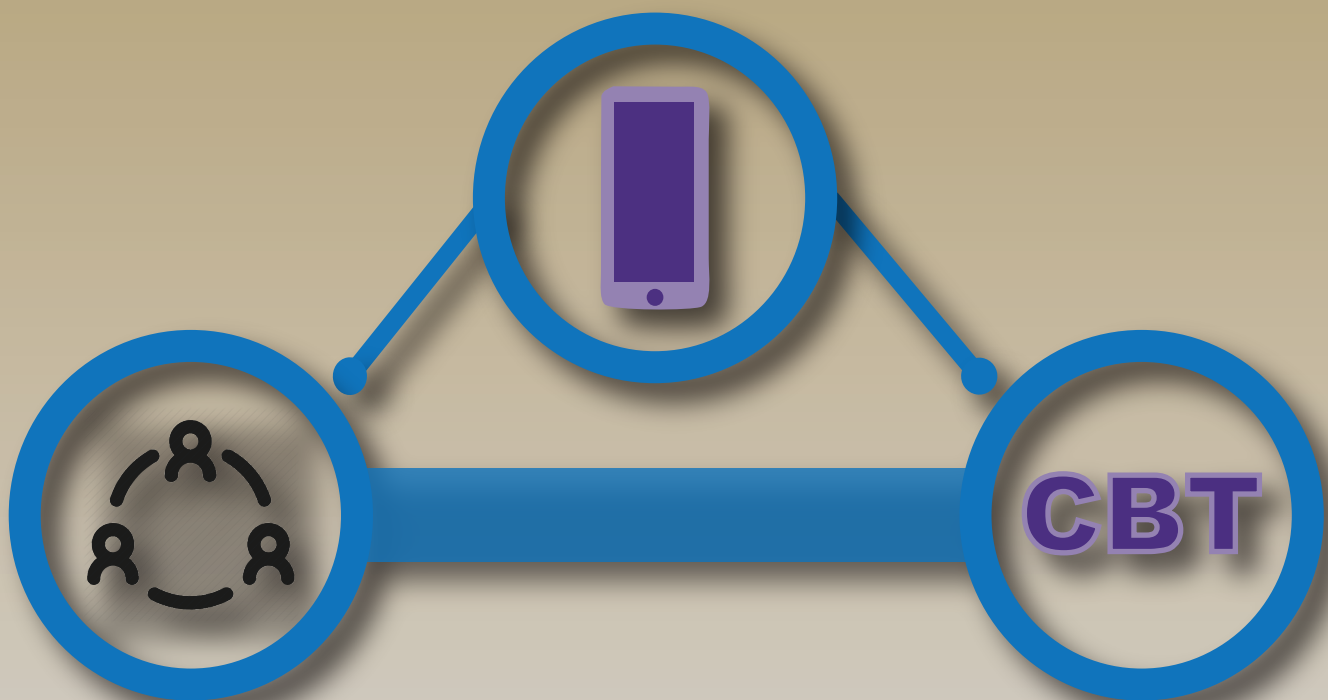


A NOVEL TIERED APPROACH TO BRIDGING THE MENTAL HEALTH TREATMENT GAP IN LOW RESOURCE, LOW-INCOME AREAS

A mental health treatment intervention model that combines Mobile Communication Technology, Lay health Workers and Cognitive behavior therapy to create an effective agile program that can respond to a community's mental health needs is feasible and warranted.



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Winter Quarter 2019

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Winter Quarter 2019
INFO 498
Independent study

A novel three-tiered approach to bridging the mental health treatment gap

INTRO

One of the most pressing issues in the world is Mental Illness. Mental illness is a large part of population health and can have large effects on society with many people experiencing it in some form or another. As a part of population health, mental health is a large factor in a countries economic outlook. For example, a populace with high occurrences of depression is going to be less productive as being depressed can cause decreased work output, or even no workout put. Problems with mental health can weigh especially hard on less developed nations as they lack the infrastructure to deal with mental health issues. While mental health is a vast problem current treatment plans by States, Intergovernmental Organizations, and Non-Governmental organizations are not meeting the needs of populations around the world, particularly in low resources low-income areas. To close the treatment gap in mental health care in low resource low-income areas a novel Intervention model that combines mobile phones, Cognitive Behavioral Therapy, and Lay-Health workers should be implemented.

Mental Health is a large field and refers to disorders that affect your mood, thinking, and behavior. These disorders can range from more common diseases like anxiety, which is a disease that causes intense, excessive, and persistent worry and fear about everyday situations (NIMH), to less common more complex disorders like Dissociative identity disorder, Where an individual develops a whole new personality. For the purposes of simplicity, this paper is going to mainly focus on common mental disorders such as depression, generalized anxiety disorder (GAD), panic disorder, phobias, social anxiety disorder, obsessive-compulsive disorder (OCD) and post-traumatic stress disorder (PTSD) (National Collaborating Centre for Mental Health). This is because these are the mental illness most people encounter and need treatment for.

A key feature of Mental illness that separates it from other none communicable disease, i.e. diseases that are not transmissible directly from one person to another, is comorbidity. Comorbidity describes two or more disorders or illnesses occurring in the same person (Valderas et al 2009). What this means is that mental health can also be related to, or present with other diseases. Additionally, this means that mental health issues can develop specifically because of other diseases being present. Other diseases can include HIV, Diabetes, Physical injury, or a variety of chronic illness. A study found that "there is a two-way relationship between mental illnesses and other chronic conditions" and that "the existence of a different chronic condition (as well as HIV/AIDS) exacerbates the risk of developing a mental disorder, and vice versa"(Bloom 2011). What this shows is that with the spread of communicable disease like AIDS it is also necessary to develop methods to treat the mental health issues that come with the other diseases.

An article looked at the issue of rural mental health from the stakeholder's point of view and found several key findings. The article found that the top priorities for rural respondents were access to quality health services, nutrition, and weight status, diabetes, and fourth most important mental health. While to the number one top priority this article shows that mental care is something rural stakeholders want. This part of the article is important as it lays out directly

what stakeholders in the rural health care field want. Having first person sources for rural community health needs is vital and this article provides that plainly. This article also provides guidance on which other health arenas are important to rural stakeholders. This is important because one of the main strengths of a software application is its ability to layer intervention. Having data about the fact that nutrition and diabetes are problems that could possibly be solved with increasing intervention layering within a software application.

Not only do rural Americans want increased mental healthcare treatment there is a societal need for it. Opioid addiction is a substance abuse problem which is one of the common mental illnesses, a type of compulsion disorder. The current mental health epidemic affecting the United States is the Opioid epidemic. One statistic describing the scope of the epidemic is that "The number of Americans succumbing to drug overdoses more than tripled between 1999 and 2015" (Sandhya 2018). That there is an increasingly large amount of people dying as a result of this epidemic. The addiction epidemic is however not limited to just opioid. There are a wide variety of drugs that go into that statistical increase for instance "While prescription opioids were involved in just over 17,000 overdose deaths in 2016, heroin was responsible for 15,500 overdose deaths that year, a 20 percent jump from a year before. Synthetic drugs caused 19,000 deaths — a 100 percent increase"(Sandhya 2018). The problem is much larger in scope and complexity. Traditional policy solutions might be more viable if the problem was just limited to opioids and policymakers could pass legislation to increase regulations on the prescribing of these drugs. However, because the addiction epidemic includes a variety of addictive substances it would be difficult and time-consuming to create new legislation to lock them all down. The addiction epidemic affects populations differently in different areas. For instance, in the Midwest and west coast, Methamphetamine is a larger cause of deaths with "Montana seeing more than a 400 percent increase in meth violations from 2010 to 2015" (Sandhya 2018). This statistic illustrates that across the nation drug addiction is a huge problem that stretches from Maine to California. These aforementioned increases in deaths over time is a trend and shows that this is a problem that may only get worse if intervention methods aren't introduced. There has been some momentum to combat this issue with a "The 2018 appropriations omnibus spending law provided about \$4 billion to combat the epidemic, the largest amount to date" (Sandhya 2018). This is a good step, however, money has been put to this problem before such as in 2016 when the house passed the Comprehensive Addiction and Recovery Act and the 21st Century Cures Act, and there still was an increase in overdose deaths by 12% from 2016 to 2017. What this means is that simply putting money towards the problem isn't enough and new methods of treating addiction are needed.

Low resources low-income areas are at particular risk to the harms of mental illness. In a study looking at deaths they "Analyzed death certificate data during 1999–2015 and reported that suicide rates in less urban areas are higher than in more urban areas and the gap in rates has been widening (Kegler 2017)". What this shows is that the lack of mental health care in rural communities is exacerbating the aforementioned mental health problems laid out in this paper. This is a need that needs a rapid response that can be deployed across rural areas. A team of researchers did a literature review of the current landscape of rural mental health and illustrated some of the issues facing this demographic. The review lays out some of the problems rural communities face in getting mental health treatment. The key three barriers according to the review are limited access to specialty mental health providers, lack of sufficient mental health training, expertise and coordination; finally limited utilization of available mental health services because of stigma or lack of awareness(Gamm 2010). Specialty mental health workers include a

psychiatrist, child psychiatrists or anyone with specialized mental health training at a high level. The solutions proposed in this review mainly have to do with mental health pipeline adjustments. These adjustments take the form of increased recruitment of individuals from rural communities into graduate mental health programs and funneling existing medical school students into rural areas. This is a viable solution long term; however, in the short term i.e. within a decade, quicker solutions will be needed. This literature review provides an overview of rural mental health and gives more background to the problem.

Low resources low-income areas offer a particular challenge as traditional treatment methods often don't work or are inaccessible in these areas. Not only is mental health care costly it often simply isn't there in communities it needs to be. A study by the American Journal of Preventive Medicine found that "a majority of non-metropolitan counties 65% do not have a psychiatrist and almost half of the non-metropolitan counties 47% do not have a psychologist" (Andrilla 2018). There is a glaring need for psychological treatment in rural areas that are not being met. This lack of care in rural areas has pernicious effects on those areas. This glaring need is mainly due to a lack of providers. CDC surveilled some data and found that "Suicide rates in nonmetropolitan/rural counties are consistently higher than suicide rates in metropolitan counties" (Ivey-Stephenson 2018). This again shows that in rural areas mental illness is a more pernicious problem. Additionally, this shows the effects of lacking mental health services, death. The people that live in rural areas face a larger treatment gap in mental health services and the lack of treatment is having dire consequences.

Developing countries also have a need for mental healthcare. While their needs don't necessarily take the form of an epidemic of addiction, there is still a large need. This is a paper published by the World Bank that investigates the links between adverse events and mental illness, focusing on the country of Nigeria. This is a broader paper that contains a variety of analysis relating to the context of mental illness. For instance, the paper discusses how the global cost of depression and anxiety alone in terms of lost productivity is estimated to be around one trillion dollars (Jamison et al 2018). That fact is distinctive and illustrates the extent of the problem and offers an incentive for solving the problem of mental illness. One of the specific links found in this paper is that exposure to a conflict has a large and strong relationship with developing depression, specifically a 15.3% increase in the probability of depressive symptoms (Jamison et al 2018). There are triggers for mental illness for people near conflict and people near conflicts are at risk groups for mental illness, specifically depression. This is a need area for people and that this paper helps illustrate the contexts with which the proposed intervention might exist, conflict zones. Another key fact found in this study is that parental depression is correlated with a lower likelihood that a family spends money on education expenditures (Jamison et al 2018). This finding illustrates how far-reaching the effects of mental illness, specifically, depression can be. Also indicates how a cycle of poor societal outlooks can be created by untreated mental illness. Overall this study gives a varied view on mental health in Nigeria and was very recently published in December 2018 which contributes to its relevance.

Conflict can affect mental illness regardless of location. In another paper by the World Bank Development Research Group, two authors conducted a literature review of the mental health effects of conflict. The areas the researchers review literature from are Europe, specifically Bosnia and Herzegovina. The review is unique in that the review measures conflict from numbers from international organizations rather than assessments based on respondents memories. One of the key findings from the review is that older people and women are more likely to have worse mental health as a result of exposure to conflict (Quy-Toan et al 2009). This

is important because it identifies which groups are most at risk to mental health illness when conflicts happen. This knowledge of at-risk groups combined with the aforementioned Nigeria data to create a clearer picture of mental health and conflict. Showing that in certain contexts there is a connection between conflict and mental illness. Additionally, the review found that people with more education have better mental health measurements (Quy-Toan et al 2009). This paper in totality is useful because it shows clear examples of how conflict can cause mental health problems both which populations are more likely to be affected, and which are likely to be a bit more resilient. The paper highlighting which groups are most vulnerable to mental health issues helps inform how interventions should be shaped and take note of accessibility to women, less educated populations and older people. These data points continue to add more background on the issue of mental health problems and how they proliferate around the globe.

The challenges of getting health care to people in rural areas are similarly present in developing nation contexts. A study in a global health journal that aimed to investigate the possibility of introducing western mental health models in developing countries and found the main problems being lack of skilled worker, different cultural base, and lack of infrastructure (Kopinak J. K. 2015). The piece certainly highlights that it is an uphill battle to adopt western methods in developing states. This article is useful in that it takes a specific look at the challenges of adapting mental health care into the developing world and points at a lot of the pain points the three-tier intervention approach hopes to solve. The article even comes to some of the same conclusions, that in the intermediary Lay-health workers maybe need to meet the treatment gap. Additionally, the journal piece illustrates how vital integrating the local people and culture is to the success of any mental health intervention. The paper does say it is possible to improve mental health outcomes in low income Saharan African countries but more research is needed. Another study that looked into the possibility of integrating mental health care into primary care in Ethiopia. This study was able to demonstrate the feasibility of using lay health workers to deliver mental health care (Hailemariam 2016). However, the article lays out a couple of themes that make it hard for mental healthcare to be integrated. First, there is simply a lack of available services. However, the main barrier for most respondents was affordability. The study also takes a valuable lens in that it evaluates the problem from an equity point of view. The study does find that is harder for women to access mental healthcare services, mostly due to a lack of socio-economic opportunities. This article is well cited and has the unique facet of taking a look at the mental health issue through an equity lens, all of which make it instructive for developing my thesis. The problem of cost is not unique to developing or less developed nations. The Peterson Center on Healthcare and the Kaiser Family Foundation found that "Adults who have any mental illness and report an unmet need for care most often report not using care due to the cost"(SAMHSA 2017). This again shows that cost is a barrier for people seeking health care even in a highly developed nation such as the United States. The cost of mental healthcare can be high which is a barrier to people accessing care in a variety of societal contexts. These barriers lead to a treatment gap which can lead to negative outcomes.

Mental health is a vast public health problem and will cause a large amount of economic loss to states around the world. An Embo report found that "Overall, more than 50% of the general population in middle- and high-income countries will suffer from at least one mental disorder at some point in their lives"(Trautmann 2016). Not only is mental health a prevalent issue that affects millions of people it also affects people of all income and economic levels. In addition, the "WHO estimates that 25% of all patients using a health service suffer from at least one mental, neurological or behavioral disorder, most of which are undiagnosed or untreated"

(Bloom 2011). Mental health issues permeate a vast swath of society. This prevalence across the globe means that, there is also a vast economic cost associated with mental illness "Between 2011 and 2030, the cumulative economic output loss associated with mental disorders is thereby projected to US\$ 16.3 trillion worldwide, making the economic output loss related to mental disorders comparable to that of cardiovascular diseases, and higher than that of cancer, chronic respiratory diseases, and diabetes "(Trautmann 2016). Again this illustrates how costly mental health disease burdens are.

INTERVENTION CONTEXT

There are several types of psychological treatment for mental disorders. There are methods like Freudian psychoanalysis which looks at childhood wounds to get at the root causes of conflict (Psychology Today). However, for this intervention, the treatment method is going to focus on Cognitive Behavioral Therapy. Cognitive Behavioral Therapy, often abbreviated to CBT, is a form of psychotherapy that treats problems and boosts happiness by modifying dysfunctional emotions, behaviors, and thoughts (Psychology Today). CBT is a popular therapy form and has been employed and been proven successful in treating mental illnesses. This effectiveness is what makes it ripe for opportunity, to help people in low resource, low-income environments. Another intriguing option for a solution to the problem of access to mental healthcare in rural settings is the Lay Health Worker. A lay health worker is defined by the World Health Organization as "a member of the community who has received some training to promote health or to carry out some health-care services but is not a health-care professional" (WHO). The strength of the lay health worker is there is much less time investment spent on them compared with a more traditional mental health care worker. Additionally, because it's possible to train locals to be lay health workers they come as workers with a native understanding of the local cultures and custom which is incalculably valuable for doing healthcare work. Another avenue for a solution can be found in the field of mobile health, also known as mHealth. The Global Observatory for eHealth of the World Health Organization defines mobile health as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices"(Young-Taek Park 2016). This avenue takes advantage of the increasing power of mobile devices to create new solutions for health problems. The mobile aspect of this technology is also important because that means solutions developed using mobile health methods will be more flexible in ways that solutions that are based on a static inpatient facility's or static practitioner locations can't be. Other researchers have come to similar conclusions about mobile health being an effective avenue for treating mental illness in the 21st century. The article details with sources about how mobile health has been shown to be feasible as an approach for people with mental illness (Ben-Zeev 2016). The researcher details out how cheap and widely available phones have become and the opportunities this offers in the mental health arenas (Ben-Zeev 2016). As mobile phones become cheaper and more ubiquitous the effectiveness of mobile health can only increase. Other modes of intervention have been tried before, some using ideas such as cognitive behavioral therapy and traditional in-person therapy methods. A study that focused on Interpersonal psychotherapy, a subsection of cognitive based therapy, as a possible treatment method for depression in Uganda. This was the first controlled clinical trial of a psychological intervention in resource-poor Sub-Saharan Africa and found that that IPT was highly effective at reducing depression and depression symptom and that these treatment methods are feasible in a

rural Sub-Saharan Africa low resource environment (Bolton P et al 2003). This shows that cognitive behavioral therapy can work in low resource rural areas. This is a possible avenue to explore when treating mental illness in low resource rural areas.

A study that looked into the possibility of integrating mental health care into primary care in Ethiopia and how locals would feel about the approach. The article lays out a couple of themes that make it hard for mental healthcare to be integrated, the main problems being a lack of available services, and affordability (Hailemariam 2016). These problems with accessing care are similar to what is happening in rural America and accessing mental health care. The paper concludes with finding respondents were welcoming of new mental health care and even that the field was prime for lay health worker integration in the intervention (Hailemariam 2016). A team of researchers responding to a large treatment gap in mental health treatment capabilities, 10 psychiatrists for a population of 13 million, investigated if lay health worker delivered psychological intervention could improve symptoms of depression and anxiety in Zimbabwe. The intervention studied was also a form of cognitive behavioral therapy where a patient identifies a problem (e.g. unemployment) rather than a symptom or diagnosis. Participants were taught a structured approach to identify problems and finding workable solutions through 4 individual sessions with lay health workers than in peer-led groups. Overall the study concluded that Lay Health Worker administered primary care with education and support resulted in improved symptoms at 6 months (Verhey et al 2016). This study is instructive in that it highlights that lay health workers can be effective at treating mental illness. The study also shows that lay health workers can deliver cognitive behavioral therapy in an effective manner.

Another study looked at the possibility of introducing western mental health models in developing countries. It's important to include this study because it looks at a different treatment case in Africa, specifically Uganda. Differing perspectives from differing areas need to make sure the intervention method is viable in a variety of situations. This article is also useful in that it takes a specific look at the challenges of adapting mental health care into the developing world and points at a lot of the pain points my thesis hopes to solve such as the treatment gap left by lack of worker and mental health care infrastructure. The article even comes to similar conclusion that in the intermediary Lay-health workers maybe need to meet the treatment gap (Kopinak 2015). This again shows the feasibility of Lay health workers in treating mental illness in these low resource low-income environments. The study also illustrates it is feasible to combine lay health workers and cognitive behavior therapy. Another study on examined the usage of Mobile Communication Technology (text-based solutions) aimed at preventing relapse and recurrence in remitted, recurrently depressed patients and found that "Overall uptake of the intervention and adherence was high with a low time investment of therapists"(Kok 2014). This study looks directly at mental health care effectiveness with Mobile technology and concludes that mobile technology would indeed increase the effectiveness of mental health care. Another key characteristic is that this study did employ SMS messaging and phone calls to keep patients up with their action plan. Overall the study concluded that LHW-administered primary care with education and support resulted in improved symptoms at 6 months. A cost-effective solution of Lay Health workers and Mobile Cognitive Therapy would be a great way to combat mental health crisis in resource-scarce areas.

Technology has also been used for behavior change in the medical setting before. Particularly short message services or text message has proven effective in a clinical setting. This is a review that aimed to compile and analyze evidence on online and mobile-based interventions for psychosis. They found evidence that SMS messages helped patients continue to take their

schizophrenia medications, helped as an early warning for relapses, and increased social contacts (Alvarez-Jimenez et al 2014). The online interventions reviewed also had positive results and those online based interventions could possibly be replicated on Smartphones (Alvarez-Jimenez et al 2014). The SMS findings are particularly promising for my thesis as it shows mobile phones can be effective in treating more intensive mental disorders such as schizophrenia. The behavior modification shown here would be an indicator of future success with depressive and anxious patients with cognitive behavioral methods.

Studies have also shown that SMS technologies can treat other diseases. This is a study review that aimed to find whether phone text-messaging (SMS) was effective at enhancing adherence to antiretroviral therapy in people with HIV. The literature review concluded with finding that patients that receive SMS messages did have higher adherence to their medication regimes (Horvath et al 2012). Additionally, they found that the length of messages didn't matter but that daily messages did prompt better adherence than weekly messages (Horvath et al 2012). This study supports my thesis in that it shows SMS messaging can help patients stick to a treatment plan. Additionally, the review shows that technology can improve outcomes in other health sectors. This is promising as comorbidity is a core issue with mental health illnesses. This is a study that took place in Germany that aimed to evaluate the effectiveness of text message-based intervention. During the study, the patients intermittently received text messages that would help with relaxation techniques (Schlicker et al). The key thing about this study that makes it valuable for inclusion is how it evaluated personally tailor messages. The people conducting the study took messages from patients during their in-hospital therapy that patients self-wrote that contained what they learned during therapy. Interestingly the study found that the individualized messages were not more effective than the standardized ones (Schlicker et al). This means that for SMS treatment messaging standardization may be a more feasible path as it allows for easier scaling to large populations because you don't necessarily need to tailor specifically to the person for the treatment to be effective. However, in the end, the study concludes both standardized and individualized messages helped reduce the severity of symptoms (Schlicker et al).

Ghana is a useful area to look at as in Ghana they have similar problems with accessing mental healthcare that rural Americans have, which is not enough clinics or practitioners. Also like rural America, Ghana has a fairly decent telecommunications infrastructure. The infrastructure needed to support mobile health interventions being data connectivity of some kind and access to electricity. An article here that looks at the case study of Ghana and found that "stakeholders from all sectors (patients, providers, government officials, and traditional and faith healers) were open to exploring whether mobile health approaches could promote more humane care, reduce human rights violations, and improve the clinical outcomes of those in need" (Ben-Zeev 2018). Also found that despite less than ideal literacy among the populace that did not hinder mobile phone use. The article also had the important observation on how integrated spiritual healing is in this society and that any treatment method that would try to bypass that would be a mistake. Additionally, the paper illustrates they have the overall same feasibility of mobile health interventions while underscoring the need for administrators of interventions to have cultural knowledge of the patients.

This is a study that looks at the feasibility of using mobile health in the Middle East. The study took the form of a survey of Palestinians in the West Bank and had several important findings. The study found that respondents were at an increased risk of mental illness due to their prolonged exposure to political violence (Ben-Zeev et al 2017). This shows that conflict again is

an exacerbator for mental health issues and shows that this stays true in Middle Eastern contexts. Additionally, the study found that the people in the West Bank were receptive to mobile health approaches. The study looked into the viability of mobile health in this context and they found that mobile health approaches would be appropriate as there was sufficient infrastructure to support mobile phone technology (Ben-Zeev et al 2017). The infrastructure that is needed and is present in the area is 3G data and power. This is important because it again shows the feasibility of mobile health in another area beside rural America. The article also shows that mobile health can be flexible and be feasible in areas one might not normally think it would be. The article is also useful in that it illustrates that the people here also suffer a lot of the same problems as people in rural America, mainly a lack of train mental health professionals.

A study aimed to develop and test the feasibility of web-based Cognitive Behavior Therapy to support self-management in patients with type 2 diabetes. The intervention took the form of a smartphone application that allowed users to record diary entries, allowed researchers to send feedback to users based on ACT principles and diaries entries, and finally had audio files with relaxation and mindfulness exercises (Nes et al. 2012). The participants found the online diaries to be useful and help with developing values, goals and lifestyle changes (Nes et al. 2012). This study shows that Cognitive behavioral therapy delivered by mobile phone is feasible and produces positive results. Additionally, the study illustrates the need for effective User Interface design when creating mental health mobile software.

Mobile health interventions can also be applied to more unique sub-population groups such as youths. A randomized controlled trial that aims to investigate the effectiveness of a mobile phone application "Mobile-type" in a primary care setting. The app consisted of a system that periodically prompted users to record their mood and then the app sends that data to a General Health Care Practitioner. The main benefit of the app was assistant self-monitoring of emotional state (Reid et al 2011). The study ultimately concluded that the app was effective at increasing user's emotional self-awareness and supported General Practitioners in delivering mental health care (Reid et al 2011). This study was valuable because of its unique characteristics. First, this study was focused on youths aged 14-24. Additionally, the study states the phone all of the participants used, a Sony Ericsson Z750i. This type of phone is relatively cheap and is likely to reflect the type of phones available in low resource environments. The youth focus of the study also helps show that mobile software mental healthcare interventions can work for this demographic.

Refugees are also a group of the population that is in need of mental healthcare in developing contexts and around the world more broadly. The World Bank created a paper that looks at the relationship to people of refugee status and the risk of mental illness. One of the areas it highlights well with its research is how mental illness is often connected to other factors such as economic status, refugee status, or other diseases like HIV (Marquez et al 2016). This is useful to know because it lends credence to the idea that approaches to solve one of those issues should be adaptable to layer an intervention to solve another issue. This is where mobile-based interventions are so strong because and an app can have a section focusing on helping with mental health symptoms but then down the line a developer could roll out a new feature that helps with HIV management or help with refugee migration. The paper also mentions how Lay-health workers can be an effective quick way to get mental health care to people that need it, which is another component of my original thesis. Finally, this paper argues how vital delivering maternal mental healthcare is by highlighting how mothers are at increased risk of depressive symptoms (Marquez et al 2016). This is an important finding to note as it again informs how the

intervention should be tailored if it can be to be maximally effective at improving societal outcomes. This study also indicates a possible cycle of poor outcomes with the mental health of one family member affecting another.

Veterans are also a somewhat unique group that would be a target group of this intervention. This is a study that looked at how veterans with post-traumatic stress disorder feel about mobile application treatment interventions. The study results found that there was a strong dichotomy that exists where participants either really liked apps or really disliked them with the divide being between rural and urban, with age not having a significant factor on participants' attitudes towards the application (Connolly et al 2018). The study is important as it adds valuable information in understanding a specific population. First, it is a study that looks at a specific population with mental health issues and contrasts how their age and location may affect how receptive they are to treatment. The findings suggest there may be some trouble with rural veterans and acceptance of this intervention but that in urban areas there is a promise. Additionally, conflict triggered mental health issues are also issues that affect people in Sub-Saharan Africa as previously discussed and treating this type of mental illness in an effective manner is vital. The study also had key data points and findings that weren't in the other studies reviewed, particularly a problem with a lack of personality. A significant portion of the participants found the mobile applications hard to connect on an interpersonal level (Connolly et al 2018). This indicates that a mobile health alone intervention may not be most ideal as the technology alone lacks a human element that is needed. Additionally, this may indicate a need for more voice support and feedback that users can interact with. The increase in interactivity would hopefully make the app more personable and usable to this target population. Finally, a key thing that was illustrated by this study is that some users found having their symptoms laid out on the screen distressing and enforced the problems they are experiencing (Connolly et al 2018). This is a development that wasn't seen in other studies but makes sense when thought about. A person who is going through depressive symptoms may not want to be reminded they are going through depressive systems as that reminder could actually end up reinforcing the depression symptoms. This is important to know as it indicates that a feature to toggle off symptom displays may be valuable for inclusion in the mobile health intervention. The study also highlights how when creating interventions considerations must always be made to the ethics of the intervention and possible negative effect the intervention could have on participants.

While single studies are useful in understanding the usefulness of cognitive behavior therapy as an avenue, systemic reviews hold more weight because they give a larger view of results. Cognitive behavioral therapy is a powerful tool that can also be used to improve other health outcomes besides mental illness. An article introduces evidence that apps can better help patients reach their health goals. The article did a literature review of studies that used apps to reach fitness goals. The literature review article concluded that health and fitness apps often contain behavior change methods and that the more of these that are included the more successful the app is at changing behavior (Higgins, J. P. 2016). This article is important for understanding the usefulness of cognitive behavior therapy because while fitness is not directly analogous to mental health, these studies still show that behavior change models work with mobile software and programming. Additionally, this review looked at a study that demonstrated that social media integration was highly effective when paired with behavior change models (Higgins, J. P. 2016). This is important because people in Sub-Saharan Africa are per capita using social media more often than their western country peers, the main social media platform being WhatsApp.

This is a literature review that aimed to review the research evidence supporting the efficacy of mental health apps for mobile devices. The review looked at smartphone apps targeted at treating mental health symptoms of Depression, Anxiety/Stress, and Substance Use. First looking at depression the review looked at 3 mobile apps focused on depression and found that in 3 studies participants showed a reduction in their depressive symptoms with patients using the "Get Happy" app which had significant reductions in depression symptoms (Donker 2013). The wider relative scope of this study means that the results are a bit more valid and again concluded that cognitive behavioral therapy and mobile health work together. This is important as depression is a mental illness that affects a lot of people and this part of the review adds more credence to the idea the mobile health can be a solution. For the review of anxiety apps, the review looked at three Random Controlled trials focused on one mobile app (Mobile Stress Management) and found that all studies showed a reduction in anxiety symptoms with one study showing a significant reduction (Donker 2013). Anxiety is another major common mental illness and this review shows it's feasible to treat anxiety with combined cognitive behavioral therapy and mobile health. Finally, the review looked at an app that combined mobile software CBT and face to face CBT with a therapist and found that participants in that study had a reduction in their urges to use substances (Donker 2013). Also intriguing as this illustrates the cognitive behavior therapy can be used with mobile health to treat substance abuse. Substance abuse is another subject of mental illness and currently is seeing a large uptake in America so finding evidence of feasible treatment methods here is promising. This literature review overall does show positive results with only one trial showing mobile apps to have no effect on mental health symptoms. Additionally, this review included a study on substance abuse treatment and found mobile phones to be effective in treating that mental health problem and this is a valuable area of software use.

While systemic reviews are useful literature reviews that look at specific mental illnesses and mobile health effectiveness at treatment option is important as well for a more specified viewpoint. A literature review also looked at anxiety specifically and the possibility of treating it with mobile health methods. This is a systemic review and meta-analysis of all randomized controlled trials that use smartphone applications to treat symptoms on anxiety. The review found that the strongest evidence for using smartphones to treat anxiety disorders appears to be when they are integrated with the delivery of face to face interventions (Firth et al 2017). This review is useful in that it aligns with my central thesis that a program that combines a mobile app with a healthcare worker is the best approach to providing effective care. The review also shows direct feasibility of treating anxiety with mobile health and cognitive behavioral therapy. The review also underscores the need for face to face components when determining which interventions models work best. Another study by the same group did a literature review looking at the feasibility of mobile health solutions in treating depression specifically. The reviewers analyzed 18 randomized trials that looked at 22 smartphone apps and found that apps based on Cognitive Based therapy were indeed successful in reducing depressive symptoms. One interesting part of this review is that it actually found that apps that used in-person and mobile interventions were, in fact, less effective than an intervention that was app only (Firth et al 2017). This conflicts with my previous findings that found that a dual approach worked best. However, the researchers theorized this was because not that the dual method was bad but that methods that relied on an in-person and app intervention used apps that were less robust and comprehensive (Firth et al 2017). Additionally, this review found indications that apps used in application feedback were more effective than those that didn't (Firth et al 2017). What this means is that

when creating a treatment plan it is important to not make a less robust app simply because an in-person intervention is layered with the app. This also shows that communication is a valuable part that must be included in a treatment method if it hopes to be successful.

Another important part of mobile health is as technologies advance the mobile platform and mobile health as an offshoot of mobile technology will have more possibilities in ways to innovate treatment. This is a single study that looked at using a mobile phone app to treat depression that uses context-aware systems to detect the user's status to provide context-specific treatment. The app used mobile software Cognitive Based Therapy approach that other apps reviewed have used but additionally layers a data collection component with the therapy. The app passively collects data about the user such as location, proximity to other Bluetooth devices, ambient light, and accelerometer. The app periodically sends this data to a cloud server. The app also asks users to periodically report their mood and emotional statuses. The app backend then combines the self-reported data and sensor data and attempts to deduce the user's mood in the future and provide CBT based on that mood. In the end, the study found the software to be somewhat successful and predicting a user's emotional state with a 63% accuracy rate and that patients had a reduction in depressive symptom over time (Burns 2011). This study is instructive in that it is the first attempt to use combine machine learning with mobile software CBT in a trial setting. While the results were limited by the study size it does point to the feasibility of this method. The restrictions mentioned in the study such as data connectivity and battery life means this method is unlikely to be used in rural communities at this time but as infrastructure progresses this integration of machine learning becomes a promising possible new feature.

PROPOSED INTERVENTION

The intervention model I propose would be a combined strategy of integrating Cognitive Behavioral Therapy, a mobile phone, and lay health worker. This would look like an application on either an iPhone or Android phone that has multiple modules. One part of the application would focus on mood recording. What this would look like is visual scale containing symbols representing moods on a color gradient scale. The next part of the app would be solutions to help alleviate symptoms such as relaxation techniques or coping strategies. The final main portion of the app would be some type of communication portal to connect to a health care professional. This communication portal would be vital as the research cited previously suggests that interventions have more success when there is an interpersonal component. Finally, there should be SMS or push notifications enabled within the app so patients using the apps can get reminders, updates, or new treatment information. This mobile software approach is preferable to a simple text message-based mobile health intervention because of the plethora of features that can be offered in a mobile app that can't be offered by text message. Additionally, apps can be updated with new software and can integrate more advanced technologies like machine learning for more effective health care. Another part of this intervention is the lay health workers. Lay Health Workers also known as Lay Councilors or Community Health works are individuals with little or no formal medical training who are given basic tools of helping people with mental illness. Their training is often quick taking up anywhere from 6 to 10 weeks of time. The advantage of lay health workers is it is easier to train people in basic counseling techniques than it is to train a counselor to recognize and understand the complex social relations and cultures or a given area not to mention language

in a short amount of time. With the lay health workers ready the next phase of the intervention would be to familiarize them with the application and its functions. The technology would then be used by mental health professionals to go into a community, set up shop where available, get patients to download the software and start treatment. The app would work as an amplifier for the abilities of the mental health professional by providing some remedial care right on the app itself and allow for contact if the patient needs more extensive treatment. Additionally, through the mood monitoring the app would allow a single mental health professional to track a larger magnitude of patients than would be possible without the app.

There may be some skepticism in using an application on a phone to help combat mental illness but some studies show it's possible. A team of biomedical engineers and psychiatrists created a prototype smart-phone application that offered users the ability to access therapeutic exercise and mobile therapists for dealing with mental health issues. The study had promising results finding that "Participants quickly grasped the Mood Mapping and therapeutic concepts, and applied them creatively in order to help themselves and empathize with others. Applications developed for mobile phones hold promise for delivering state-of-the-art psychotherapies in a non-stigmatizing fashion to many people who otherwise would not have access to therapy" (Morris 2010). What this study found is that it is possible with mobile applications to generate positive mental health outcomes. Additionally, because the app can be kept private and doesn't require going into an office or anything its prime for people who don't want to be stigmatized or are less mobile. A paper published in the Journal of Mental Health found similar results. This paper conducted a review of the field of mobile mental health and conducted a proof of concept study themselves and found that "Preliminary analyses found that participants' symptoms of stress, anxiety, depression, and overall psychological distress were significantly reduced after using an interactive self-help software, which includes real-time self-monitoring with short message service prompts and brief online modules grounded in cognitive behavioral therapy" and concluded that "These preliminary results support the feasibility of implementing mobile phone-based interventions with the potential of improving psychological wellbeing" (Harrison 2011). What the paper illustrates is that there is indeed feasibility to use mobile phone-based software to help people suffering from mental health issues.

LIMITATIONS OF INTERVENTION

One of the biggest limitations of this intervention is the language and cultural barriers. The problem is that it is hard for traditional therapy treatments to work in a context in which they weren't developed within. Additionally, some mental illness concepts might not translate well or exist at all in some local dialects or cultural knowledge. The language and cultural barrier could be overcome with more specified literature created for mental healthcare. A study in Zimbabwe aimed to develop an indigenous measure of common mental disorders in the Shona language in Zimbabwe; the researchers were ultimately successful and were able to create the Shona Symptom Questionnaire which is an already developed questionnaire for a measure of common mental disorders in Harare (Patel et al 1997). This does show that it's possible to translate jargon heavy western medicine diagnostic tools into a native language of a completely different culture. While it's possible it also takes a lot of time and a specific team of researchers to do so. Thus this approach may not be viable in the immediacy for intervention situations. The study that investigated the cultural differences in mental health group therapy in Uganda and found that "The biggest obstacle to the intervention was that there wasn't a single word to describe

depression in the local Uganda dialect and they had to match the local depression-like syndromes "Yo'kwekyawa" and "Okwekubazida" with depression symptoms in the DSM-4" (Bolton et al 2003). This shows that language is indeed a possible obstacle to intervention. However, it also shows it's possible through enough study of the local language and customs to translate therapy methods and language. The problem is this translating would take time to execute and then implement effectively. However, this is where the strength of my proposed intervention of integrating Lay health workers comes in. Lay health workers would be community members with already ingrained cultural knowledge, thus overcoming some of the language and cultural barriers.

The lay health workers themselves could also be a limitation to this intervention. Training even in limited health care tools and services can be hard to do, especially in low resource rural areas. However mobile phones could be used to train the health workers as well as deliver the treatment intervention. In this study, researchers investigate the effectiveness of using mobile phones to help educate midwives in rural South Africa. The study concluded that there was a lot of potential to educate health workers with mobile phones but that workers themselves didn't necessarily know of all of the possibilities of the mobile phone and that there are some positive metrics such as high phone penetration with 95% of respondents having a phone and half of those having a smartphone (Chippis et al 2015). The study puts forth the idea that having institutions utilizing mobile phone education more would be vastly beneficial. This article is valuable to my thesis in that it highlights another way that mobile phones can be useful with regards to mental health. Ultimately showing that lay health workers can themselves benefit from mobile-based delivery systems. Again the strength of the three-layered intervention is that the three sections can help overcome the shortcomings of the others.

A counterclaim to the efficacy of using mobile phone-based interventions and traditional care approach is the lack of patient retention and adherence. People already are fairly sporadic with phone use; it's entirely possible that someone in mobile mental health programs simply gives up on the program. That is a valid concern and in fact, there was a paper published that looked at this problem. The paper took a randomized controlled trial of 129 remitted patients with episodes of depression and found that "Overall uptake of the intervention and adherence was high with a low time investment of therapists, and our results indicate Mobile CT as an acceptable and feasible approach to both participants and therapists" (Kok 2015). While concern for patient retention is a valid one it is unfounded because with proper follow-up care retention rates can stay relatively within the margin of error. This further validates the idea that mobile-based software is a valid way to increase positive mental health outcomes.

While software-based solutions are ideal there are situations in low resources areas where such technology capable of running software might not be available. However, cell phones with basic text function may be more available and there are text-based solutions for amplifying mental healthcare effectiveness in rural areas. While it isn't ideal it would be possible to still combine the three-layer approach with only text messaging and not software. As gone over in previously in this paper SMS text messaging is a feasible method to administer cognitive behavioral therapies. Meaning applying a text-based adherence program to lay health workers would indeed boost their effectiveness. The final limitation of the intervention is how young of a state the field is in. There are indeed a good amount of studies showing, Lay Health Worker, Mobile Health, and Cognitive Behavioral Therapy feasibility in treating mental illness. However large-scale studies on each haven't been done as the field is so new. Additionally, there were none that I came across that explicitly aimed to combine the three in a rural setting. This means that there would be a level of uncertainty with this intervention and its effectiveness.

Cognitive-based therapy also has limitations in its implementation. This paper investigates mental illness and the variety of approaches actors on the political stage can take to improve outcomes whether that is new treatments or new policy. One of the key findings in this paper is that cognitive-based therapy is indeed an effective method to treat mental illness but has a relatively high cost per patient compared to other methods which make it a somewhat restricted approach (Levin C et al 2016). This is a useful finding for intervention because it again validates that cognitive-based therapy is a valid method of treatment and that there is a need for finding a cost-effective way to deliver it. Another interesting finding is that while cognitive based therapy in some contexts may not be cost effective in some case it can be. For instance, this paper reviewed a case in Thailand that found that combining CBT with Older Generic brand depression medication was an effective and cost-effective method of treatment (Levin C et al 2016). What this means is the cognitive behavioral therapy isn't always more costly and when compared with other avenues of treatment can actually create cheaper intervention cost person. The use of lay health workers and mobile health can still be a feasible treatment method for those in low resource environments.

Another limitation of this intervention is that there would need to be significant will power and funding behind it to implement. This is because it is an entirely new unproven method and people who may want to implement this intervention might be hesitant to do so. Additional new tools and programs would need to be developed for this intervention and would all have to be tested. However, there is a literature review that argues that emergency situations whether natural disasters or armed conflicts offer an opportunity to accelerate mental health reform. The logic laid out is that emergency situations bring humanitarian aid and attention which could be channeled into mental health treatments that normally wouldn't get such resources. The review looks at several case studies including Afghanistan, Burundi, and Kosovo and was able to show in each case that mental health services were developed in some capacity, where they were unlikely to before because of newly lack of available outside aid (Epping-Jordan et al 2015). While the sustainability of these project reviewed is questionable the problem that this approach attempts to overcome is the apathy that can come when attempting to combat more intangible diseases such as depression and anxiety. While this approach may not be the best for long term stability it demonstrates a possible way more research into the field may be generated through harnessing the political will for solutions that appear in times of crisis. This approach also matches well with the proposed three-tiered intervention method for a variety of reasons. The main reason for working well with the intervention is speed. Mobile health platforms and lay health workers are both much faster to set up and deploy than traditional mental health programs and facilities. Which means that once a crisis occurs the intervention would be easier to set up and get going. Adaptability is another reason this approach works with the proposed three-tiered intervention. Being a mobile health software based intervention means new modules can be rolled out remotely. This makes the software, and intervention, more adaptable to a variety of situations. For instance, in giving mental healthcare to people involved in an extreme weather event the app could also direct people to the nearest shelter or it could direct people away from dangerous situations. This would minimize the participant's exposure to traumatic events and create more improved outcomes. The app could also function as a communication outlet to aid groups so affected populations could get help and treatment outside of the scope of the intervention by contacting outside groups.

CONCLUSION/SUMMARY

It is certainly difficult to treat mental illnesses in rural areas and developing states due to lack of resources and infrastructure, but it is still possible with lay health workers, mobile health, and cognitive behavioral therapy combined. Lay health workers are health workers that have quick but effective training and the needed cultural and language knowledge. Lay health workers have also been proven to work at delivering care to a variety of populations in a variety of locations. The mobile health platform provides an effective delivery method. The delivery method has worked in a text message format to bring positive treatment outcomes for a variety of diseases. A software approach has also been shown to be feasible in improving mood and other health outcomes like fitness. Additionally, mobile health has been shown that it can be adaptable and mobile with a patient that may live in precarity or areas without the traditional mental healthcare infrastructure. Cognitive behavioral therapy is a strong psychological treatment tool that has been shown to work in a variety of contexts ranging from western countries to African and Middle Eastern countries. Cognitive behavioral therapy has also shown to be feasible in working for a variety of populations. There are barriers to this intervention notably for nonwestern countries language and culture barriers. The barrier for western countries being infrastructure and acceptability limitations. However, the three-tiered approach has feasibility in covering the weakness of each component as a singular intervention by combining them all into one intervention. Mental Health has a huge impact on the economies and societies and left untreated can create cycles of destruction. These burdens are even harder for developing states to deal with is they may not have the resources to deal with mental health problems. However mental health outcomes in a given developing state can be vastly improved with a program that combines Mobile Communication Technology and Lay health Workers to create an effective agile program that can respond to a community's mental health needs.

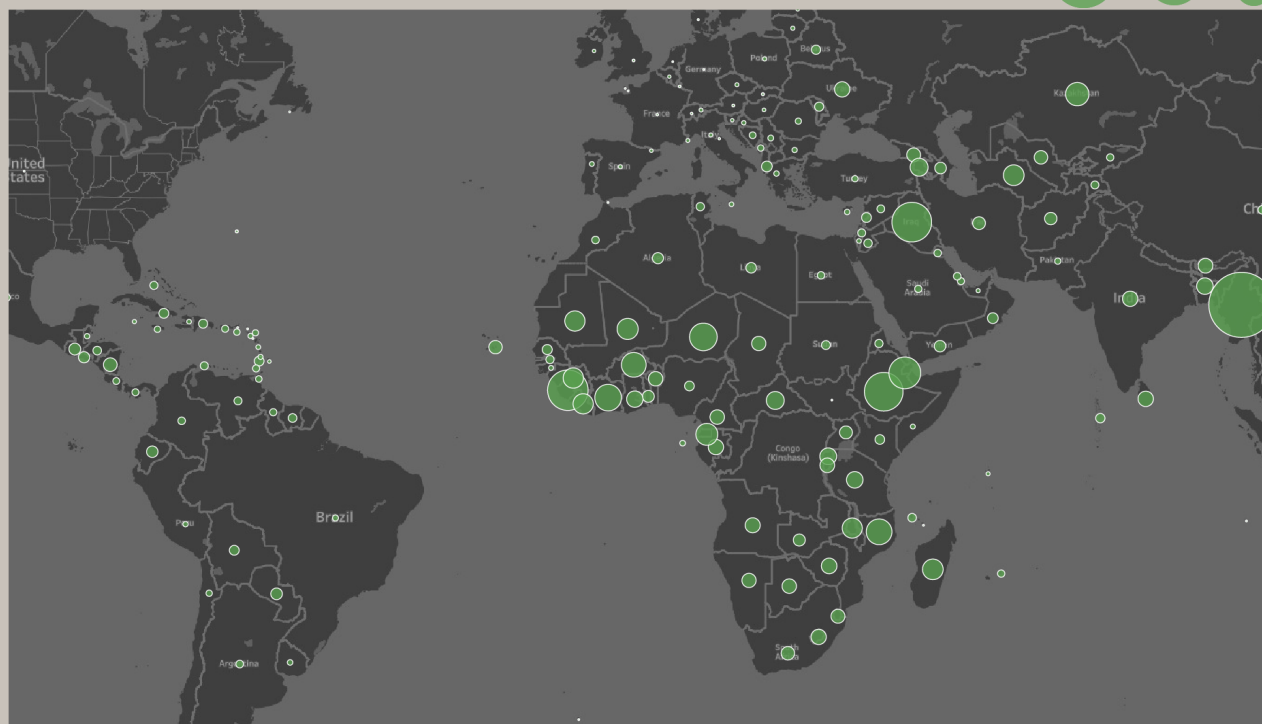
Appendix

Graphic is based on International Telecommunication Union data

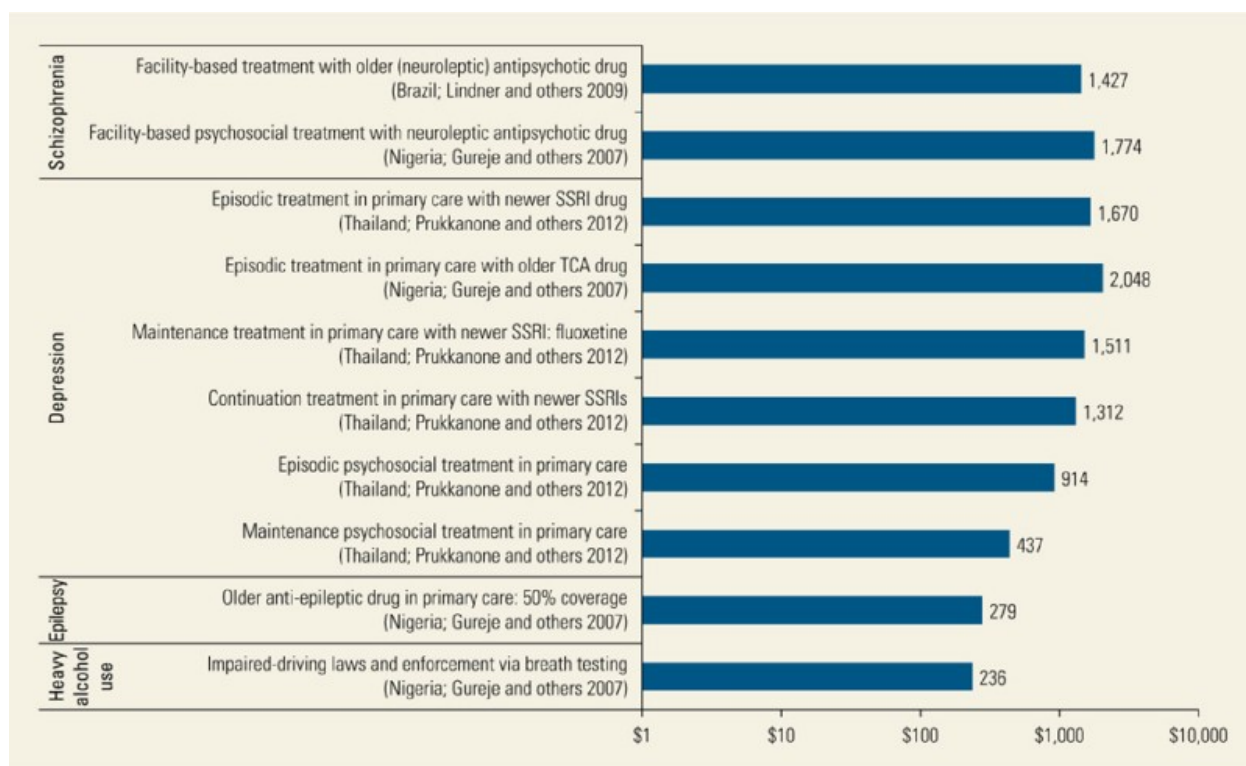
LARGEST INCREASE OF INDIVIDUALS USING INTERNET

Size shows percentage increase of individuals using internet from 2007 to 2017

14,029% 10,000% 5,000%



Graphic from one of the cited studies that shows intervention cost data



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