Ethnic inequalities in patient safety in Dutch hospital care
van Rosse, F.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
Chapter 3

Ethnic inequalities in arthroplasty rates in the Netherlands: a record linkage study.

Floor van Rosse, Ellen Uiters, Susan Picavet, Marie-Louise Essink-Bot, Martine de Bruijne

Submitted
Chapter 3

**ABSTRACT**

**Introduction**

Osteoarthritis (OA) is a major cause of disability in the ageing population. Despite a higher prevalence of OA among ethnic minorities, studies suggested a lower receipt of total joint arthroplasty (TJA). We assessed ethnic inequalities in TJA consumption in a healthcare system characterised by universal access.

**Methods**

We estimated total hip arthroplasty (THA) and total knee arthroplasty (TKA) rates within the general population and within the hospitalised population of Dutch, Turkish, Surinamese and Antillean origin by linking the discharge register to the population register. Stepwise logistic regression analysis was used to calculate the odds ratio (OR) of being admitted for THA or TKA for each ethnic group while adjusting for age, sex, comorbidity and socioeconomic status.

**Results**

We found contrasting consumption patterns for THA and TKA. Dutch patients were more likely to undergo THA than individuals of Turkish (OR 0.27), Surinamese (OR 0.20) or Antillean (OR 0.23) origin. Ethnic minority patients older than 65 were more likely to undergo TKA than the ethnic Dutch population (ORs 1.18-1.83).

**Discussion**

The consumption pattern of TKA was in line with the higher prevalence of OA among ethnic minority groups. However, THA rates were lower in ethnic minority patients despite a higher prevalence of hip OA. Potential explanations for this discrepancy may include lower levels of healthcare seeking with OA symptoms, or less THA advised by orthopaedic surgeons among ethnic minority groups. However, the contrasting patterns of TKA and THA rates remain unexplained and warrant further research.
INTRODUCTION

Osteoarthritis (OA) is a major cause of disability worldwide.[1] In the US, OA affected 33.6% of adults aged 65 years or older in 2005.[2] In the Netherlands, OA prevalence was 53.8 per 1000 men and 88.5 per 1000 women in 2011.[3] Pain and disability caused by advanced OA can be treated with total joint arthroplasty (TJA), mainly total knee arthroplasty (TKA) and total hip arthroplasty (THA). Recent decades have seen an increase in TJA consumption to treat OA. In the Netherlands, treatment of OA with TKA and THA increased by 196% and 53%, respectively, between 1995 and 2005, and the number of TJAs is expected to steadily increase until 2030.[4] Reasons for the increase may include increasing quality and availability of TJA, ageing of the population, and more and older patients becoming eligible for TJA due to improved techniques.[4]

During patient inclusion for a cohort study on different wards in four different hospitals in the Netherlands, we observed an underrepresentation of ethnic minority patients at orthopaedic surgery wards compared to other wards, especially among the patients who were admitted for THA or TKA.[5] This observation surprised us since OA prevalence is not lower among ethnic minority groups. Ethnicity-specific disability-adjusted life years (DALY) estimations showed that OA is among the leading causes of DALYs for all female ethnic minority groups living in the Netherlands, and that the burden of OA is higher for ethnic minority groups than for ethnic Dutch persons.[6] National reports showed that 34% of the Dutch population older than 55 reported joint symptoms, while this was up to 56% for the main ethnic minority groups living in the Netherlands.[7]

Internationally, ethnic inequalities in TJA have been reported.[8-14] Potential explanations include factors such as ethnic inequalities in (financial) healthcare access, patient factors like health literacy and preferences, and healthcare provider factors like ethnic inequalities in TJA recommendations.[8-16] Most studies were carried out in the US, a country lacking universal healthcare access. Little or no research has been done on ethnic inequalities on treatment of OA by TJA across ethnic groups in countries with healthcare systems characterised by universal access like the Netherlands.

Background information on TJA consumption pathway

The care pathway for TJA includes several actions and decisions on the part of the care providers and the patient, which we described in a model following Levesque’s model of access to healthcare.[17] (Figure 1) First, the patient must experience OA symptoms and seek healthcare. In the Netherlands, the general practitioner (GP) is the point of entry to the healthcare system and the gate-keeper for referral to the medical specialist. National GP practice guidelines advise early treatment options including painkillers and physiotherapy in the case of mild symptoms.[18] Where more severe symptoms occur such as disability and severe pain, the patient is referred to an orthopaedic surgeon, whose recommendation on
TJA is based on national guidelines.[19] An X-ray combined with the patient’s symptoms and other patient-related factors like comorbidity and age play a role in the healthcare providers’ recommendation. Based on personal risk-benefit considerations, the patient and physician take a shared decision regarding whether or not to proceed to surgery.

In the study period (1995-2005), all patients had universal healthcare access covered by a national insurance system, and healthcare insurance completely covered the costs of TJA for each patient. Additionally, geographical distances to GPs and hospitals are generally small, since the Netherlands is a densely populated country. Consequently, we have assumed that geographical and financial barriers to healthcare were negligible for the current study.

**Objectives**

We explored inequalities in THA and TKA rates among ethnic Dutch and ethnic minority groups in a healthcare system characterised by universal access. Following the international literature, we hypothesised lower THA and TJA consumption among ethnic minorities despite the higher burden of OA.
METHODS

We used two different approaches to investigate ethnic inequalities in TJA. First, we estimated the proportion of adults undergoing THA and TKA in the general population for different ethnic groups living in the Netherlands. Second, we analysed the proportion of adults undergoing THA and TKA for different ethnic groups in the hospitalised population. In this second analysis we used logistic regression techniques to analyse the potential contribution of explanatory variables (age, sex, socio-economic status (SES), and comorbidity) to the inequalities in THA and TKA between ethnic minority patients and ethnic Dutch patients.

Data collection

We constructed a cohort of patients hospitalised in all Dutch hospitals between 1 January 1995 and 31 December 2005 by probabilistic linking of the national hospital discharge register (HDR), the Dutch population register (PR), and socio-economic data from Statistics Netherlands. This linked database was also used for a study on ethnic variations in readmissions and length of hospital stay. Linkage of these databases was in accordance with privacy regulations. The HDR is a database on admissions, not individuals, where data are coded by professionals based on patient records. The PR was used to assess ethnic background. Ethnic groups were classified according to country of birth and the country of birth of the parents, in accordance with the Statistics Netherlands definition. Linking variables were sex, date of birth and four digits of the postal code. Unique linking of the databases with these linking variables has been reported to be successful in 87.6% of cases. Successful linkage percentages differ by ethnic origin (details on linkage percentages and reasons for unsuccessful linkage are described in Appendix 1). We restricted our dataset to the period 1995-2005 for three reasons. First, after 2005, registration of surgical procedures in the HDR was no longer compulsory, and thus incomplete. Second, the period 1995-2005 was a stable period regarding the Dutch healthcare system. After 2005, insurance rules changed in the Netherlands, meaning this study period reflected universal access to TJA. Third, specialised private hospitals were not included in the database, and from 2005 onwards, TJA's carried out in specialised private hospitals increased. In 2007, 2% of THAs and 5% of TKAs nationally were carried out in specialised private hospitals which increased to 3% and 8% respectively in the five years up to 2012.

Outcome measure

Of all uniquely linked hospital admissions, we identified all patients who had OA as primary diagnosis and underwent a THA or TKA as principle intervention. Intervention codes 58145 and 58150 as defined by Dutch Hospital Data represent THA and TKA. To define OA cases we used the International Shortlist for Hospital Morbidity Tabulation (ISMHT) codes 1301 and 1302 representing ‘arthrosis of the hip’ and ‘arthrosis of the knee’.
Other variables

Other variables obtained from the HDR were age, sex, comorbidity and type of insurance and neighbourhood as proxies for SES. Comorbidity was assessed by the Charlson Index, based on the secondary diagnoses registered for each admission in the HDR.[28]

All individuals living in the Netherlands had a social or private healthcare insurance (income above the threshold for social insurance) and both types gave access to identical healthcare facilities. To estimate SES, information on the SES of the neighbourhood of residence was derived from the Social and Cultural Planning Office of the Netherlands. For the years 1994, 1998, 2002 and 2006, the social status of all neighbourhoods in the Netherlands was computed based on education, unemployment and income.[29]

Inclusion and exclusion criteria

We included patients aged between 45 and 80 years old, since TKA and particularly THA are seldom applied in patients younger than 45. We included four ethnic groups living in the Netherlands: Dutch, Turkish, Surinamese and Antillean patients. The Moroccan population was excluded because the numbers of Moroccan TJA patients were too small due to low percentages of unique linkages as a result of imprecise birth dates (e.g. only 32% within men 60-74 years of age). Appendix 1 provides insight into the various ethnic groups living in the Netherlands.

Data analysis

First, we estimated TJA rates in the general population, per 1000 persons living in the Netherlands by ethnic group. We took the year 2000 as reference year. We obtained numbers of the total population of ethnic groups from Statistics Netherlands.[30] Since the data linkage for ethnic minority groups is less optimal than for ethnic Dutch patients, we computed an adjusted TJA rate per 1000 persons based on the specific unique linkage percentages per ethnic group, which varied from 79% to 95%. Appendix 1 contains exact linkage percentages by ethnic group. (Appendix 1)

Second, we analysed the hospitalised population from 1995 to 2005. Descriptive statistics of all hospitalisations of patients who had OA as primary diagnosis and underwent a THA or TKA as principle intervention were calculated for each ethnic group, using SPSS 20.0. We compared the number of patients that had a TJA for OA to the total hospitalised population for each ethnic group and assessed the odds of having a THA or TKA compared to Dutch hospitalised patients for different ethnic groups, using stepwise logistic regression analysis. In the crude model, only ethnic group was taken into account. In the adjusted models, age, sex, comorbidity and socio-economic indicators were added stepwise. The associations between these factors and THA or TKA were assessed by Odds Ratios (ORs) with 95% confidence intervals (95% CI). Because there was an interaction between age and outcome in the TKA analysis, we used two age strata for TKA: 45 to 65 years of age, and 66 to 80 years of age.

For the logistic regression analysis we needed to reduce our dataset because of the large sample size of Dutch patients and the technical limitations of the software. Therefore,
Statistics Netherlands provided us with a random sample of ethnic Dutch admissions to achieve roughly the same size as the other largest ethnic groups. We verified that the random sample was representative for the total Dutch hospitalised population regarding age, sex, diagnosis, intervention and hospital of admission.
RESULTS

The results for THA and TKA are presented separately. For each one, we first present the adjusted and unadjusted TJA rate per 1000 persons within the general population, followed by the analyses within the hospitalised population.

THA

In the general population, the rate of THA operations was highest among Dutch patients. The rate increased with age for all ethnic groups, with the most pronounced increase among the Dutch population. Females of all ethnic groups had higher THA rates than men (Figure 2). Results in the hospitalised population from 1995-2005 showed the same pattern. THA rates were higher among Dutch patients (1.4%) than among all ethnic minority groups (0.2%) (Table 1). Logistic regression analysis within the hospitalised population showed that all ethnic minority groups were less likely to be admitted for a THA than the Dutch population. Adjustment for age, sex, comorbidity and SES attenuated the difference but it remained statistically significant. The OR after maximal adjustments varied from 0.20 (95%CI 0.17-0.23) for Surinamese patients to 0.27 (95%CI 0.23-0.32) for Turkish patients (Table 2).

TKA

In the general population the rate of TKA was similar for all ethnic groups and increased with age, except for Antillean/Aruban females, who had higher rates than other ethnic groups (Figure 3). Results in the hospitalised population from 1995-2005 showed that TKA rates were quite similar for all ethnic groups with the lowest rate among Turkish patients (0.5%) and the highest among Antillean patients (0.8%) (Table 1). In the hospitalised population younger than 65, ORs for TKA for Surinamese and Turkish patients did not differ from ethnic Dutch patients, but Antillean patients had a higher OR (1.51, 95%CI(1.21-1.89) after adjustments for age, sex, comorbidity and sex). In patients aged 65 or older, all ethnic minority groups had higher ORs than ethnic Dutch patients. Antillean patients had the highest OR compared to ethnic Dutch patients(OR 1.83, 95%CI(1.49-2.25) after complete adjustments) (Table 3).
DISCUSSION

We explored inequalities in THA and TKA rates among ethnic Dutch and ethnic minority groups in a healthcare system characterised by universal access. We hypothesised lower rates of THA and TKA despite the higher burden of OA in ethnic minorities based on our observations and findings in international literature. Our hypothesis was confirmed for THA, since ethnic minorities were up to five times less likely to be admitted for THA than ethnic Dutch patients. For TKA, our results showed the opposite, especially in patients older than 65, where ethnic minority patients were up to two times more likely to undergo TKA.

Several factors may contribute to these contradictory findings. The higher consumption of TKA among ethnic minorities is in line with the higher burden and prevalence of knee OA among ethnic minorities, but in contrast with some international studies. For example, Byrne et al. found that blacks were less likely to choose TKA than whites,[13] and Allen et al. found that African-Americans were less willing to undergo TJA than whites.[31] Two other studies found that ethnic minorities underwent fewer TKA than the majority population.[9,10] Perhaps ethnic inequalities in access to healthcare explain these differences between countries, which we would not expect in the Netherlands because of the universal access system.(Figure 1)

The less frequent receipt of THA among ethnic minority groups may reflect underuse in this group or overuse in ethnic Dutch patients. There is no ‘golden standard’ for THA consumption but persons with equal needs and comorbidity should have the same chance to undergo THA.[32] Future research should identify the phase of the path from symptoms to surgery (Figure 1) in which ethnic minorities with hip OA might lack access or whether there is ethnic variation in indicating THA by orthopaedic surgeons. Several causes may be present in the access process. In the first phase, ethnic minorities with hip OA might not seek healthcare with their symptoms. Competing diseases could be the cause of less healthcare-seeking with OA symptoms. But barriers could also be present in the GP- and outpatient phases, for instance due to lack of language proficiency, low health literacy, or perceived cultural distance to the Dutch healthcare system. Similar barriers were also found in several international studies.[11,13] In our study, Turkish patients – the only group for whom a language barrier might be expected – had higher ORs for THA than Surinamese and Antillean patients. Therefore, we speculate that health literacy is a more important predictor for THA receipt than language proficiency. Since THA is a more invasive and difficult surgery than TKA, it might be that orthopaedic surgeons only chose surgery in patients of whom they are absolutely sure that they understood the procedure and the risks, and were less likely to recommend surgery to patients with low health literacy. A systematic review of determinants of demand for THA and TKA showed that “the demand is driven by patients’ willingness to undergo surgery. In turn, patients’ willingness is determined by their knowledge about the technology and their expectations about the outcomes of the procedure, and by local or regional idiosyncratic surgical decision making practice”.[16]
Another, completely different, possible explanation for the lower receipt of THA among the Turkish, is that Turkish patients tend to use healthcare in their host country. It is therefore possible that they received their THAs in Turkey.[33]

**Strengths/limitations**

The strength of this study is the large dataset with robust data. Moreover, linkage of databases enabled us to make valid distinctions by country of birth.

A limitation for the interpretation of the present findings is the lack of data on the pre-surgery phase of patients with OA. Data on GP referrals for OA are available in other datasets, but because distinction between different ethnic groups was not possible we could not use these data in this study. Furthermore, robust data on patients that do not visit their GP with OA symptoms or the number of OA patients who were not referred by their GP, or the number of patients that did not choose to undergo TJA while recommended by the orthopaedic surgeon to do so would have enriched our study.

Two methodological limitations might have affected our results. First, we were not sure whether all secondary diagnoses – and thus comorbidity – were correctly and adequately reported because we used registry data. However, we assume that potential under-registration of comorbid conditions affected all ethnic groups equally, and thus differences between groups would remain the same. Secondly, only public hospitals were included in our dataset. We might therefore have missed some TJAs carried out in private hospitals. We believe that between 1995-2005 the number of TJAs outside regular hospitals was small or negligible.

**Implications – future research**

This study showed ethnic inequalities in THA consumption, but not in TKA. The contrasting consumption patterns by ethnic origin between THA and TKA is a topic for further research. In particular, future research should focus on the discrepancy between hip OA and THA consumption patterns of ethnic minority groups. Studies should identify whether THA is equally accessible for all ethnic groups, and focus on determinants that relate to THA consumption such as patient preferences and health literacy. Other phases of the pathway from joint complaints to TJA (figure 1) should be investigated, such as ethnic inequalities in GP referrals to orthopaedic surgeons, provision of appropriate information to the patient and shared decision making by the orthopaedic surgeon and patient following the Salzburg declaration.[34]

**Implications – practice**

Our findings may raise awareness of GPs and orthopaedic surgeons of ethnic inequalities in TJA consumption and of the potential causes. Even in a universal access healthcare system, access inequalities to THA might exist. Guidelines and patient information could be made (more) sensitive to all ethnic groups living in the Netherlands.
CONCLUSION

This explorative study shows that the consumption pattern of TKA among ethnic minority groups is in concordance with the estimated burden of knee OA, while hip THA is carried out up to 5 times more frequently in ethnic Dutch patients despite a higher burden of hip OA in ethnic minority groups and universal access to healthcare. Future studies, focusing on interaction between patients and doctors, may help to identify the causes and find solutions for this inequality.
The conceptual model was inspired by Levesque’s model of access to healthcare, [17] and specifically adapted to TJA. It was built around the four locations of the TJA care chain (home-GP-outpatient clinic-OR) On the left-hand side, patient-related factors are specified, while on the right side, care(provider) factors are listed. Concepts within one box can also relate to each other (e.g. someone’s trust in care providers can influence their willingness to seek care, or their health literacy can influence their ability to seek care).

**Figure 1** Conceptual model
Figure 2 Adjusted THA rates per 1000 persons in the *general population* for different age groups for Dutch (D), Turkish (T), Surinamese (S), Antillean/Aruban (A) males and females. *2000 = reference year*

Table 1 Rates of THA and TKA for OA within the total of hospitalised patients of the same ethnic group in the Netherlands among 45-80-year-olds (1995-2005)

<table>
<thead>
<tr>
<th></th>
<th>Dutch*</th>
<th>Turkish</th>
<th>Surinamese</th>
<th>Antillean/Aruban</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total admissions</strong></td>
<td>181155*</td>
<td>67324</td>
<td>111022</td>
<td>26146</td>
</tr>
<tr>
<td><strong>Total admissions for THA with OA as primary diagnosis</strong></td>
<td>2459*</td>
<td>146</td>
<td>239</td>
<td>62</td>
</tr>
<tr>
<td>% THA/total admissions</td>
<td>1.4%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>Total admissions for TKA with OA as primary diagnosis</strong></td>
<td>1261*</td>
<td>320</td>
<td>648</td>
<td>212</td>
</tr>
<tr>
<td>% TKA/total admissions</td>
<td>0.7%</td>
<td>0.5%</td>
<td>0.6%</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

*A random sample of Dutch patients was used.*
Table 2 Logistic regression analysis of THA among ethnic groups, stepwise adjusted for age and sex, comorbidity, and SES.

<table>
<thead>
<tr>
<th>Ethnic background (reference: ethnic Dutch patients)</th>
<th>Step 1 Ethnic background Odds ratio (95% CI)</th>
<th>Step 2 + Age Odds ratio (95% CI)</th>
<th>Step 3 + Sex Odds ratio (95% CI)</th>
<th>Step 4 + comorbidity Odds ratio (95% CI)</th>
<th>Step 5 + SES Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkish</td>
<td>0.16 (0.13-0.19)</td>
<td>0.22 (0.19-0.26)</td>
<td>0.24 (0.20-0.29)</td>
<td>0.23 (0.19-0.27)</td>
<td>0.27 (0.23-0.32)</td>
</tr>
<tr>
<td>Surinamese</td>
<td>0.15 (0.13-0.18)</td>
<td>0.19 (0.17-0.22)</td>
<td>0.18 (0.16-0.21)</td>
<td>0.18 (0.16-0.20)</td>
<td>0.20 (0.17-0.23)</td>
</tr>
<tr>
<td>Antillean</td>
<td>0.17 (0.13-0.22)</td>
<td>0.23 (0.18-0.30)</td>
<td>0.22 (0.17-0.28)</td>
<td>0.22 (0.17-0.28)</td>
<td>0.23 (0.18-0.30)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>1.04 (1.03-1.05)</td>
<td>1.04 (1.03-1.05)</td>
<td>1.04 (1.04-1.05)</td>
<td>1.05 (1.04-1.05)</td>
</tr>
<tr>
<td>Sex (Ref: male)</td>
<td></td>
<td>2.41 (2.23-2.62)</td>
<td>2.34 (2.16-2.53)</td>
<td>2.39 (2.20-2.59)</td>
<td></td>
</tr>
<tr>
<td>Comorbidity * (Ref: no comorbidity)</td>
<td></td>
<td>0.01 (0.01-0.03)</td>
<td>0.01 (0.01-0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES – cat 2 (ref: Cat 1)</td>
<td></td>
<td>0.89 (0.82-0.96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES – cat 3 (lowest SES)</td>
<td></td>
<td>0.71 (0.62-0.82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td>1.26 (1.16-1.37)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significant ORs (p < 0.05) are in boldface type

* Comorbidity was added as a dichotomous variable. Charlson scores 0 and 1 (no or little comorbidity) were grouped into the reference category (0), scores 2 and higher (significant comorbidity) were grouped into “1”.
Figure 3 Adjusted TKA rates per 1000 persons in the general population for different age groups for Dutch (D), Turkish (T), Surinamese (S), Antillean/Aruban (A) males and females.

* 2000 = reference year
Table 3 Logistic regression analysis of TKA among ethnic groups, stepwise adjusted for age and sex, comorbidity, and SES, in two strata: Patients aged 45-65 and patients aged 66-80.

<table>
<thead>
<tr>
<th>Ethnic origin (reference: ethnic Dutch patients)</th>
<th>Step 1 Ethnic background Odds ratio (95% CI)</th>
<th>Step 2 + Age Odds ratio (95% CI)</th>
<th>Step 3 + Sex Odds ratio (95% CI)</th>
<th>Step 4 + comorbidity Odds ratio (95% CI)</th>
<th>Step 5 + SES Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age 45-65</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkish</td>
<td>0.85 (0.72-1.02)</td>
<td>0.91 (0.77-1.09)</td>
<td>1.05 (0.88-1.25)</td>
<td>0.99 (0.83-1.18)</td>
<td>0.96 (0.80-1.67)</td>
</tr>
<tr>
<td>Surinamese</td>
<td>0.85 (0.73-1.00)</td>
<td>1.00 (0.85-1.17)</td>
<td>0.99 (0.84-1.16)</td>
<td>0.96 (0.81-1.12)</td>
<td>0.96 (0.81-1.14)</td>
</tr>
<tr>
<td><strong>Age 66-80</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antillean</td>
<td>1.27 (1.02-1.58)</td>
<td>1.58 (1.27-1.97)</td>
<td>1.52 (1.22-1.90)</td>
<td>1.52 (1.22-1.89)</td>
<td>1.51 (1.21-1.89)</td>
</tr>
<tr>
<td>Turkish</td>
<td>1.14 (0.95-1.38)</td>
<td>1.27 (1.05-1.55)</td>
<td>1.53 (1.26-1.86)</td>
<td>1.48 (1.21-1.79)</td>
<td>1.57 (1.29-1.92)</td>
</tr>
<tr>
<td>Surinamese</td>
<td>1.19 (1.05-1.34)</td>
<td>1.23 (1.09-1.39)</td>
<td>1.10 (0.98-1.24)</td>
<td>1.10 (0.97-1.24)</td>
<td>1.18 (1.03-1.34)</td>
</tr>
<tr>
<td>Antillean</td>
<td>1.97 (1.61-2.41)</td>
<td>2.07 (1.69-2.54)</td>
<td>1.76 (1.43-2.16)</td>
<td>1.77 (1.44-2.17)</td>
<td>1.83 (1.49-2.25)</td>
</tr>
</tbody>
</table>

Significant ORs (p < 0.05) are in boldface type
APPENDIX 1

Unique linkage percentages per ethnic group in year 2000
Description of reasons for unsuccessful linkage
Background information on ethnic groups living in the Netherlands

Percentages of unique linkages in year 2000 for ethnic groups within different age groups.

<table>
<thead>
<tr>
<th>Age</th>
<th>Dutch</th>
<th>Turkish</th>
<th>Surinamese</th>
<th>Antillean/Aruban</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-59</td>
<td>86%</td>
<td>79%</td>
<td>81%</td>
<td>81%</td>
</tr>
<tr>
<td>60-74</td>
<td>91%</td>
<td>84%</td>
<td>91%</td>
<td>89%</td>
</tr>
<tr>
<td>75+</td>
<td>95%</td>
<td>93%</td>
<td>95%</td>
<td>93%</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45-59</td>
<td>86%</td>
<td>79%</td>
<td>83%</td>
<td>82%</td>
</tr>
<tr>
<td>60-74</td>
<td>90%</td>
<td>82%</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>75+</td>
<td>92%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

**Linkage percentages used for analyses**

Since age groups of the linkage table are not the same as the age groups of our analysis, we used the correct linkage percentage of age group 45-59 to calculate adjusted rates in our age groups 45-55 and 55-64, and the linkage percentage of age group 60-75 to calculate adjusted rates in our 65-80 age group. The source reference distinguishes between first- and second-generation persons within ethnic minority groups, and because our sample has hardly any 2nd generation persons, we used first-generation linkage percentages.

**Reasons for ethnic differences in correct linkages**

Linkage of the HDR and PR can be unsuccessful when two people have the same date of birth and the same 4-digit postal code, or in persons who often move and thus change postal codes frequently, like students. The dates of birth of some first-generation migrants of Turkish and Moroccan ethnic origin are according to a non-Gregorian calendar. When the PR converts their date of birth to the Gregorian calendar, usually the 1st of January or the 1st of July are chosen (born in winter vs. born in summer). This results in many persons with the
same date of birth. When two persons with the same date of birth and the same sex also live in the same neighbourhood and thus have the same postal code, they cannot be linked.

**Background information on ethnic groups living in the Netherlands**

The main non-European ethnic groups in the Dutch population (16 million inhabitants in 2005) include Surinamese (329,430 persons in 2005), Antilleans/Arubans (130,538 persons in 2005), Turkish (358,846 persons in 2005), and Moroccans (315,821 persons in 2005). Suriname (Dutch Guyana) is a former Dutch colony. Most Surinamese people speak Dutch. The Surinamese population is ethnically diverse, and consists mainly of people who originate from West Africa and South Asia, and those of mixed origin. From 1975 onwards, many Surinamese people moved to the Netherlands with their families, including both younger and older individuals. The Antillean and Aruban population (the islands are also former colonies) is predominately of West African, European, and mixed origin, and migration to the Netherlands has been relatively stable over time. Most Antilleans speak Dutch. Many Antillean migrants moved to the Netherlands in the 1980s and 1990s to work and study. Turkish and Moroccan men came to the Netherlands as labour migrants in the 1960s and 1970s and were later followed by their families. Neither of these two groups originally spoke Dutch.
REFERENCES


2) http://www.cdc.gov/arthritis/basics/osteoarthritis.htm


19) www.cbo.nl/thema/Richtlijnen/Overzicht-richtlijnen/Bewegingsapparaat (in Dutch)


24) http://www.lroi.nl/nl/publicaties/jaarrapportage (In Dutch)


26) http://www.dutchhospitaldata.nl/codebeheer/verrichtingen (In Dutch)

27) http://apps.who.int/classifications/apps/icd/implementation/hospitaldischarge.htm


30) http://statline.cbs.nl/statweb/ (In Dutch)


33) Nielsen SS, Yazici S, Petersen SG, Blaakilde AL, Krasnik A. Use of cross-border healthcare services among ethnic Danes, Turkish immigrants and Turkish descendants in Denmark: a combined survey and registry study. BMC Health Serv Res. 2012 Nov 13;12:390.