Long-term risk of tuberculosis among immigrants in Norway

MG Farah,1,2* HE Meyer,1,2 R Selmer,1 E Heldal1 and G Bjune2

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Background Two-thirds of the tuberculosis (TB) cases in Norway were discovered among immigrants. Some cases were discovered at arrival, but many develop the disease several years post-migration. Knowledge about how long after migration to Norway TB were discovered will enable us to better target preventive measures including preventive therapy. This study examines the long-term risk of TB among immigrants in Norway.

Methods All non-Nordic immigrants who arrived in Norway between 1986 and 2002, as registered by the Norwegian Directorate of Immigration, were followed-up. Their TB status was determined from the National Tuberculosis Registry. Observation period for TB cases was calculated from the date of arrival in Norway to TB registration. For persons without TB, it was calculated from the date of arrival in Norway to the date of emigration from Norway, date of death, or until end of follow-up (December 31, 2002).

Results For immigrants from Africa and Asia, the TB rates were 190 and 80 per 100 000 person-years (PY), respectively, at 7 years post-migration. For immigrants from Somalia, Pakistan, Vietnam, and the former Yugoslavia, the rates were 520, 160, 210, and 40 per 100 000 PY respectively, at 7 years post-migration. These rates were 7 to 90 times higher than the crude TB incidence for Norway. This increased risk applies to both genders, pulmonary and extra-pulmonary sites.

Conclusion These results indicate the need for health personnel to be aware that immigrants remain at high risk of TB many years post-migration. Screening for TB on arrival should be strengthened, and preventive therapy for those with recent TB infection should be considered.

Keywords Immigrants, screening, long-term, tuberculosis, incidence, Norway

In Norway, immigrants constituted 4% of tuberculosis (TB) cases in the mid 1970s and 76% in 2002. In the same period, the proportion of immigrants in the total population increased from 2.4 to 6.9%. In 2002, the TB incidence was 1.4 per 100 000 among those born in Norway and 61.9 per 100 000 among immigrants.1 The incidence of TB is higher among immigrants who come from countries with a high incidence of TB.2 The morbidity of TB among immigrants thus mirrors the TB prevalence in their country of origin.3 DNA fingerprinting of bacterial strains in Norway indicated a low degree of transmission after arrival, implying that most immigrants were infected prior to arrival.4 Several studies have shown that the highest risk of TB occurs during the first few years post-migration.5–8 However, in certain immigrant groups, the risk may remain high for many years post-migration.9–11 A high risk of TB may also persist if immigrants frequently travel back to a high TB prevalence country.12

The control of TB in Norway and most of Europe is generally based on passive case finding supplemented by contact tracing and eventually preventive therapy for recently infected persons.13 Compulsory screening for TB on arrival has also been implemented in Norway, since the mid-1970s, for persons from high prevalence countries who will stay more than 3 months. It includes tuberculin skin test for all age groups. In addition, mass miniature X-ray (MMR) or ordinary chest X-ray is done for those aged 15 and above.14 The aim is to detect persons with TB as soon as possible in order to provide treatment and prevent them from transmitting TB to others.
This screening system has not been entirely effective, particularly for immigrants arriving in Norway for family reunification or work reasons. In 1999 only 50% of new arrivals in Oslo from high prevalence countries attended the screening despite compulsory notification and personal reminders. The participation rates were different across different immigrant groups. For some immigrant groups, the proportion of attendance was only ~25%. This problem of poor attendance participation rates was confirmed by another study investigating TB screening attendance among asylum seekers in 1987–1995.

It is important to assess the TB incidence in immigrants in different countries. This is the first study evaluating the long-term risk of TB among all immigrants coming to Norway. We are not aware of any previous studies that have presented detailed information about dates of immigration, emigration, deaths, and registration of TB, from the whole immigrant population enabling the calculation of long-term incidence rates of TB. We aimed to determine if incidence rates among immigrants decreased towards the level for those born in Norway or if their long-term risk remained high. In addition, the aim was to compare the long-term incidence rates in men and women, as well as for pulmonary and extra-pulmonary TB.

Materials and methods

Study population

For the purpose of this study, an immigrant is defined as a person born in a country other than Norway. Second generation immigrants (i.e. persons born in Norway to two foreign-born parents) and immigrants from the Nordic countries (Sweden, Denmark, Finland, and Iceland) were excluded. All other immigrants including refugees, asylum seekers, and persons immigrating for work or other reasons, were included. Tourists (i.e. persons staying in Norway for <3 months) were excluded. We also excluded all children under the age of five because the Norwegian Directorate of Immigration (UDI) Registry also includes records of many children who were born in Norway to immigrant parents. Since our study was based on risk of TB after arrival, we included only persons aged five and above to exclude children born in Norway to immigrant parents.

TB cases data

A total of 1981 TB cases were reported among immigrants to the National TB Registry during 1986–2002. This is 46% of all cases reported in Norway during that period. Information on date of arrival was available for 1856 (94%) cases. For those with information on date of arrival, only 1553 cases arrived in Norway during 1986–2002. From the 1553 cases, 1514 cases were aged five and above and included in the study. All cases in the National TB Registry are cross-checked in the UDI Registry. No TB cases had negative observation time i.e. persons whose date of arrival in Norway was after the date of emigration from Norway or death. In accordance with the Norwegian guidelines for the prevention and control of TB, an individual who had both pulmonary and extra-pulmonary TB was categorized as a pulmonary TB case.

Immigrant population data

The immigrant population data was collected from the UDI Registry in Norway. According to the UDI Registry, 386 382 immigrants aged five and above arrived in Norway from January 1, 1986 to December 31, 2002. The ascertainment of the immigrant population who arrived in Norway is fairly complete with the exception of possible undocumented persons. There are no data available concerning the undocumented immigrants, but it is estimated that there are ~5000 undocumented immigrants living in Norway (Kaare Vassenden, Statistics Norway, personal communication). The UDI receives information on date of emigration from Norway from the Norwegian police and on date of death from the Norwegian Population Registry. The completeness of the emigration from Norway data is not assessed, whereas the mortality data are nearly complete. There were also 5386 (1.4%) persons who had a negative observation time. These persons constituted 1.4% of the study population and were excluded from the analysis. However, this is more a problem with erroneous data entry in the UDI Registry than a systematic problem. If there was no exact date of arrival at the Registry, we used alternative data from the Registry, which indicated that the person had arrived in Norway (e.g. first date of appearing at the Norwegian Immigration Authority).

Methods

We studied the long-term TB incidence among immigrants coming to Norway by matching retrospectively all non-Nordic immigrants who arrived in Norway between 1986 and 2002 as registered by the UDI and with respect to TB as registered by the National TB Registry.

TB rates (number of TB cases per 100 000 person-years (PY) of observation) are hazard rates and were calculated from standard life table analysis using 1 year time intervals. The life table method takes into account the changing denominator over time. In the life table analysis date of arrival was defined as time 0 for each person. The total number of PY of observation for TB cases, over the whole follow-up, was calculated from date of arrival in Norway to TB registration date at the National TB Registry. For persons without TB, the total number of PY of observation was calculated from date of arrival in Norway to date of emigration from Norway, date of death or the end of follow-up (December 31, 2002).

We calculated TB rates per 100 000 PY for immigrants from different regions of the world. Rates for immigrants from countries with high TB incidence (Somalia, Pakistan, Vietnam, and former Yugoslavia) are presented separately. We also calculated sex specific rates and rates for pulmonary and extra-pulmonary TB for these countries. We first calculated the TB rates for each year in the first 7 years post-immigration. The rest of the follow-up was combined as 8 years or more due to small numbers of cases after the first 7 years. We also calculated the total TB incidence rates for the whole study period. It was calculated by summing the numerators and denominators in the incidence rates over all time intervals separately.

Information on how TB cases were detected was registered and included passive case finding (due to their symptoms), TB screening at entry, follow-up of close contacts of identified infectious cases, and follow-up of previous abnormal MMR. Other cases were registered from other screening programmes. The MMR screening method consisted chest X-ray read independently by two chest physicians who coded the results including calcification in lung or hilum, pleural changes, and
pulmonary changes. If at least one of the readers recommended a follow-up, the film was also read by a referee. 18

Statistical analysis

We used the statistical package SPSS, version 11.0 for analysing our data. To calculate the TB rates, we used the SPSS Survival procedure with Life Tables. Confidence interval (CI) for the TB rates has been included. When testing the overall difference in the rates in men and women, we included sex as a covariate in the Cox regression model for survival analysis. We did both these for the first 3 years of observation and for the whole period of follow-up combined. The test of difference between pulmonary and extra-pulmonary TB rates was based on the rate difference divided by approximate standard deviation (SD) to the difference.17 P-values < 0.05 were considered as significant.

This study received approval from the Royal Ministry of Justice and the Data Inspectorate in Norway.

Results

Of the 1514 TB cases included in this study, the majority came from Africa (mostly from Somalia and Asia (mostly from Pakistan and Vietnam). For cases from Europe, the majority were immigrants from former Yugoslavia (Table 1).

There were 922 cases of pulmonary TB and 592 cases of extra-pulmonary TB. The majority had pulmonary TB with the exception of those from Somalia and Pakistan (Table 1). The most frequent site for extra-pulmonary TB was lymph nodes, especially among those from Africa and Asia.

Median age for TB cases at arrival and at TB registration was 26 years and 29 years, respectively. Of all TB cases 76% were <35 years of age at the time of arrival to Norway and 68% of all cases were <35 years at TB registration. Of the cases 52% were male, while 58% of the immigrants without TB were male.

The median observation period between arrival in Norway and TB registration for all cases was 1.5 years (range: 0–15.4 years). TB cases from Asia had the largest median interval (2.1 years) and Europe (not including Nordic countries) the shortest (0.5 years). Among selected countries, TB cases from Pakistan had the largest interval (2.8 years) and cases from former Yugoslavia the shortest interval (0.6 years) (Table 1).

Among cases from former Yugoslavia, 143 (87%) were diagnosed within the first 5 years post-migration to Norway. Among cases from Somalia, Pakistan, and Vietnam, 341 (79%), 122 (69%), and 128 (78%) of the cases, respectively were diagnosed within the first 5 years post-migration.

TB rates were highest in the first years post-migration (Table 2). The rates declined sharply from the first to the second year post-immigration. Among immigrants from Somalia, there was also a prominent reduction from the second year to the third year. But for most immigrant groups, TB rates were still much higher than the crude TB incidence for Norway even after 7 years post-migration. At 7 years post-migration, the rates ranged from 2 to 91 times the national TB incidence across the different immigrant groups. For immigrants from Somalia, Pakistan, and Vietnam, the rates at 7 years post-migration were 371 times, 114 times, and 150 times higher, respectively, than the TB incidence for those born in Norway.

For immigrants from Somalia and Pakistan, the rates were higher among women than men in the first 3 years post-migration (P = 0.04 for immigrants from Pakistan and P = 0.05 for immigrants from Somalia) (Figure 1). After 3 years there was no significant difference. For all immigrants together and for the total follow-up, women had slightly higher rates (90 per

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Table 1 Characteristics of tuberculosis patients and total number of new immigrants aged five and above from selected countries and world regions registered in Norway, 1986–2002

<table>
<thead>
<tr>
<th>Region</th>
<th>n</th>
<th>TB cases</th>
<th>Median age in years</th>
<th>Median time from arrival to TB registration (range) in years</th>
<th>Total number of new immigrants, 1986–2002</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male (%)</td>
<td>Pulmonary (%)</td>
<td>At arrival</td>
<td>At TB registration</td>
</tr>
<tr>
<td>Europe except Nordic countries</td>
<td>236</td>
<td>58</td>
<td>88</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Former Yugoslavia</td>
<td>164</td>
<td>54</td>
<td>87</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>Other</td>
<td>72</td>
<td>68</td>
<td>90</td>
<td>28</td>
<td>30</td>
</tr>
<tr>
<td>Africa</td>
<td>619</td>
<td>58</td>
<td>51</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>Somalia</td>
<td>430</td>
<td>57</td>
<td>44</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Other</td>
<td>189</td>
<td>61</td>
<td>66</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Asia</td>
<td>642</td>
<td>44</td>
<td>60</td>
<td>27</td>
<td>30</td>
</tr>
<tr>
<td>Pakistan</td>
<td>177</td>
<td>43</td>
<td>48</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>Vietnam</td>
<td>165</td>
<td>47</td>
<td>68</td>
<td>28</td>
<td>32</td>
</tr>
<tr>
<td>Other</td>
<td>300</td>
<td>43</td>
<td>63</td>
<td>27</td>
<td>31</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>17</td>
<td>59</td>
<td>70</td>
<td>27</td>
<td>30</td>
</tr>
</tbody>
</table>

| All immigrants                | 1514| 52       | 61                  | 26        | 29                | 386 382³    |

¹ Nordic countries: Sweden, Denmark, Finland, Norway, and Iceland.
² No TB cases reported for those aged five and above in the study period for the world regions, which are not otherwise in the table.
³ Including immigrants (25 872 persons) from the world regions, which are not otherwise in the table.
The difference was no longer significant when adjusted for age and birth place ($P = 0.2$) (adjusted rate ratio = 1.071; 95% CI 0.965–1.188).

Among immigrants from Pakistan, Vietnam, and former Yugoslavia the pulmonary TB rates were much higher than the rates for extra-pulmonary TB in the first year post-migration ($P < 0.001$) (Figure 2). The decrease in TB rates in the first years post-migration, however, was more pronounced for

### Table 2  Tuberculosis rates (95% CI) per 100 000 PY in Norway among new immigrants aged five and above from selected countries and world regions registered in Norway, 1986–2002

<table>
<thead>
<tr>
<th>Years since arrival</th>
<th>Europe except Nordic countries</th>
<th>Former Yugoslavia</th>
<th>Other</th>
<th>Africa</th>
<th>Somalia</th>
<th>Other</th>
<th>Asia</th>
<th>Pakistan</th>
<th>Vietnam</th>
<th>Other</th>
<th>Latin America and the Caribbean</th>
<th>All immigrants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>90 (70–110)</td>
<td>240 (200–280)</td>
<td>40</td>
<td>790 (690–890)</td>
<td>1540 (1300–1780)</td>
<td>400 (320–480)</td>
<td>280 (240–320)</td>
<td>790 (690–890)</td>
<td>1540 (1300–1780)</td>
<td>400 (320–480)</td>
<td>280 (240–320)</td>
<td>210 (190–230)</td>
</tr>
<tr>
<td>2</td>
<td>20 (10–30)</td>
<td>50 (30–70)</td>
<td>10</td>
<td>430 (350–510)</td>
<td>930 (750–1130)</td>
<td>160 (100–220)</td>
<td>110 (90–130)</td>
<td>220 (160–280)</td>
<td>220 (160–280)</td>
<td>110 (90–130)</td>
<td>70 (50–90)</td>
<td>90 (70–110)</td>
</tr>
<tr>
<td>3</td>
<td>20 (10–30)</td>
<td>50 (30–70)</td>
<td>4</td>
<td>240 (160–320)</td>
<td>410 (250–570)</td>
<td>120 (60–180)</td>
<td>120 (100–140)</td>
<td>180 (120–240)</td>
<td>410 (250–570)</td>
<td>120 (100–140)</td>
<td>70 (50–90)</td>
<td>70 (50–90)</td>
</tr>
<tr>
<td>4</td>
<td>20 (4–20)</td>
<td>60 (20–100)</td>
<td>4</td>
<td>180 (120–240)</td>
<td>480 (280–680)</td>
<td>120 (60–180)</td>
<td>120 (100–140)</td>
<td>150 (90–210)</td>
<td>480 (280–680)</td>
<td>120 (60–180)</td>
<td>70 (50–90)</td>
<td>60 (40–80)</td>
</tr>
<tr>
<td>5</td>
<td>10 (2–20)</td>
<td>40 (0.1–8)</td>
<td>x</td>
<td>150 (110–210)</td>
<td>380 (180–580)</td>
<td>60 (20–100)</td>
<td>60 (40–80)</td>
<td>70 (10–130)</td>
<td>380 (180–580)</td>
<td>60 (40–80)</td>
<td>70 (50–90)</td>
<td>30 (0–60)</td>
</tr>
<tr>
<td>6</td>
<td>10 (2–20)</td>
<td>4 (0.1–8)</td>
<td>x</td>
<td>50 (10–90)</td>
<td>520 (290–760)</td>
<td>70 (10–130)</td>
<td>80 (60–100)</td>
<td>70 (10–130)</td>
<td>520 (290–760)</td>
<td>80 (60–100)</td>
<td>70 (50–90)</td>
<td>40 (20–60)</td>
</tr>
<tr>
<td>7</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
<td>x</td>
<td>50 (10–90)</td>
<td>400 (300–500)</td>
<td>70 (10–130)</td>
<td>80 (60–100)</td>
<td>70 (10–130)</td>
<td>400 (300–500)</td>
<td>80 (60–100)</td>
<td>70 (50–90)</td>
<td>40 (20–60)</td>
</tr>
<tr>
<td>8+</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
<td>x</td>
<td>10 (2–20)</td>
<td>310 (290–330)</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
<td>310 (290–330)</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
<td>10 (2–20)</td>
</tr>
<tr>
<td>Total period</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
<td>x</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
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<td>30 (26–34)</td>
<td>30 (26–34)</td>
<td>30 (26–34)</td>
</tr>
</tbody>
</table>

**a** 8+ years: 8–17 years combined.

**b** Nordic countries: Sweden, Denmark, Finland, Norway, and Iceland.

**c** x: no TB rates due to small numbers after third year post-migration.

**d** Including immigrants (25 872 persons) from the world regions, which are not otherwise in the table.
The remaining cases were discovered through other TB screening programmes.

Discussion

Our study has shown that the risk of TB was high in the first few years post-migration for all immigrant groups. Other studies have reported similar findings.5–8,10 The rates were higher than those reported in the countries of origin.3 The high initial incidence rates may be partly explained by a high detection rate in the obligatory TB screening process at arrival.10 The stress of immigration may also contribute to the high TB rates in the first years post-migration. Physiological and psychological changes that may result from chronic stress on immigration might increase the susceptibility to reactivate TB from a latent infection.19–21

We also found that increased risk of TB among immigrants persists many years post-migration. For immigrants from Somalia, the risk of TB at 7 years post-migration was 520 per 100 000 PY. This is almost 90 times higher than the crude TB incidence in Norway. Immigrants from Pakistan, Vietnam, and former Yugoslavia had also high TB rates many years post-migration. The risk of TB among immigrants mirrors the TB prevalence in their country of origin.3,22 Studies of TB among immigrants in Canada have suggested that previous exposure to TB in the country of origin predicts future risk throughout a person’s life.23,24 But there might be little awareness among health personnel that most immigrants from high prevalence countries remain at high risk of developing TB many years post-migration.

Some studies have shown that women have a higher risk than men of developing TB following infection, especially those in younger age groups.25,26 Maturational and hormonal factors might play a role in the development of TB disease for women.27 But little is known about gender difference in long-term risk of TB. We found that women had slightly higher TB rates than men in most immigrant groups, particularly in the first 3 years post-migration. After that the risk decreased, but remained at high levels for both genders. The median age for TB cases at TB registration in both men and women was 29 years. However, the long-term increased risk in women was no longer significant when adjusted for age and birthplace.

In our study, the risk of extra-pulmonary TB remained high for most immigrants even 7 years post-migration. Many studies have shown high extra-pulmonary rates for immigrants from Africa and Asia.2,28–30 Age distribution could explain some of these observations. It is known that persons at younger age are more susceptible than older persons to TB forms such as lymph node and bone/joint TB.31 From a public health perspective, the high frequency of extra-pulmonary TB has less consequence for the spread of the disease throughout the population as most cases of extra-pulmonary TB are not infectious. However, they could cause a diagnostic challenge for health personnel and could easily be overlooked. They could also enhance the risk of delay in diagnosis with the risk of increased severity and mortality.32,33

The strength of our study was that we followed-up on all immigrants individually with respect to TB, emigration from Norway or death, enabling us to calculate the long-term incidence rates and change in incidence over time for TB.
We have also evaluated incidence rates by gender and TB site. One of the study’s limitations was that we did not include children under the age of five based on the fact that children born in Norway to immigrant parents who are not Norwegian citizen might be included in the UDI Registry. The other limitation was that there was no information on date of arrival for 6% of TB cases and there were missing data (1.4%) in the immigrant population data.

**Implications for TB control**

The first priority for TB control is to identify and treat active TB cases on arrival. Although the screening for TB at arrival is compulsory in Norway, the system of screening has been shown to be not entirely effective.\(^{15,16}\) Other studies from Australia and UK have also shown that only 27 and 60%, respectively, complied with the screening programmes.\(^{34,35}\) In The Netherlands, which has one compulsory screening at arrival followed by voluntary 6-monthly screening during the first 2 years of residence, attendance for screening declined from >95% at entry to <50% in the second year after arrival leading to a reconsideration of the screening policy.\(^{36}\) In our study, although 335 cases were identified through the screening control programme at arrival, it is possible that some of the other cases that were discovered post-migration might have been present but undetected at arrival. This potential delay in diagnosis may possibly have contributed to the high rates in subsequent post-migration years. Strengthening TB screening programmes upon arrival might reduce the number of delayed cases. However, it is not likely that cases that were discovered 6–7 years post-migration would have been present at arrival. Another way to reduce the long-term risk of TB is to use preventive therapy for recent TB infection, especially in cases identified at entrance screening. The value of such therapy, especially with the isoniazid (INH) drug, has been shown in two studies.\(^{37,38}\) But the side effects and the compliance of such therapy need to be closely monitored. For those >35 years of age, the risk of INH induced toxic effects increases significantly.\(^{39}\) Compliance with preventive therapy can also be poor.\(^{40,41}\)

**Conclusion**

The risk of TB among immigrants remains high many years post-migration. There is also an increased rate of extra-pulmonary TB, a diagnosis easy to overlook. It is equally important to suspect TB in women as in men. Screening for TB on arrival should be strengthened, and preventive therapy for those with recent TB infection should be considered.

**Acknowledgements**

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**KEY MESSAGES**

- The risk of TB in many immigrant groups in Norway remained high many years post-migration.
- The increased long-term risk of TB is for both genders as well as for pulmonary and extra-pulmonary TB.
- The diagnosis of extra-pulmonary TB requires high awareness among health personnel.
- It is important to strengthen TB screening for immigrants at arrival.

**References**
