REVIEW OF LITERATURE
2. REVIEW OF LITERATURE

With the goal of reviewing the available data on mortality in women as compared to men, this section examines age-sex segregated data on tuberculosis mortality. Section 2.1 reviews data from high income countries. The historical data suggests increased mortality risk among younger women tuberculosis patients. Section 2.2 attempts to analyze various Indian studies to see whether a comparable phenomenon can be identified. Section 2.3 of the review examines the risk factors for mortality due to tuberculosis with specific reference to women.

2.1. Age and sex segregated historical data from European nations and America

Age and sex segregated historical data on tuberculosis mortality are available from a number of sources from the developed nations. Data reported for England and Wales by Daw identifies that during the decade of 1851-60, the age of peak mortality was similar in men and women, being highest in the age group of 25 to 34 years\(^\text{12}\) (Table 1). A shift in the peak age of mortality was observed after the 1860’s, with mortality being highest in men in the age group of 35 - 44 years, and in women in a younger age group of 25 - 34 years. This age-difference in peak mortality rates between men and women persisted till the 1890’s, after which the age at peak mortality shifted by a decade in both groups, being 45-54 years in men, and 35 - 44 years among women. The difference in the peak age of mortality between men and women tuberculosis patients was evident in this data till the 1940’s.\(^\text{12}\) A similar age and gender based difference in tuberculosis mortality is also evident from the data of Dahlberg who compared mortality due to tuberculosis in England and Wales, France and Sweden.\(^\text{13}\) In 1936, the highest tuberculosis mortality in England and Wales was in the age group of 15 – 35 years in women as compared to 40 – 50 years in men.\(^\text{13}\) Data from Sweden and France,\(^\text{13}\) were identical to that observed for England and Wales, that is mortality was higher among young women as compared to men (Table 1). Data based on ‘old medical records’ from Iceland between 1926 and 1950 also showed a higher mortality rate among women than men in the same age group\(^\text{15}\) (Table 1).

A more recent study involving retrospective analysis of medical records of tuberculosis cases in Birmingham, notified between 1989 and 1995, also reported a higher mortality in the younger ages in women than men (30 – 39 years versus 40 – 49 years
respectively). Higher risk of mortality among younger women has also been reported from the Netherlands. Between 1993 and 1995 higher SMR was reported among women at younger ages (25 - 34 years) as compared to men (35 - 44 years). These observations were not evident in later data on tuberculosis mortality, such as that reported between 1992 and 2002 for tuberculosis patients from Serbia.

Historical data on tuberculosis mortality from the American continent too, substantiate the observations from the European nations. Age and sex distributed decadal mortality data for the state of Massachusetts indicated that the mortality rate was higher in younger women than men from the 1880s till the 1930s (Table 1). Identical observations were noted in the data of Yerushalmy and Moriyama who reported higher tuberculosis mortality at a younger age in both white and non-white women as compared to men (Table 1). Other studies also reported higher mortality at a younger age in women than men amongst Japanese residents in the United States of America (USA), although this was not observed among young female Japanese residents in the Hawaiian islands (Table 1). The higher occurrence of tuberculosis mortality in younger women is also reflected in higher case notifications among younger women, as compared to men in the same age groups. In England and Wales for example, between 1945 and 1949, there was higher notification of tuberculosis among women aged between 15 and 24 years than men in the same age groups (231 per 100 000 versus 189 per 100 000 population respectively) (Table 1).

Table 1: Age and sex distributed data on tuberculosis mortality at different points of time and setting

<table>
<thead>
<tr>
<th>Study setting/population</th>
<th>Peak mortality (per 100 000 population)</th>
<th>Ref no</th>
</tr>
</thead>
<tbody>
<tr>
<td>England and Wales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1851-60</td>
<td>25-34 years, 416.3 per 100 000</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>25-34 years, 469.0 per 100 000</td>
<td></td>
</tr>
<tr>
<td>1861-70</td>
<td>35-44 years, 424.4 per 100 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-34 years, 448.2 per 100 000</td>
<td></td>
</tr>
<tr>
<td>1871-80</td>
<td>35-44 years, 419.8 per 100 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-34 years, 363.1 per 100 000</td>
<td></td>
</tr>
<tr>
<td>1881-90</td>
<td>35-44 years, 368.5 per 100 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25-34 years, 293.2 per 100 000</td>
<td></td>
</tr>
<tr>
<td>1891-00</td>
<td>45-54 years, 329.6 per 100 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35-44 years, 226.4 per 100 000</td>
<td></td>
</tr>
<tr>
<td>1901-10</td>
<td>45-54 years, 293.4 per 100 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35-44 years, 171.0 per 100 000</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Age Group</td>
<td>Death Rate Per 100,000</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>1911-20</td>
<td>45-54 years</td>
<td>233.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-34 years</td>
</tr>
<tr>
<td>1921-30</td>
<td>45-54 years</td>
<td>172.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-24 years</td>
</tr>
<tr>
<td>1931-40</td>
<td>45-54 years</td>
<td>139.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-24 years</td>
</tr>
<tr>
<td></td>
<td>England and Wales, 1936</td>
<td>40-50 years</td>
</tr>
<tr>
<td></td>
<td>France, 1931 – 35</td>
<td>40-50 years</td>
</tr>
<tr>
<td></td>
<td>Sweden, 1931 – 35</td>
<td>40-50 years</td>
</tr>
<tr>
<td></td>
<td>Iceland</td>
<td></td>
</tr>
<tr>
<td>1926-30</td>
<td>15-19 years</td>
<td>274</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15-19 years</td>
</tr>
<tr>
<td>1936-40</td>
<td>20-29 years</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1941-45</td>
<td>30-39 years</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1946-50</td>
<td>20-29 years</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-39 years</td>
</tr>
<tr>
<td></td>
<td>Massachusetts, US</td>
<td></td>
</tr>
<tr>
<td>1880</td>
<td>20-29 years</td>
<td>444</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1890</td>
<td>30-39 years</td>
<td>368</td>
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<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1900</td>
<td>30-39 years</td>
<td>296</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1910</td>
<td>30-49 years</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1920</td>
<td>40-49 years</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td>1930</td>
<td>50-59 years</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-29 years</td>
</tr>
<tr>
<td></td>
<td>US 1939-41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-29 years</td>
</tr>
<tr>
<td></td>
<td>Non-whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-24 years</td>
</tr>
<tr>
<td>1942</td>
<td>Whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-29 years</td>
</tr>
<tr>
<td></td>
<td>Non-whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-24 years</td>
</tr>
<tr>
<td>1943</td>
<td>Whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-34 years</td>
</tr>
<tr>
<td></td>
<td>Non-whites</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20-24 years</td>
</tr>
<tr>
<td>1944</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2. Age and sex distributed data from India

A review of Indian studies identified a paucity of age and sex distributed tuberculosis mortality data. Thus, studies reporting age and sex distributed prevalence data were used to determine whether peak prevalence of tuberculosis occurred in younger women. Studies reporting age and sex segregated prevalence data are enlisted in Table 2. Similar to observations from high income countries,\textsuperscript{53} higher prevalence was detected in women at younger age groups (Table 2).

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{Whites} & \textbf{Non-whites} & \textbf{US, 1950} \\
\hline
45-54 years, & 45-54 years, & 45-54 years, \\
80.2 per 100 000 & 212.3 per 100 000 & 30-34 years, \\
& & 189.5 per 100 000 \\
30-34 years, & 20-24 years, & 30-34 years, \\
& 32.8 per 100 000 & 13.3 per 100 000 \\
\hline
\textbf{Japanese in} & \textbf{Non-whites} & \textbf{Japanese in} \\
\textbf{US, 1949 – 52} & & \\
45-54 years, & 45-54 years, & 45-54 years, \\
70.4 per 100 000 & 45.4 per 100 000 & 35-44 years, \\
& & 35.8 per 100 000 \\
\hline
\textbf{Hawaii,1949-51} & & \\
45-54 years, & 45-54 years, & 30-39 years \\
49.3 per 100 000 & 23.5 per 100 000 & \\
\hline
\textbf{Birmingham, UK} & & \\
\textbf{1989 – 1995} & & \\
40-49 years & 40-49 years & \\
& 30-39 years & \\
\hline
\textbf{Netherlands} & & \\
\textbf{1993 – 1995} & & \\
35-44 years, & 25-34 years, & 25-34 years, \\
SMR = 32 (95 % CI= 17-53) & 29 (95% CI =7.8 – 73) & 25-34 years, \\
& & 29 (95% CI =7.8 – 73) \\
\hline
\textbf{Serbia, 1992-2002} & & \\
45-54 years, & 45-54 years, & \\
8970 per 100 000 & 4650 per 100 000 & \\
\hline
\textbf{England and Wales} & \textbf{Peak case notification rate} & \textbf{England and Wales} \\
\hline
15-24 years, & 15-24 years, & 15-24 years, \\
189 per 100 000 & 231 per 100 000 & 15-24 years, \\
15-24 years, & 15-24 years, & 15-24 years, \\
158 per 100 000 & 214 per 100 000 & 15-24 years, \\
15-24 years, & 15-24 years, & 15-24 years, \\
113 per 100 000 & 118 per 100 000 & 15-24 years, \\
15-34 years, & 15-34 years, & 15-34 years, \\
76 per 100 000 & 45 per 100 000 & 15-34 years, \\
25-34 years, & 25-34 years, & 25-34 years, \\
48 per 100 000 & 25 per 100 000 & 25 per 100 000 \\
\hline
\end{tabular}
\end{table}

# Some of these rates have been calculated to bring uniformity to the data
Table 2: Age and sex segregated prevalence data in the Indian studies

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Study</th>
<th>Study design and period</th>
<th>Sample size</th>
<th>Peak prevalence</th>
<th>Ref no</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Males</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>ICMR</td>
<td>Multi-centric longitudinal study 1955 - 58</td>
<td></td>
<td>16 155</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td>Calcutta</td>
<td></td>
<td></td>
<td>22 780</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td>Delhi</td>
<td></td>
<td></td>
<td>29 240</td>
<td>45-54 years</td>
</tr>
<tr>
<td></td>
<td>Hyderabad</td>
<td></td>
<td></td>
<td>15 986</td>
<td>25-34 years</td>
</tr>
<tr>
<td></td>
<td>Madanpalle</td>
<td></td>
<td></td>
<td>14 970</td>
<td>25-34 years</td>
</tr>
<tr>
<td></td>
<td>Patna</td>
<td></td>
<td></td>
<td>16 665</td>
<td>35-44 years</td>
</tr>
<tr>
<td></td>
<td>Trivendum</td>
<td></td>
<td></td>
<td>64 385</td>
<td>35-54 years</td>
</tr>
<tr>
<td>2.</td>
<td>Bangalore</td>
<td>Longitudinal study 1961 - 68</td>
<td></td>
<td>18 000</td>
<td>44-54 years</td>
</tr>
<tr>
<td>5.</td>
<td>Chennai</td>
<td>Prevalence in household contacts, 1956 - 57</td>
<td></td>
<td>22 847</td>
<td>40-49 years</td>
</tr>
<tr>
<td>8.</td>
<td>Raichur, Karnataka</td>
<td>Prevalence survey November 1988 – March 1989</td>
<td></td>
<td>82 000</td>
<td>45-54 years</td>
</tr>
<tr>
<td>9.</td>
<td>Tiruvallur</td>
<td>Prevalence survey 1999 - 2004</td>
<td></td>
<td>93 670</td>
<td>45-54 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tribal population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. North Arcot</td>
</tr>
</tbody>
</table>
The earliest prevalence study reporting age and sex segregated prevalence data was from the multi-centric nationwide survey conducted by the ICMR between 1955 and 1958. Higher prevalence was reported in young women than men from urban areas in Calcutta, Delhi, Hyderabad and Madanpalle (Figure 1). This age difference in the peak prevalence between the sexes was inapparent in the urban areas of Patna and Thiruvananthapuram (erstwhile Trivendum) (Figure 1).

Figure 1: Age sex distribution of tuberculosis prevalence in the ICMR sample survey 1955–58

Similar to the results from the ICMR sample survey, evidences indicating a higher burden of tuberculosis at younger ages among women were available from various studies conducted between 1956 and 1978 (Figure 2). Prevalence data from the longitudinal survey conducted in Bangalore between 1961 and 1968 observed a peak tuberculosis prevalence between 15 and 34 years in women as compared to 35–54 years in men. A prevalence survey conducted in the Kashmir valley, reported a higher prevalence in women aged between 25 and 34 years than men in the same age group. A household survey conducted in Tumkur district revealed that the prevalence peaked between 30 and 39 years in women. A study conducted on household contacts of tuberculosis patients in Chennai
revealed a higher prevalence in women aged between 20 and 24 years than men in the same age group\(^{33}\) (Figure 2).

Figure 2: Age sex distribution of tuberculosis prevalence in India between 1950 and 1978 as reported by various studies\(^{32-35}\)

The age difference in distribution of peak prevalence between the two genders becomes inapparent in studies reported after the 1980s. Prevalence data from a household survey consisting of 23,000 residents in the North Arcot district did not reveal any difference in the peak prevalence by age between men and women.\(^{44}\) Similarly, data reported in the prevalence surveys conducted in the peri-urban areas in Bangalore,\(^{41}\) Raichur (Karnataka),\(^{43}\) rural areas in Tiruvallur\(^{42}\) and Wardha,\(^{38}\) did not reveal an excess prevalence in women at an younger age group than men (Figure 3). However a study based on registration data from the RNTCP in Bellary during 2003-2004 revealed that there were more women patients in the younger age groups between 25 and 34 years than men in the same age group, accessing anti tuberculosis treatment\(^ {40}\) (Figure 3).
Age and sex segregated prevalence data from the tribal population in north Arcot detected a peak in the younger age groups in women as compared to men (35–44 years versus 45 – 54 years). \(^{36}\) Similarly in surveys conducted amongst the tribal populations in Wardha\(^ {38}\) and Madhya Pradesh,\(^ {39}\) the peak prevalence of tuberculosis cases was between 25 and 34 years in women as compared to 35 and 44 years in men (Figure 4).
Figure 4: Age sex distribution of tuberculosis prevalence in tribal population in India as reported by various studies

2.3 Risk factors for tuberculosis morality

This section of the review provides firstly, an overview of risk factors for tuberculosis infection, disease and mortality (Table 3 and 4), followed by a review of the risk factors associated with the risk of mortality among women. These risk factors fall into broad categories of clinical, socio-demographic, economic and behavioural risk factors.

2.3.1. Clinical risk factors

Previous history of tuberculosis, treatment default, treatment failure, sputum positive status, co-morbidities such as HIV infection and diabetes are well established factors associated with the risk of tuberculosis (Table 3). Studies conducted in rural areas in western Kenya identified history of tuberculosis as a risk factor for mortality (adjusted hazards ratio, AHR = 1.6, 95% CI = 1.3 – 1.9).\(^{54}\) Similar results were obtained from retrospective cohort studies conducted in Ethiopia (AHR = 1.74, 95% CI = 1.439 – 2.096),\(^{55}\) Democratic Republic of Congo (adjusted odds ratio, AOR = 1.45, 95% CI = 1.12 – 1.87)\(^{56}\) and surveillance data from the fifteen countries from the European Union (EU) (AOR = 1.89, 95% CI = 1.73 – 2.07).\(^{57}\) Association between treatment default and mortality was observed in two separate cohort studies conducted in Mexico (Hazards Ratio, HR = 5.21, 95% CI = 3.06 – 8.87\(^{58}\) and AOR = 8.9,
95% CI = 3.3 – 2.4\(^{59}\)). A meta analysis of 30 studies by Agulier et al reported association between tuberculosis mortality and sputum smear positive status (OR = 1.39, 95% CI = 1.2 – 1.6).\(^{60}\) A case control study conducted in Russia identified an association between tuberculosis mortality and sputum positive status (OR = 4.07, 95% CI = 2.85 – 7.77).\(^{61}\) A study conducted amongst the contacts of active tuberculosis cases in British Columbia, also revealed an association between sputum smear positive status and tuberculosis mortality (AHR = 1.59, 95% CI = 1.07 – 2.37).\(^{62}\) A study conducted in western Kenya identified sputum negative status as a risk factor for mortality among tuberculosis patients (AHR = 1.5, 95% CI = 1.2 – 1.7).\(^{54}\) Co-morbidities (HIV infection) was observed to be associated with tuberculosis /tuberculosis mortality in studies conducted in Kenya (AHR = 3.3, 95% CI = 2.4 – 4.5),\(^{54}\) Washington (HR = 4.2, 95% CI = 2.9 – 6.3),\(^{63}\) Democratic Republic Congo (AOR = 3.56, 95% CI = 2.88 – 4.41),\(^{56}\) Mexico (HR = 24.3, 95% CI = 9.0 – 65.6),\(^{58}\) Barcelona (AHR = 7.7, 95% CI = 4.5 – 13.3),\(^{64}\) North America (Relative Risk, RR = 3.94, 95% CI = 2.23 – 6.96)\(^{65}\) and Brazil (OR = 5.58, 95% CI = 2.38 – 13.07).\(^{66}\) Association was observed between diabetes and tuberculosis /mortality due to tuberculosis in studies conducted in Iraq (P = 0.001)\(^{67}\) and eastern China (relative risk, RR = 7.37, 95% CI = 2.28 – 23.77).\(^{68}\) Apart from the co-morbidities, weight loss (as a proxy measure of immune-suppressed status) was identified to be associated with risk of tuberculosis mortality in longitudinal studies reported from Mexico (HR = 2.4, 95% CI = 1.02 – 5.63\(^{58}\) and AOR = 3.9, 95% CI = 1.5 – 10.9\(^{59}\) respectively). History of close contact with a person with tuberculosis was identified with risk of acquiring tuberculosis in cohort studies conducted in central and eastern China (RR = 4.42, 95% CI = 1.78 – 10.97 and RR = 68.27, 95% CI = 33.81 – 137.9),\(^{68}\) Shanghai (RR = 2.17, 95% CI = 1.40 – 3.37),\(^{69}\) British Columbia (AHR = 9.57, 95% CI = 6.66 – 13.75)\(^{62}\) and The Gambia (OR = 1.62, 95% CI = 1.18 – 2.21).\(^{70}\)

2.3.2. Socio-demographic risk factors

Being male associated with an increased risk of tuberculosis and tuberculosis mortality in Washington (HR = 1.5, 95% CI = 1.2 – 2.0), Iraq (P = 0.000),\(^{67}\) Taiwan (HR = 1.83, 95% CI = 1.23 – 2.71),\(^{71}\) Ethiopia (AHR = 2.2, 95% CI = 1.3 – 3.9),\(^{72}\) surveillance data from fifteen countries in the EU (AOR = 1.48, 95% CI = 1.35 – 1.61),\(^{57}\) North America (RR = 2.3.5, 95% CI = 1.17 – 4.74),\(^{65}\) Shanghai (RR = 1.93, 95% CI = 1.43 – 2.6),\(^{69}\) Singapore (AHR = 1.40, 95% CI = 1.00 – 1.98)\(^{73}\) and amongst the contacts of tuberculosis cases in British Columbia (AHR = 1.96, 95% CI = 1.51 – 2.55).\(^{62}\) Age (35 years and above) was
associated with risk of tuberculosis and tuberculosis mortality in retrospective cohort studies and surveys conducted in Kenya (AHR = 1.5, 95% CI = 1.2 – 1.9), Washington (HR = 1.05, 95% CI = 1.05 – 1.06),63 Taiwan (HR = 1.06, 95% CI = 1.04 – 1.07),71 Democratic Republic of Congo (AOR = 1.92, 95% CI = 1.57 – 2.35),56 Singapore (AHR = 6.0, 95% CI = 3.04 – 11.75),73 Netherlands (AHR = 45, 95% CI = 17 – 24),27 Southern Mexico (HR = 1.04, 95% CI = 1.02 – 1.05),58 Barcelona (AHR = 3.5, 95% CI = 2.1 – 5.7),64 Southern Ethiopia (AHR = 1.01, 95% CI = 1.0 – 1.1),72 Shanghai (RR = 1.89, 95% CI = 1.8.9 – 3.76),69 in surveillance data from 15 EU countries (AOR = 5.18, 95% CI = 3.40 – 7.88)57 and amongst male jail inmates in Pakistan (AOR = 3.5, 95% CI = 1.9 – 6.7).74

### 2.3.3. Economic risk factors

Unemployment and homelessness were reported to be associated with risk of mortality in a case control study conducted in Russia (OR = 3.13, 95% CI = 1.94 – 5.04 and OR = 1.99, 95% CI = 1.08 – 3.67).61 Homelessness was also reported to be associated with risk of acquiring tuberculosis in meta analysis of 30 studies by Aguiler et al.60 Association between risk of acquiring tuberculosis and minimal education and unemployment were also reported from anti tuberculosis trial conducted in the North America (RR = 1.78, 95% CI = 1.08 – 2.93 and RR = 2.74, 95% CI = 1.67 – 4.5).65 Lowest income quintile in British Columbia was associated with risk of acquiring tuberculosis (AHR = 3.26, 95% CI = 1.80 – 5.92).62 A case control study conducted in Malawai, identified migration as a risk for acquiring tuberculosis (OR = 1.6, 95% CI = 1.3 – 1.9).75 Residence in the city area was associated with risk of mortality due to tuberculosis in a longitudinal study conducted in Barcelona (AHR = 1.2, 95% CI = 1.1 – 1.7).64

### 2.3.4. Behavioural risk factors

Alcoholism, smoking and illicit drug usage were identified in the global literature to be associated with risk of acquiring tuberculosis as well as with mortality due to tuberculosis. Smoking was associated with tuberculosis mortality in Iraq (P = 0.000)67 and with tuberculosis disease in central China (RR = 2.04, 95% CI = 1.27 – 3.29),68 Shanghai (RR = 3.64, 95% CI = 2.56 – 5.17)69 and amongst male jail inmates in Pakistan (AOR = 2.6, 95% CI = 1.6 – 44).74 Alcoholism was reported to be associated with tuberculosis mortality in Netherlands (AHR = 2.4, 95% CI = 1.1 – 5.3),27 Barcelona (AHR = 1.7, 95% CI = 1.2 – 2.4),64 North America (RR = 2.41, 95% CI = 1.48 – 3.92)65 and with
tuberculosis disease in South Africa (OR = 1.97, 95% CI = 1.4 – 2.77)\textsuperscript{26} and in British Columbia (AHR = 7.56, 95% CI = 4.31 – 13.25).\textsuperscript{62} A longitudinal study conducted in Barcelona reported an association between illicit drug usage (IDU) and tuberculosis mortality (AHR = 7.7, 95% CI = 4.5 – 13.3).\textsuperscript{64} Anti tuberculosis treatment trial conducted in North America too reported a similar association between IDU and risk of tuberculosis mortality (RR = 1.79, 95% CI = 1.09 – 2.92).\textsuperscript{65}

\textbf{2.3.5. Access to treatment}

An increased risk of mortality among patients accessing private practitioners for anti tuberculosis treatment has been reported from a cohort study conducted in Washington (HR = 2.2, 95% CI = 1.1 – 4.6).\textsuperscript{63} A case control study conducted in Russia revealed that a diagnosis delay longer than four weeks was associated with tuberculosis mortality risk (OR = 2.62, 95% CI = 1.15 – 6.00).\textsuperscript{61}

Table 3: Identified risk factors associated with acquiring tuberculosis/mortality from studies conducted globally

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Study setting</th>
<th>Study design, period and population</th>
<th>Sample size, Outcome measure</th>
<th>Identified Risk factors</th>
<th>Ref no</th>
</tr>
</thead>
</table>
| 1.    | Kenya (Rural Western)  | Patients registered at health facility in two districts 2006-08 | 9381, AHR (95% CI)          | Age, 35-44 years = 1.5 (1.2 – 1.9)  
45-54 years = 1.6 (1.2-2.0)  
>65 years =3.1 (2.3 – 4.2)  
HIV = 3.3 (2.4 – 4.5)  
HIV with ART = 2.0 (1.5 – 2.8)  
Unknown ART status = 2.8 (2.1 – 3.6)  
Unknown HIV status = 2.8 (2.1 – 3.7)  
Sputum negative = 1.5 (1.2 – 1.7)  
Retreatment cases = 1.6 (1.3 – 1.9) | 54     |
| 2.    | Addis Ababa, Ethiopia  | Retrospective Cohort June 04 - 09  | 6450 AHR (95% CI)          | Retreatment = 1.74 (1.439 – 2.096), P = 0.000  
Weight > 34 kg, 0.089 (0.8 – 0.97), P = 0.012 | 55     |
| 3.    | Kinshasa, Democratic Republic of Congo | Retrospective cohort study January 2006 – May 2007 | 5685 patients AOR (95% CI) | Mean age >35 years = 1.92 (1.57 – 2.35)  
History of TB = 1.45 (1.12 – 1.87)  
Sputum negative = 1.90 (1.51 – 2.40)  
HIV positive = 3.56 (2.88 – 4.41) | 56     |
| 4.    | 15 countries, EU      | Surveillance data 2002 - 04         | 39 566 AOR                  | Male = 1.48 (1.35 – 1.61)  
Age 20 – 39 years = 1.88 (1.23 – 2.88) | 57     |
<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th>Study Type</th>
<th>Time Period</th>
<th>Sample Size</th>
<th>Effect Size</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.</td>
<td>Southern Mexico</td>
<td>March 1995 – April 2003</td>
<td>8195 HR</td>
<td>Male = 2.23 (1.25 – 3.99) Age = 1.04 (1.02 – 1.05) Weight loss = 2.4 (1.02 – 5.63) HIV infection = 24.3 (9.0 – 65.6) Treatment default = 5.21 (3.06 – 8.87)</td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>Southern Mexico</td>
<td>Community based follow up study March 1995 – October 2000</td>
<td>454, AOR</td>
<td>Treatment default = 8.9 (3.3 – 2.4) Weight loss = 3.9 (1.5 – 10.9)</td>
<td></td>
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</tr>
<tr>
<td>7.</td>
<td></td>
<td>Review /meta analysis of studies published between 1994 - 2005</td>
<td>30 studies OR</td>
<td>Alcohol = 2.27 (1.69 – 3.06) Homeless = 2.87 (2.04 – 4.02) HIV = 1.66 (1.36 – 2.05) Sputum positive = 1.39 (1.2 – 1.6) Male = 1.37 (1.19 – 1.58)</td>
<td></td>
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</tr>
<tr>
<td>8.</td>
<td>Samara, Russia</td>
<td>Retrospective case control, 1999 - 2003 morality</td>
<td>92 cases, 368 controls OR</td>
<td>Age 40 – 50 years = 2.61 (1.50 – 4.55), P&lt;0.001 Unemployment = 3.13 (1.94 – 5.04), P = 0.001 Homeless = 1.99 (1.08 – 3.67), P = 0.02 Sputum positive = 4.07 (2.85 – 7.77), P &lt; 0.001 Diagnosis delay &gt; 4 weeks = 2.62 (1.15 – 6.00), P = 0.02 DOTs practitioner = 0.80 (0.50 – 1.30), P = 0.03</td>
<td></td>
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<tr>
<td>9.</td>
<td>British Columbia</td>
<td>Retrospective cohort of contacts of active cases recorded at BC div of TB control 1990 - 2000</td>
<td>42593 AHR</td>
<td>Alcoholism = 7.56 (4.31 – 13.25), P &lt; 0.001 Munnourishment = 28.52 (11.73 – 69.32),P &lt; 0.001 Incomplete treatment = 2.47 (1.11 – 5.49), P = 0.027 Non household contact = 2.64 (1.82 – 3.83), P &lt; 0.001 Household = 9.57 (6.66 – 13.75), P &lt; 0.001 Smear positive = 1.59 (1.07 – 2.37), P = 0.021 4th income quintile = 2.01 (1.05 – 3.86), P = 0.035 3rd income quintile = 3.24 (1.76 – 5.95), P&lt; 0.001 2nd income quintile = 3.5 (1.92 –</td>
<td></td>
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<tr>
<td>No.</td>
<td>Location</td>
<td>Type of Study</td>
<td>Start Date - End Date</td>
<td>Sample Size</td>
<td>Hazard Ratio (95% CI)</td>
<td>Additional Statistics</td>
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<tr>
<td>10</td>
<td>Washington</td>
<td>Cohort January 1993 – December 2005 State dept TB registry</td>
<td>3451 HR (95% CI)</td>
<td>Age = 1.05 (1.05 – 1.06) Male = 1.5 (1.2 – 2.0) HIV co infection = 4.2 (2.9 – 6.3) Private provider = 2.2 (1.1 – 4.6)</td>
<td></td>
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<tr>
<td>11</td>
<td>Barcelona, Spain</td>
<td>Retrospective longitudinal study, 1995 - 2005</td>
<td>762 AHR (95% CI)</td>
<td>Age, 41 – 60 years = 3.5 (2.1 – 5.7) &gt; 60 years = 14.6 (8.9 – 24) Residence in city = 1.1 (1.8 – 1.7) Alcoholism = 1.7 (1.2 – 2.4) HIV and IDU = 7.7 (4.5 – 13.3)</td>
<td></td>
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<tr>
<td>12</td>
<td>North America</td>
<td>TB treatment trial, April 1995 – November 1998</td>
<td>1075 RR (95% CI)</td>
<td>Age per 1 year increase = 1.04 (1.03 – 1.06), Male = 2.35 (1.17 – 4.74), Less than high school = 1.78 (1.08 – 2.93), P = 0.023 Unemployed = 2.74 (1.67 – 4.5), P &lt; 0.0011 Illicit drug usage = 1.79 (1.09 – 2.92), P = 0.021 Alcohol = 2.41 (1.48 – 3.92), P = 0.0004 Homeless = 1.69 (1.0 – 2.83), P = 0.047 HIV = 3.94 (2.23 – 6.96), P = 0.0001</td>
<td></td>
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<tr>
<td>13</td>
<td>Brazil</td>
<td>Retrospective cohort study January 2002 – December 2008</td>
<td>561 OR (95% CI)</td>
<td>HIV infection = 5.58 (2.38 – 13.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Khuzestan, Iraq</td>
<td>Retrospective medical records of notified cases, 2002- 2006</td>
<td>93 $\chi^2$, P value</td>
<td>Male = 0.000, Smoking = 0.000 HIV = 0.06 DM = 0.001 AIDS = 0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>China (Central and Eastern)</td>
<td>Cohort 2009 - 2011</td>
<td>177 529 RR (95% CI)</td>
<td>History of TB = 7.0 (9.35 – 44.47) Contact history = 4.42 (1.78 – 10.97)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Location</td>
<td>Study Design</td>
<td>Study Details</td>
<td>Odds Ratio (95% CI)</td>
<td>P Value</td>
<td></td>
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</tr>
<tr>
<td>Shanghai, China</td>
<td>Survey, pulmonary TB in sanitary workers, Dec 1985 – Feb 1986</td>
<td>Smoking = 2.04 (1.27 – 3.29) History of contact = 6.92 (2.47 – 19.31) DM = 7.37 (2.28 – 23.77)</td>
<td>RR (95% CI)</td>
<td></td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>The Gambia</td>
<td>Household based Case control March 1999 – January 2001</td>
<td>Age &gt; 50 years = 2.67 (1.89 – 3.76) Male = 1.93 (1.43 – 2.6) Smoker heavy = 3.64 (2.56 – 5.17) History of contact = 2.17 (1.40 – 3.37)</td>
<td>OR (95% CI)</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Taiwan</td>
<td>Prospective observational January 2007 – December 2009</td>
<td>Male = 1.83 (1.23 – 2.71) Age = 1.06 (1.04 – 1.07) Malignancy = 3.41 (2.53 – 4.60) Renal inefficiency = 3.0 (1.94 – 4.63) Anorexia=1.58 (1.15-2.16)</td>
<td>HR (95% CI)</td>
<td></td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>Retrospective cohort 2000 - 2006</td>
<td>Age 45 – 64 years = 6.00 (3.04 – 11.75), P &lt; 0.0005 &gt; 65 years = 20.56 (10.76 – 39.28), P &lt; 0.0005</td>
<td>AHR (95% CI)</td>
<td></td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>All registered patients between 1993 - 1995</td>
<td>Age &gt; 65 years = 45 (17 – 24) Alcohol = 2.4 (1.1 – 5.3) Drug addiction = 3.5 (1.1 – 11.5) Malignancy = 3.1 (2.2 – 4.4) HIV infection = 9.9 (5.4 – 18.0)</td>
<td>AHR (95% CI)</td>
<td></td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Southern Ethiopia</td>
<td>Retrospective cohort study 1998 - 2006</td>
<td>Age = 1.01 (1.0 – 1.1), P &lt; 0.01 Male = 2.2 (1.3 – 3.9), P = 0.01 Non farmers = 6.3 (3.6 – 11.1), P&lt; 0.01</td>
<td>AHR (95% CI)</td>
<td></td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Pakistan, North West Frontier Province</td>
<td>Jail inmates July – September 2001</td>
<td>Age &gt; 42 years= 3.5 (1.9 – 6.7) Illiteracy = 2.2 (1.4 – 3.4) Smoking, 1-5 cigarettes = 2.6 (1.6 – 4.4) 6 – 10 = 2.8, (1.6 – 5.2) &gt; 10 = 3.2 (1.3 – 8.2)</td>
<td>AOR (95% CI)</td>
<td></td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Karonga district, Malawi</td>
<td>Case control November 1996 – September 2001</td>
<td>Single (previously married) = 3.9 (2.8 - 5.3) Migration = 1.6 (1.3 – 1.9)</td>
<td>OR</td>
<td></td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>
### 2.3.6. Risk factors identified in Indian studies

Several Indian studies have also reported association of the above mentioned factors with the risk of mortality among tuberculosis patients (Table 4). Risk of acquiring tuberculosis or mortality due to tuberculosis has been associated with previous history of tuberculosis, frequent contact with patients was associated with the risk of tuberculosis amongst health care workers in Vellore, HIV- infection (RR = 8.3, 95% CI = 6.1 – 10.8), diabetes mellitus (RR = 3.0, 95% CI = 1.5 – 7.8) and chronic diseases (OR = 1.8, 95% CI = 1.10 – 2.93) were identified as the major immune suppressive risk factors in cohort studies conducted in India. Body weight less than 35 kg, low BMI and malnourishment were other immunosuppressive conditions (excluding co-morbidities) associated with risk of acquiring tuberculosis and mortality due to tuberculosis. Amongst the socio-demographic factors, male sex and age were reported to be associated with the risk of developing tuberculosis. A case control study conducted in Bangalore revealed a protective effect amongst patients with education of more than 10 years (OR = 0.24, 95% CI = 0.11 – 0.51). Indoor pollution (RR = 1.5, 95% CI = 1.2 – 3.2) was reported as a risk factor for developing tuberculosis in a review by Narasimhan et al. Amongst behavioural risk factors, alcoholism and smoking were observed to be associated with risk of tuberculosis as well as mortality due to tuberculosis.

<table>
<thead>
<tr>
<th>Study setting</th>
<th>Study design, period and population</th>
<th>Sample size, Outcome measure</th>
<th>Identified Risk factors</th>
<th>Ref no</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tiruvallur, SI</td>
<td>Community based survey May 1999 – April 2000</td>
<td>676 OR (95% CI)</td>
<td>Weight &lt; 35 kg = 3.8 (1.8 – 7.9) Previous history = 3.8 (1.7 – 8.2) Treatment default = 3.3 (1.1 – 9.1) Failure = 16.5 (2.1 – 127.5)</td>
<td>25</td>
</tr>
</tbody>
</table>
|   | Rural Tiruvallur district, SI | Retrospective study May 1999 – Dec 2004 | 3818 | AOR (95% CI) | Age > 45 years = 2.345 (1.557 – 3.533)  
|   |   |   |   |   | Earlier history of tuberculosis = 1.615 (1.102 – 2.368)  
|   |   |   |   |   | Alcoholism = 2.015 (1.357 – 2.992)  
|   |   |   |   |   | Body weight less than < 35 kg = 3.709 (2.434 – 5.652)  |
|   | Rural Tiruvallur, south India | Retrospective cohort study, 2000 – 2003 mortality | 3388 | AHR (95% CI) | Age 45 – 59 years = 1.9 (1.6 – 2.3),  
P = 0.000  
|   |   |   |   |   | > 60 years = 3.1 (2.6 – 3.8), P = 0.000  
|   |   |   |   |   | Cat I = 1.8 (1.3 – 2.3), P = 0.000  
|   |   |   |   |   | Cat II = 2.0 (1.4 – 2.7), P = 0.000  
|   |   |   |   |   | Default = 6.4 (5.4 – 7.4), P = 0.000  
|   |   |   |   |   | Smoker = 1.2 (1.0 – 1.4), P = 0.034 |
|   | Tiruvallur, South India | Cross sectional community June 2001 – Dec 2003 | 93 945 | APOR (95% CI) | Age > 45 years = 3.3 (2.7 – 4.1)  
|   |   |   |   |   | Male = 2.5 (1.9 – 3.3)  
|   |   |   |   |   | Smoker = 2.1 (1.7 – 2.7)  
|   |   |   |   |   | Alcoholic = 1.5 (12.2 – 2.0)  |
|   | - | Review | RR (95% CI) | HIV = 8.3, 6.1 – 10.8  
|   |   |   |   | Malnourishment = 4.0 (2.0 – 6.0)  
|   |   |   |   | DM = 3.0 (1.5 – 7.8)  
|   |   |   |   | Alcohol = 2.9 (1.9 – 4.6)  
|   |   |   |   | Smoking = 2.6 (1.6 – 4.3)  
|   |   |   |   | Indoor pollution = 1.5 (1.2 – 3.2)  |
|   | Vellore, CMC | Nested Case control, Health care workers March 2003 – December 2004 | 101 cases 101 controls | OR (95% CI) | BMI < 19 kg/m² = 2.6 (1.39 – 4.85)  
|   |   |   |   |   | Frequent contacts with patients = 2.83 (1.47 – 5.47)  |
|   | Bangalore, SI | Hospital based Case control October 2001 – October 2003 | 189 cases = 189, controls = 189, OR (95% CI) | Education > 10 years = 0.24, 0.11 – 0.51,  
|   |   |   |   |   | Smoking = 2.31 (1.12 – 4.79)  
|   |   |   |   |   | Alcohol = 2.13 (1.02 – 4.44)  
|   |   |   |   |   | Chronic diseases = 1.80 (1.10 – 2.93)  
|   |   |   |   |   | BMI < 18.5 kg/m² = 11.11 (5.62 – 21.98)  |

# OR = Odds ratio, AOR = Adjusted Odds Ratio, APOR= Adjusted Prevalence Odds Ratio, HR = Hazard ratio, AHR = Adjusted Hazard Ratio, ART = Anti retroviral Therapy, DM = Diabetes Mellitus, TB = Tuberculosis, BMI = Body Mass Index, SI = South India
2.4. Risk factors associated with mortality due to tuberculosis in women

This section reviews the risk factors associated with tuberculosis mortality among women. There are several lines of evidence suggesting that in addition to the risk factors described above, socio-economic barriers leading to lower case notification and lower treatment seeking amongst women from developing countries significantly contribute towards increased mortality risk.\textsuperscript{16,17,19–21}

2.4.1. Socio-cultural and behavioural factors

The socio-cultural and behavioural risk factors enhancing the vulnerability of women are available from several lower income countries. Longitudinal demographic surveillance data from Bangladesh, for example, reported underutilization of health care facilities by women and an association between son preference and sex-based difference in nutrition, intra-family resource allocation, care provision.\textsuperscript{16,82} Notably, studies from high-income countries reported a higher likelihood of reporting and seeking care than men.\textsuperscript{83–85} Thus a higher social vulnerability is observed in women as compared to men from low-income countries, as well as women from high-income countries.

Evidences from Indian studies report a multiple step decision-making process occurs among women, prior to presentation at any treatment centre.\textsuperscript{17,46} In-depth interviews conducted in India identified barriers associated with underutilization of tuberculosis services.\textsuperscript{17} Self image, familial and social status, access to intra-family resources, social stigma associated with health issues \textit{viz.} tuberculosis, HIV, reproductive complaints were further reflected in preference of private practitioner or sub-optimally qualified practitioner.\textsuperscript{17,18,46} Thus differential utilization of health care services and a longer patient delay, along with underplaying social stigma are identified in Indian studies examining gender differences.\textsuperscript{17,20,86}

A relatively lesser likelihood of notifying tuberculosis is observed among women in the low-income countries than men.\textsuperscript{17} A preference of private practitioner or sub-optimally qualified practitioners or traditional healer is also reported in various studies conducted in low-income countries.\textsuperscript{87–89} It was also reported that despite a prior knowledge of available diagnostic and free treatment facilities, Nepalese women did not prefer government health providers.\textsuperscript{88} Similar to reports obtained from cultural epidemiological studies conducted in Vietnam\textsuperscript{8} and Bangladesh,\textsuperscript{19,20} a significant proportion of Indian women preferred private
provider services while seeking tuberculosis treatment (63.0 % women versus 51% men, \( P < 0.05 \); \(^{21}\) 80.3% women versus 63.6% men, \( P < 0.05 \))\(^{47}\)). A higher out of pocket expenditure was also reported among Indian women than men, while seeking care (INR 500 versus INR 300, \( P < 0.0010 \)).\(^{21}\)

Evidence from Vietnam suggests a significantly longer mean total delay in accessing treatment among women than men (13.3 weeks versus 11.4 weeks, \( P = 0.02 \)).\(^{90}\) The same study also reported a longer health care provider delay i.e. time lapse between first visit to any health care provider and diagnosis of tuberculosis, among women patients than men (7.7 weeks versus 5.5 weeks, \( P = 0.003 \)).\(^{90}\) Similar results were also reported from studies conducted in Bangladesh, \(^{91}\) Nepal \(^{88}\) and China.\(^{92}\) Although no statistical significance was observed, health care provider delay was slightly higher in Indian women than men (37 days versus 30 days).\(^{21}\) Other evidences suggest an association between marital status (being a house wife) and diagnosis delay among Indian women (\( P = 0.04 \)).\(^{20}\) Longer patient delay i.e. time lapse between onset of symptoms and first visit to health care provider, was observed among Bangladeshi women\(^{91}\) but not amongst Indian women.\(^{21}\) Thus, a complex socio cultural underplay is deciphered in women tuberculosis patients from low income countries.

Studies have reported the association between social stigma and preference of private/sub-optimally qualified health care providers amongst women, thereby being responsible for a longer delay in presentation at the DOTS centres. Various studies highlight the higher perception of stigma due to tuberculosis among women in low income countries.\(^{17,19,47,48}\) A higher stigma index was reported amongst women tuberculosis patients than men in Bangladesh (1.22 versus 0.88) and India (1.28 versus 1.08) in a multicentric study conducted at four sites i.e. Bangladesh, Columbia, Malawi and India.\(^{48}\) Women were more likely to be reluctant to disclose disease status.\(^{17}\) There was lack of self esteem,\(^{20}\) perception of social isolation,\(^{20,93}\) fear of divorce/abandonment by husband/in-laws\(^{48}\) associated with tuberculosis in women. A community based survey conducted in the southern parts of India, reported that more women (21%) than men (14%) faced stigma and inhibitions while discussing their illness with family and friends.\(^{48}\) Women also perceived their presence at social events to be more unwelcome owing to their illness than men (18% versus 12%).\(^{48}\) Fear of loss of spousal support and termination of marriage using tuberculosis as an excuse were reported by Indian women.\(^{94}\) Instances where of representation of the mother of an unmarried female tuberculosis patient as the
patient are also reported, highlighting the stigma associated with tuberculosis. Evidences have also attributed social stigma as the reasons for avoiding supervised regimen by women. Tuberculosis related stigma was more pronounced in women of the South East Asian Region (SEAR) and in the Indian sub continent as compared to that in the Sub Saharan African nations (The Gambia, Nigeria, Malawi). Therefore a complex interplay among the socio cultural determinants affecting tuberculosis outcome was observed in women from low income countries.

There is a paucity of gender segregated behavioural data on tobacco and alcohol consumption, even though an association was observed between mortality due to tuberculosis and smoking tobacco and alcohol consumption. Only an isolated study reported association between smoke-less tobacco use and tuberculosis mortality among women with low BMI (less than 16.0 kg/m²). Studies that investigated the association between tuberculosis mortality and alcoholism or smoking did not include women as asking such questions were considered impolite or number of women with these risks were few.

2.5. Key findings of the review of literature on tuberculosis mortality in women

Thus the key findings of this review identify that there appears to be an increased risk of mortality due to tuberculosis at a lower age in women than men. Although indirect data from India appeared to corroborate this observation, a paucity of age and sex segregated mortality data was observed in the Indian literature. The review also observed that in addition to the clinical, socio-demographic and behavioural risk factors, a complex interplay of socio-cultural factors are associated with tuberculosis and or risk of mortality due to tuberculosis (Section 2.3).

Thus this thesis study explored two questions, viz:

1. Is there an increased mortality in younger women than male tuberculosis patients in India? (Section 4.2 and 4.3)
2. Do risk factors for tuberculosis mortality differ between males and females? (Section 4.4)