

Geodemographic analysis of tuberculosis patients in Karachi, Pakistan

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Tuberculosis (TB) is endemic in Karachi, Pakistan, and even with the discovery of other infectious diseases no significant change is evident in its epidemiological profile while analyzing the temporal incidence. There is significant evidence to support the fact that poverty is the leading cause of TB. A number of scholarly analyses have documented associations among patients' characteristics (sex, age group); social factors (education, origin of the patient, smoking, alcohol and drug use); environmental factors (house types, room density, source of water, garbage collection and disposal), and economic factors etc. The purpose of the present study is to provide cogent and relevant arguments for the characteristics of tuberculosis patients in terms of social and economic profiles in the study area. Forty-nine selected variables have been used in the present study for analysis. Three factors have emerged as responsible for the spread of tuberculosis in the study area. An insight into variables for Factor I reveals that features related to urbanization appear to be categorically responsible for the spread of TB in Karachi, especially among the white collar persons and low, middle-class residents. The results of the present study can help the city authorities for improving downtown areas renovation as per quality of life demand.

Key Words: *factor analysis, tuberculosis, Karachi, epidemiology, ecological impacts.*

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Introduction

Mycobacterium tuberculosis (MTB) is composed of closely related bacterial sub-

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species which affect both human beings as well as animals (Wirth et al., 2008). Tuberculosis being highly contagious, its infection has been responsible for the high human casualty to the tune of around a million persons in the world in 2013, according to the World Health Organization (WHO, 2013). Tuberculosis (TB) is endemic in Karachi, Pakistan, and even with the discovery of other infectious diseases no significant change is evident in its epidemiological profile while analyzing the temporal incidence. The increasing number of diagnostic centers for TB patients indicates that a limited number of centers face the burden of TB patients.

Data for Karachi reveals that there were large number of patients, especially in the towns of New Karachi and Liaquatabad, where the rate of incidence due to TB in 2010 was 8.5 cases per 100 000 inhabitants, while in all of Karachi the hospitalization rate for the year was 7.2 cases per 100 000 population (Miandad et al., 2014).

In view of the gravity of the problem with reference to TB, several studies relating to this serious health issue have been published which were based on primary and secondary data collected from patients registered at diagnostic centers (Kruuner et al., 2001; Qazi et al., 2009; Jenkins et al., 2014) and was aimed at the description of epidemiology of different types of TB, its insurgency and drug resistance (Nunes, 2007; Middelkoop et al., 2009; Yazdani et al., 2010; Wang, et al., 2012; Roza et al., 2012; Borraccino et al., 2014).

There is evidence that low profile of human life is the primary cause of infectious diseases and a number of scholarly studies have documented association between characteristics of patients (sex, age group), their social factors (education, income, source of revenue, origin of patient, addiction to alcohol, smoking, drug use, etc.), and environmental factors (housing, room density, employment conditions, source of water at home, garbage collection and disposal etc. (Souza et al., 2000; Ezzati and Lopez, 2004; Lonroth, et al., 2009).

Among the social, environmental and biological determinants of TB, most encompass the poorer classes of the population. Risk factors recognize poverty as a root cause (Oxlade and Murray, 2012; Harlingand Castro, 2014), and there is an emergent need not only to intervene on financial status but also on the proximal risk factors to which the poor are significantly being exposed. Although, some epidemiological studies have pursued to measure the impacts of these factors, only a few have made efforts to identify explicitly the routes and methods by which poverty culminates in TB (Hossain et al., 2012; Mangtani et al., 1995). Although geographical literature regarding the association of environmental and social factors pertaining to association with TB exists for various countries of the world, few studies have been made in Pakistan (NTPP, 2012; Shafqat and Jamil, 2012; Siddiqui et al., 2011).

Since the mid-1980s, tuberculosis notifications have increased in both developing and developed countries (Hayward et al., 1995). The purpose of this study is to prove that the rise in tuberculosis may be related to an increase in underlying social deprivation, geo-demographic status and ecological factors among the population of the study area. PCA based Factor Analysis has been employed for the 49 variables deemed relevant to cover various aspects of the present investigation. Factor Analysis has been employed to explain correlations among the original variables thereby facilitating the development of cause and effect model regarding the quality of life of the patients.

Materials and methods

Study Area

Karachi, the thickly populated port city of Pakistan, comprises 16 million (estimated) souls over 800 km² area while 0.9 million (estimated) are living on a covered area of 2 800 km². Located strategically between 24.750 to 25.656 N and 66.653 to 67.574 E on the coast of the Arabian Sea, northwest of the Indus delta, it covers an area of 3 600 km² (Huda et al., 2013a). The city falls in an administrative Division of Sindh Province, comprised of six districts. Due to the perspective of micro level incidence, the unit of study selected is the previously Local Government setup which was composed of 18 towns and 6 military administered cantonments.

Research design and sample size

The present study followed standard techniques for collection of data and analysis. The questionnaire was designed under the domain of Pakistan TB Control guidelines and characteristics of the city's socioeconomic conditions (Table 1). The questionnaire consisted of queries pertaining to basic information regarding patients, their socioeconomic and ethnic backgrounds. Questions related to ecological and biological conditions, awareness regarding symptoms of the disease and other related information were also part of the questionnaire in order to achieve a comprehensive coverage of the objectives of the study and collection of registered TB patients (secondary data) from National Tuberculosis Control Program, Karachi Sindh, Marie Adelaide Leprosy Centre, SATA (Sindh Anti-TB Association), PCS (Pakistan Chest Society), Green Star, TB centers, hospitals and publications of the WHO, World Bank and Stop TB Partnership.

A Likert scale format was designed and used to elicit individual each patient's responses. Subsequent to significant discussions with experts 07 major questions were selected. The score range on each question depends on categories answers, so the total for the seven questions outcomes were 49. Data was collected through face to face interviewing of patients at TB diagnostic centers in the study area. The average prevalence of patients (p) at a confidence level 95%, confidence interval (CI) of 4 (alpha=0.05) and a deviation (d) of 0.02 was 20%. The acceptable sample size was thus determined to be 1260 as per last population census. The questionnaire survey, which was conducted over a period of eight months (March to October 2013). Data were entered into a Microsoft Excel spreadsheet and analyzed with SPSS Version 20.

Characteristics of variables

The present work has been conducted through a compilation of indicators which provide a comprehensive direction to researchers for calculating the complicated indices and conducting quality research (Table 1). Such a procedure has been utilized on the statement that doing so must be beneficial and a perfect substitute for examining several individual procedures, species and so on (Landres, 1992).

Table 1. Selected Variables

No.	Abbreviation	Variables
1	Unmarried-TR	Unmarried / Total Respondents
2	EPTB-TR	Extra pulmonary TB/Total Respondents
3	Above-SSC-TER	Matric and above education/Total Educated Respondents
4	08-11-PPR-TR	Person per room/Total Respondents
5	Female-TR	Female respondent/Total Respondents
6	Below_SSC-TER	Below Secondary School Certificate/Total Educated Respondents
7	04-07-PPR-TR	Person per room 04-07/Total Respondents
8	FH_Continue-TFH	Patients family history whose treatment continue
9	Unemp-TMR	Unemployment/Total Male Respondent
10	A>15 000-TR	Income more than 15 000/Total Respondents
11	FH_Cured-TFHR	Patients cured in families/Total Respondents
12	Family_HistoryTB	Patients having TB patient any time
13	Punjabi-TR	Punjabi speaking/Total Respondents
14	Meat-01-/week-TR	Patients eat meat once in a week/Total Respondents
15	Sep-Res-TR	Patients who live separate room/Total Respondents
16	Un-Plan-TR	Living in unplanned area/Total Respondents
17	Garbage-TR	Garbage near house/Total Respondents
18	Urdu-TR	Urdu speaking/Total Respondents
19	Aware-No-TR	Do not have awareness regarding TB/Total Respondents
20	Pat-Resi-combined-TR	Patients who sharing accommodation/Total Respondents
21	Precau-Y-TR	Awareness regarding precautionary measures/Total Respondents
22	Local Treat-TR	Patients who got treatment from local area/Total Respondents
23	Non-ownership-TR	Living in non-ownership houses/Total Respondents
24	Seraiki-TR	Seraiki speaking/Total Respondents
26	B<15000-TR	Income less than 15 000/Total Respondents
27	PTB-TR	Patient with pulmonary TB/Total Respondents
27	Male-TR	Male respondent/Total Respondents
28	other-L-TR	Other languages/Total Respondents
29	Plan-TR	Patients who belong to planned area/Total Respondents
31	Katcha-TR	Katcha house residents patient/Total Respondents
32	Resurgence-TR	Resurgence/Total Respondents
33	H_Wife-TFR	Housewives patients/Total Female Respondents
34	FH-Died-TFHR	Any family member died due to TB/Total Respondents
35	01-03-PPR-TR	Person per room 01-03/Total Respondents
36	Pashto-TR	Pashto/Total Respondents
38	Profes-TMR	Professional employee/Total Male Respondents
39	Illit-TR	Illiterate/Total Respondents
40	Private-TMR	Private job/Total Respondents
41	Labr-TMR	Laborer/Total Respondents
42	More-06-m	More than 06 months diagnosis/Total Respondents
43	Cig.-smoker-TMR	Regular smoker/Total Male Respondents
44	BCG-N-TR	Patients who have not vaccinated of BCG/Total Respondents
45	Diag-06-month-TR	Before 06 month diagnosis/Total Respondents
46	Diag-03-month-TR	Diagnosis within 03 months/Total Respondents
47	Married-TR	Married/Total Respondents
48	Govt. S-TMR	Gov. Servant patients/Total Respondents
49	Food-02/d	Take food twice daily (including breakfast)/Total Respondents

TB patients not only transmit mycobacterium thus entailing serious effects on physical health, social and economic wellbeing (Aggarwal, 2010) but the social repercussions may include loss of job, disturbance on marital life, ostracism by family members and the local community, even loss of shelter (Lawn, 2000). An amplified series of danger ranging from TB sickness to active disease relate with starvation, due to the pessimistic impact of micro and macro nutrient shortages on the cell-mediated resistant system (Cegielski et al. 2004; McMurray and Cegielski, 2007). Malnutrition weakens the immune system and increases the chances of host's receptiveness to infection. This infection leads to a reduction in appetite, micronutrient as well as nutrient malabsorption and distorted metabolism leading to wasting, hence can become a source contributor to conditions liable to promoting the risk of TB.

A close relationship has also been estimated between poverty and TB (Nair et al., 1997; Diamond et al., 2001; Kaulagekar et al., 2006; Diwan, 1999). Education is the vital force of human civilization provides choices to people regarding the varieties of lives they wish to live, but also enables them to express their views amidst the community in which they live but also imbibes confidence in their personal relationships (UN, 2005). Educational achievements are stepping-stones for ensuring and availing better-earning opportunities which nurture the roots of the quality of life of human beings. It not only bestows socioeconomic status and stability to its owners but makes available to individuals a wide range of alternatives for the manner in which they may arrange their lives. It inculcates awareness regarding all facets of life inclusive of health and diseases (Khan et al., 2006). In the study area, the uneducated populace is not only partly responsible for creating social and economic problems but are also a great cause of backwardness, a phenomenon visible in densely populated settlements (Burke et al., 2008).

It has also been suggested that improvement of the economy, better housing and living conditions, attainment of education for both males and females, and reduction of poverty are long term goals for reduction of susceptibility to diseases, especially TB. According to Gupta (2009), smoking was one of the leading causes of TB. Poor people are compelled to reside in damp, dark, dusty, ill-ventilated houses with no heating which promote the survival of TB bacteria. Due to a shortage of money, people suffer from stress, causes of the weakening of the immune system, henceforth contraction of TB. People in developing countries with a shortage of money were unable to purchase medicines for the treatment of TB.

Living in overcrowded housing areas coupled with housing congestion magnify contact with coughing and sneezing people harboring TB germs in their lungs and throats which can be a dominant cause of the spread of TB. The density of people also enhances the spread of TB, and highly positive correlation has been observed between them (Ploubidis et al., 2012). Literacy plays a significant role in improving the quality of health as well as life. Secretary General UNO, Ban Ki-moon stated on 8th September 2008, that it has a direct impact on health as it not only prevents reading of medical instructions and such people are oblivious of facts related to infectious diseases like TB and other diseases like AIDS, malaria, etc. TB being contagious, it spreads more rapidly among the poor people of developing countries, the majority of who live in houses built of mud/stone/wood/bricks, etc. Mayer (2006), found in his research that lack of mobility or permanence of settlement has a tendency of favoring stability in the spatial distribution of

infection. It has been reviewed that 97% of total TB cases is detected in low-income countries. Poverty forces people to live in congested, ill-ventilated dwellings, as a result of which infectious diseases thrive.

Data collection and statistical analysis

Data was collected through questionnaire during eight months period among patients in the 18 towns of Karachi diagnosis centers enlisted on the National Tuberculosis Program medical records. Spatial analysis of temporal data within the precincts of town boundaries have been portrayed through GIS application, while for multivariate analysis variables were grouped into the following dimensions: patient characteristics (sex, age group, race); social factors (education, income, source of revenue, origin of the patient, addiction to alcohol, smoking and drug use); and environmental factors (housing types, room density, employment conditions, masonry housing, source of potable water for household use and consumption, garbage around settlements).

With the help of Principal Component Analysis (PCA), three factors have been documented for explaining the spread of tuberculosis in the study area. Data was analyzed using SPSS 20 for Windows. Factor Analysis, one of the easiest, reliable and comprehensive techniques for the multivariate study has been utilized (Weinbach and Grinnell, 2001) by Charles Spearman (Cattell 2008) as a means of analyzing the results from intelligence tests and later used by other disciplines. The technique clearly investigates the variables that may be responsible for the phenomena under observation. It has the advantage of reducing the enormous array of data into compact factors (Abdi et al., 2013).

Results and discussion

Figure 1 reveals the spatial pattern of TB incidence in the towns of Karachi from 2010 to 2013. An insight into the spatial scenario of 2010 reveals that the highest incidence was found in Liaquatabad, Malir and New Karachi towns ranging from 1 001-1 500 cases. Korangi, Gulshan-e-Iqbal, Saddar, and Lyari had cases between 501-1 000 while the other 11 towns had below 500 cases. In 2011, highest incidence was found in Korangi town (2 501-3 000) followed by Liaquatabad (2 001-2 500) and Saddar towns (1 501-2 000). New Karachi and Malir towns had incidence range between 1 001-1 500, Gulshan-e-Iqbal, Orangi and Lyari towns between 501-1 000 and the remaining 10 towns below 500 cases. In 2012, the highest number of cases were found in Korangi Town (2 001-2 500). Liaquatabad had the second highest range i.e. between 1 501 and 2 000; Saddar, Malir and New Karachi had the third highest range, i.e., between 1 001-1 500. Gulshan-e-Iqbal, Orangi and Lyari towns had between 501-1 000 cases while 10 towns had below 500 cases.

In 2013, highest cases were found in Korangi and Saddar towns ranging between 2001-2 500. Liaquatabad town had an incidence between 1 501-2 000, New Karachi and Malir towns' incidence ranged between 1 001-1 500; Gulshan-e-Iqbal, Orangi and Lyari towns had between 501-1 000; and 10 towns had cases below 500.

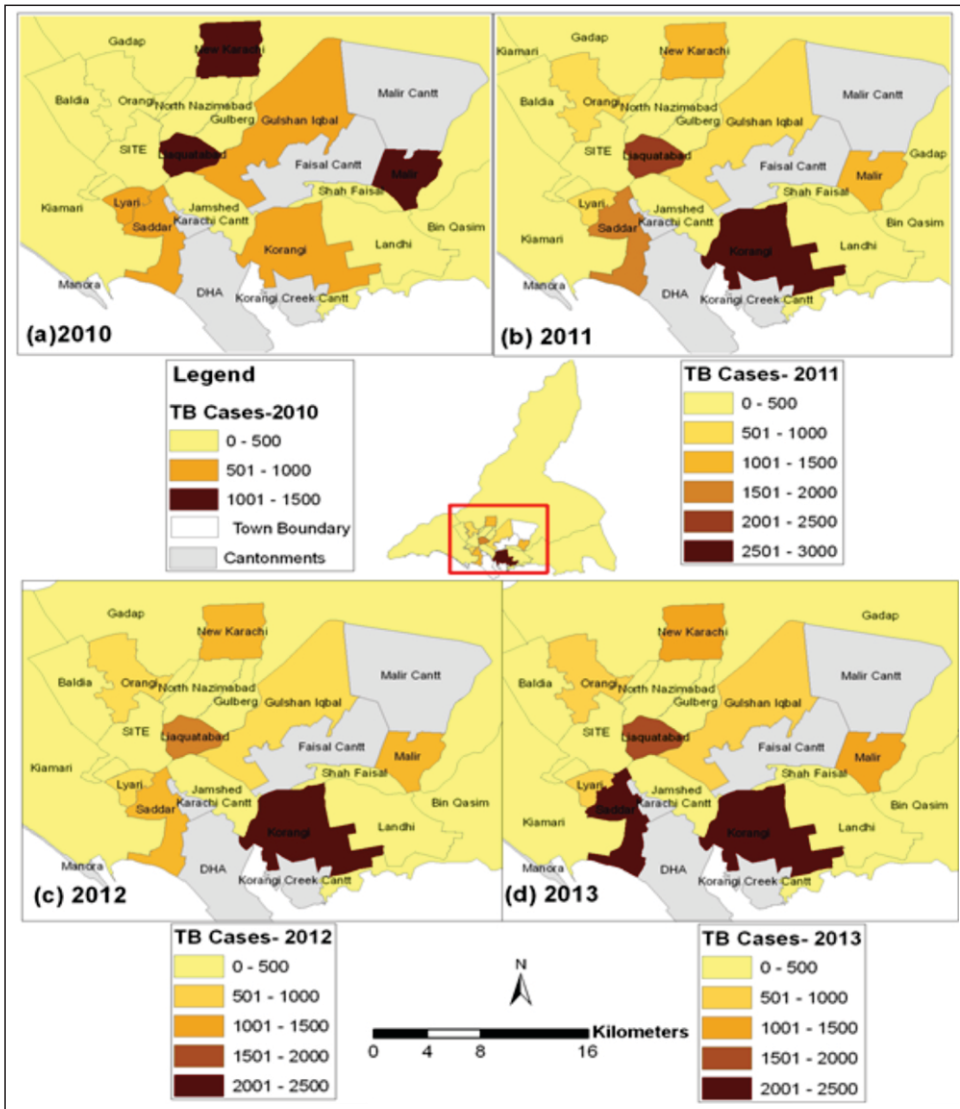


Figure 1. Spatial Patterns of TB Incidence in Towns of Karachi- 2010-2013

The spatiotemporal analysis revealed an interesting scenario observed in 06 towns (i.e. Gulshan-e-Iqbal, Korangi, Liaquatabad, Lyari, Malir and New Karachi), that these towns had 63.47% cases out of the total registered cases, which were thus the most highly vulnerable. The remaining 12 towns had 36.53% of the TB cases. The population of towns with high incidence comprised 36% of the city's population while 64 % of the population were residents of the other 12 towns. These 06 towns had 63.35, 60.94 and 63.11 % of the cases in 2011, 2012 and 2013 respectively. NTP should pay more attention towards these towns for the eradication of the disease.

For the investigation of cause and effects relationship in the perspective of quality of life of tuberculosis patients with reference to the increase of TB in the study area, PCA-based factor analysis was employed for the 49 variables deemed

Table 2. Rotated Sums of Squared Loadings

Total	% of Variance	Cumulative %
26.436	53.95	53.95
15.852	32.35	86.30
3.274	6.68	92.98

relevant to cover various relevant aspects. Table 2 explains total variance extracted by PCA technique. Table 3 shows three factors and their variance that have been extracted from the selected variables. The data pertaining to the 49 variables explains 92.98 % of the total variance. The first Factor explains 53.95 % of the variance, with more than 50 % of the variables showing the strong correlation among themselves, while Factors II and III explain 32.35 and 6.68% respectively of the variance. The results prove that the rise in tuberculosis may be related to an increase, in underlying social deprivation, geodemographic status and ecological factors among the population of the study area.

Factor I – Socioeconomic and demographic Status

The first factor accounts for 53.95% of the total variance with reference to all the selected variables (Table 2). The nature of the factor is clearly identifiable by very high positive loadings more than 0.50 for 38 variables and one high negative loading. An insight into the variables for Factor I (Table 3) reveals that features related to unbalanced urbanization appear to be categorically responsible for the spread of TB in Karachi, especially among poor status residents. Unstable social life, especially due to low, restricted incomes has emerged as significant among the TB patients. All variables recording positive (1.0 to 0.50) and negative (-1.0 to -.50) loadings reveal that they behave in a certain consistent fashion. Positive loadings have been recorded for all attributes that are responsible for the occurrence and spread of TB, while the negative loadings for food consumed twice a day, shows just the reverse (Huda et al., 2013b). It explains the significant role of diet in curtailing as well as fighting the disease.

Highest positive loadings of variables have emerged for unmarried to total respondents (0.98), extrapulmonary patients (0.96), secondary school certificate and above educated (0.96), 08-11 persons per room residents (0.95), female population (0.95), educated below secondary school (0.94), 04-07 persons per room (0.93), continuation of the disease or family history (0.93), unemployment (0.91), income above PKR 1 5000 (0.90), patients cured in families (0.89), history of TB in their families (0.89), Punjabi speaking (0.89), patients eating meat once in a week (0.88), patient living in separate rooms (0.86), patients residing in unplanned areas (0.85), garbage near patients residence (0.85), Urdu speaking (0.84), patients lacking awareness regarding TB (0.84), patients sharing accommodation (0.83), patients having awareness regarding precautionary measures (0.83), patients who availed treatment from the local area (0.81), non-ownership households (0.80), Seraiki speaking (0.78), Sindhi-speaking (0.77), income below PKR 8 000 (US\$ 80) (0.75), patients of other languages (0.74), patients with pulmonary TB (0.74), patients who are residents of planned localities (0.74), patients living in combined family systems (0.73), patients living in *katcha* houses (0.71), resurgence of TB

Table 3. Rotated Component Matrix

No	Factor I		Factor II		Factor III	
1	Unmarried-TR	0.98	Cig-smoker-TMR	0.92	Food-2/d	0.79
2	EPTB-TR	0.96	Married-TR	0.90	Diag-6-month-TR	0.68
3	SSC &Abov-TER	0.96	Male-TR	0.85	more-6-m	0.65
4	8-11-PPR-TR	0.95	Illit-TR	0.85	Pashto-TR	0.20
5	Female-TR	0.95	Pashto-TR	0.82	unemp-TMR	0.18
6	Below_SSC-TER	0.94	Labr-TMR	0.80	Other-Langu-TR	0.14
7	4-7-PPRTR	0.93	1-3-PPR-TR	0.79	Unmarried-TR	-0.13
8	FH_Continue-TFH	0.93	Profes-TMR	0.78	Profes-TMR	0.12
9	Unemp-TMR	0.91	FH-Died-TFHR	0.78	Cig-smoker-TMR	0.12
10	A>15000-TR	0.90	Private-TMR	0.74	A>15000-TR	0.11
11	FH_Cured TFHR	0.89	H_Wife-TFR	0.73	FH_Cured-TFHR	0.11
12	Family History TB	0.89	Resurgence-TR	0.72	Sep-Res-TR	0.11
13	Punjabi-TR	0.89	PTB-TR	0.67	Below_SSC-TER	0.10
14	Meat-1-/week-TR	0.88	Combi-Res-TR	0.67	BCG-NTR	0.09
15	Sep-Res-TR	0.86	Katcha-TR	0.65	Family_HistoryTB	0.09
16	UnPlan-TR	0.85	B<15000-TR	0.65	UnPlan-TR	0.07
17	Garbage-TR	0.85	Other-Langu-TR	0.64	Male-TR	0.06
18	Urdu-TR	0.84	Plan-TR	0.63	8-11-PPR-TR	0.06
19	Aware-No-TR	0.84	Seraiki-TR	0.60	4-7-PPR-TR	0.05
20	Pat-Resi-combined-TR	0.83	Non-ownership-TR	0.60	SSC &Abov-TER	0.05
21	precau-N-TR	0.83	BCG-N-TR	0.59	Aware-No-TR	0.05
22	Local Treat-TR	0.81	Local Treat-TR	0.59	PTB-TR	0.04
23	Non-ownership-TR	0.80	Pat-Resi-combined-TR	0.55	FH_Continue-TFH	0.04
24	Seraiki-TR	0.78	Aware-No-TR	0.54	Garbage-TR	0.04
25	Sindhi-TR	0.77	Sindhi-TR	0.54	Resurgence-TR	0.02
26	B<15000-TR	0.75	precau-N-TR	0.53	Urdu-TR	0.02
27	Other-Langu-TR	0.74	Urdu-TR	0.52	Local Treat-TR	0.01
28	PTB-TR	0.74	Garbage-TR	0.52	Meat-1-/week-TR	0.01
29	Plan-TR	0.74	Diag-6-month-TR	0.51	FH-Died-TFHR	-0.02
30	Combi-Res-TR	0.73	Sep-Res-TR	0.48	B<15000-TR	-0.03
31	Katcha-TR	0.71	Meat-1-/week-TR	0.46	Pat-Resi-combined-TR	-0.03
32	Resurgence-TR	0.69	Govt S-TMR	0.46	1-3-PPR-TR	-0.04
33	H_Wife-TFRF	0.68	UnPlan-TR	0.45	Non-ownership-TR	-0.04
34	H-Died-TFH	0.62	Family_HistoryTB	0.44	H_Wife-TFR	-0.06
35	R1-3-PPR-TR	0.61	FH_Cured-TFHR	0.44	Female-TR	-0.06
36	Pashto-TR	0.53	FH_Continue-TFH	0.35	Plan-TR	-0.09
37	Male-TR	0.51	4-7-PPR-TR	0.35	Combi-Res-TR	-0.10
38	Profes-TM	0.50	Punjabi-TR	0.33	Labr-TMR	-0.11
39	Rillit-TR	0.45	SSC &Abov-TER	0.29	Punjabi-TR	-0.12
40	Private-TMR	0.42	Female-TR	0.28	Sindhi-TR	-0.12
41	Labr-TMR	0.39	Below_SSC-TER	0.24	precau-N-TR	-0.13
42	more-6-m	0.37	EPTB-TR	0.22	Seraiki-TR	-0.14
43	Cig-smoker-TMR	0.17	A>15000-TR	0.17	EPTB-TR	-0.17
44	BCG-N-TR	0.12	Unmarried-TR	0.10	Private-TMR	-0.20
45	Diag-6-month-TR	0.09	8-11-PPR-TR	0.03	Illit-TR	-0.22
46	Diag-3-month-TR	0.00	Food-2/d	-0.05	Katcha-TR	-0.23
47	Married-TR	-0.29	Diag-3-month-TR	-0.06	Married-TR	-0.23
48	Govt S-TMR	-0.34	Unemp-TMR	-0.20	Govt S-TMR	-0.50
49	Food-2/d	-0.53	More-6-m	-0.35	Diag-3-month-TR	-0.98

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.a Rotation converged in 6 iterations.

among patients (0.69), housewives (0.68), patients whose family member died due to TB (0.62), patients residing in room density 01-03 persons per room (0.61), Pashto-speaking (0.53), male population (0.51) and professional employees (0.50) have emerged as being responsible for spread of TB.

On the basis of correlation among variables regarding the spread of TB, Factor I has highlighted the major causes. The unmarried population has shown lowest incidence comparatively to married (37% to total patients) due to their lower burden of responsibility, awareness of TB and independent movement around their living areas thus aiding intake of fresh air. Incidence among married (63%) depicts socioeconomic constraints in the family where parents go hungry and share

their food with their offspring. The need for marriage for both males and females is recognized as an essential requisite for family making. High incidence of the disease may be attributed to females' culturally rigorous and backward thinking of the resident ethnic groups (Miandad et al., 2015) because they do not allow their females to spend their time in the open environment. The pattern of employment structure among TB patients has also provided evidence for cause of the disease because 38% of disease incidence among housewives and 14%, 12%, 11%, 7%, 5%, 20% and 11% respectively among labourers, self-employed, students, textile labourers, the jobless, drivers and other job categories respectively, in addition to 37% incidence stamped over unmarried patients because they live under poor socioecological conditions.

Based on all positive loadings Figure 2 portrays a high degree of explanation for Factor I in which a complex manifestation points towards earnings and sources of living in a weak city administration which are causes responsible for strengthening of mycobacterium. All the supporting variables pertain both to social, ecological and demographic parameters of urban living as being responsible for the incidence of the disease strongly supported by the disinterested city administrative authorities which does not ensure the implementation of related betterment laws, hence delegation of low standard of living under extremely congested urbanized conditions in the study area. Factor I also supports escalation in TB incidence in the study area due to environmental degradation because the depressing quality of life does not help in the organization of people's lives in an organized and civilized manner.

Factor II – Socioeconomic and ecological

The second factor explains 32.35 % (Table 2) of the total variance of a geodemographic parameter of TB patients. The rotated factor matrix shows that significant highest positive loading (Table 3) have been recorded for smokers to total respondents (0.92) followed by married to total respondents (0.90), male to total respondents (0.85), Pashto-speaking to total respondents and laborer patients to total respondents (0.80). Other supporting positive loadings have been recorded for patients residing in a condition of 01-03 persons per room (0.61), professional employees (0.78), patient's relative died due to TB (0.78), small private businessmen (0.74), housewife (0.73), resurgence patients (0.72), PTB (0.67), patients living in combined family system (0.67), patients who lived in *katcha* houses (0.65), monthly income below PKR 8 000 (0.65), other languages (0.64), residents of planned areas (0.63), Seraiki speaking (0.60), non-ownership household (0.60), patients who have not been vaccinated by BCG to total respondents (0.59), patients who received treatment from local areas (0.59), patients who lived in combined family systems (0.55), awareness regarding TB (0.54), Sindhi-speaking (0.54), patients who had awareness regarding precautionary measures (0.53), Urdu speaking (0.52), garbage near patient's residence (0.52) and TB diagnosis before 06 months (0.51). All these variables, viewed in a general perspective, justify the entitlement of this factor as Socioeconomic cum Ecological.

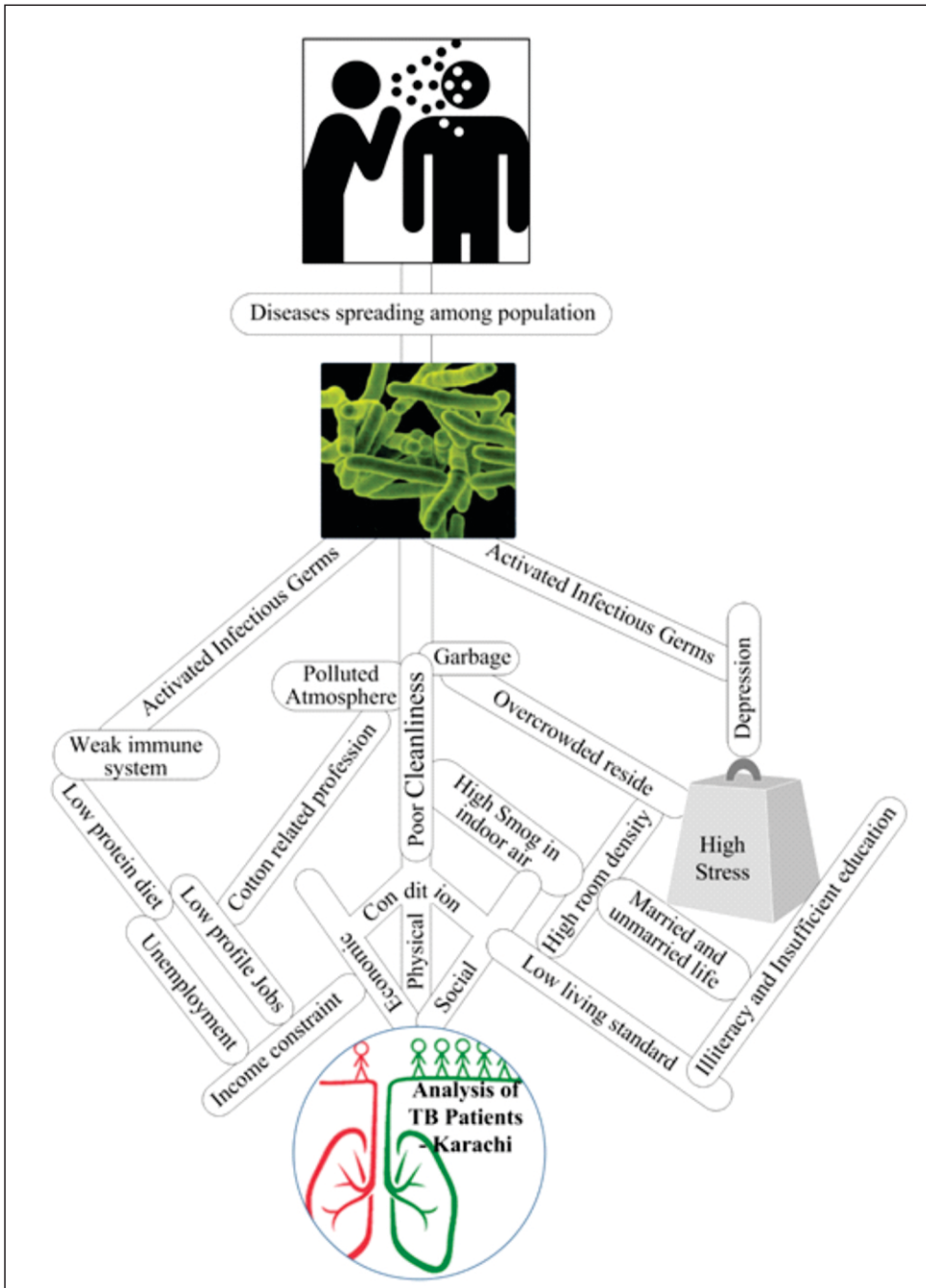


Figure 2. Major Factors responsible for spread of TB in the study area

Karachi is Pakistan's busiest port Major industries and businesses are located there. It has approximately 3600 industrial units in the formal sector. The major industries are pharmaceuticals, textile, paper, leather, marble, ceramics, rubber, stationery, glass, plastic, iron, electronics, agricultural, foods and dairy products

(GoP, 2006). According to KDA-MPD/AERC report, (1989) 75 % of the labourers are employed in the informal sector. Karachi Development Plan (KDA, 2000) focuses mainly on the textile, carpet, garment, leather and light engineering sectors in low-income settlements and in recent years, a link between formal and informal sectors has been established with the formal sector sub-contracting work to informal establishments (Hassan and Mohib, 2003).

According to KDA (2000), most of the paper industries, solid waste sorting, recycling, garment, leather tanning and manufacturing, light engineering and carpet industries, all function from within or near *katchiabadies* and slums. In the case of the leather and garment sectors, the formal industries contract piecemeal manufacturing of their items to skilled workers within *katchiabadies* through middlemen. Economic growth though directly responsible for expanding productive employment in itself cannot reduce poverty. Only productive and remunerative employment can help to reduce or eliminate poverty and deprivation.

Various studies have revealed that low-wage workers survive under extreme conditions in the study area. With an increase in poverty level, a concurrent increase in unemployment and access to basic services like health, housing and education continue to increase and poor households increasingly face distress, which is intensified by additional factors. Malnutrition, especially among children from low-income families, increases their susceptibility to infectious diseases. The risk of exposure to diseases gets magnified due to unhygienic environmental conditions in the provision of food (Hussain et al., 2003). Susceptibility to infection is increased by inability and inaccessibility of their children to BCG vaccination. In addition, provision of protective facilities like safety belts, protective eye wears, hand gloves, shoes, helmets, and masks for workers at their workplaces is far from satisfactory (Kumar, 2012).

More than 02 million workers were employed in the construction industry which is the backbone of all developmental activities. Attention should be directed towards health, safety and occupational hazards in this industry. In order to ensure health and safety of its workers, the government must enact relevant legislation for the provision of benefits like Workmen's Compensation, Social Security, Old-age Pension, etc. available to workers in other formal sectors (GoP, 2010). However, it is a major challenge to extend such type of labor protection to the workers in the large and diverse informal economy, which engages millions of people from the country's large geographic area. Numerous workers in the informal economy, engaged in low-paid, low-productivity jobs under harsh, unhealthy and hazardous conditions are not covered by labor laws (Kousar, 2010).

Various studies have identified that smoking plays a significant role in increasing the risk to TB disease (Wang et al., 2007). The very high positive loading for smokers to total respondents (0.92) has emerged as a significant variable with respect to males for TB growth in the study area because 81.58% male respondents out of total smokers, while 63.25% out of total male respondents and 38.06% out of total respondents recorded TB affected patients compared to females. Most of the patients fell in the age group 21-30 years followed by 51-60 and above age group. Although, a high percentage of females above 50 years old reported smoking of cigarettes due to some routine diseases such as constipation, etc. among low-income groups. Otherwise usually smoking is strongly prohibited for females.

Unfortunately, however, it has been observed that smoking in recent years is increasing among younger age groups of females as a fashion in emulation of TV dramas, where elite class display smoking as a fashion. This can create an alarming health situation for low-income communities as the negative impact of smoking among elites is compensated by balanced diets, which the low-income groups cannot afford, thus giving an open invitation to infections and diseases especially TB. All the social, economic, ecological and demographic factors go on in a vicious circle initiating and perpetrating TB.

Factor II is composed of 09 social, 06 economic and 08 ecological variables; thus it can be entitled socioeconomic cum ecological factor as an undercurrent. The first 06 variables are loading highest on the factor; emerged as prominent and different from that of Factor I, in addition to the variable on cigarette smokers, married and males which have emerged with high loadings. An undercurrent of the social aspect is the significance of the variable related to males, highlighting the fact that males have emerged as significant contributors to the spread of TB disease, along with gender bias as revealed in other relevant literature (Neyrollers and Quintana-Murci, 2009).

Factor III - Diet and diagnosis

The third factor explains 6.68 % (Table 2) of the total variance of variables on data pertaining to TB patients. The rotated factor matrix shows that significant highest positive loading (Table 3) has been recorded for food twice a day to total respondents (0.79), followed by diagnosis 06 months to total respondents (0.68) and diagnosis more than 06 months to total respondents (0.65). These 03 variables, viewed in a general perspective justify the entitlement of this factor as Diet and Diagnosis. Schaible and Kaufmann (2004) stated that the causes of a tendency to consumption revealed relationships among nutrition, diet and the causes of infectious disease and had recommended a balanced diet for those displaying the earliest stages of the disease.

Population increases characterized by widespread poverty, food insecurity and limited access to a healthy diet are most likely to suffer from HIV and TB epidemics. All three factors are interlinked in a vicious cycle (World Food Program). Underdeveloped regions or countries of the world suffer from malnutrition and tuberculosis where problems of considerable magnitude exist. From the narrow clinical point of view and from the broader perspective of prevention and therapeutics management of individual cases, with regard to control of tuberculosis in developing countries the prevalence of widespread malnutrition among the population poses serious problems.

Because of a whole complex of coincidental environmental factors, direct evidence of the effect of nutrition on tuberculosis is difficult to decipher. Mortality and morbidity from tuberculosis in a population facing food shortage points towards the view that malnutrition has an enormous weight, in spite of limitations regarding their contribution towards the view of exacerbation of TB. The problem of malnutrition and tuberculosis in underdeveloped countries is further aggravated by the high prevalence of HIV infection, as it is a significant factor in adversely affecting the nutritional status of patients (Gupta et al., 2009; Rao and Gopalan, 1996).

Karachi is the financial hub of Pakistan. People of different classes and creeds reside in various areas of the megapolis commensurate with their financial capabilities and social loyalties. High-class families reside in 1000 sq. meter bungalows, while those belonging to the lower financial class live cramped up in congested dwellings; slums, *katchiabadies* or manage to survive in the open air. This difference between living standards was found during the surveys as well. Low-income population being unable to afford utility expenditures, house rent, maintenance, school fees of children, quality food eke out a living under such conditions. All these problems are magnified by malnutrition which goes on in a vicious cycle. Diet and TB are linked to each other. A balanced diet helps maintain the body immune system hence all types of resistance inclusive to that of mycobacterium becomes strong. Poverty prevents people from purchase and consumption of good quality nutritious food, thus further reducing their immunity. Infection with HIV further exacerbates the chances of contracting infectious diseases like tuberculosis. Patients' food intake per day as this variable reveals the highest loading in Factor III. Highest values for patients of both sexes (males 38.75% and females 40%) in the age group 60+ have emerged as being TB patients.

The proportion of TB patient respondents in different age groups in terms of food intake reveals that the percentage of female respondents was greater than that of males. i.e. 52.5 compared to 47.5 %. The percentage of female as well as male respondents in the age group 60+ was highest (i.e. 40%) and (38.75%) respectively. The lowest intake of food twice a day has been recorded both among males and females was in the age group 41-50, 07 % for males and lowest for females i.e. 8.5 %. As revealed by field observation, elderly people of both sexes have been found to be facing the problem of low calorie/food intake which is an alarming health revelation. Food intake is better among the younger age groups compared to that of the older. According to the WHO and Stop TB partnership, undernourishment and weak resistance power were recognized as threats for TB. Sufficient food can help reduce starvation while healthy nutrition can help avoid infection, reinforce the immune system and prevent unintentional weight loss caused by TB.

Late diagnosis is a major risk factor in underdeveloped countries. Among more than two-thirds of the patients, the private sector was the first choice for seeking treatment. Delay in availing treatment facilities was due to a number of factors e.g. economic, socio-demographic, pursuing non-specialized personnel for care, visiting several health care providers before final diagnosis, wastage of time in reaching healthcare facilities, etc. (Dye et al., 1999). A vicious cycle of repeated visits to same level health care centers was the core problem leading to delay in access to specialized TB services hence delayed diagnosis, resulting in prolonged non-specific antibiotic treatment. Specialized TB service centers provide specific TB treatments (Storla et al., 2008).

Conclusion

The occurrence of TB has shown an increasing trend in the study area, and distribution of males and females with a marginal difference were found. The TB patients' quality of life is strongly undermined due to low income and congested

residence (among respondents) in the study area. The geodemographic analysis with an added insight into administrative authorities and the ethnic element supports a multi-factorial theorization of tuberculosis and provides a relevant context concerning disease transmission with the local environmental, cultural and politico-economic processes.

The study has a number of implications for researchers, policy makers and healthcare providers at both public and private sectors. The present study has identified that TB patients mainly comprise the labor class with low literacy, low incomes and hence extremely poor household hygienic conditions, which go on in a vicious cycle perpetrating poverty and disease. In the perspective of TB control, the government should build better housing schemes under the domain of quality living and also make efforts to control housing density and construction on encroached land. In addition, the administration should ensure the promotion of the significance of quality food, as well as develop open green spaces in overcrowded residential areas. It is also necessary for communities to improve interaction among other groups which reside in close proximity to their settlements. Such ameliorative activities will act as an impetus in changing and improving lifestyles and cultures hence trigger improvement of health.

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