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Daily contact with a patient and poor housing affordability as determinants of pulmonary tuberculosis in urban Pakistan

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ABSTRACT

Objective: This study aimed to evaluate the factors associated with pulmonary tuberculosis (TB) among individuals aged 15 years or more in urban Karachi, Pakistan.

Design and setting: A case–control design was implemented in three major tertiary-care hospitals to select cases (n = 342) with active pulmonary TB (*i.e.* two sputum smears positive for *Mycobacterium tuberculosis* with clinical and radiographic evidence of current pulmonary TB and diagnosed between August 2002 and October 2003. Selected controls (n = 342) were surgery patients from the same hospitals at time of recruitment of the cases, without clinical and radiographic evidence of pulmonary TB.

Results: Multivariable logistic regression model showed that daily contact with a pulmonary TB patient (adjusted odds ratio [OR_{adj}]) = 5.07; 95% CI: 3.31, 7.78), and poor housing affordability (*i.e.* rented vs. owned) (OR_{adj} = 1.59; 95% CI: 1.13, 2.26) were significantly associated with pulmonary TB status. The overall adjusted summary population attributable risk (%) for both the risk factors together was 38.7.

Conclusion: Reaching out to underprivileged TB patients for delivery of DOTS and focused education of patients and their contacts about *M. tuberculosis* transmission mode may substantially minimize pulmonary TB risk in this and similar settings.

Background

Globally, tuberculosis (TB) remains the second leading cause of death from an infectious disease with 8.8 million (range, 8.5–9.2 million) incident TB cases, 1.1 million (range, 0.9–1.2 million) deaths from TB among HIV-negative people and an additional 0.35 million (range, 0.32–0.39 million) deaths from human immunodeficiency virus (HIV) - associated TB in 2010 [1–3]. TB affects mostly adults in the economically productive age groups; around two-thirds of cases are estimated to occur among people aged 15–59 years and also more common among men than women [3].

In 2010, based on an annual incidence (231 cases per 100,000 population) and prevalence (364 cases per 100,000 population) of all types of TB, Pakistan ranked 6th among the 22 countries with the highest burden of TB in the world. Furthermore, Pakistan contributes about 44% of TB burden in the Eastern Mediterranean Region [4]. Despite the availability of highly efficacious treatment for decades and the adoption of DOTS by the NTP (Pakistan's National Tuberculosis Control Program) in 1995, these latest statistics showed an alarming increase over previously reported burden of TB in Pakistan [4].

Risk factors for TB identified in other parts of the world include intensive immigration from high prevalence to low

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prevalence countries, contact with a TB patient, poor socio-demographic factors, tobacco smoking, alcohol abuse, HIV infection and institutionalization [5–12]. The role of these and other locally prevalent risk factors threatening TB control in Pakistan are yet to be fully established. Therefore, this case–control study aimed to evaluate the factors associated with pulmonary TB among individuals aged 15 years or more in urban Pakistan.

Methods

Study design and setting

This case–control study was conducted at three tertiary care hospitals in Karachi – the largest city and economic hub of Pakistan with a metropolitan area of 3530 km^2 and 17 million ethnically diverse populations. The publicly funded health care system lacks adequate financial and human resources, facilities and equipment, appropriate organizational structure with poor quality of services [13]. Pakistan's private sector makes a major contribution to providing health care, particularly in major cities. For this study, Civil Hospital (CH), Jinnah Postgraduate Medical Center (JPMC) and Liaquat National Hospital (LNH) were selected. Of these hospitals, CH and JPMC are public whereas LNH is a semi-private hospital. These hospitals were selected because they receive patients of almost all socioeconomic strata of Karachi.

Definitions and selection of cases and controls

A *case* of pulmonary TB was defined as an individual aged 15 years or more with active pulmonary TB, *i.e.* two positive sputum smears for *Mycobacterium tuberculosis*, clinical and radiographic evidence of current pulmonary TB and had been diagnosed for the first time between August 1, 2002 and October 31, 2003. A *control* was defined as an individual aged 15 years or more, attending the surgical departments of the above-mentioned hospitals at the time of recruitment of the cases, without clinical and radiographic evidence of pulmonary TB, as recorded in the medical file of the hospital. Cases were selected from the TB clinics of the study hospitals. Since the source population of the cases cannot be easily identified in a hospital-based study, therefore, controls were selected from the surgical departments of the same hospital in order to have a similar referral pattern as the cases. This provided some reassurance that all subjects come from the same source population [14–17]. Controls admitted with complaints or diseases of the respiratory system or with a past history of TB were excluded from the study. Cases and controls were also excluded if they were unable to give an interview due to ill health or unstable state of mind.

Questionnaire and data collection

A structured and pre-tested questionnaire was used for data collection. The questionnaire comprised six components, including questions on socio-demographic characteristics, exposure to smoke from a biomass stove, contact with a pulmonary TB patient, history of institutionalization, tobacco smoking status and history of chronic diseases. Two trained interviewers collected the data from all the enrolled cases and controls.

Ethical considerations

A written informed consent was sought from all patients/guardians after explaining the purpose of the study and assuring the confidentiality of collected information. The study protocol was approved by the institutional ethics review committee, and permission for data collection was sought from the heads of TB clinics and the surgery departments of the study hospitals.

Sample size

For this study, a sample size of at least 185 cases and 185 controls was estimated based on the 33% prevalence of smoking among potential control subjects [18], an alpha error of 0.05 [19], study power of 80% and an odds ratio (OR) $\geqslant 2$ to relate most of the risk factors with pulmonary TB status.

Statistical analyses

Data were double entered using EPI-INFO version 6.04 (Centers for Disease Control and Prevention, Atlanta, GA, USA) and analyzed with SPSS version 14 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were computed to describe the distribution of various characteristics of cases and controls. Using simple logistic regression, unadjusted OR and their 95% confidence intervals (CI) were calculated to assess the association of each variable with pulmonary TB. All independent variables associated ($P \leqslant 0.25$) with the pulmonary TB status in univariable analyses were considered for inclusion in the multivariable logistic regression model [20]. These included age, gender, ethnicity, educational level, marital status, housing affordability, overcrowding, past hospitalization, exposure to a relative with TB and daily contact with a TB patient. Adjusted ORs (OR_{adj}) and their 95% CI were used for interpretation of the final model. Additionally, the parameters' estimates from the final model were used to compute the population attributable risk (PAR) percent of TB for each risk factor and summary PAR (%) for all the risk factors together [21].

Results

A total of 342 cases and 342 controls were recruited in the study. Response rate was 99.8%. The mean (SD) age (years) of cases and controls was 33.3 (16.7) and 40.7 (15.7), respectively. The proportions of male cases and controls were 52% and 48%, respectively. Furthermore, 55% of the cases and 73% of the controls were currently married. The proportions of cases and controls with no formal school education were 25% and 30% respectively. Additionally, 77% of the cases and 70% of the controls were living in overcrowded housing (Table 1). Univariable logistic regression analyses showed that age, marital status, house ownership, ethnicity, overcrowding, occupation, a family member who smoked, past

Table 1 – Distribution and univariate analysis of demographic factors associated with pulmonary tuberculosis in a case–control study, Karachi, Pakistan, August 2003–October 2003.

Variable	Cases = 342 n (%)	Controls = 342 n (%)	OR[ξ]	95% CI[*]	p
Age (years) Mean ± SD	33.3 ± 16.7	40.7 ± 15.7	0.97	0.96–0.98	<0.01
Gender					0.25
Male	177 (51.8)	192 (56.1)	1.00	–	
Female	165 (48.2)	150 (43.9)	1.19	0.88–1.61	
Ethnic group					0.24
Urdu	142 (41.5)	150 (43.9)	1.00	–	
Sindhi	44 (12.9)	60 (17.5)	0.77	0.49–1.22	
Punjabi	48 (14.0)	39 (11.4)	1.30	0.81–2.10	
Pushtoon	49 (14.3)	33 (9.6)	1.57	0.95–2.58	
Balochi	15 (4.4)	15 (4.4)	1.06	0.49–2.24	
Others	44 (12.9)	45 (13.2)	1.03	0.64–1.66	
Education					0.14
Matric or higher	85 (24.9)	102 (29.8)	1.00	–	
Secondary	63 (18.4)	44 (12.9)	1.72	1.06–2.78	
Primary	62 (18.1)	56 (16.4)	1.33	0.84–2.11	
None	132 (38.6)	140 (40.9)	1.13	0.78–1.64	
Current marital status					<0.01
Married	188 (55.0)	250 (73.1)	1.00	–	
Unmarried	154 (45.0)	92 (26.9)	2.23	1.62–3.07	
Housing affordability					0.01
Good (owned house)	213 (62.3)	242 (71.4)	1.00	–	
Poor (rented house)	129 (37.7)	97 (28.6)	1.51	1.09–2.08	
Overcrowding[φ]					0.06
No	80 (23.4)	101 (29.8)	1.00	–	
Yes	262 (76.6)	238 (70.2)	1.39	0.99–1.96	
Current employment status					0.44
Employed	136 (39.8)	146 (42.7)	1.00	–	
Unemployed	206 (60.2)	196 (57.3)	1.13	0.83–1.53	
Occupation					0.01
None	100(29.2)	85 (24.9)	1.00	–	
Unskilled laborer	57 (16.7)	52 (15.2)	0.93	0.58–1.49	
Housewife	69 (20.2)	98 (28.7)	0.59	0.39–0.91	
Student	36 (10.5)	17 (5.0)	1.80	0.94–3.43	
Service	80 (23.4)	90 (26.3)	0.76	0.49–1.15	
Past smoking status					0.49
Never	258 (75.4)	253 (74.0)	1.00	–	
Occasional	24 (7.0)	19 (5.6)	1.24	0.66–2.32	
Regular	60 (17.5)	70 (20.5)	0.84	0.57–1.24	

ξ Odds ratio.

* 95% Confidence interval.

φ Overcrowding was defined as more than 2 persons per habitable room. Habitable rooms were defined as all rooms of the house excluding kitchen, store room, verandah and bathrooms.

hospitalization, concurrent chronic disease, exposure to a relative with TB, daily contact and sharing of unwashed utensils with a TB patient were significantly ($p \leqslant 0.25$) associated with the TB status (Table 2).

The final multivariable logistic regression model included daily contact with at least one pulmonary TB patient, poor housing affordability (rented vs. owned), age and past hospitalization (Table 3). Pulmonary TB cases compared with the controls were more likely to have had daily contact with at least one pulmonary TB patient ($OR_{adj} = 5.07$; 95% CI: 3.31, 7.78) or have had poor housing affordability ($OR_{adj} = 1.59$; 95% CI: 1.13, 2.26) after adjusting for the effects of age and past hospitalization. The adjusted PARs (%) for daily contact with a TB patient and poor housing affordability was 29.7 and 12.7 respectively. An overall adjusted summary PAR (%) for both the factors together was 38.7 (Table 3).

Discussion

Daily contact with at least one pulmonary TB patient and housing affordability (rented vs. owned house as an indicator of socioeconomic status) were identified as independent risk factors for pulmonary TB among individuals aged 15 years or older. The finding of daily contact with at least one pulmonary TB patient at home or in the work place as an independent risk factor in this evaluation is consistent with those of earlier studies [7,11,12,22]. This finding has an important implication for prevention of *M. tuberculosis* transmission. It reiterates the call for screening of those having frequent contact with TB patient(s) and warrants curative or prophylactic therapy as required [23–25]. Pakistan's national TB control program is being implemented mainly through the public sector infrastructure in a setting, wherein 80–96%

Table 2 – Distribution and univariable analyses of risk factors associated with pulmonary tuberculosis in a case–control study, Karachi, Pakistan, August 2003–October 2003.

Variable	Cases = 342 *n* (%)	Controls = 342 *n* (%)	OR[ξ]	95% CI[*]	*p*
Family member smoker[‡]					0.07
No	228 (66.7)	248 (73.2)	1.00	–	
Yes	114 (33.3)	91 (26.8)	1.36	0.98–1.89	
Friend smoker					0.92
No	284 (83.0)	285 (83.3)	1.00	–	
Yes	58 (17.0)	57 (16.7)	1.02	0.68–1.53	
Type of fuel used[‡]					0.86
Gas or electricity	293 (85.7)	292 (86.1)	1.00	–	
Wood or kerosene oil	49 (14.3)	47 (13.9)	1.04	0.67–1.60	
Exposure to biomass smoke[ϕ]					0.96
No	297 (86.8)	294 (86.7)	1.00	–	
Yes	45 (13.2)	45 (13.3)	0.99	0.64–1.54	
Past hospitalization					<0.01
No	237 (69.3)	188 (55.0)	1.00	–	
Yes	105 (30.7)	154 (45.0)	0.54	0.39–0.74	
Ever been in a prison					0.59
No	324 (94.7)	327 (95.6)	1.00	–	
Yes	18 (5.3)	15 (4.4)	1.21	0.60–2.44	
Suffering from a chronic disease[§]					0.09
No	289 (84.5)	272 (79.5)	1.00	–	
Yes	53 (15.5)	70 (20.5)	0.71	0.48–1.06	
Exposed to a relative with TB[†]					<0.01
None	208 (60.8)	298 (87.1)	1.00	–	
Distant relative	20 (5.8)	8 (2.3)	3.58	1.55–8.29	
At least one close relative	114 (33.3)	36 (10.5)	4.54	2.99–6.87	
Daily contact with a TB patient					<0.01
Never	216 (63.2)	308 (90.1)	1.00	–	
Ever (at least one)	126 (36.8)	34 (9.9)	5.28	3.48–8.02	
Shared utensils daily with a TB patient					<0.01
No	257 (75.1)	316 (92.4)	1.00	–	
Yes	85 (24.9)	26 (7.6)	4.02	2.52–6.43	

ξ Odds ratio.
* 95% Confidence interval.
‡ Sample size of controls is 339.
ϕ Biomass includes wood and animal dung.
§ Includes hypertension, diabetes mellitus, cardiovascular diseases, renal diseases and others.
† Close relative includes parents, spouse, children, sibling and grandparents whereas distant relative includes uncle/aunt, nephew/niece, cousin, neighbor and friend.

Table 3 – Multivariable logistic regression model of determinants for pulmonary tuberculosis: a case–control study, Karachi, Pakistan, August 2003–October 2003.

Risk factor	Adjusted odds ratio[*]	95% Confidence interval	*P*	PAR (%)[**]
Daily contact with a TB patient (at least one vs. none)	5.07	3.31–7.78	<0.001	29.7
Housing affordability (rented vs. owned)	1.59	1.13–2.26	0.01	12.7

Overall PAR (%) for both for both factors together was 38.7.
* Adjusted for the effects of age and history of past hospitalization.
** PAR (%) = population attributable risk percent.

of TB cases are first seen by the private health care providers [24,25]. Notably, TB control efforts in settings like this are convoluted by unawareness and poor adherence to the World Health Organisation's (WHO) and national TB treatment guidelines by private practitioners and poor treatment compliance by the patients [26–28]. Therefore, focused education of TB patients and their family members during their initial contact with health workers in the private/ public sector about how *M. tuberculosis* is spread and the significance of treatment compliance may help interrupt the transmission chain of the causative agent in settings like this.

Corroborating the findings of earlier studies [6,9,11,12], lack of home ownership as a proxy variable for low socioeconomic status was found to be an independent risk factor for pulmonary TB. Exactly how lack of home ownership as a measure of low socioeconomic status leads to increased TB risk is

still unclear. Perhaps it results in poor nutrition, and/or psychological stress rendering the immune system vulnerable to *M. tuberculosis* infection and development of overt disease.

Study limitations

The presented data had some limitations. *First*, controls were recruited from surgical in-patients assuming that they represented the same source population as the cases, and had surgical patients developed pulmonary TB, they would have attended the same hospital for treatment. *Second*, pulmonary TB incident and prevalent cases diagnosed in the last year were included in the study. Controls were recruited on the same day as the cases. Therefore, time windows for exposures assessment for cases and controls might not have coincided. *Third*, controls were not tested with the same rigor as cases to establish their pulmonary TB status. Since, it was neither possible nor desirable to subject potential controls to the same diagnostic protocol to determine their TB free status. Therefore, some misclassification of controls cannot be ruled out, though the possibility of such occurrence was very low. *Fourth*, case–control design has an inherent problem of recall bias. Recall can also be differential with cases being more likely to remember exposures to putative risk factors as compared with controls. However, cases and controls were patients in this instance, therefore, it is likely that exposure misclassification if occurred, indeed would have been non-differential in nature.

Conclusion

In, urban Pakistan daily contact with at least one pulmonary TB patient and an SES indicator (home ownership) are directly and independently associated with pulmonary TB status. Reaching out to underprivileged TB patients for delivery of DOTS and focused education of patients and their contacts may lessen pulmonary TB risk in this and similar settings.

Conflict of interest

None.

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