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Socio-Demographic Determinants of Adult Tuberculosis: A Matched Case-Control Study in Bangladesh

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Abstract: Tuberculosis (TB) is a multi-systemic infectious disease that has evoked a substantial disease burden in developing countries, including Bangladesh. The aim of this study is to determine the socio-demographic risk factors for adult tuberculosis. A matched case-control study was conducted with 178 cases and 179 controls from a selected TB hospital in Dhaka. Data was collected via face-to-face interview using a standard structured questionnaire, posing questions about socio-demographic, clinical and behavioral factors where tuberculosis patients were matched for age and sex to controls. Crude and multivariate logistic regression analyses were used to analyze the data. The multivariate logistic regression analysis indicated that over-crowding in a house (OR = 3.49, CI = 2.08-5.93), contact with TB patients during the last 6 months (OR = 1.789, CI = 0.917-3.559) and employed participants (OR = 1.99, CI = 1.175-3.458) were positively associated with the development of TB. Besides, monthly income (>25000 taka) (OR = 0.291, CI = 0.151-0.547) and urban living (OR = 0.295, CI = 0.163-0.527) are found negatively associated with the TB status. The identified determinants for the development of adult tuberculosis reflect a complex interaction among socio-demographic conditions. Tuberculosis control would benefit from a collaboration of broad public health activities in improving the socio-demographic factors.

Keywords: Tuberculosis, Risk Factors, Matched Case-Control Study, Infectious Disease, Bangladesh

Introduction

Tuberculosis (TB) is a multi-systemic infectious disease that contributes tocommunicable disease morbidities worldwide (Rajeswari *et al*., 1999). Developing countries, such asBangladesh, often suffer from high burden of TB, primarily due to poverty (Shetty *et al*., 2006). InBangladesh, the incidence rate was approximately 225/100,000 per year while themortality rate was 46% in 2010 (Banu *et al*., 2012). Approximately 64,000 people die solely due to TB inBangladesh per year, on average (Gupta *et al*., 2002) According to previous studies in developedcountries in Europe and North America, the most predominant risk factors of TBdevelopment included: Homelessness, unemployment, a high-risk lifestyle and the spreadof HIV infection. Since Bangladesh is a developing country, major proportion of thepopulation of Bangladesh is prone to the aforementioned risk factors. According to thecurrent estimate, Bangladesh ranks fifth on the list of countries facing the highest TBburden. Moreover, TB patients in Bangladesh lack access to an adequate supply ofmedications that they can take in order to effectively eliminate their health issues (de Vries *et al*., 2010; MMWR, 2011).

Malnutrition is primarily quantified by Body Mass Index (BMI) (WHO, 2008), which couldpotentially worsen TB prognosis, resulting in delayed recovery and higher mortality rates (UNAIDS, 2013; Boccia *et al*., 2011; NICUS, 2016; Jeon and Murray, 2008; Kim *et al*., 2008). Bangladesh being a country riddled with a large number of populationliving under the poverty line, malnutrition may play a significant role as a precursor toTB and this study sought to determine if there is any such association using BMI data.Finding a correlation between nutrition and TB can help justify nutritional interventionsas an integral component of attaining Millennium Development Goal 6 (MDG6).

According to previous literatures, TB cases are heavily skewed towards low-income andemerging economies, where the Indian subcontinent contains the largest cluster of TB cases (Ahmed *et al*., 1999; Dye *et al*., 1999; Raviglione *et al*., 1995; Sundre *et al*., 1992). The National Tuberculosis Program (NTP) of Bangladesh adopted the Directly Observed Treatment Short course (DOTS) strategy and rapidly expanded to reachalmost full coverage in 2006 (Hossain *et al*., 2012). However, there are still gaps in accessibility for urbanslum dwellers due the highly stigmatized nature of TB in highly impoverished areas, aswell as limited healthcare access. The same urban slum dwellers also struggle the most inattaining proper nutrition.

According to a similar study in Kenya, poor nutrition was a prominent factor for TBreactivation and mortality, while food supplementation was observed to accelerate therapeutic benefits (Mazars *et al*., 2001). Although the study yielded an association, the cross-sectionaldesign did not allow for the determination of a causal relationship.

Poor nutrition is a predominant risk factor for contracting TB and mortality (Zachariah *et al*., 2002; WHO, 2012; Pakasi *et al*., 2009), butthere is insufficient evidence that nutritional support can improve TB treatment responseand outcomes. Hence, this study aimed to identify the other socio-demographicdeterminants of tuberculosis among the Bangladeshi adult population, after adjusting forfew clinical and behavioral factors.

Methods

Study Area, Design, Study Population and Sample Size

This case control study was conducted in Shyamoli TB Hospital in Dhaka, Bangladesh, which houses the largest number of TB referral cases. The cases were TB patients (age 18years and older) who were diagnosed from the Shyamoli TB Hospital. They wereinterviewed immediately after diagnosis and we enrolled the TB patients in the studyuntil the sample size was achieved.

The controls were patients in the same hospital who did not manifest signs and symptomsof TB that had no history of TB during the last one year. The controls are selected fromthe outpatient unit of the Shyamoli TB Hospital and presented with minor diseases suchas colds, diarrhea, or fever. We selected the controls individually matched to cases by age (year of birth ±2) and sex.

Given 5% significance level and 80% power, the calculated sample size for a case-controlstudy design was 358, which yielded 179 cases and 179 controls. Consecutive sampleswere drawn until the sample sizes were achieved and the participants were selected via apurposive sampling scheme. One of the cases was not able to complete the interview andtherefore we excluded the case from our study, which remains 178 cases and 179 controls. The individuals had to be aged 18 or above in order to eligible for this study. Pregnant women were not considered eligible to partake in the study.

Research Methodology

Data was collected via an in-person interview, using a standard semi-structuredquestionnaire that posed questions about important socio-demographic characteristicssuch as: Date of birth, gender, height, weight, marital status, education, number of roomsin the living house, family history of TB during last one year, average monthly familyincome, family size, professional status, type of residence, water supply, chronic diseasehistory and smoking history. The age was inferred from the participant's date of birthand the Body Mass Index (BMI) was calculated based on measured height and weight (kg/m^2). With the exception of BMI and age, which were considered continuousvariables, the rest of the adjusted variables were categorical. We calculated crowding indensity levels, which refers to the average number of people living per room (family size/number of rooms).

Ethical Approval

Ethical approval for the study protocol was obtained from the North South UniversityEthics Review Committee and Shyamoli TB hospital. Written informed consent was obtained from each participant.

Statistical Analysis

R software was used to analyze the data. The responses to the questionnaires wereclassified into categorical variables and continuous variables. The descriptive statisticswere calculated for all the variables, including mean, standard deviation, frequencies andpercentages. The results were expressed in terms of their adjusted Odds Ratio (OR) andcorresponding 95% Confidence Intervals (CI). Independent factors associated with TBwere established using the multivariate logistic regression analysis.

Results

Characteristics of the Study Participants

About 178 cases (TB patients) and 179 controls (non-TB patients) consented to participate in thestudy and fulfilled the eligibility criteria. The mean age of the participants were 28.0 years and the mean BMI was 21.03. Table 1 shows the patients characteristicscorresponding to TB status. Among these covariates, education beyond the secondarylevel, crowding, average monthly income and area of living were found significantlyassociated with the TB status according to the values of unadjusted odds ratios. SinceBMI and age are continuous variables, the box plots for age and BMI are illustrated in Fig. 1. According to Fig. 1, the average age indicates that cases were slightly olderthan the control groups (case: 28.3

years; controls: 27.6 years), which is expected as thecases were matched to controls by age. Moreover, the average BMI of cases was foundlower than the average BMI of controls. This is also expected because nutritional status isusually found lower in patients with active pulmonary tuberculosis compared withcontrols.

Table 2 shows clinical and behavioral factors associated with TB along with theiradjusted odds ratios. The risk factors for adult TB were found as: Contact with TBpatients during the last 6 months, unemployed (housewife/students), crowding (morethan 2 persons living in one room), poverty (family income less than 25000 BDT) andrural living. A multivariate logistic regression model was fitted afteradjusting theextraneous variables, as illustrated in Table 2. It appears that participants who lived in aresidence with more than 2 persons in one room are 3.49 times more likely to have TBcompared to the persons who are living 2 persons or single person in one room(OR=3.49, CI= 2.08-5.93). The study suggests that urban living reduces 70% risk ofhaving TB compared to the rural living (OR=0.30, CI=0.16-0.53). The contact with TBpatients during the last 6 months increases 79% chance of developing TB (OR= 1.79, CI=0.92-3.56). The poverty is also found a significant variable in the TB status. Theparticipants having average family income greater than 25000 BDT are 71% less likely tohave the TB compared to the participants having average family income less than 25000BDT.

Table 1: Patient's characteristics and unadjusted odds ratio of each covariates and case-control

Factors	Categories	Case	Control	OR (CI)	P-Value
Sex	Female	77 (50%)	78		
	Male	101 (50%)	101	1.01(0.67-1.54)	0.952
Educational status	<=5 years schooling	114 (60%)	77		
	6+ years schooling	64 (39%)	102	0.42 (0.28-0.65)	<0.001
Marital status	Unmarried	38 (44%)	49		
	Married	140 (52%)	130	1.39 (0.86-2.27)	0.186
Occupation	Unemployed	109 (47%)	124		
	Employed	69 (56%)	55	1.43 (0.92-2.22)	0.111
Crowding*	≤ 2.0	67 (33%)	134		
	2+	111 (71%)	45	4.93 (3.15-7.82)	<0.001
Monthly income	<25000 BDT	157 (61%)	102		
	>25000 BDT	21 (21%)	77	0.18 (0.101-0.30)	<0.001
Area of living	Rural	105 (66%)	53		
	Urban	73 (37%)	126	0.29 (0.19-0.45)	<0.001
Water supply	Others (pond etc.)	56 (60%)	38		
	Tap	122 (46%)	141	0.59 (0.36-0.94)	0.029
Family history of TB	Yes	29 (60%)	19	1.64 (0.89-3.09)	0.118
	No	149 (48%)	160		
Contact with TB patients	Yes	38 (64%)	21	2.04 (1.15-3.69)	0.015
	No	140 (47%)	158		
Diabetic history	Yes	21 (44%)	27	0.75 (0.40-1.39)	0.364
	No	157 (51%)	152		
Chronic disease history	Yes	39 (46%)	46	0.81 (0.50-1.32)	0.401
	No	139 (51%)	133		
Smoking history	Yes	69 (54%)	58	1.32 (0.86-2.04)	0.21
	No	109 (47%)	121		

*Family members to room ratio

Table 2: Adjusted relationship between covariates and case-control that is analyzed by multivariate logistic regression model

Factors	Reference	Estimate	OR	LCL	UCL	P-value
Education (6+ years schooling)	≤5 years schooling	-0.265	0.767	0.451	1.308	0.327
Marital status (married)	Unmarried	0.211	1.235	0.678	2.245	0.488
Professional status (Employed)	Unemployed	0.693	1.999	1.175	3.458	0.011
Crowding >2.0	≤ 2.0	1.251	3.492	2.079	5.933	<0.001
Monthly income > 25000 BDT	<25000 BDT	-1.231	0.291	0.151	0.547	<0.001
Area of living (urban)	Rural	-1.217	0.295	0.163	0.527	<0.001
Water (tap)	Others	0.503	1.653	0.879	3.148	0.121
Contact with TB patients (yes)	No	0.582	1.789	0.917	3.559	0.091
Diabetics history (yes)	No	0.148	1.160	0.553	2.432	0.692
Chronic disease history (yes)	No	-0.482	0.617	0.337	1.116	0.113
Smoking history (yes)	No	0.254	1.289	0.769	2.166	0.335

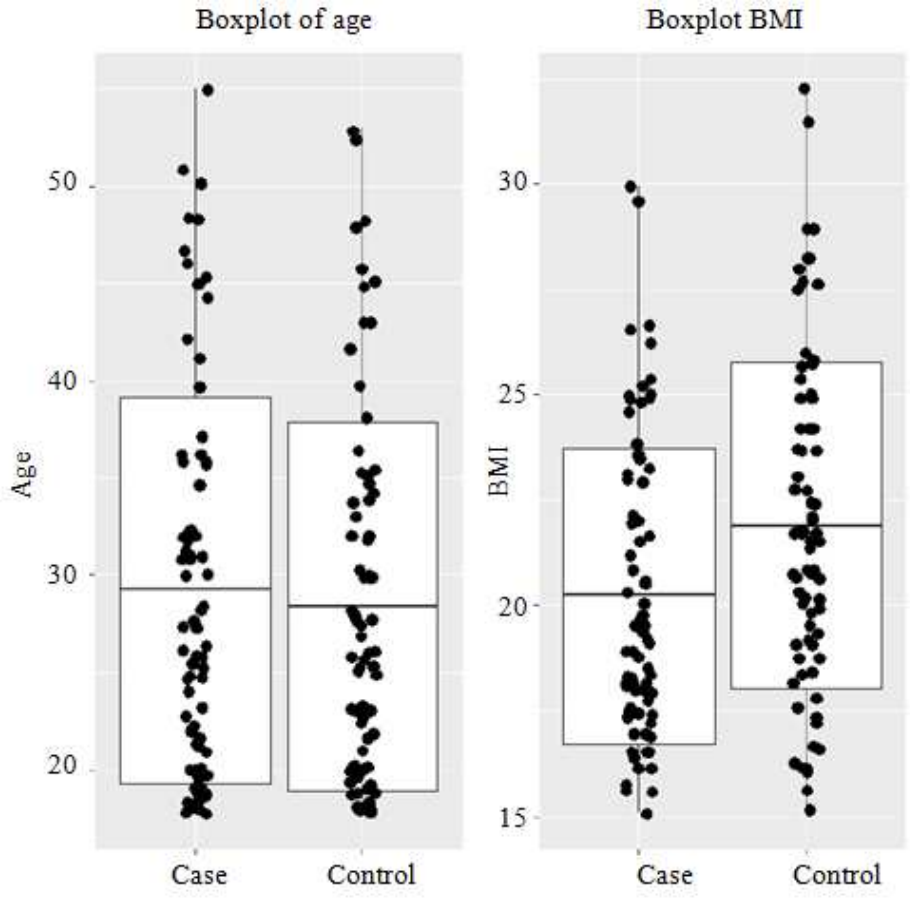

Fig. 1: The box plot for age and BMI

Discussion

This case control study of 178 cases and 179 controls showed that there are multiplefactors contributing to the development of adult TB.

The association between diabetes and tuberculosis was found in previous studies in thesame discipline. A recent systematic review by Jeon and Murray (2008) demonstrated that diabetescarried a Relative Risk (RR) of 3.11 in cohort studies, while the case-control studiesdisplayed heterogeneous odds ratio (OR=1.16) with confidence interval of 0.55-2.43.Since the association between diabetes and TB is borderline significant, this studyportrays a complex relationship between communicable and non-communicable diseases,thus warranting further investigation.

Based on the findings from the multivariate analysis in this particular study, ruralresidents were more likely to contract tuberculosis, compared to urban-dwellingresidents. It is also asserted in other studies that rural residents were more susceptible toTB due to late health care services and more rapid transmission rates (Geng *et al*., 2002; Story *et al*., 2007). Thiscurrent study also observed a significant association between the overcrowding and TB.Overcrowding is a prominent risk factor of rapid transmission of communicable diseasessuch as TB, which explains why, based on the findings of the current study, residentswho inhabited smaller houses with a smaller number of rooms were more likely tocontract TB.

This study posited that patients with a higher monthly income (>25000 BDT/month) wereless susceptible to tuberculosis. A study from China showed that lower socio-economicstatus was associated with increased vulnerability to tuberculosis (CTCC, 2004). Since ruralresidents in Bangladesh typically receive smaller monthly wages, they are more prone topoverty than urban residents (Ullah, 2004). Therefore, they will not necessarily receive the sameaccess to readily available and affordable healthcare services that their urban counterpartswould (Khan *et al*., 2012).

In this study, pursuing an education beyond the secondary level showed a protectiveeffect against TB, which is also supported by the findings from an age- and sex-matchedcase control study in South Africa with similar results (Gandhi *et al*., 2006).

Conclusion

The public health dimension of Bangladesh is highly complex, with multifaceted riskfactors contributing to chronic infectious diseases such as tuberculosis. Based on thefindings of the study, education level, monthly income, crowding and area of living were significantly associated with the susceptibility to tuberculosis in the adult population ofBangladesh. In order to reduce TB burden in Bangladesh, ensuring accessibleeducation to the poor and rural communities. Moreover, nutritional interventions and supplementation mandates, along with preventive measures against non-communicable diseases, would be helpful, for reducing chances of adults contracting TB.

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Author's Contributions

Samira Dishti Irfan: Manuscript writing.

Mohammad Omar Faruque: Data collection and design.

Mahabub Ul Islam: Data collection and data screening.

Shubrandu Sutradhar Sanjoy: Manuscript writing and review.

Dilshad Afrin: Manuscript review.

Ahmed Hossain: Research design, Manuscript writing, data screening, data analysis.

Declarations

Ethics, Consent and Permissions

All the participants signed the informed consent forms prior to enrolment in the study. This study was approved in February 2016 by the Research Ethics Committee of the School of Health and Life Sciences of North South University in Dhaka, Bangladesh.

Consent to Publish

Consent for publication is included in the consent to participate in research.

Availability of Data

Click here for the data file. http://individual.utoronto.ca/ahmed_3/index_files/data/data.html

Competing Interests

The authors declare that they have no competing interests.

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Abbreviations

TB: Tuberculosis
BMI: Body mass index
OR: Odds ratio
CI: Confidence interval
SD: Standard deviation