Original Article

Defeating diabetes in the desert: A community-based mHealth diabetes screening intervention in Jodhpur Rajasthan

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Abstract

Background: There is a paucity of demonstrated models for mHealth-based diabetes screening and coordinated care in India, especially in western Rajasthan, which is the part of Thar desert. **Materials and Methods:** JSPH collaboratively developed and implemented an easy-to-use, noninvasive, mobile phone-based screening interview, to identify adults at high risk for diabetes. The high risk for diabetes was defined using multiple clinical and epidemiologic criteria, all based on the evidence for India and globally. Since participants above 35 years or older were only considered in the screening, the application was designed to categorize the participants as high and low risk. **Results:** Out of 4000 screened participants, the percentage of males and females were 51% and 50%, respectively. Participants found to be at high risk and low risk were *n* = 3600 (90%) and 400 (10%). The mean age of high- and low-risk participants was 52.2 (+12.8) and 36.2 (+4.2), respectively. Of the 3600 high-risk individuals who have been given a follow-up interview, 90.50% of high-risk individuals obtained diabetes testing, and of these, 65.67% had a written report showing they test positive for diabetes or prediabetes, requiring ongoing clinical care. **Conclusions:** JSPH mHealth application provided a novel noninvasive way to better identify those at high diabetes risk in the community and demonstrated how to optimize the use of mobile health methods in diabetes prevention and care services.

Keywords: Community health workers, diabetes, mobile applications, mobile health

Introduction

India is experiencing a rapid health transition, with rising burden of chronic disease which accounts for 53% of all death and 44% of disability-adjusted life years.[1,2] Earlier estimates, from the Global Burden of Disease Study, projected that the number of deaths attributable to chronic diseases would rise from 3·78 million in 1990 to 7·63 million in 2020.[3]

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Typically, an individual in India presents to medical care for diabetes at late stages, leading to a greater medical, financial, and social burden on him/her and his family and the healthcare system.[4,5] There is a great need to prevent diabetes from occurring, to know who has diabetes at an early stage so care can be managed, and to prevent complications in known individuals with diabetes, especially where access to specialist care is limited.[5,6]

Mobile health technology is increasingly cited as a useful and cost-effective tool to rapidly assess disease risk and coordinate linkages to clinical care, from the community level, even

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in remote rural settings.[7] According to numerous studies, mHealth technology is feasible and accepted for disease detection and management.[7-9] India has an extensive mobile technology-enabled communications infrastructure, reaching even remote settings. A diabetes diagnosis and care model utilizing a robust mobile communications infrastructure could help in the fight against diabetes in India. Potential uses of mHealth include early detection and diagnosis, facilitating communications between community providers and primary care physicians, and individualized health promotion messaging and counseling to prevent diabetes and its complications.[10,11] Yet to date, there is a paucity of demonstrated models for mHealth-based diabetes screening and coordinated care in India and especially in western Rajasthan, which is the part of the Thar desert. The Jodhpur School of Public Health (JSPH) received a one-year grant from the Tata Trust to design and test a Jodhpur community-based strategy using mobile health technology to survey households and detect and triage individuals at high risk for diabetes.

Materials and Methods

JSPH collaboratively developed and implemented an easy-to-use, noninvasive, mobile phone-based screening interview, to identify adults at high risk for diabetes. The high risk for diabetes was defined using multiple clinical and epidemiologic criteria, all based on the evidence for India and globally.[12-14] These criteria for high risk of diabetes are mentioned in Figure 1.

The mobile app was coded to cue the interviewer to deliver specific and individually tailored health advising through Standardized Health Education Messages (SHEM), tailored to the participant's level of risk to be delivered at the time of screening. The SHEM scripts include advising at-risk individuals to seek diabetes blood testing at their preferred medical facility, as well as the specific reasons they are being advised to seek testing.

The screening protocol includes a systemic random sampling of households based on mapping provided by publicly available voter rolls. Community health worker interviewers were trained to approach their assigned households and invite adults meeting inclusion criteria to participate in the screening program with informed consent. A systematic sampling method was undertaken to select households for the screening program. Adults of age 35 years or older in the home, who were currently available to participate, were screened. A brief follow-up interview was conducted 3 weeks later, to determine whether the participant has obtained diabetes testing, and if so, whether they were diagnosed with diabetes or prediabetes. The protocol for the screening program was approved by the ACMERI Institutional Review Board, prior to initiating field screening activities.

*AGE>=45 years OR

*AGE>=45 years and no history of diabetes test OR

*Indian Diabetes Risk Score(IDRS) > 60 (calculated from age, physical activity, family history, and waist circumference) OR

*Waist Circumference> 90cm (MALE) or >80 cm (FEMALE) OR

*Any female participant reports giving birth to a baby >4kg birth weight,

OR

ANY PARTICIPANT REPORTS HISTORY OF (One or more):

*Elevated Blood Sugar from a prior blood test

*Diabetes not under medical care

*Elevated blood pressure

Figure 1: Criteria for high risk of diabetes

Results

Out of 4000 screened participants, the percentage of males and females were 51% and 50%, respectively. Since participants above 35 years or older were only considered in the screening, the application was designed to categorize the participants as high and low risk. Participants found to be at high risk and low risk were n = 3600 (90%) and 400 (10%). The mean age of high- and low-risk participants was 52.2 (±12.8) and 36.2 (±4.2), respectively. Table 1 summarizes the key characteristics of the participants screened comparing the high-risk versus low-risk individuals.

The data indicate that approximately 90% of the first 4000 screened individuals are identified as high risk for diabetes. At the time of screening, using the tailored and cued mobile-based Standardized Health Education Messages (SHEM), 100% of these individuals were advised of their high risk and advised to seek diabetes testing.

Of the 3600 high-risk individuals who have been given a follow-up interview, 90.50% of high-risk individuals obtained diabetes testing, and of these, 65.67% had a written report showing they test positive for diabetes or prediabetes, requiring ongoing clinical care. Figure 2 shows the comparison of high risk identified via IDRS and JSPH mHealth application scoring criteria.

Discussion

This community-based mHealth diabetes program provided a noninvasive screening intervention for classifying individuals

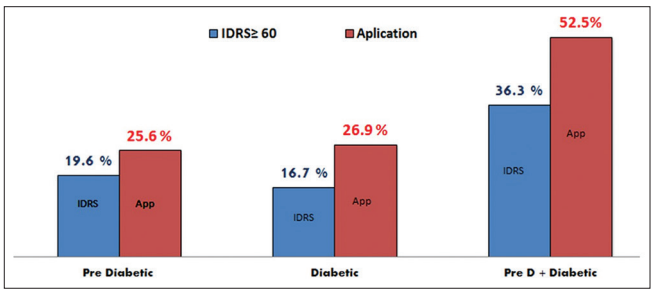

Figure 2: Comparison of high risk identified via IDRS and JSPH mHealth application scoring criteria

Table 1: Characteristics of those screened at high versus low risk for diabetes, (*N*=4000)

Characteristic	High diabetes risk (*n*=3600) No. (%)	Low diabetes risk (*n*=400) No. (%)	*P*
Sex			
Male	1760 (44%)	252 (6%)	X^2=28.11 *P*<0.0000001
Female	1840 (46%)	148 (4%)	
Mean age (SD)	52.2 (12.8)	36.2 (4.2)	*t*=0.533 *P*=0.59
Marital status			
Never married	36 (1%)	0	n/a
Currently married	3294 (91.5%)	370 (92.7%)	X^2=0.34 *P*=0.27
Separated/divorced	7 (0.2%)	12 (0.3%)	X^2=54.1 *P*<0.0000001
Widowed	111 (3.1%)	0	n/a
Other	21 (0.6%)	12 (0.3%)	X^2=22.8 *P*<0.0000008
Work status			n/a
Full-time employed	676 (18.8%)	159 (39.7%)	X^2=94.6 *P*<0.0000001
Part-time employed	270 (7.5%)	28 (7.9%)	X^2=0.06 *P*=0.39
Self-employed	507 (14.1%)	64 (16%)	X^2=0.92 *P*=0.16
Homemaker	1612 (44.8%)	128 (32.1%)	X^2=23.4 *P*<0.0000006
Student	11 (0.3%)	8 (0.2%%)	X^2=18.4 *P*<0.000008
Retired	349 (9.7%)	0	X^2=94.6 *P*<0.0000001
Top 3 Occupational areas reported	Office admin Management Business and financial	Business and financial Office admin Management	
SES classified by BG Prasad System monthly income (INR/mo)			
Upper class (5357+)	1472 (40.9%)	197 (49.3%)	X^2=335 *P*<0.0000001
Upper middle class (2652–5356)	187 (5.2%)	29 (7.3%)	X^2=2.5 *P*=0.05
Middle class (1570–2651)	111 (3.1%)	7 (1.7%)	X^2=1.7 *P*=0.09
Lower middle class (812–1569)	70 (1.1%)	4 (1.1%)	X^2-1.2 *P*=0.12
Lower class (<811)	11 (0.3%)	0	n/a
Has access to mobile phone for own use	2361 (65.6%)	305 (76.3%)	X^2=17.95 *P*<0.0000113
Aware/heard of diabetes ever before	3232 (89.8%)	396 (99.2%)	X^2=35.21 *P*<0.0000001
Ever prior diabetes test	1890 (52.5%)	168 (42%)	X^2=15.47 *P*<0.000041
Previous history of high blood sugar	590 (16.4%)	9 (2.3%)	X^2=55.42 *P*<0000001
Diabetes family history			
Any family member with diabetes	619 (17.2%)	66 (16.6%)	X^2=0.07 *P*=0.38
Parent history of diabetes			
Father	108 (2.9%)	12 (3.1%)	X^2=0.02 *P*=0.43
Mother	169 (4.7%)	34 (8.5%)	X^2=10.05 *P*=0.0007
Both parents	48 (1.3%)	2 (0.56%)	X^2=1.4 *P*=0.1
Self-reported level of physical activity in a typical day			
None	244 (6.8%)	106 (26.5%)	X^2=172.9 *P*=0.0000001
Strenuous	205 (5.7%)	13 (3.4%)	X^2=3.7, *P*=0.026
Mild	2592 (72%)	220 (54.9%)	X^2=49.8, *P*=0 0.0000001
Female only: History of giving birth to a baby >4 kg	90 (2.5%)	1 (0.3%)	X^2=7.21 *P*=0.0036
History of being told he/she has high blood pressure	838 (23.3%)	7 (1.7%)	X^2=98.84 *P*<0.0000001
History of being told he/she has high cholesterol	259 (7.2%)	0	n/a
History of being told he/she has any cardiovascular disease	173 (4.8%)	0	n/a
History of having lost all or most natural teeth	305 (8.5%)	1 (0.3%)	X^2=33.3 *P*<0.0000001
Current tobacco use	295 (8.2%)	1 (0.3)	X^2=32.01 *P*<0.0000001
Healthcare provider seen for any related condition	428 (11.9%)	15 (3.7%)	X^2=23.39 *P*<0.0000006
Any preventive health advice received in the last 2 years	3376 (93.8%)	332 (82.9%)	X^2=60.2 *P*<0.0000001
Mean waist circumference (SD), cm			
Male	92.60 (SD=12.5)	80.12 (SD=13.04)	*t*=2.4 *P*<0.012
Female	93.98 (SD=17.15)	72.57 (SD=18.61)	*t*=4.2 *P*<0.00002
Mean Indian Diabetes Risk Score (SD)	62 (16.6)	38.7 (14.75)	*t*=2.33 *P*=0.01986

Contd...

Table 1: Condt...

with high risk for diabetes. Each of the individuals qualified as high risk for diabetes was identified based on the validated evidence-based epidemiologic or clinical criteria. With a wide range of criteria for high diabetes risk, and given the known high prevalence of diabetes and prediabetes in the Indian setting, it

is not surprising to see that such a high proportion of screened individuals in the Jodhpur community are identified as high risk. Various studies have mentioned that in India there is an increased risk of diabetes due to fast cultural and social changes such as aging populations, increasing urbanization, sedentary lifestyles, dietary changes, and unhealthy behavior.[14,15] Additionally, it is recognized that Indians have a higher level of insulin resistance and a stronger hereditary susceptibility to diabetes.[15,16]

It was found that on sociodemographic characteristics, there was no statistically significant difference in risk of diabetes based on sex or age, though there is a tendency for older individuals to be identified as high risk. The literature suggests that elderly persons are more likely than younger generations to get hyperglycemia and eventually type 2 diabetes because they have been exposed to sugar for a longer period of time.[17,18]

Regarding mobile phone access, only 65% of high-risk individuals reported their own mobile phone usage, a significantly lower proportion compared to low-risk individuals. There may be factors associated with lower mobile phone access including older age. This finding suggests that messaging for high-risk individuals and the use of mHealth technologies may need to account for the details of mobile phone access and usage. Emphasis has been made by various authors to comprehend the level of gadget usage awareness among the elderly as they frequently lack technical skills, making it hard for them to take advantage of programs that require digital competence.[19]

There was a measurable proportion of high-risk individuals who had a history of prior diabetes testing and even known high blood sugar in the past. This subgroup of individuals requires further analysis for testing/diagnosis status, healthcare utilization, and factors that would influence whether they are engaged in appropriate care for a diabetes or prediabetes condition. This subgroup may require more specific interventions using the mHealth platform.

High-risk individuals were also seen to have measurable proportions of associated clinical conditions, including related conditions such as hypertension, and possible periodontal disease. These are known clinical risk factors associated with diabetes and suggest future areas to undertake training and awareness building, for both the community and for clinical providers, to optimize the detection and diagnosis of those with diabetes or prediabetes.[20]

Only 12% of the high-risk group reported having seen a healthcare provider in the prior year. This is important for future intervention planning as it appears that those who require greater access to medical advice and evaluation are not utilizing it. Similar intercessions are suggested in various studies.[21,22] For the program, this strongly suggests that clinical partnerships specially with primary care and family physicians are crucial to link those detected at high risk in the community, to appropriate resources for testing, diagnosis, and care.[23,24] Further analysis is needed to determine the supports and barriers to utilizing medical care in the high-risk group.

Finally, the findings from the waist circumference measurement and Indian Diabetes Risk Score meet the established criteria for high diabetes risk, and help support and validate the classification of high- and low-risk individuals used in our screening methodology.

Conclusion

JSPH mHealth application has helped to inform how to better identify those at high diabetes risk in the community, how to optimize the use of mobile health methods in their diabetes prevention and care services, and how to improve the linkage, from community screening and high-risk identification, to testing and diagnosis and continuing clinical care.

Key points

mHealth application developed by JSPH has helped in identifying people in the community who are at high risk for developing diabetes. It has also demonstrated that the use of mHealth technology technologies could lead to better identification and management of diabetes in communities where awareness is low, as it allows for coordinated care and better communication between patients and primary healthcare providers.

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Conflicts of interest

There are no conflicts of interest.

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