Introduction

The prevalence of diabetes in Western societies is rapidly rising. Currently over 180 million persons worldwide have diabetes and this number is expected to have doubled in the year 2030. Next to a sedentary lifestyle, ethnicity is an important determinant of diabetes. Especially migrants to Western societies have an increased risk of diabetes. This has been clearly demonstrated for African and Asian migrants to the USA or the UK, who have a far higher prevalence of diabetes than the indigenous population. Migrants from Turkey and Morocco are among the largest ethnic minority groups in Europe. Turkish migrants mainly live in Germany, Belgium, the Netherlands, and Austria, while Moroccans largely reside in Belgium, Spain, the Netherlands and France. The largest concentrations of migrants in Europe are found in urban areas. In Amsterdam, the Netherlands, Turkish and Moroccan migrants account for 5.2% and 8.8% of the Amsterdam population against 2.2% and 2.0% of the total Dutch population. The absolute numbers of Turkish and Moroccan migrants in the Netherlands were 373,000 and 417,000, respectively, in 2008. Their numbers are expected to rise in the coming years due to the relatively high immigration figure and their higher birth-rate.

Diabetes may be more prevalent among Turkish and Moroccan migrants, as was concluded from a review by Uitewaal et al. However, recent information on the prevalence of diabetes among Turkish and Moroccan migrants is scarce and sample sizes of previous studies were relatively small. More accurate information on the prevalence of diabetes among ethnic Turkish and Moroccan minorities living in Europe is needed, especially among elderly individuals (≥55 years).

It is still unknown whether differences in demographic variables, such as socioeconomic status and in lifestyle factors, such as obesity and physical activity, can explain the higher prevalence of diabetes among Turkish and Moroccan migrants. More information on the differences in determinants of diabetes between ethnic groups can help to define specific target groups for the prevention of diabetes.

In view of these considerations, we investigated the prevalence of diabetes in Turkish, Moroccan and Dutch individuals living in Amsterdam, the Netherlands. Our sample included a relatively large number of Turkish, Moroccan and Dutch individuals aged ≥55 years. We also investigated whether differences in diabetes prevalence could be explained by differences in demographic and lifestyle factors between ethnic groups.

Methods

Study population

In 2004, a general health survey was conducted in Amsterdam by the Public Health Service of Amsterdam in collaboration with the National Institute for Public Health and the Environment. The study sample was drawn from the municipal population register within five districts in Amsterdam. The combined population of these five districts is representative for the total population of Amsterdam. First, the sample was stratified by ethnicity (Dutch, Turkish, Moroccan) and age (age groups: 18–34, 35–44, 45–54, 55–64, and ≥65 years) to ensure sufficient numbers in each ethnic and age group.
Table 1 Study population by age and ethnicity

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Dutch</th>
<th>Turkish</th>
<th>Moroccan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–34</td>
<td>64</td>
<td>72</td>
<td>47</td>
<td>183</td>
</tr>
<tr>
<td>35–44</td>
<td>96</td>
<td>98</td>
<td>75</td>
<td>269</td>
</tr>
<tr>
<td>45–54</td>
<td>111</td>
<td>96</td>
<td>78</td>
<td>285</td>
</tr>
<tr>
<td>55–64</td>
<td>108</td>
<td>72</td>
<td>71</td>
<td>251</td>
</tr>
<tr>
<td>65–70</td>
<td>38</td>
<td>37</td>
<td>43</td>
<td>118</td>
</tr>
<tr>
<td>Total</td>
<td>417</td>
<td>375</td>
<td>314</td>
<td>1106</td>
</tr>
</tbody>
</table>

Table 2 shows the characteristics of the study population in the three ethnic groups. Response rates did not differ significantly between ethnic groups. Turkish individuals were younger than Dutch individuals, and the Moroccan sample included fewer females than the Dutch sample. Far more Turkish and Moroccan individuals had a low socioeconomic status than Dutch individuals. Both Turkish and Moroccan individuals were less physically active and more overweight and obese compared to Dutch individuals. Glucose and HbA1c levels were less favourable in both Turkish and Moroccan individuals as well.

Diabetes

Table 2 also describes the diabetes prevalence among the three ethnic groups in the Amsterdam population. The prevalence of diabetes in Turkish and Moroccan individuals living in Amsterdam was significantly higher compared to Dutch individuals.

Effect of demographic and lifestyle factors on ethnic differences in diabetes

Table 3 evaluates the differences in demographic and lifestyle factors that may explain the higher prevalence of diabetes in Turks and Moroccans. We used the crude prevalence of diabetes among the three ethnic groups for these analyses. These crude estimates represent the prevalence of diabetes among Dutch, Turkish and Moroccan individuals within the study sample. The crude diabetes prevalence was higher than the estimates in the population of Amsterdam, and the difference between ethnic groups was larger. This is due to the relative oversampling of elderly in the sample, especially among ethnic minority groups.

Demographic factors

When we adjusted the analyses for the demographic variables age, sex and socioeconomic status, the prevalence of diabetes increased in the Dutch and Turkish group, while it decreased in the Moroccan group. This effect was mainly due to the younger age of the Moroccans and the largely lower socioeconomic status among Turks and Moroccans.

Definitions

Classification of diabetes was based on questionnaire data (diagnosed diabetes) and blood levels of non-fasting glucose and HbA1c (undiagnosed diabetes). Diagnosed diabetes was defined as self-reported diabetes and the use of antidiabetic medication (oral hypoglycaemic agents or insulin). Undiagnosed diabetes was defined as no known diabetes, a non-fasting glucose level >11.0 mmol/l and an HbA1c level >6.5%. Ethnicity was based on the self-reported country of birth of the respondent and his/her parents according to the definition of the Dutch Ministry of Internal Affairs. Overweight was defined as a body mass index (BMI) ≥25 kg m⁻² and obesity as a BMI ≥30 kg m⁻². Four categories of educational level were used as a proxy for socioeconomic status: low (up to primary school education), medium low (max. 4 years of secondary education), medium high (>4 years of secondary education or median professional education) and high (higher professional education or university). Physically active was defined as at least half an hour of moderate activity on at least 5 days a week.

Measurements

The health interview covered several aspects of physical and psychological health and was conducted in the respondent’s language of choice (either in Turkish, Moroccan-Arabic, Berber, English or Dutch). The questionnaire used in this interview was translated into Turkish, Arabic and English, and validated by back translation by certified translators. The physical examination was conducted after the health interview, by a trained nurse. Measurements included blood pressure (in duplicate), height, weight and waist and hip circumference (in duplicate). Non-fasting blood samples were collected to determine glucose and HbA1c levels. The samples were processed at the Central Clinical Chemical Laboratory of the Erasmus Medical Centre in Rotterdam, the Netherlands, by use of standard laboratory techniques.

Statistical analyses

First, we compared the prevalence of diabetes between ethnic groups by use of ANOVA. In order to collect sufficient information to provide valid estimates of diabetes prevalence in ethnic groups and at older age, we oversampled ethnic groups and older age groups. To provide information on the diabetes prevalence in the Amsterdam population, we corrected for oversampling and non-response by weighting our study sample for the age and sex distribution of the Dutch, Turkish and Moroccan populations living in Amsterdam. Second, we investigated whether the differences in the prevalence of diabetes in our study sample could be explained by the observed differences in demographic variables such as age, sex and social economic status or by the observed differences in lifestyle factors such as physical activity, BMI and waist-to-hip ratio (WHR) by use of ANCOVA. Third, we investigated the prevalence of diabetes in the three ethnic groups per age group by use of ANOVA. The Dutch group was used as reference group in all analyses. All analyses were performed using SPSS 12.0 for Windows.
Diabetes prevalence in the population of Amsterdam regardless of ethnic group. In all other age groups (35–44, 45–54, 55–64 and 65–70), diabetes occurred more frequently in Moroccan than in Dutch individuals. Diabetes prevalence among Turkish individuals was significantly higher in the age groups 55–64 and 65–70 years. The typical age of onset differed between ethnic groups as well. Twelve percent Moroccans already had diabetes at age 35–44 years, while the Turks reached a similar frequency at age 45–54 years and the Dutch at age 55–64 years. Diabetes prevalence in Moroccans aged 65–70 years reached almost 50%. However, the numbers of individuals in this age-group were relatively small (table 1).

**Discussion**

The key findings of this study show that the prevalence rates of diabetes in Turkish and Moroccan migrants were respectively two and over three times higher than in the indigenous Dutch population. In addition, diabetes occurred at younger ages among Turks and especially Moroccans.

**Table 2 Characteristics of the study population**

<table>
<thead>
<tr>
<th>Demographic variables</th>
<th>Dutch (n = 417)</th>
<th>Turkish (n = 375)</th>
<th>Moroccan (n = 314)</th>
<th>Total (n = 1106)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response rate, %</td>
<td>46</td>
<td>50</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>Age, years</td>
<td>47.7 (12.6)</td>
<td>45.9 (13.2)*</td>
<td>48.4 (13.8)</td>
<td>47.3 (13.2)</td>
</tr>
<tr>
<td>Female sex, %</td>
<td>58</td>
<td>53</td>
<td>46**</td>
<td>53</td>
</tr>
<tr>
<td>Low socioeconomic status, %</td>
<td>15</td>
<td>62**</td>
<td>65**</td>
<td>45</td>
</tr>
</tbody>
</table>

**Lifestyle factors**

Despite the relatively large differences in physical activity between ethnic groups, adjustment for this factor did not materially change the prevalence of diabetes. When we further adjusted the analyses for BMI and WHR, the prevalence of diabetes increased among Dutch individuals, while it decreased among Turkish and Moroccan individuals. The prevalence of diabetes among Dutch individuals remained significantly different from Moroccan individuals, while the observed difference between Dutch and Turkish individuals was no longer significant.

**Diabetes and age**

The prevalence of diabetes was strongly related to age, as is shown in figure 1. Diabetes did not occur before age 35, regardless of ethnic group. In all other age groups (35–44, 45–54, 55–64 and 65–70), diabetes occurred more frequently in Moroccan than in Dutch individuals. Diabetes prevalence among Turkish individuals was significantly higher in the age groups 55–64 and 65–70 years. The typical age of onset differed between ethnic groups as well. Twelve percent Moroccans already had diabetes at age 35–44 years, while the Turks reached a similar frequency at age 45–54 years and the Dutch at age 55–64 years. Diabetes prevalence in Moroccans aged 65–70 years reached almost 50%. However, the numbers of individuals in this age-group were relatively small (table 1).

**Figure 1 The prevalence of diabetes with age in Dutch, Turkish and Moroccan individuals**

*Significant difference as compared to the same Dutch age group. There were no individuals with diabetes <35 years.

**Table 3 The total prevalence of diabetes among Dutch, Turkish and Moroccan individuals adjusted for demographic and lifestyle variables**

<table>
<thead>
<tr>
<th>Prevalence of diabetes</th>
<th>Dutch (n = 417)</th>
<th>Turkish (n = 375)</th>
<th>Moroccan (n = 314)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude</td>
<td>4.1</td>
<td>10.7**</td>
<td>17.8**</td>
</tr>
<tr>
<td>Model 1 adjusted for demographic factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>3.8</td>
<td>11.5**</td>
<td>17.2**</td>
</tr>
<tr>
<td>Age and sex</td>
<td>3.9</td>
<td>11.5**</td>
<td>17.2**</td>
</tr>
<tr>
<td>Age, sex and socioeconomic status</td>
<td>4.7</td>
<td>10.9*</td>
<td>16.6**</td>
</tr>
<tr>
<td>Model 2 additionally adjusted for lifestyle factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical activity</td>
<td>4.8</td>
<td>10.9*</td>
<td>16.6**</td>
</tr>
<tr>
<td>Physical activity and BMI</td>
<td>5.6</td>
<td>10.2</td>
<td>16.2**</td>
</tr>
<tr>
<td>Physical activity, BMI and WHR</td>
<td>6.0</td>
<td>9.9</td>
<td>16.5**</td>
</tr>
</tbody>
</table>

The Dutch group was used as reference group. Model 1 was adjusted for age, sex and socioeconomic status. Model 2 was adjusted for age, sex, socioeconomic status, physical activity, BMI and WHR.

*P<0.05, **P<0.001
Part of the higher prevalence rates of diabetes among Turks and Moroccans could be explained by differences in diabetes risk factors such as low socioeconomic status and obesity between ethnic groups. However, when we accounted for these factors, diabetes still remained more frequent among Moroccan individuals, while the prevalence among Turkish individuals was still higher, but no longer significantly different from the indigenous population. Consequently, the higher prevalence of diabetes among Turkish migrants can in part be explained by their lower socioeconomic status and higher prevalence rate of obesity. These factors could not explain the difference between Moroccan migrants and the indigenous population. The fact that these demographic and lifestyle factors could not explain all of the ethnic differences in diabetes prevalence, indicates that other features such as genetic susceptibility, other endogenous factors or environmental factors may be responsible for the higher frequency of diabetes among Moroccan and Turkish migrants. Several studies have shown that other endogenous factors related to the metabolic syndrome, such as dyslipidaemia and hypertension increase the risk of developing diabetes. In this study measurements of blood pressure, total and HDL cholesterol levels were included and differences in these factors between ethnic groups were in fact shown. These differences might be related to the differences found in diabetes prevalence.

Overweight and obesity (BMI \( \geq 30 \text{ kg m}^{-2} \)) were most prevalent among Turkish individuals, followed by Moroccan and indigenous individuals. Over 70% of the Turks and Moroccans in our study sample were overweight, as compared to 48% in the indigenous population. Obesity was nearly twice as frequent among Turks and Moroccans, >33% were obese as compared to 18% in the indigenous population. Overweight and obesity are the main avoidable risk factors for diabetes, and explained part of the higher frequency of diabetes among Turkish and Moroccan individuals. These results suggest that the prevalence of diabetes among both these ethnic groups may be reduced by interventions that target overweight and obesity.

Diabetes was most frequent among the oldest age groups. Remarkably, our data show that the diabetes frequency typically starts to rise from age 35–44 years in Moroccans, from age 45–54 years in Turks and from age 55–64 in the indigenous population (figure 1). The typical age of onset is thus one to two decades earlier in Turks and Moroccans, respectively, as compared to the indigenous population. Current general practice standards in the Netherlands recommend screening for diabetes in high risk groups >45 years of age. Our findings may suggest that a lower age limit for diabetes screening is needed for individuals of Moroccan descent. Furthermore, the early onset of diabetes increases the lifetime risk for diabetic complications, since diabetes duration is an important determinant of complications. This specific group needs additional attention in diabetes prevention and care.

The higher prevalence rates of diabetes among Turkish and Moroccan migrants as compared to the indigenous population were comparable to those reported by Uitewaal et al. Dijkshoorn et al. also found higher prevalence rates of diabetes among these ethnic groups. However, since their estimates of diabetes prevalence were based on self-reports an exact comparison to our data cannot be made.

The diabetes prevalence rates we found in our study among Turkish and Moroccan migrants are also comparable to those found in studies in Turkey and Morocco. Turkish health surveys in the late 1990s and early 2000s show a prevalence of diabetes of 4.2–7.2%, which is similar to what we found. A Moroccan national health survey from 2000 presents an average prevalence of diabetes of 6.6%, rising to 11.3% in urban areas, which is comparable to what we found. However, Turkish and Moroccan individuals living in Amsterdam are younger than the populations living in Turkey and Morocco. Therefore, the prevalence of diabetes we found among migrants is relatively high. The changes accompanied by migration, such as adaptation to a Western lifestyle, could be responsible for the relatively high prevalence of diabetes. For instance, the prevalence of overweight and obesity, both strong risk factors for diabetes, is much higher among Turks and Moroccans living in Europe than among those living in Turkey and Morocco. Furthermore, many Turkish and Moroccan migrants living in Amsterdam originate from rural areas, and have a low socioeconomic status which increases the risk of diabetes.

This study had several strengths. First, we are the first to present data on the current prevalence of diabetes among two large immigrant groups living in an urban area in Europe. Second, our study had a large sample size stratified for different age groups. As compared to previous studies we included a large number of elderly migrants aged ≥55 years, the most important population at risk for diabetes. Therefore, we were able to present an accurate prevalence of diabetes at higher age among ethnic minority groups. Third, for a general health survey response rates were relatively high among migrants, especially among Turkish individuals, and the response rates were comparable between the three ethnic groups. The overall response rate of 45% is comparable to previous health surveys in the Netherlands. Furthermore, the number of individuals who did not receive an invitation due to incorrect residential data is likely to be high because of the high mobility of the Amsterdam population, which may have negatively affected the response rate. Altogether, we consider the study sample to be representative for the Amsterdam population.

This study has some limitations as well. First, diabetes was diagnosed based on self-report and the use of anti-diabetic medication, while undiagnosed diabetes was based on non-fasting glucose levels and HbA1c instead of using fasting glucose samples. However, within our general health survey it was not possible to collect fasting blood samples or perform an OGTT. We therefore believe that this is the best estimate on diabetes that can be derived from this general health survey. About 10% of the individuals with diabetes were unaware of their condition. This low percentage is probably due to the use of non-fasting instead of fasting blood samples, which can identify about 40% of undiagnosed diabetic individuals. The results presented here are likely an underestimation of the prevalence of diabetes, which may limit our comparability with other studies on the prevalence of diabetes. However, we used the same method to define diabetes in the three ethnic groups. Therefore, our conclusion that diabetes is more prevalent among Turks and Moroccans is not affected. Second, we were not able to discriminate between type 1 and type 2 diabetes. However, only 11 individuals in our study sample (all of Moroccan descent) started using insulin within 6 months after the diagnosis of diabetes, which might indicate that they could have type 1 diabetes. Therefore, most of the individuals with diabetes in our study sample had type 2 diabetes. This also suggests that type 1 diabetes may be more frequent among Moroccans as compared to Turkish and Dutch individuals, as has been observed previously.

In summary, this study highlights that Turks and Moroccans living in Europe have an increased risk of diabetes as compared to the indigenous European population. Part of these differences can be explained by higher rates of obesity among ethnic minorities, and may therefore be avoidable. Furthermore, the typical age of onset of diabetes in both Turks...
and Moroccans is respectively one and two decades younger than in the indigenous population. Since the number of migrants and their age is expected to rise in the future it is of crucial importance to develop interventions targeting ethnic minority groups in order to prevent the development of diabetes.

Conflicts of interest: None declared.

Key points

- We are the first to present data on the current prevalence of diabetes among two large immigrant groups, Turks and Moroccans, living in an urban area in Europe.
- We found a two to three times higher prevalence of diabetes among Turkish and Moroccan migrant groups as compared to the indigenous population.
- We found that a large part of this higher prevalence can be explained by the higher rate of obesity among Turkish and Moroccan migrants.
- As compared to previous studies we included a large number of elderly migrants, between 55 and 70 years, in our study, the most important population at risk for diabetes. Therefore, we were able to present information on the prevalence of diabetes at higher age among ethnic minority groups.
- We found that the typical age of onset of diabetes in both Turks and Moroccans is respectively one and two decades younger than in the indigenous population.

References


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