Using a Screening Toolkit to Determine the Prevalence of Non-Communicable Diseases in an Urban Slum of Mumbai, India: A Cross-Sectional Study

Ria Rungta (riarungta@gmail.com)
Yale University School of Public Health https://orcid.org/0000-0001-6959-4896

Andrew T. DeWan
Yale University School of Public Health

Vijaykumar Gawali
Bhaktivedanta Hospital & Research Institute

Luc de Witte
The University of Sheffield

Saria Hassan
Yale University School of Medicine

Research article

Keywords: Non-communicable disease, screening, slums, India, global health

Posted Date: December 8th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-122509/v1

Abstract

Background: Higher than national rates of non-communicable diseases have been found in some urban slums of India. This has been attributed to potentially lower levels of education and decreased access to preventative care. We sought to assess the prevalence of NCDs in a Mumbai slum compared to national averages and understand the association with social determinants of health.

Methods: We used a screening toolkit called THULSI (Toolkit for Healthy Urban Life in Slums Initiative) in a community health-camp setting to screen 266 slum dwellers for obesity (BMI above 25 kg/m^2), elevated blood pressure (SBP > 120 mm of Hg and DBP > 80 mm of Hg), and elevated blood glucose (RPG > 200 mg/dL). A health survey was administered to understand the demographic data and information about health-seeking behavior of the slum dwellers. The collected data was analyzed to determine the prevalence of each condition and associations with different social determinants of health such as literacy and education level, diagnosis and marital status, age, gender, place of care, employment, availability of toilet, and languages spoken.

Results: Of the screened population, 72.6% had elevated blood pressure, 9.0% had elevated blood glucose, 63.2% were obese, and 12.4% were overweight. These rates were 2.81, 1.04, and 3.84 times higher than the national averages, respectively. Of the study population, 26.7% had one condition, 53.4% had two conditions, and 7.9% had all the three conditions we screened for. Male gender (OR: 3.33, 95% CI: 1.37, 8.07) and older age (35-49 years OR: 3.03, 95% CI: 1.52, 6.05, 49-63 years OR: 7.22, 95% CI: 3.06, 17.05, >= 63 years OR: 6.82, 95% CI: 2.12, 22.00) were associated with increased odds of elevated blood pressure, not being previous diagnosed (OR: 0.04, 95% CI: 0.01, 0.13) was associated with lower odds of elevated blood glucose, and older age (35-49 years OR: 2.51, 95% CI: 1.21, 5.21, 49-63 years OR: 4.95, 95% CI: 2.06, 11.92) was associated with increased odds of obesity.

Conclusion: We found higher than national rates of the NCDs and high comorbidity in the screened slum population of Mumbai. This signifies the need for screening services and the importance of awareness and education in this population.

Background

According to the UN-Habitat estimates, one in eight people in the world live in slums.[1] The number of slum dwellers have continued to grow each year and this remains an important factor for the persistence of poverty in the world.[1] A slum household is defined as “a group of individuals living under the same roof in an urban area who lack one or more of durable housing, sufficient living space, easy access to safe water and adequate sanitation, and security of tenure.”[2] In India, about 30% of the total population of 1.3 billion people lives in slums.[3,4] This means that about 390,000,000 Indians live in slums around the country.

Since slums are often left out of planned urban development, residents face increased risk of non-communicable diseases (NCDs) due to, among other factors, pollution-related risks and physical inactivity-related risks that accompany urban sprawl.[5] For instance, a survey conducted in Haryana found roughly 19% of the surveyed slum population to be overweight and 16.5% to be hypertensive.[6] Furthermore, a pilot study conducted by the World Health Organization (WHO) and the Indian Council of Medial Research (ICMR) found that in six selected cities, roughly 21.4% of the slum residents were obese and 20.8% were newly diagnosed with hypertension.[7] A study in a slum of Bangalore found that out of 3693 people that were screened, 35.5% had hypertension,16.6% had diabetes, and 20.1% and 5.7% of these people were screened for the first time in their lives for hypertension and diabetes, respectively.[8]

Nationally, roughly 19.7% are overweight or obese, 25.8% have raised blood pressure, and 8.7% have raised blood glucose in India.[9,10,11] Therefore, previous research has highlighted two important NCD characteristics for the Indian slum population: higher than national rates of NCDS are found in slums and residents are often unaware of their condition.

This lack of awareness in slums could be attributed to factors such as poverty, low levels of education, and the high opportunity cost (the time and money spent in services could potentially be better utilized elsewhere) of pursuing preventative and wellness services. [12] For instance, research done in a Bangalore slum found that the median monthly income of slum dwellers was around $47 and although education was an important factor for dwellers, only the top 10% highest earning households could afford a school education for their children. [13] Low levels of education can further exacerbate unawareness of the importance of preventative health care. [14] There is also ineffective health outreach in the slums due to social exclusion. [14] Lack of early intervention programming contributes to the higher rates of NCDs and complications from these NCDs including strokes, myocardial infarctions, and kidney failure. [15]

In this study, we sought to further our understanding of the rates of NCDs among slum-dwellers in India and the potential association with social determinants of health. Understanding these associations are critical to determining avenues for intervention and improved healthcare. Our specific objective is to determine the prevalence of obesity, elevated blood pressure, and elevated blood glucose in an urban slum of Mumbai with a chronic disease screening toolkit previously used in Bangalore. We then sought to compare the prevalence to the national average and determine the presence of any associations with critical social determinants of health.

Methods

Study Setting

Mumbai is located in southwestern India and is considered to be the country's financial and commercial centre.[16] Approximately 18.41 million live in Mumbai and roughly 40% of these individuals reside in slums.[17] This study was conducted in slums located in P-South Ward of Mumbai. The total population of the slums located in this region of Mumbai is 210,591.[18]

Before the study was initiated, extensive working relationships were formed with the community leaders of the local area who are familiar with the residents of the slums located in P-South Ward. These were members of a local non-profit organization called Shivraj Prathisthan who regularly organize events and charity drives in the slum. The project was explained in detail to the leaders and their feedback was incorporated into the development of the study. This study was approved by the Institutional Review Board at Yale University (IRB Submission ID: 2000027023) and the Ethics Committee for Biomedical and Health Research at BhaktiVedanta Hospital in District Thane.

Study Design

This was a community-based cross-sectional study. Data on socio-economic characteristics and health-seeking behaviors was collected by self-report via a health survey that was distributed at the time of the study.

The Screening Toolkit

In this study, screening was conducted for three non-communicable diseases: obesity, elevated blood glucose, and elevated blood pressure. The toolkit used for screening was called THULSI (Toolkit for Healthy Urban Life in Slums Initiative).[19] This toolkit was developed as a cross-collaborative global effort between the University of Sheffield,

Bangalore Baptist Hospital, ZUYD University of Applied Sciences, e-Health enablers, and Icarus Nova. THULSI has already been used for screening purposes in a Bangalore slum.[8] THULSI consists of various screening tools and devices such as glucometers, weighing scales, tape measure, BP monitor, and a cuff. It also has an electronic component in the form of an android-based application that was used to collect the health survey on an electronic tablet. The health survey was tailored to collect demographic information and health-seeking behaviors of the residents. The tablet was connected to a thermal printer that was used to immediately print out the results of the screening. Trained paid workers from the community used the toolkit to screen residents. These were college-level educated women who resided in the slums and certified medical technicians who were fluent in the local languages. These workers were provided extensive training over a period of two days which involved practice sessions on using the toolkit. The training was overseen by Digi Health Platform Pvt Ltd, the company that manufactured THULSI.

Recruitment and Data Collection

The study was conducted over a period of four days. The study team, which included the trained workers, medical technicians, the principal investigator, and members from Shivraj Prathisthan, set up camp in the community ground of the slum for a minimum of four hours each day. This community ground was accessible to all members of the P-South Ward slums. The camp was publicized in the slums with the use of a displayed banner and word-of-mouth advertising by the non-profit and workers. Since the camp was set up in the central community ground, residents of the slum saw it when they left their homes and they could walk-in and get screened on any of the four days. When a resident approached the study, they were first asked for their written consent in Hindi, Marathi, or English. They then completed the health survey and measurements for blood pressure, blood glucose, height, and weight were taken by the trained medical technicians using the toolkit. Results were provided to the slum resident which could be used as a referral for future treatment at the local government healthcare provider. This helped connect residents to further care and promoted awareness of local healthcare services. Upon screening, each resident was offered a health literacy brochure containing information and preventative measures for the condition they screened positive for and a small household item that cost 100 rupees as remuneration. This promoted awareness of the NCDs and importance of preventative measures.

Standard Definitions

The standard cutoffs used for the determination of each non-communicable disease are categorized as follows:

Table 1
Standard Definitions

Body Mass Index [20]	
Normal	BMI values 18.5 kg/m^2–22.9 kg/m^2
Overweight	BMI value 23.0 kg/m^2 to 24.9 kg/m^2
Obesity	BMI above 25 kg/m^2
Blood Pressure [21]	
Normal	SBP < 120 mm of Hg and DBP < 80 mm of Hg
Prehypertension	SBP 120–129 mm of Hg and DBP < 80 mm of Hg
Stage 1 Hypertension	SBP 130–139 mm of Hg or DBP 80–89 mm of Hg
Stage 2 Hypertension	SBP 140–180 mm of Hg or DBP 90–120 mm of Hg
Critical	SBP ≥ 180 mm of Hg or DBP ≥ 120 mm of Hg
Blood Glucose [22]	
Elevated Blood Glucose	RPG > 200 mg/dL
Non-Elevated Blood Glucose	RPG < 200 mg/dL

Study Variables

BMI: The body mass index is a physical measurement used to assess the total amount of body fat. It was calculated by dividing weight in kilograms (kg) by the square of height in meters (m^2). BMI was calculated for all adults (18 years and above).[20] Those with a BMI that fell in the ranges of overweight and obese were categorized as overweight or obese.

Elevated blood pressure: Blood pressure was recorded for all participants in the sitting position in the right arm. Those with a blood pressure that fell in the prehypertension, Stage 1 hypertension, Stage 2 hypertension, and critical ranges were categorized as having elevated blood pressure.

Elevated blood glucose: Blood glucose was measured using the glucometer for all participants. Random plasma glucose was used for the determination of elevated blood glucose. Those with a measurement greater than 200 mg/dL were categorized as having elevated blood glucose.

Age: The four age groups used were 21–35, 35–49, 49–63, and > = 63. In the bivariate analysis for the outcome of elevated blood glucose, participants were categorized in three age groups (21–49, 49–63, >= 63) for ease of calculation.

Sex: The two categories used in this study were male and female.

Literacy level: Participants were categorized in three groups, illiterate, able to read, and able to read and write.

Education level: Participants were categorized in three groups, those with less than high school level of education, those with a high school degree, and those with some college or a college degree.

Employment status: Participants were categorized in four groups, those who were unemployed, employed in the service or labor industry, self-employed, and the other group. The other group comprised of those who were employed in the government or private sector.

Languages spoken: Since Hindi and Marathi are the primary languages spoken in the slum, the two categories used were those who spoke Hindi or Marathi and those who spoke only another language, such as English, Bengali, Gujarati, Kannada, or Telugu.

Marital status: The two categories used were married and unmarried, separated, or widowed.

Primary place of care: The two categories used were government and private clinic or hospital.

Availability of toilet: Participants were categorized in two groups, those with a toilet in their home and those who used a community toilet. This was used as a marker for socio-economic status. This approach of using availability of toilet to assess socio-economic status is often taken in low to middle income countries since it can indicate a household's "material circumstance." [23]

Diagnosis status: Participants were categorized in two groups based on whether they had been previously diagnosed or not.

Comorbidity: Participants were categorized based on whether they had one, two, or all three of the NCDs screened for in the study.

Statistical Analysis

All data analysis was done using SAS software.[24] Descriptive analysis was performed to understand the demographical characteristics of the screened population. The prevalence of each condition was analyzed. The three variables of BMI, blood pressure, and blood glucose were considered to be dependent variables and the other study variables were independent variables. Bivariate analysis in the form of chi-squared or Fisher test was performed at the 0.05 level to determine significant associations between each dependent and independent variable. Those independent variables that were deemed to be significant in the bivariate analysis were entered into a logistic regression model (both unadjusted and adjusted) to estimate the odds of having each condition.

Power and Sample Size

Minimum sample size was estimated using the formula $n = [Np(1- p)]/[(d^2/Z^2 1- \alpha/2 * (N -1) + p (1-p)]$, where Z is the Z-score, Np is the population size, d is the margin of error, and p is the estimated prevalence of the condition based on previous studies. Sample size was determined to have 80% power with a type I error rate of 5%. A detailed sample size calculation is shown in an additional file (Additional File 1). The estimated minimum sample size is 260 among the three outcomes to be included. In our study, we screened a total of 294 individuals with 266 individuals included in this analysis due to missing data.

Results

Among the 266 subjects, a majority of the population fell in the 35–63 age range (59.8%), were females (75.6%), had less than high school level of education (71.4%), were unemployed (77.8%), spoke Hindi or Marathi (96.2%), were married (95.5%), sought care at government healthcare providers (61.7%), and had a toilet in their home (68.8%) (Table 2). Of the total population, 41.4% were illiterate and 37.9% could read and write (Table 2).

Of the screened population, 72.6% had elevated blood pressure, 9.0% had elevated blood glucose, 63.2% were obese, and 12.4% were overweight (Table 2). These rates of overweight and obesity, elevated blood pressure, and elevated blood glucose were 3.84, 2.81, and 1.04 times higher than the national average, respectively.[25,11,10] Of the screened population, 26.7% only had one of the three conditions screened for, 53.4% had two, and 7.9% had all three.

Table 2
Description of the Sample

Characteristic	N = 266	Characteristic	N = 266
Age (years)		**Place of Care**	
21–35	70 (26.32)	Missing	49(18.42)
35–49	84 (31.58)	Government	164 (61.65)
49–63	75 (28.20)	Private	53(19.92)
>= 63	37 (13.91)	**Availability of Toilet**	
Sex		Community	83 (31.20)
Female	201(75.56)	In home	183 (68.80)
Male	65(24.44)	**Blood Pressure**	
Literacy		Normal	73 (27.44)
Illiterate	110(41.35)	Prehypertension	13 (4.89)
Read	55(20.68)	Stage 1 Hypertension	94 (35.34)
Read and Write	101(37.97)	Stage 2 Hypertension	83 (31.20)
Educational level		Critical	3 (1.13)
Less than high school	190(71.43)	**Blood Sugar**	
High school	51(19.17)	Normal	242 (90.98)
College plus	25(9.40)	Between 200–300 mg/dL	18 (6.77)
Employment		Above 300 mg/dL	6 (2.26)
Unemployed	207(77.82)	**Obesity**	
Self-Employed	21(7.89)	Underweight	13(4.89)
Labor or Service Industry	18(6.77)	Normal	52(19.55)
Other	20(7.52)	Overweight	33(12.41)
Languages Spoken		Obese	168(63.16)
Hindi/Marathi	256 (96.24)	**Comorbidity**	
Other	10 (3.76)	One condition	71 (26.69)
Marriage status		Two conditions	142 (53.38)
Married	254(95.49)	Three conditions	21 (7.89)
Unmarried/Separated/Widowed	12(4.51)		

Elevated Blood Pressure

Age, sex, and availability of toilet had a statistically significant association with elevated blood pressure. Of those with elevated blood pressure, 65.8% were between 35–63 years of age. A majority of them were also female (70.0%) and had a toilet in their home (74.1%). Although diagnosis status was not statistically significant with this outcome, 91.2% of those with elevated blood pressure had never been diagnosed for this condition before (Table 3).

Table 3: Description of the sample according to elevated blood pressure, blood glucose, and overweight/obesity

	Total (N = 266)	Elevated Blood Pressure (N = 193)		Elevated Blood Glucose (N = 24)		Obesity/Overweight (N=201)	
Characteristic	N	N (Column %)	p-value	N (Column %)	p-value	N (Column %)	p-value
Age (years)			<0.001		0.003		<0.001
21-35	70	33 (17.10)		8 (33.33)		44 (21.89)	
35-49	84	61 (31.61)				68 (33.83)	
49-63	75	66 (34.20)		14 (58.33)		67 (33.33)	
>= 63	37	33 (17.10)		2 (8.33)		22 (10.95)	
Sex			<0.001		0.572		0.301
Female	201	135(69.95)		17(70.83)		155(77.11)	
Male	65	58(30.05)		7(29.17)		46(22.89)	
Literacy			0.606		0.390		0.230
Illiterate	110	83(43.01)		12(50.00)		89(44.28)	
Read	55	40(20.73)		6(25.00)		40(19.90)	
Read and Write	101	70(36.27)		6(25.00)		72(35.82)	
Educational level			0.095		0.783*		0.230
Less than high school	190	142(73.58)		19(79.17)		149(74.13)	
High school	51	31(16.06)		4(16.67)		35(17.41)	
College plus	25	20(10.36)		1(4.17)		17(8.46)	
Employment			0.109		0.253*		0.645*
Unemployed	207	143 (74.09)		16 (66.67)		156 (77.61)	
Self-Employed	21	18 (9.33)		4 (16.67)		18 (8.96)	
Labor or Service Industry	18	16 (8.29)		2 (8.33)		13 (6.47)	
Other	20	16 (8.29)		2 (8.33)		14 (6.97)	
Languages Spoken			0.294*		1.000*		0.710*
Hindi/Marathi	256	184 (95.34)		23 (95.83)		194 (96.52)	
Other	10	9 (4.66)		1 (4.17)		7 (3.48)	
Marriage status			0.521*		0.609*		0.495*
Married	254	183 (94.82)		24 (100.00)		193 (96.02)	

Unmarried/Separated/Widowed	12	10 (5.18)		0 (0.00)		8 (3.98)	
Place of Care			0.079		0.586*		0.698
Missing (49 missing)	49						
Government	164	109 (72.19)		14 (70.00)		125 (76.22)	
Private	53	42 (27.81)		6 (30.00)		39 (23.78)	
Availability of Toilet			0.002		0.003		0.403
Community	83	50 (25.91)		1 (4.17)		60 (29.85)	
In home	183	143 (74.09)		23 (95.83)		141 (70.15)	
Diagnosis Status	–		0.369		<0.001*	–	–
Previously Not Diagnosed	–	176 (91.19)		5 (20.83)		–	–
Previously Diagnosed	–	17 (8.81)		19 (79.17)		–	–

Table Values are n (column %) and may not sum to 100% due to rounding *Indicates that P-value is for Fisher's exact test, else it is for chi-squared

Upon adjusting for the other significant covariates, those who belonged to the 35–49 age category, the 49–63 age category, and the 63 or older age category had 3.03 times (95% CI 1.52–6.05), 7.22 times (95% CI 3.06–17.05), and 6.82 (95% CI 2.12-22.00) times higher odds of elevated blood pressure than those who belonged to the 21–35 age category, respectively (Table 4). Upon adjustment, males had 3.33 (95% CI 1.37–8.07) times higher odds of having elevated blood pressure than females (Table 4). Without adjusting for any covariates, those who used the community toilet had 0.42 (95% CI 0.24–0.74) times lower odds of having elevated blood pressure than those with a toilet in their homes (Table 4). However, upon adjustment, this significant association disappeared.

Table 4
Logistic Regression Results for Elevated Blood Pressure, Blood Glucose, and Overweight/Obesity

	Total (N = 266)	**Elevated Blood Pressure (N = 193)**		**Elevated Blood Glucose (N = 24)**		**Obesity/Overweight (N = 201)**	
Characteristic	N	N (Column %)	p-value	N (Column %)	p-value	N (Column %)	p-value
Age (years)			< 0.001		0.003		< 0.001
21–35	70	33 (17.10)		8 (33.33)		44 (21.89)	
35–49	84	61 (31.61)				68 (33.83)	
49–63	75	66 (34.20)		14 (58.33)		67 (33.33)	
>= 63	37	33 (17.10)		2 (8.33)		22 (10.95)	
Sex			< 0.001		0.572		0.301
Female	201	135(69.95)		17(70.83)		155(77.11)	
Male	65	58(30.05)		7(29.17)		46(22.89)	
Literacy			0.606		0.390		0.230
Illiterate	110	83(43.01)		12(50.00)		89(44.28)	
Read	55	40(20.73)		6(25.00)		40(19.90)	
Read and Write	101	70(36.27)		6(25.00)		72(35.82)	
Educational level			0.095		0.783*		0.230
Less than high school	190	142(73.58)		19(79.17)		149(74.13)	
High school	51	31(16.06)		4(16.67)		35(17.41)	
College plus	25	20(10.36)		1(4.17)		17(8.46)	
Employment			0.109		0.253*		0.645*
Unemployed	207	143 (74.09)		16 (66.67)		156 (77.61)	
Self-Employed	21	18 (9.33)		4 (16.67)		18 (8.96)	
Labor or Service Industry	18	16 (8.29)		2 (8.33)		13 (6.47)	
Other	20	16 (8.29)		2 (8.33)		14 (6.97)	
Languages Spoken			0.294*		1.000*		0.710*
Hindi/Marathi	256	184 (95.34)		23 (95.83)		194 (96.52)	
Other	10	9 (4.66)		1 (4.17)		7 (3.48)	

	Total (N = 266)	Elevated Blood Pressure (N = 193)		Elevated Blood Glucose (N = 24)		Obesity/Overweight (N = 201)	
Marriage status			0.521*		0.609*		0.495*
Married	254	183 (94.82)		24 (100.00)		193 (96.02)	
Unmarried/Separated/Widowed	12	10 (5.18)		0 (0.00)		8 (3.98)	
Place of Care			0.079		0.586*		0.698
Missing (49 missing)	49						
Government	164	109 (72.19)		14 (70.00)		125 (76.22)	
Private	53	42 (27.81)		6 (30.00)		39 (23.78)	
Availability of Toilet			0.002		0.003		0.403
Community	83	50 (25.91)		1 (4.17)		60 (29.85)	
In home	183	143 (74.09)		23 (95.83)		141 (70.15)	
Diagnosis Status	–		0.369		< 0.001*	–	–
Previously Not Diagnosed	–	176 (91.19)		5 (20.83)		–	–
Previously Diagnosed	–	17 (8.81)		19 (79.17)		–	–

Elevated Blood Glucose

Age, availability of toilet, and diagnosis status had a statistically significant association with the outcome of elevated blood glucose. Of those with this condition, 58.3% were between 49–63 years of age, 95.8% had a toilet in their home, and 20.8% had not been previously diagnosed (Table 3).

Without adjusting for any covariates, those between 49 to 63 years of age had 4.19 (95% CI 1.67–10.50) times higher odds of having elevated blood glucose than those in the 21–49 age category (Table 4). However, upon adjusting for other covariates, this association disappeared. Those who used the community toilet had 0.09 (95% CI 0.01–0.64) times lower odds of having elevated blood glucose than those who had a toilet in their home (Table 4). This association also disappeared upon adjusting for other covariates. Upon adjustment, those who had not been previously diagnosed had 0.04 (95% CI 0.01–0.13) times lower odds of having elevated blood glucose than those who had been previously diagnosed (Table 4).

Obesity

Age was statistically significantly associated with being over-weight or obese, where 67.2% of those between the ages of 35–63 were overweight or obese (Table 3).

Those between the ages of 35 and 49 and those between the ages of 49 and 63 had 2.51 times and 4.95 (95% CI 1.21–5.21, 95% CI 2.06–11.92) times higher odds of being overweight or obese than those between the ages of 21

and 35 (Table 4), respectively. This model was not adjusted for any covariates since the bivariate analysis did not show any other statistically significant variables.

(Insert Tables 3 and 4 here)

Comorbidity

There was a statistically significant association between age and availability of toilet and comorbidity. A majority of those with all three conditions were between 49–63 years of age (52.4%, $P < 0.001$) and had a toilet in their home (95.2%, P 0.033). 38.0% of those with one condition were between 21–35 years of age (Table 5). None of the other variables were significantly associated with comorbidity.

Table 5
Description of the sample according to comorbidity

Odds of Having Elevated Blood Pressure				
Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age				
21–35	Reference	Reference	Reference	Reference
35–49	2.97 (1.52, 5.82)	0.002	3.03 (1.52, 6.05)	0.002
49–63	8.22 (3.55, 19.04)	< 0.001	7.22 (3.06, 17.05)	< 0.001
>= 63	9.25 (2.96, 28.87)	< 0.001	6.82 (2.12, 22.00)	0.001
Sex				
Female	Reference	Reference	Reference	Reference
Male	4.05 (1.75, 9.36)	0.001	3.33 (1.37, 8.07)	0.008
Availability of Toilet				
Community	0.42 (0.24, 0.74)	0.003	0.60 (0.32, 1.12)	0.109
In home	Reference	Reference	Reference	Reference
Odds of Having Elevated Blood Sugar				
Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age (years)				
21–49	Reference	Reference	Reference	Reference
49–63	4.19 (1.67, 10.50)	0.002	1.55 (0.50, 4.76)	0.448
>= 63	1.04 (0.21, 5.13)	0.959	0.40 (0.07, 2.41)	0.320
Availability of Toilet				
Community	0.09 (0.01, 0.64)	0.017	0.12 (0.02, 1.01)	0.051
In home	Reference	Reference	Reference	Reference
Diagnosis Status				

Table Values are n (column %) and may not sum to 100% due to rounding

*Indicates that P-value is for Fisher's exact test, else it is for chi-squared

Odds of Having Elevated Blood Pressure				
Previously Not Diagnosed	0.03 (0.01, 0.10)	< 0.001	0.04 (0.01, 0.13)	< 0.001
Previously Diagnosed	Reference	Reference	Reference	Reference
Odds of Obesity/Overweight				
Characteristic	Unadjusted OR (95% CI)	p-value	–	–
Age			–	–
21–35	Reference	Reference	–	–
35–49	2.51 (1.21, 5.21)	0.013	–	–
49–63	4.95 (2.06, 11.92)	< 0.001	–	–
>= 63	0.87 (0.38, 1.96)	0.731	–	–
	Comorbidity			
Characteristic	One (N = 71)	Two (N = 142)	Three (N = 21)	p-value
Age (years)				<0.001
21–35	27 (38.03)	25 (17.61)	0 (0.00)	
35–49	17 (23.94)	48 (33.80)	8 (38.10)	
49–63	10 (14.08)	52 (36.62)	11 (52.38)	
>= 63	17 (23.94)	17 (11.97)	2 (9.52)	
Sex				0.657
Female	55(77.46)	102(71.83)	16 (76.19)	
Male	16(22.54)	40(28.17)	5 (23.81)	
Literacy				0.559
Illiterate	27(38.03)	62(43.66)	11 (52.38)	
Read	13(18.31)	29(20.42)	5 (23.81)	
Read and Write	31(43.66)	51(35.92)	5 (23.81)	
Educational level				0.577*
less than high school	47(66.20)	106(74.65)	17 (80.95)	
high school	17(23.94)	22(15.49)	3 (14.29)	
college plus	7(9.86)	14(9.86)	1 (4.76)	

Table Values are n (column %) and may not sum to 100% due to rounding

*Indicates that P-value is for Fisher's exact test, else it is for chi-squared

Odds of Having Elevated Blood Pressure				
Employment				0.519*
Unemployed	58 (81.69)	106 (74.65)	15 (71.43)	
Self-Employed	3 (4.23)	14 (9.86)	3 (14.29)	
Labor or Service Industry	3 (4.23)	11 (7.75)	2 (9.52)	
Other	7 (9.86)	11 (7.75)	1 (4.76)	
Languages Spoken				0.890*
Hindi/Marathi	68 (95.77)	135 (95.07)	21(100.00)	
Other	3 (4.23)	7 (4.93)	0 (0.00)	
Marriage status				0.803*
Married	67 (94.37)	135 (95.07)	21 (100.00)	
Unmarried/Separated/Widowed	4 (5.63)	7 (4.93)	0 (0.00)	
Place of Care				0.114
Government	51 (85.00)	82 (73.21)	11 (64.71)	
Private	9 (15.00)	30 (26.79)	6 (35.29)	
Availability of Toilet				0.033
Community	24 (33.80)	42 (29.58)	1 (4.76)	
In home	47 (66.20)	100 (70.42)	20 (95.24)	

Table Values are n (column %) and may not sum to 100% due to rounding

*Indicates that P-value is for Fisher's exact test, else it is for chi-squared

Discussion

This study confirms the significantly higher prevalence of NCDs among urban slum-dwellers in Mumbai compared to the national average of India. As the population of these slums continues to grow, it becomes imperative to understand what factors are associated with NCDs in these settings as a means of curbing the NCD epidemic in the country. The study done in Bangalore using THULSI too found that the rates of all three conditions were higher than the national average.[8] This highlights the fact that slum residents are more often vulnerable to non-communicable diseases than the general population in India.

We found that a vast majority of those with identified NCDs had not been previously diagnosed and had more than one condition. This signifies the need for raising awareness of the importance of screening services and providing access to adequate services. A vast majority of the screened residents were also found to be illiterate, unemployed, and had less than high school level of education. These socio-economic characteristics can play a role in the poor health-seeking behavior of the slum community due to factors such as ineffective health outreach, high opportunity cost of pursuing preventative care, and lack of awareness.[12]

The study also found that a majority of participants with elevated blood pressure, elevated blood glucose, and two or more conditions had a toilet in their home. As mentioned earlier, this variable was used as a marker for socio-economic status, and availability of toilet in the home is indicative of a higher status than those who used a community toilet.[23] A systematic review conducted by Allen et al. has suggested that a higher socio-economic status is associated with greater physical inactivity, and consumption of processed foods, salts, and fats in low-income and lower-middle-income countries.[26] This association could explain the link between presence of toilet in the home and greater prevalence of NCDs and comorbidity.

THULSI not only allowed us to bring screening to a traditionally underserved population, but also created part-time work opportunities for residents of the slum to work as study staff members. The extensive training imparted to the staff members is a step in the direction to create a self-sustaining and local model of screening for diseases. This community-based partnership approach is especially important for the success of global healthcare ventures and to allow the screening tool to reach the residents who need it the most.[27]

It has been found that unawareness of the health condition and distance to the healthcare facility are often common barriers to linkage to care.[28] Residents who screened positive were provided with a health literacy brochure and linked to primary care by provision of receipts. This was a crucial part of the study to reduce barriers to linkage, ensure continuity of care, and make the residents aware of their condition and healthcare services in their area. Linkage to care is especially important to ensure long-term access to care and reduce the possibility of manifestations such as strokes, myocardial infarctions, and kidney failure.[15]

There were some limitations to our study that are worth noting. For instance, the methodology of setting up camp in the community area, inviting slum residents for screening, and offering remuneration could have increased the possibility of selection bias and affected the generalizability of the study since the residents who took part in the study may not be an accurate reflection of the general slum population. We measured blood pressure and blood glucose at one time point in this population, but these measurements are not perfect markers for the presence of hypertension and diabetes since more than one abnormal value separated in time is often required to confirm the diagnosis of the two conditions. The health-survey was conducted by staff members, introducing the possibility of social desirability bias – where the screened population answers questions in a manner that will be viewed as favorable.

Conclusions

This study found high rates of non-communicable diseases in the slum population in Mumbai and provided screening services to several individuals who had never been screened before. The high percentage of unemployment, lack of education, and illiteracy signify the importance of focusing on these socio-economic characteristics for the development of this population. The results of this study highlight the excessive burden of non-communicable diseases in the urban slum in Mumbai and the need to develop preventative interventions for this population.

Abbreviations

THULSI
Toolkit for Healthy Urban Life in Slums Initiative
WHO
World Health Organization
ICMR

Indian Council of Medial Research
NCD
Non-communicable Disease

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board at Yale University (IRB Submission ID: 2000027023) and Ethics Committee for Biomedical and Health Research at BhaktiVedanta Hospital in District Thane.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to a non-disclosure agreement made between Yale University and RX Digi Health Platform Private Limited, the data owner. The data can be made available by the corresponding author on reasonable request and prior approval of the data owner and the author.

Competing interests

The authors declare that they have no competing interests.

Funding

The project proposal received funding from the Sustainable Health Initiative, a program of the Yale Institute for Global Health, at Yale University for collection of the data.

Authors' contributions

RR designed the health survey, coordinated the data collection activity, analyzed and interpreted the data, and wrote the manuscript. AD assisted in data analysis and revised the manuscript. VG assisted in study design. LW is one of the developers of THULSI and helped in study design and revision of manuscript. SH assisted in study design, data interpretation, and revision of manuscript. All authors read and approved the final manuscript.

Acknowledgements

We thank Shivraj Prathisthan, members of the study team, and the participants for their contribution to the study. We thank Pankaj Rungta and Poonam Rungta for their support in the recruitment and coordination of the study team. The data collection of this study was supported by Sustainable Health Initiative, a program of the Yale Institute for Global Health at Yale University.

References

1. Nairobi PT, Slum. Almanac 2015/2016 Tracking Improvement in the Lives of Slum Dwellers. 98 (2015).
2. Habitat U. UN-Habitat State of the World's Cities 2006/7. (2006).

3. Population. total - India | Data. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=IN.
4. Urban Affairs M. of H. and. *Handbook of Urban Statistics*.
5. WHO | Housing-related health risks. *WHO* http://www.who.int/sustainable-development/cities/health-risks/slums/en/.
6. Anand K, et al. Are the urban poor vulnerable to non-communicable diseases? A survey of risk factors for non-communicable diseases in urban slums of Faridabad. Natl Med J India. 2007;20:115–20.
7. Deepa M, Pradeepa R, Anjana R, Mohan V. Noncommunicable Diseases Risk Factor Surveillance: Experience and Challenge from India. Indian J Community Med. 2011;36:50–6.
8. George CE, et al. Health issues in a Bangalore slum: findings from a household survey using a mobile screening toolkit in Devarajeevanahalli. BMC Public Health. 2019;19:1–12.
9. WHO | World Health Organization. http://gamapserver.who.int/gho/interactive_charts/ncd/risk_factors/overweight/atlas.html.
10. GHO |. By category | Raised fasting blood glucose (≥ 7.0 mmol/L or on medication)(age-standardized) - Estimates by country. *WHO* https://apps.who.int/gho/data/node.main.NCDRGLUCA?lang=en.
11. GHO |. By category | Raised blood pressure (SBP ≥ 140 OR DBP ≥ 90), age-standardized (%) - Estimates by country. *WHO* https://apps.who.int/gho/data/node.main.A875STANDARD?lang=en.
12. Unger A, Riley LW. Slum Health: From Understanding to Action. *PLoS Med* 4, (2007).
13. Roy D, et al. Survey-based socio-economic data from slums in Bangalore, India. Sci Data. 2018;5:1–9.
14. Shetty P. Health care for urban poor falls through the gap. The Lancet. 2011;377:627–8.
15. Riley LW, Ko AI, Unger A, Reis MG. Slum health: Diseases of neglected populations. BMC International Health Human Rights. 2007;7:2.
16. Mumbai. | India | Britannica. https://www.britannica.com/place/Mumbai.
17. Mumbai (Greater Mumbai). City Population Census 2011–2020 | Maharashtra. https://www.census2011.co.in/census/city/365-mumbai.html.
18. Deshmukh MS, CONDITIONS OF SLUM POPULATION OF MAJOR SUB-URBAN WARDS. OF MUMBAI IN MAHARASHTRA. 2013;2:7.
19. THULSI. – Health in Slums. http://healthinslums.com/?page_id=2527.
20. Appropriate body-mass. index for Asian populations and its implications for policy and intervention strategies. The Lancet. 2004;363:157–63.
21. Whelton PK, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* **71**, e127–e248 (2018).
22. Getting Tested | Basics | Diabetes | CDC. https://www.cdc.gov/diabetes/basics/getting-tested.html (2019).
23. Galobardes B, Shaw M, Lawlor DA, Lynch JW. Indicators of socioeconomic position (part 1). J Epidemiol Community Health. 2006;60:7–12.
24. for Academics SO *SAS OnDemand*. (SAS Institute Inc, 2015).
25. WHO | World Health Organization. http://gamapserver.who.int/gho/interactive_charts/ncd/risk_factors/obesity/atlas.html.
26. Allen L, et al. Socioeconomic status and non-communicable disease behavioural risk factors in low-income and lower-middle-income countries: a systematic review. The Lancet Global Health. 2017;5:e277–89.

27. Collins SE, et al. Community-based Participatory Research (CBPR): Towards Equitable Involvement of Community in Psychology Research. Am Psychol. 2018;73:884–98.
28. Rachlis B, et al. Identifying common barriers and facilitators to linkage and retention in chronic disease care in western Kenya. BMC Public Health. 2016;16:741.
29. OpenEpi Menu. https://www.openepi.com/Menu/OE_Menu.htm.
30. Banerjee S, Mukherjee TK, Basu S. Prevalence, awareness, and control of hypertension in the slums of Kolkata. Indian Heart J. 2016;68:286–94.
31. Dasappa H, Fathima FN, Prabhakar R, Sarin S. Prevalence of diabetes and pre-diabetes and assessments of their risk factors in urban slums of Bangalore. J Family Med Prim Care. 2015;4:399–404.
32. Department of Community Medicine TNMC Mumbai. Maharashtra I, Jajulwar DM B. An epidemiological cross-sectional study to determine the prevalence of overweight and obesity and its association with factors such as the hours spent in physical activity, dietary habits in an adults of Urban Slum of Mumbai. *jmscr* **6**, (2018).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AdditionalFiles.docx