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Title
Comprehensive Screenings for Diabetes, Hypertension, and Mental Illness in Rural India

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Comprehensive Screenings for Diabetes, Hypertension, and Mental Illness in Rural India

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ABSTRACT

Diabetes, hypertension, and mental health illnesses constitute a substantial portion of the healthcare burden in rural India. These issues, if left untreated, can lead to debilitating diseases and further burdens on society. The aim of this study was to assess the prevalence hypertension, diabetes, and mental health illnesses in a rural Indian population. It was hypothesized that high levels of hypertension and diabetes would be present in the rural Indian village, along with a higher prevalence of depression in this community compared to other rural areas due to the high incidence of disability in the village. The health screening was conducted on 1195 patients with 973 respondents included in the study. The first phase of the study showed that a majority of the respondents had above average blood pressure values, high incidences of underweight patients, and a moderate number of respondents at risk for diabetes. The second phase of the study showed that half of the population surveyed had a depression level of moderate or higher severity. In addition, the results of the anxiety also identified that a majority of the population suffered from mild to moderate anxiety. Drastic improvements in access to education, diet, and health care are required in order to alleviate the medical conditions assessed in this study. Furthermore, the results from the depression and anxiety screenings show a large population that requires mental health treatment, although any connection between the specific disabilities faced by the villagers and these issues requires further investigation.

INTRODUCTION

The study was conducted in the village of Anandwan, located roughly 100 km from the metropolitan city of Nagpur in Central Maharashtra. The village was established primarily as a rehabilitation center for leprosy patients and other residents with a range of disabilities (i.e visual, auditory and speech impairments). These individuals are self-sufficient in terms of basic subsistence through agriculture and other micro-scale industries that are run entirely by the residents of the village. The village has a population of nearly 2,500, making it one of the largest communities of disabled people in the entire world.

Leprosy, or Hansen's disease, is a chronic infectious disease that is caused by the bacterium Mycobacterium leprae and typically affects the skin and peripheral nerves. Many studies in the past have shown a higher prevalence of psychiatric disorders, such as depression, in populations affected by Hansen's disease compared to normal populations. Kumar et. al surveyed 540 subjects with leprosy for psychiatric disturbances and found a prevalence rate of 9.9%, compared to 6.3% in the general population[1]. The World Health Organization (WHO) projects that depression-related suicide will be the second leading cause of death in the world by the year 2030[2]. Due to the increasing rates of depression, it is important to destigmatize mental illness, educate the population, and provide access to mental health professionals for individuals in this isolating position.

The International Diabetes Foundation has reported that there are 382 million people worldwide living with diabetes. In recent years, urban India has also faced the same global diabetes epidemic with over 65 million citizens diagnosed with diabetes. Although much is known about the increasing rates of diabetes prevalence in urban India, little is known about the rates of diabetes in rural India; this study was undertaken to observe the possible effects of the epidemic on a rural Indian village. In addition to assessing diabetes risk, hypertension was also assessed and the population was surveyed for high blood pressure as well as BMI. The assessment of risk factors such as high blood pressure, blood glucose level, and BMI can provide an accurate understanding of the population's health.

MATERIALS & METHODS

The study conducted was a cross-sectional design implemented in the rural community of Anandwan, India. The village for this study has a population of approximately 2,500 and had 1,165 villagers seen in the health clinic. The health screening clinic was set up in the local hospital in the village with the help of the lead doctor and the nursing staff. All villagers that came for the screening were allowed to participate in the study. All persons below 18 years of age were excluded from the study but were screened for diabetes and depression. Complete confidentiality was ensured by assigning each patient an unique identification code and consent was obtained from all participants.

HEALTH CLINIC: VITALS & DIABETES SCREENING

The clinic was set up as two separate stations. The first station was in charge of the initial screening, where the patient's name, age, height, weight, waist size, pulse, blood pressure, and blood glucose level were measured, and general observational notes were taken. Data in this station was recorded using a structured health questionnaire that included the aforementioned parameters. Weight was recorded in kilograms and was obtained by using electronic scales at the clinic. Waist size was obtained using measuring tape under the ribs on the level of the navel while standing. Blood pressure was obtained using the Omron 3 Series monitor. Blood glucose levels were obtained using the Accu-Chek diabetes monitoring kits and strips. A control solution was used for the monitors at the start of the clinic each morning to ensure a proper readout. The blood glucose levels were taken on a random basis throughout the day; some of the data had fasting blood glucose levels and some had postprandial levels.

Particulars	Score
Age [years]	
< 35 [reference]	0
35-39	20
≥ 50	30
Abdominal obesity	
Waist < 80cm [female], < 90 [male] [reference]	0
Waist ≥ 80 - 89cm [female], ≥ 90-99cm [male]	10
Waist ≥ 90cm [female], ≥ 100cm [male]	20
Physical activity	
Exercise [regular] + strenuous work [reference]	0
Exercise [regular] or strenuous work	20
No exercise and sedentary work	30
Family history	
No family history [reference]	0
Either parent	10
Both parents	20
Minimum score	0
Maximum score	100

Table 1. Parameters of the Indian Diabetes Risk Score (IDRS). The parameters of age, abdominal obesity, physical activity, and family history were used when surveying the population. Each parameter was given a score based on the responses provided. A score of >60 labeled the respondent at risk.

The study was conducted using the methods of the Indian Diabetes Risk Score[3]. The Indian Diabetes Risk Score was developed from the Chennai Urban Rural Epidemiology Study (CURES), which recruited over 26,000 individuals and tested the efficacy of the risk score model. The study had a sensitivity of 72.5% and a specificity of 60.1% for determining undiagnosed diabetes. The development of the model allowed for the identification of undiagnosed diabetic subjects in a cost effective manner. The following details were obtained as part of the health questionnaire to generate a risk score for each subject: age, sex, physical activity (number of hours exercising, working, and sitting), family history, waist size, and blood glucose levels. The responses obtained were coded according to the methods of the Indian Diabetes Risk Score (Table 1). All respondents with scores ≥ 60 were labeled as at risk for diabetes.

HEALTH CLINIC:DEPRESSION & ANXIETY SCREENING

The depression screening was conducted using the PHQ-9 survey. The surveys were developed and validated by Kroenke et. al as an accurate measure for assessing and monitoring depression severity. Surveys were in the local languages of Marathi and Hindi and the fluent clinic staff were trained to conduct the surveys. Similarly, to conduct the anxiety screenings, the GAD-7 survey was used to assess anxiety severity. The PHQ-9 has a set of nine questions while the GAD-7 has seven questions. The scores from each of the surveys were summed and the level of severity was judged using the criteria on Table 2 for depression and Table 3 for anxiety.

RESULTS

A comprehensive health screening was conducted in the village on 1,165 respondents of whom 973 were adults and 192 were children. The adult population consisted of 559 females (57.4%) and 413 males (42.4%) with an average age of 44.4 years and the child population of 192 respondents had an average age of 13.5 years. All participants were screened for hypertension, BMI, diabetes, depression, and anxiety.

The screening for hypertension amongst the population revealed that 60.6% of the subjects had an above average blood pressure with 36.7% of the respondents falling in the range for pre-hypertension and 23.8% in the range for Stage 1 or Stage 2 hypertension. The BMI analysis of the population showed that of the 973 adults screened, 376 respondents (38.6%) fell in the underweight range while 85 adults (8.7%) were in the range for pre-obese, and 25 adults (2.7%) were in the range for obesity. The diabetes screening was conducted using the methods of the Indian Diabetes Risk Score. The screening revealed that 16.4% of the respondents were at risk for diabetes.

| PHQ-9 Score		Depression Severity
0-4	(n = 114)	Non-minimal
5-9	(n = 213)	Mild
10-14	(n = 232)	Moderate
15-19	(n = 88)	Moderately Severe
20-27	(n = 4)	Severe

Table 2. PHQ-9 Scores and Severity Levels. The PHQ-9 scores obtained from surveying the population were added up for each individual and the depression severity was labeled using the following ranges.

| GAD-7 Score		Anxiety Severity
0-4	(n = 65)	Minimal
5-9	(n = 108)	Mild
10-14	(n = 44)	Moderate
15-21	(n = 3)	Severe

Table 3. GAD-7 Scores and Severity Levels. The GAD-7 scores obtained from surveying the population were added up for each individual and the depression severity was labeled using the following ranges.

The screenings for depression using the PHQ-9 surveys were conducted and showed the following results. The number of people labeled as None/Minimal depression was 13.33%-17.27% (88 - 114 people), Mild depression was 32.37%-35.76% (213-236), Moderate depression was 35.15%-30.45% (201-232), Moderately Severe was at 13.33%-14.70% (88-97), and finally Severe depression was 0.61%-4.39% (4-29). The explanation for the range of percentages used can be found in the Statistical Analysis section of the Methods. Figure 1 shows the means PHQ values obtained for the two different genders with the females have a higher average score. The females had an average score of 10.4 while the males had an average of 9.5. Figure 2a. shows the mean PHQ values based on age, showing that the younger age group (18-35) also displayed a greater severity in their presentation of depression than the older population. The younger age group had a mean PHQ score of 11.5 while the 55+ had a mean score of 9 and the difference between these two groups is significant. Figure 2b shows the prevalence of depression in each category of severity between age groups. The figure shows that the younger age groups show higher prevalence of depression in the more severe categories (moderately severe and severe). Table 2 shows the cutoff ranges for the various PHQ scores obtained and the label of the depression severity. Finally, as shown by Figure 4, frequency decreased with increasing risk, indicating that a smaller subset of the population displayed a high risk for diabetes.

The screenings for anxiety were conducted using the GAD-7 surveys and resulted in 29.55% of respondents with minimal anxiety, 49.10% with mild anxiety, 20% with moderate anxiety. Table 3 shows the cutoff ranges for the various GAD scores obtained and the level of the anxiety severity.
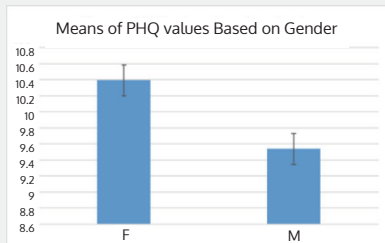

Figure 1. The mean PHQ scores of females and males of the Anandwan population. The results show that females ($\bar{x}$=10.39, s=5.12) have a slightly higher mean PHQ score than males ($\bar{x}$=9.54, s=4.60). Female scores in Anandwan were significantly higher than male scores (t_{636}=2.24, p=.0127).
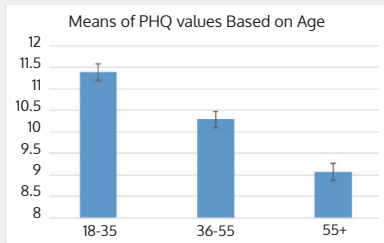


Figure 2a. The mean PHQ values based on the three ages groups of 18-35 ($\bar{x}$=11.38, s=5.04), 36-55 ($\bar{x}$=10.28, s=4.87), and 55+ ($\bar{x}$=9.07, s=4.7). There was a significant difference in mean PHQ scores between the three age groups (F_2=11.12, p=1.79 x 10-5). The 18-35 shows the highest PHQ scores relative to both the older age groups.
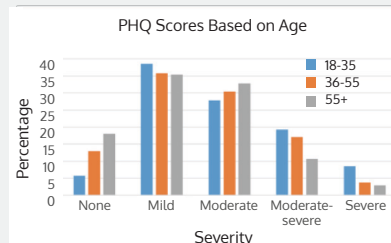
Figure 2b. The severity of depression in relation to the age group prevalence was observed in the Anandwan population was observed. The younger age group show a higher prevalence than both the middle age group and older age group in the more severe categories of depression.
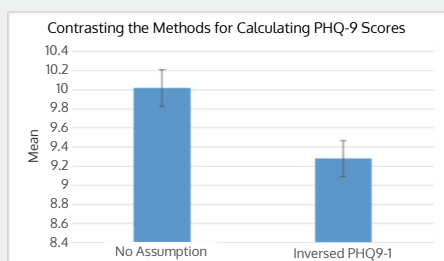
Figure 3. The figure shows the mean PHQ scores obtained using the two models used for testing. The no assumption ($\bar{x}$=10.02, s=4.92) and the inversed model ($\bar{x}$=9.23, s=4.81) show a significant difference, which explains the use of the percentage ranges seen in the results (t1299=2.74, p=.0031). The model created is further explained in the methods section.
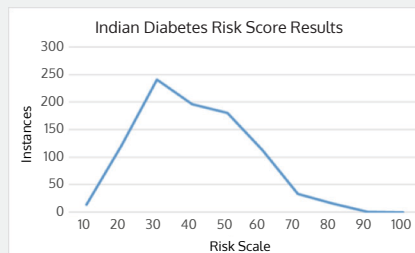
Figure 4. Instances of each score, in 10 point increments, taken from the IDRS assessment. A risk score of 30 showed the highest prevalence (250 responses) amongst the diabetes risk score values. As expected, frequency decreased with increasing risk, indicating that a smaller subset of the population displayed a high risk for diabetes. The threshold value over which an individual would be at risk for diabetes was determined to be 60.

DISCUSSION

The research conducted in the analysis of the Body Mass Index (BMI) of the population aimed to find if there is a large percentage of the population having a BMI that falls in the range of obese or pre-obese and if there is a correlation to diabetes. The high percentage of the respondents that fell in the underweight category raises many questions about the nutritional health of the population. People who are underweight run the risk of many conditions such as malnutrition, respiratory disease, osteoporosis, and a range of other medical conditions. Results found that BMI and the Diabetes Risk Score index were overall positively correlated. An intervention program that focuses on the central kitchen and the ingredients used to make the daily meals can help improve diets to ensure that the majority of the population maintains a BMI in the normal range and may reduce incidences of the aforementioned weight-related health conditions.

An epidemiological review analyzed hypertension prevalence, awareness, and control in rural populations of India in a region-specific manner. In a 2008 study by the WHO, the prevalence of elevated blood pressure in Indians was 32.5%. Hypertension is a significant risk factor for coronary heart disease and stroke, posing a significant burden on the Indian healthcare system[4].The fact that hypertension can lead to cardiovascular disease and is strongly correlated to heart attacks is important to consider in a place such as a rural village in India due to minimal access to healthcare, which could lead to higher mortality rates in villagers with hypertension. The fact that early treatment of a heart attack can prevent or limit damage to the heart muscle and immediate treatments such as oxygen therapy, clot-busting medications, and other medications are not readily available means that persons in Stage 1 and Stage 2 levels of hypertension may be at very serious risk. Analyzing over 140 studies on hypertension in India published between 2011 and 2013, the overall prevalence of hypertension in India was found to be 29.2%[3]. In West India, the prevalence of hypertension in rural populations, analyzed across 2 studies and 4,832 participants, was found to be 18.22%[3], slightly lower than the prevalence of hypertension in Anandwan when data was collected (23.8%). Preventative measures can be taken with the younger population, however, the older population are reliant upon access to blood pressure medications or other forms of medical care. Village intervention programs and ensuring the access to the necessary medications can restore hypertension levels to the normal range.

The Indian Diabetes Risk Score (IDRS) was used to assess the population and label people at risk for diabetes. One of the parameters of the IDRS was the family history of diabetes. When surveyed, a high percentage of the population answered that they had no family history of diabetes or were unaware of a family history of diabetes. It's possible that many villagers did not know of any family history of diabetes, so a higher percentage of people may be at risk than the results indicate. The prevalence of diabetes is predicted to double globally from 171 million in 2000 to 366 million in 2030, with a maximal increase in India5 and while the prevalence of diabetes in the village is relatively low compared to the epidemic numbers in many developed nations as well as other parts of India, it is still important to educate people in proper diet and exercise in order to prevent the spread of this disease. The westernization of urban India may have played a role in the increasing rates of diabetes in urban India due to an access to a previously unobtainable diet. While the incidence of diabetes in rural India is about one quarter the incidence of diabetes in urban India5, the effects of urbanization in these populations needs to be carefully monitored. As this industrialization and urbanization of rural India cannot be stopped, it is more effective to educate individuals on the importance of healthy diet and exercise in preventing diabetes. It is also important to continue to conduct diabetes assessments in the village, using

accurate measures such as HbA1c tests, in order to determine whether implemented programs are effective in reducing diagnoses of diabetes over time.

Depression was found to be the most common psychiatric comorbidity. Several studies conducted in India also identified a higher than normal rate of suicide or suicidal ideation in leprosy patients. In addition, one group used the Beck and Hamilton scale for depression to determine that 70% of leprosy patients displayed moderate to severe depression.[6] In the analysis conducted using the PHQ-9 scale for depression in this study, half of the surveyed population displayed moderate to severe depression. Several groups also found a significant increase in the prevalence of anxiety disorders in leprosy patients compared to controls.[6] Using the GAD-7 assessment in this study, the majority of the population was found to display mild to moderate levels of anxiety. Leprosy and other disabilities faced by the individuals in the village may be a significant contributing factor to this high level of mental health illness, although further testing needs to be conducted using a control group of healthy patients in the village in order to determine the influence of these factors on mental health. A significant finding in the mental health assessment shows a large difference in the severity of depression between the genders; women had a mean PHQ-9 score of about 0.8 points above men. This issue could be partly explained due to the fact that all the medical assistants conducting the surveys were female; this may have increased the level of comfort and trust held by the female patients, leading to more accurate responses. In addition, females on average have been found to have a higher prevalence of depression across all age groups, according to a study conducted in Chennai, India[7]. In another finding, the youngest age group showed mean PHQ-9 scores higher than both of the older population subsets. This trend, which may seem counterintuitive, has been replicated in many studies across India[8]. Further assessment of this younger population is needed to ensure that this finding is accurate and not a result of the younger people being more truthful in their responses. The importance of assessing and treating mental health disorders cannot be understated. In order to overcome the stigma associated with mental health and a lack of access to health care, a thorough process of destigmatization, education, and access to mental health resources are required in rural communities.

CONCLUSION

These results are useful for understanding the prevalence of mental health in this part of rural India and the lack of resources and infrastructure to understand and solve these issues. As mental health issues have increasingly gained prevalence on a global level, it is important that developing countries such as India begin addressing, assessing, and providing resources to solve these problems.

While this data is extremely valuable in assessing the problems in Anandwan, this data may not be applicable to all of rural India. This village is unique in that the majority of the meals people eat come from one central kitchen, making the treatment of hypertension and diabetes a somewhat easier process. It is interesting to note that while the prevalence of hypertension and diabetes risk was high, the percentage of underweight individuals was also high. Therefore, novel treatments may need to be examined in order to resolve these issues in people who are underweight. Reducing food intake and increasing exercise may not be a safe or healthy option for underweight individuals with diabetes, whereas these treatments are commonly used to reduce risk in those who are overweight or obese. Confirming the accuracy of the risk score to diagnostic data to test for diabetes will also be helpful in further validating this assessment and distinguishing individuals who have diabetes from those who are at high risk. Indian diet and culture are heavily tied to the increasing prevalence of diabetes and hypertension, especially in urban regions. Further research into the causes of diabetes and hypertension in rural, generally underweight populations will aid in determining an effective course of treatment.

[1]UCSD, Revelle College, B.S, Physiology & Neuroscience, 2016. [2]UCSD, Warren College, B.S, Physiology & Neuroscience, 2016. [3]Project RISHI, San Diego, California. [4]UCSD, Marshall College, B.S, General Biology, 2016.

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Vaish Sridhar

Vaish is a 4th year Physiology/Neuroscience major with a Psychology minor. She is graduating in June and applying to medical schools, with hopes of one day become a doctor. While she hasn't decided which specialty she would ideally want to pursue a career in, she has always been fascinated by neurology and loves kids.
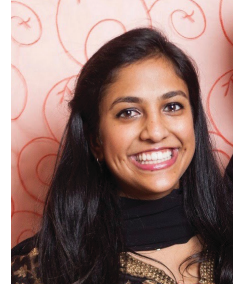
Q: What motivated you to get involved in the field of research?

A : My main motivation was helping the underprivileged population gain access to basic health care.

Q: What do you enjoy about doing research?

A : I enjoy learning something entirely new that nobody in the world has seen yet.

Q: What is your typical day like?

A : My normal day consists of attending class, working at my research lab, volunteering, finishing homework, and watching Parks and Recreation.

Q: How do you define research?

A : Research, to me, is the rigorous and methodical pursuit of the unknown.

Q: What is a book/podcast/show that you would recommend?

A : My favorite book is When Breath Becomes Air and my favorite TV show is The Office.

Q: How does the theme of "exponential growth" relate to you?

A : I think as a graduating senior, this theme especially applies to me. I am on the brink of an exponential growth in my life, in which my growth as an individual will (hopefully) will increase rapidly.