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ORIGINAL ARTICLE

Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study (AJ-DRUMSS): Study Design and Methodology – Report 1

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ABSTRACT

Purpose: To describe the methodology of Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study (AJ-DRUMSS), which was designed (i) to estimate the prevalence of diabetic retinopathy (DR) in a general population, (ii) to study the risk factors associated with DR in those with type 2 diabetes mellitus (DM), and (iii) to create awareness for early detection and develop timely interventional management for DR.

Methods: AJ-DRUMSS is an ongoing population-based cross sectional study conducted in seven wards of slums in Mumbai, India, wherein eligible subjects from the general population were screened for DR and profiled for their demographic, social and biochemical parameters to study the associations of these factors.

Results: To date, nearly 54,000 households have been enumerated for both awareness and DR prevalence in five study areas (out of seven) during 17 awareness campaigns and 78 DR screening camps. Of these, 4295 households were included in AJ-DRUMSS. Nearly 15,000 camp subjects (including subjects from awareness-focused areas who also turned up for the screening camps) were screened from the total enumerated households, of which 16.1% were diagnosed with type 2 DM. A total of 14.5% of these had evidence of DR and 3.5% had sight-threatening DR.

Conclusions: A detailed study design of AJ-DRUMSS is described. In the screening camps nearly 3.5% of the diabetic population had sight-threatening DR, which needed an active interventional strategy. This study will help in formulating efficient eye care policies, making optimum use of available resources, reorienting healthcare providers and the ignorant within the population regarding the need for periodic ophthalmic surveillance and timely intervention.

Keywords: Awareness, diabetic retinopathy, Mumbai, ophthalmic screening, prevalence, type 2 diabetes mellitus, urban slums, western India

INTRODUCTION

Diabetes mellitus (DM), presently in pandemic proportions, is the 5th leading cause of death worldwide,[1] and one of the leading causes of blindness in India as a result of diabetic retinopathy (DR) – a dubious distinction earned in the last few decades. According to the International Diabetes Federation, in 2011 there were 366 million people with DM, which is expected to rise to 552 million by 2030, mostly in

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low- and middle-income countries.[2] Unfortunately, 30–50% of those with diabetes are unaware of their condition.[3,4]

Of the many complications of DM, DR contributes to significant visual morbidity. After a 15-year history with DM, 10% of diabetics develop severe visual morbidity, of which around 2% become blind. A 20-year duration of DM increases the risk of developing retinopathy by 60–99%, and 5–53% of diabetics develop severe visual morbidity due to proliferative DR.[5,6,7]

In India, the increase in the diabetic population by 2030 is a startling projected figure of 151% as compared to 54% in developed countries.[8] In a developing country like India, increased longevity secondary to increased access to modern, relatively-efficient healthcare services and easy access to high-calorie food, has resulted in an increased prevalence of DM and its complications, adding to the existing high burden of visual morbidity.

The average annual cost per person with DM ranges from 6260 Indian national rupees (INR) for rural populations to 10,000 INR for urban populations; management of the long-term complications is an economic burden to patients, family and the community.[9]

Prevalence of DR has been widely studied across the globe[6,10–33] (Table 1). Surprisingly, there are few population-based studies on the prevalence of DR in India, and those available are mainly from the south of the country. No data are available for western India, including Mumbai, the commercial capital of India.

The Mumbai metropolis is the most populous city in India, and the fourth largest in the world. Mumbai is one of the top 10 centers of commerce in the world and generates 5% of national gross domestic product, accounts for 33% of India's yearly income tax revenue, 20% of all central excise tax collection, and 40% of foreign trade. The city generates 40 billion INR in corporate taxes, 25% of the country's industrial output, 70% of maritime trade and 70% of national capital transactions.[34] Mumbai is the seat of entertainment, with the Bollywood film industry attracting people from all walks of life to migrate to the city. It has witnessed a dynamic transformation in its demographics over less than a century and is now a

TABLE 1. Comparison of diabetic retinopathy studies worldwide.[6,10–33]

Study	Country	Study period	Study design	Participant age, years	DM, *n*	DR, %
WESDR	USA	1980–1982	Cohort of DM	≥30	1313	50.3
EDC	USA	1986–1988	Type 1 DM	>28	788	62
BDES	USA	1988–1990	Population based	43–84	410	35.1
Hoorn	Netherlands	1989–1992	Population based	50–74	626	34
Rotterdam	Netherlands	1990–1993	Population based	Elderly	6191	4.8
Taiwan	Taiwan	1991	Population based	>40	527	35.0
BMES	Australia	1992–1994	Population based	>50	252	29.0
MVIP	Australia	1992–1994	Population based	>40	233	27.5
ARIC	USA	1993–1995	Population based	45–64	2341	24
APEDS	India	1996–2000	Population based	>30	124	1.78
CHS	USA	1997–1998	Population based	69–102	296	20
Proyecto VER	USA	1997–1999	Population based	>40	1023	48
Hisayama	Japan	1998	Population based	>40	1672	4.2
Liverpool Diabetic Eye Study	UK	1998	Cohort of DM	13–92	395	33.6
Barbados Eye Study	West Indies	1998	Population based	>40	615	28.8
AusDiab	Australia	1999–2000	Population based	≥25	2177	15.3
LALES	USA	1999–2003	Population based	>40	1217	46.9
Palakkad Eye Disease Survey	India	2001	Population based	>50	260	26.8
CURES ES	India	2001–2002	Population based	>20	1715	17.6
ADDITION	Denmark	2003	Population based	40–69	763	6.8
SN-DREAMS	India	2003–2006	Population based	≥40	1414	18.0
SiMES	Singapore	2004–2006	Population based	40–80	757	35.0
UKADS	UK	2004–2007	Population based	>50	1035	40
Beijing	China	2006	Cohort of DM	20–80	2006	24.7 ± 1.0
Handan	China	2006–2007	Population based	≥30	387	43.1
Present study, AJ-DRUMMS	India	2011–2014	Population based	≥40	On going	

ADDITION, Anglo-Danish-Dutch study of Intensive Treatment in People with Screen-detected Diabetes in Primary Care; ARIC, Atherosclerosis Risk in Communities Study; AJ-DRUMMS, Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study; APEDS, Andhra Pradesh Eye Disease Study; AusDiab, Australian Diabetes, Obesity and Lifestyle Study; BDES, Beaver Dam Eye Study; BMES, Blue Mountains Eye Study; Beijing, Beijing Eye Study; CHS, Cardiovascular Health Study; CURES ES, Chennai Urban Rural Epidemiology Study (Eye Study); DM, diabetes mellitus; DR, diabetic retinopathy; EDC, Pittsburgh Epidemiology of Diabetes Complications Study; Handan, Handan Eye Study; Hisayama, Hisayama Study; Hoorn, Hoorn Study; LALES, Los Angeles Latino Eye Study; MVIP, Melbourne Vision Impairment Project; Proyecto VER, Proyecto Vision and Eye Research; Rotterdam, Rotterdam Study; SiMES, Singapore Malay Eye Study; SN-DREAMS, Sankara Nethralaya-Diabetic Retinopathy Epidemiology and Molecular Genetics Study; UKADS, UK Asian Diabetes Study; WESDR, Wisconsin Epidemiologic Study of Diabetic Retinopathy.

bustling metropolitan city, with sprawling slums. According to India's Census 2001 more than half (54.1%; 23.5% in 1991)[35] of Mumbai's population live in slums. This increase in urban slums reflects the importance of urban poverty in shaping national health policies.

The present paper describes the study design and methodology of the Aditya Jyot - Diabetic Retinopathy in Urban Mumbai Slums Study (AJ-DRUMSS).

Aims of the Study

The primary aims of our study are:

(1) To estimate the prevalence of DR in the general population of urban slums of Mumbai.
(2) To identify risk factors and study their correlation to clinical demographics, and social and biochemical parameters in those with DR.
(3) To create awareness for early detection of DR and the need for timely interventional management.

The secondary aims are:

(1) To assess knowledge, attitude and practice (KAP) for DR in the study population.
(2) To assess KAP for DR among healthcare providers in the study area.
(3) To estimate the non-response rate for ophthalmic examination and ascertain barriers.

MATERIALS AND METHODS

AJ-DRUMSS is an ongoing study, initiated in September 2010. Data collection is likely to be completed by August 2014. The study has been approved by the Institutional Review Board of Aditya Jyot Eye Hospital, Mumbai, India, and has been designed in adherence to the guidelines of the Declaration of Helsinki.[36] The study has three stages: (1) the epidemiology outline; (2) enumeration, survey and screening; and (3) data analysis and reporting.

Epidemiology Outline

At initiation of the study, demographic data of the study area was procured from India's Census 2001 and the Municipal Corporation of Greater Mumbai.

Study Design

AJ-DRUMSS is a population-based cross-sectional study in which a subset of subjects with type 2 DM will be followed-up as a long-term study cohort.

Sample Size Estimation

The sample size was calculated on the assumption that the prevalence of DR in the general population over 40 years of age was 1.3%, as estimated in the Andhra Pradesh Eye Disease Study.[21] With a relative precision of 25%, a dropout rate of 20% and a design effect of 2, the estimated sample size was 5830 eligible subjects from the general population.

Study Area

Mumbai occupies a long, narrow peninsula in the Arabian Sea on the west coast of India and is composed of an island city and a suburban area totaling 437.71km^2. It is divided into 24 wards (Figure 1).

According to the United Nations Human Settlements Programme (UN-Habitat), a ''slum household'' is a group of individuals living under the same roof in an urban area that lacks one or more of the following: durable housing of a permanent nature that protects against extreme climatic conditions, sufficient living space which means not more than three people share the same room, easy access to safe water in sufficient amounts at an affordable cost, access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people, and security of tenure that prevents forced evictions. Of the 24 wards, 23 have slums. We non-randomly selected seven wards with slum populations based on the convenience of access to these areas (Table 2, Figure 1).

Sampling

Single stage sampling was done at the level of selection of study subjects. Eligible subjects were randomly selected from the study areas. To ensure uniform contributions from each of the seven wards, 833 subjects were enumerated per ward to reach the target sample size, and thus be truly representative of the urban slums of Mumbai.

Eligibility and Exclusion Criteria

For the eligibility and exclusion criteria see Table 3.

Enumeration, Survey and Screening

The three major components were: (1) Pre-camp: Preparation for screening camp, training and quality control; (2) Camp: Screening for type 2 DM, medical history and questionnaire, anthropometric evaluation, ophthalmic examination and referrals; (3) Post-camp: Laboratory investigations and ophthalmic posterior segment assessment (Figure 2).

Pre-camp

Preparation for the screening camp included:

- *Listing and Household Enumeration*: A household was defined as family members living in the same premises and sharing a common kitchen. All houses in the study area were numbered

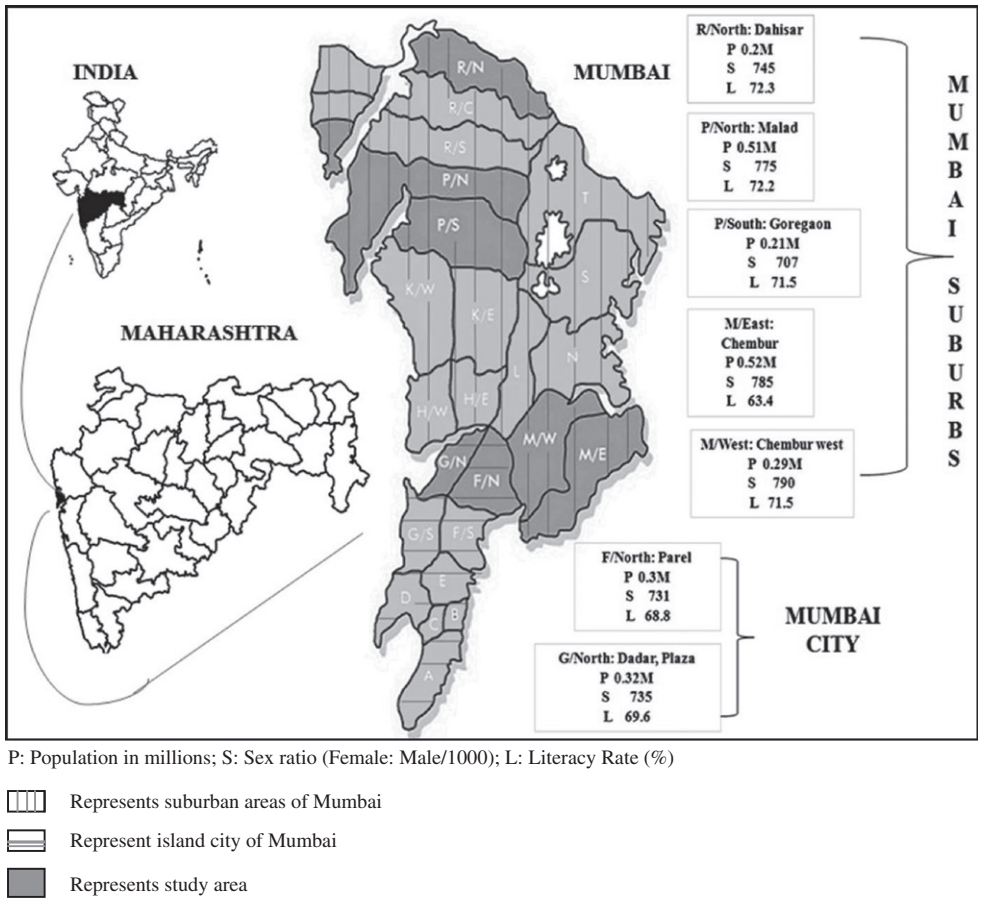


FIGURE 1. Map of Mumbai, including study area of Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.

serially during listing and enumeration. A detailed list of households in the study area was prepared by community health workers (CHWs). Rechecking by co-workers was done once to avoid duplication or omission of households.

- *Door-to-door Survey*: A door-to-door survey of all households administered the household datasheet was conducted in study areas. The household datasheet contained details of demography, language, educational qualifications, occupation, residential status, and history of ocular and systemic disease, if any. Dropout was defined as refusal by subjects to provide any information or failure to comply with eye examination after six repeated attempts. Eligible subjects were instructed to fast overnight for 8 hours and informed of the ophthalmic screening camps organized at a convenient place in their locality a day prior.
- *KAP Assessment of Health Care Providers*: A standardized KAP adapted from the Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetic Study[14] was administered in a suitable language to the health-care providers (comprised of opticians, optometrists, physicians and ophthalmologists) by the CHWs prior to conducting the awareness campaigns in their locality.
- *Awareness Camp*: Awareness campaigns were held in pre-selected areas a month prior to the screening camps targeting high risk populations, and conducted by social workers, CHWs, pharmacists and volunteers. The awareness campaigns educate the community about DM in general and DR in particular through eye model demonstrations and pamphlets printed in local languages. In each household during enumeration and survey, social workers and CHWs provided DM- and DR-related information and awareness.
- *Training*: At the start of the project, the epidemiology team underwent a DR training workshop lasting 5 days, with 8 hours per day of training sessions with the aim of ensuring each CHW and social worker were well trained in performing household surveys, enumeration, filling in the study data sheet, measuring blood pressure (BP)

TABLE 2. Comparison of demographics of Mumbai and the study area, Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.

	Wards	Total population, *n*	Slum population, *n*	Slum Population %	Non-slum Population, *n*	Sex ratio total population	Sex ratio slum F:M/1000	Sex ratio non-slum F:M/1000	Literacy rate slum, %	Literacy rate non-slum, %
Mumbai city	F/North	524,393	304,500	58.05	219,893	791	731	882	68.8	82.3
	G/North	582,007	324,886	55.82	257,121	807	735	908	69.6	82.4
Mumbai suburbs	M/East	674,850	523,324	77.50	151,526	801	785	859	63.4	75.5
	M/West	414,050	283,557	68.48	130,493	829	790	929	71.5	82.8
	P/North	798,775	508,435	63.65	290,340	819	775	901	72.2	80.8
	P/South	437,849	210,591	48.10	227,258	791	707	877	71.5	82.4
	R/North	589,887	326,235	55.30	163,652	760	687	860	71.8	81.0

F:M/1000, Female:Male/1000

and estimating fasting blood glucose (FBG). The main objective was to avoid bias or errors in any of the procedures employed.

- *Quality Control*: To ensure accurate and reliable data, a comprehensive AJ-DRUMSS manual was prepared. A monthly meeting of the epidemiological team was organized to maintain the uniformity and standardization of all the examination and diagnostic procedures. During the training sessions, inter- and intra-observer variations for clinical examination were compared (to minimize bias), with kappas of 0.8 and 1.0, respectively (where kappa >0.8 suggests good agreement between observers). Instruments like the BP apparatus and glucometer were calibrated at regular intervals and repaired/replaced at the first sign of damage/malfunction.

Camp

Screening for Type 2 DM. On the day of the screening camp, the finger prick method of FBG estimation was performed by glucometer (Ascensia Entrust, Bayer Diagnostics, Tarrytown, NY, USA) on eligible subjects. They were then categorized as provisional diabetic (PD), known diabetic (KD) or not known diabetic (NKD) as per the definitions listed in Table 4.[14,15,37] Those categorized as NKD underwent a preliminary visual acuity (VA) examination, refraction and then exited the camp. Those categorized as PD or KD were registered for the DR screening camp. A trained CHW measured the BP of registered subjects with a mercury column sphygmomanometer (Deluxe, BPMR 120, Maharashtra, India) and a stethoscope in seated position after a resting period of 5 minutes. All BP measurements were made on the right arm of each subject, using a cuff of appropriate size at the level of the heart, two readings were taken 5 minutes apart and the mean of the two was taken as the BP.

Medical History and Questionnaire. A questionnaire was administered to registered subjects wherein demographic information, and details regarding education, occupation and medical history were recorded by the CHWs. The information in the medical history recorded the duration and treatment of chronic diseases like diabetes and hypertension, family history of diabetes and degree of relatedness to the diabetic family member, symptoms related to complications of diabetes like nephropathy and neuropathy, tobacco intake and alcohol consumption. The ocular history included details of the last visit to an ophthalmologist, any existing ocular discomfort and prolonged medical or surgical interventions.

Anthropometric Evaluation

- *Body mass index (BMI)*: Height and weight of each subject was measured, and BMI calculated using

the formula weight (kg) ÷ height (m^2). Based on their BMI values, subjects are assigned as underweight (<18.50 kg/m^2), normal weight (18.50–24.99 kg/m^2), overweight (≥25.00 kg/m^2) or obese (≥30.00 kg/m^2).[38]

TABLE 3. Eligibility and exclusion criteria, Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.

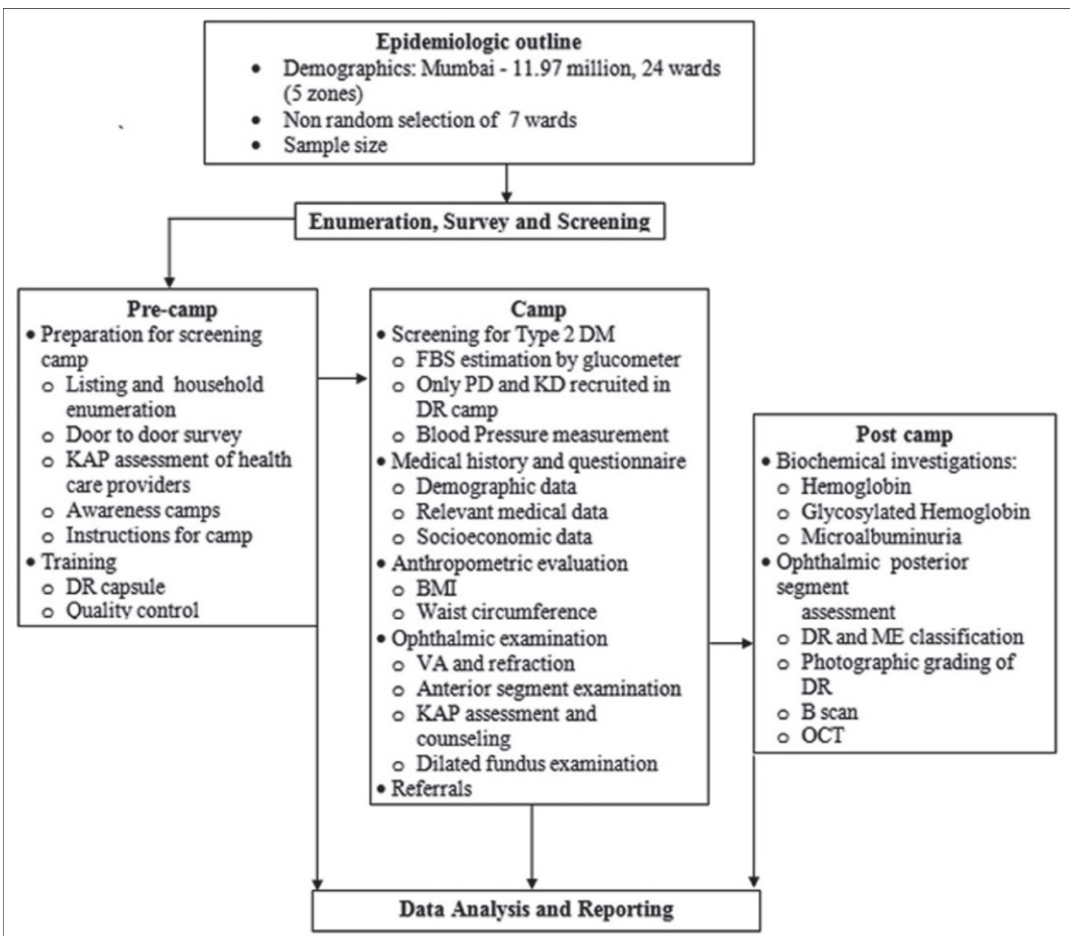
Eligibility criteria
A resident[a] aged 40 years or above
Exclusion criteria
T1DM[37]
A resident who cannot be contacted after six physical attempts by the CHWs
A resident who passes away after enumeration but prior to examination
A resident who cannot be transported to the examination centre due to health reasons
Eligible residents not present during the examination period (recorded as absent)

[a]A resident is defined as having lived in the study area for the past 6 months
CHW, community health worker

- *Waist circumference*: Circumference of the abdomen was measured 2.5 cm above the umbilicus and recorded as central obesity if ≥90 cm in males or ≥80 cm in females.[39]

Ophthalmic Examination

- *Visual Acuity and Refraction*: VA was measured using tumbling E Early Treatment Diabetic Retinopathy Study (ETDRS) chart (Revised 2000 Series ETDRS Charts, Precision Vision, La Salle, IL, USA). If VA was <4/4 (logarithm of the minimum angle of resolution, logMAR, 0.0), pinhole VA was assessed followed by objective and subjective refraction performed with a streak retinoscope (Beta 200, Heine, Germany). If the subject was unable to read 4/40 (logMAR 1.0), vision was checked at 1 m. If they were still unable to identify any of the large optotypes, ability to count fingers, detect hand movements, or to perceive light was observed which was recorded as present or absent. Those categorized as PD and KD underwent complete eye check--ups. Those categorized NKD with VA 4/4 exited



DR, diabetic retinopathy; T2DM, type 2 diabetes mellitus; FBG, fasting blood glucose; PD, provisional diabetic; KD, known diabetic; BMI, body mass index; VA, visual acuity; KAP, knowledge, attitude and practice; ME, macular edema; OCT, optical coherence tomography.

FIGURE 2. Study design of the Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.

TABLE 4. Definitions used in the Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.[14,15,37]

Type 1 Diabetes mellitus	Age <30 years at onset of diabetes in patients with insulin treatment only.
Provisional diabetic (PD)	New asymptomatic individual with a first fasting blood glucose level ≥126 mg/dl.
Known diabetic (KD)	Diagnosis of diabetes made by a medical practitioner or patient using hypoglycemic medication, either oral or insulin or both.
Not known diabetic (NKD)	Eligible candidates not meeting the criteria of PD or KD.
Newly diagnosed diabetic (NDD)	Fasting blood glucose level ≥126 mg/dl on 2 separate days; PD with glycosylated hemoglobin HbA1C ≥6.5%.
Duration of diabetes[a]	Time interval between the date of diagnosis of diabetes (as made by a diabetologist or when anti-diabetic treatment started) and the date of eye examination.
Hypertension[a]	Systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg or patient is on antihypertensive treatment.

[a]Partially adapted from Sankara Nethralaya-Diabetic Retinopathy Epidemiology and Molecular Genetics Study protocol.

from the screening camp after being given an appropriate prescription, whereas those not meeting VA 4/4 underwent a dilated fundus examination for retinal pathology.

- *Anterior Segment Examination*: Anterior segment evaluation including chamber depth and rubeosis iridis was performed using a hand held slit lamp (HSL 150, Heine, Herrsching, Germany).
- *Intraocular Pressure*: A Perkins tonometer (MK2, Haag Streit, Harlow, UK) was used to measure intraocular pressure in both eyes.
- *KAP Assessment and Counseling:* Subjects with DM underwent pupillary dilatation (tropicamide 0.5% and phenylephrine 5%). A CHW assessed the pre-counseling-KAP of subjects by administering a questionnaire (adapted from the Sankara Nethralaya: Diabetic Retinopathy Epidemiology and Molecular Genetic Study[14]) printed in local language and read aloud for those who were illiterate. They were counseled using a flip chart and demonstration of an eye model emphasizing signs, symptoms and early detection of DM/DR following which a post-counseling-KAP was assessed.
- *Dilated Fundus Examination*: A binocular indirect ophthalmoscope (Keeler Instruments Inc, Broomall, PA, USA) and +20 diopter (D) lens (v20d, Halma Holdings, Cincinnati, OH, USA) was used to examine the fundus of both eyes. While screening, documentation of the fundus was kept simplified as DR/no DR.

Referrals. Those categorized as KD or PD were referred to the base hospital for further management and thus for all practical purposes, the post-camp was limited to subjects with type 2 DM except some of those categorized as PD who may have turned out to be NKD (after glycosylated hemoglobin, HbA1C, estimation as below).

Post-camp

Laboratory Investigations: Those categorized as PD underwent confirmation by estimation of *HbA1c* (DiaSTAT HbA1c reagent kit, Bio-Rad Diagnostics Group, Hercules, CA, USA). *A HbA1c value* ≥6.5% was taken as the cut-off for diagnosis of DM.[15] All referred subjects underwent biochemical analysis for hemoglobin (calorimetric hemoglobinometer) and microalbuminuria (Clintek 50 Bayer Urine Analyzer, Siemens Medical Solutions Diagnostics, Munich, Germany) using the first morning urine specimen.

Posterior Segment Assessment

- *Classification of DR and Macular Edema:* Subjects underwent binocular indirect ophthalmoscopic evaluation after pupillary dilatation. Modified classification of DR based on the degree of retinopathy was used for DR classification[40] (Table 5). The macular area was examined with a +78D lens (v78, Halma Holdings, Cincinnati, OH, USA) to diagnose clinically significant macular edema as defined by the ETDRS.[41]
- *Photographic Grading of DR*: A 30° stereoscopic pair of color photographs of seven standard fields was taken using a fundus camera (VISUCAM 500, Carl Zeiss Meditech AG, Jena, Germany). Images were stored as uncompressed jpeg files without any enhancement. The grading of DR was based on photographs graded against the ETDRS standard photographs performed by a single experienced retinal specialist in an un-masked manner. A κ of 1.0 for intra-observer variations was observed suggesting good agreement between observations.
- *Optical Coherence Tomography (OCT) and B Scans:* OCT (OCT3, Carl Zeiss Ophthalmic Systems Humphrey Division, Dublin, CA, USA) and B scan (MARVEL, Appasamy Associates, Chennai, India) were performed on all referred subjects and documented.

Data Analysis and Reporting

Data Entry

A database of the questionnaire was maintained electronically. Double entry of data was performed.

TABLE 5. Diabetic retinopathy clinical grading in the Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study.[39]

Disease level	Findings observable upon dilated ophthalmoscopy
No diabetic retinopathy	No abnormality
Mild non-proliferative diabetic retinopathy	Only microaneurysm
Moderate non-proliferative diabetic retinopathy	Worse than mild, but less than severe
Severe non-proliferative diabetic retinopathy	Any of the following: 20 or more intraretinal hemorrhages in 4 quadrants, venous beading in >2 quadrants or intraretinal neovascularization in 1 quadrant
Proliferative diabetic retinopathy	One or more of the following: neovascularization or pre-retinal or vitreous hemorrhage

Statistical Analysis

For descriptive purposes, the prevalence rate of DR was calculated with 95% confidence intervals. For analytic purposes, appropriate parametric and non-parametric analyses were used. The study design was incorporated into the population estimates. Specifically, the weight of the sample size per ward relative to the actual population of the ward was used to weight the population estimates and the standard error estimates adjusted for the ward sampling strategy. Ward was included as a co-variate in all multivariate analyses.

RESULTS

Feasibility and Acceptability of Study Protocol

A time motion survey of the screening model was performed on a sample of 10 subjects to look at the feasibility of the camp protocol in terms of applicability to the screening population. The survey took 2 hours for information collection which included FBG estimation, BP measurement, medical history, questionnaires and anthropometric measurements (60 minutes) and ophthalmic work-up including dilated fundus examination (60 minutes) with no questionnaire fatigue and good response rate from the subjects allowing adherence to the study protocol.

KAP for DR Impact

The KAP questionnaire designed for the community was performed on the same set of subjects before and after the awareness talk. The study revealed marked improvement in awareness. The parameters analyzed were awareness of DR (before 28%; after 72%), awareness of frequent eye examination in DM (before 12%; after 86%), role of intra-vitreal injections and lasers to prevent visual loss (before 9%; after 79%).

Data so far Obtained

To date, a total of 53,949 households have been enumerated in five wards (out of seven in total) for both awareness program and AJ-DRUMSS. The number of households enumerated for AJ-DRUMSS was 4295 (Table 6).

A total of 14,739 subjects were screened from 53,949 households during 17 awareness campaigns and 78 DR screening camps of which 16.1% (2366) were diagnosed with type 2 DM. A total of 14.5% (343) of these had evidence of DR and 3.5% (82) were found to have sight-threatening DR.

DISCUSSION

UN-Habitat predicts that by 2030, one in every 3 people in the world could be living in slums. The slums in urbanized environments are fast becoming a seat for both communicable and non-communicable diseases, but due to lack of attention to these regions, little data on health-indicators exists. In this study, we create awareness about DR in these underserved sections of urban society, estimate the prevalence of DR, uncover the interplay between lifestyle and disease pattern in them and study the factors affecting disease prognosis.

The strength of this study is the large number of subjects screened from the western region of India on which there is a paucity of literature. However the study is not free from limitations, for example, the data on prevalence of DR from subjects with type 2 DM only may be misleading because of selective exclusion of subjects with type 1 DM, leading to underestimation of the actual prevalence rate. As only single stage randomization was used, it can result in biased outcomes affecting extrapolation to a larger section of the similar population. Despite these shortcomings our sample is likely to be representative of the slum population of Mumbai considering the uniformity of inclusion criteria and limited number of exclusions. We expect that this study will help understand KAP of DR among the community and eye-care providers. This would enable us to redistribute available resources and re-orient healthcare programs in these epidemically but painfully rising populations of urban slums in India and globally.

TABLE 6. Results to date from the Aditya Jyot-Diabetic Retinopathy in Urban Mumbai Slums Study (AJ-DRUMSS) and screening camps.

Mumbai wards[a]	Total enumerated households[b]	Enumeration for AJ-DRUMSS[c]		Screening and awareness camps for DR		
	Households, *n*	Households, *n*	General population, *n*[d]	Screened subjects, *n*	DM, *n* (%)	DR, *n* (%)
M/West	10,200	801	949	2951	425 (14.4)	52 (12.2)
M/East	9157	690	940	2939	520 (17.7)	92 (17.7)
P/North			All activities yet to start			
P/South						
R/North	10,790	834	953	2990	496 (16.6)	59 (11.9)
F/North	9002	921	847	2845	412 (14.5)	56 (13.6)
G/North	14,800	1049	979	3014	531 (17.6)	84 (15.8)
Total	53,949	4295	4668	14,739	2366 (16.1)	343 (14.5)

DM, diabetes mellitus; DR, diabetic retinopathy
[a]Selected 7 wards for AJ-DRUMSS in urban slums of Mumbai.
[b]Total households enumerated in each ward for prevalence and awareness of DR programs.
[c]For AJ-DRUMSS, at least 833 eligible subjects from each ward would be screened for type 2 DM. Known diabetics and provisional diabetics were directed to the screening camps, particularly the post-camp for comprehensive ophthalmological examination (DM patients to start at post-camp soon).
[d]For AJ-DRUMSS, to complete the households in a street, the required 833 sample number was exceeded in some wards.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Notice of Correction

Changes have been made to this article since its original online publication date of 27 January 2014.