The various colours of type 2 diabetes: Pathogenesis and epidemiology in different ethnic groups
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The association of physical inactivity with type 2 diabetes among different ethnic groups.

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Abstract

Background
To study differences in the association between physical inactivity and type 2 diabetes among subjects from different ethnic groups.

Methods
We analysed data on 508 Caucasian, 596 African-Surinamese and 339 Hindustani-Surinamese participants, aged 35-60 years, in the population-based, cross-sectional SUNSET study. Physical inactivity was defined as the lowest quartile of reported activity, measured with the validated ‘Short-Questionnaire-to-Assess-Health-enhancing-Physical-Activity’. Type 2 diabetes was defined as fasting plasma glucose levels ≥7.0 mmol/l or self-reported diagnosis.

Results
Physical inactivity was associated with type 2 diabetes (OR 1.63, 95%CI 1.12-2.38) in the total group after adjustment for sex, age, BMI, ethnicity, resting heart rate, hypertension, smoking, history of cardiovascular disease, having a first-degree relative with type 2 diabetes and educational level. However, this association was only significant in Caucasians (OR 3.17, 95%CI 1.37-7.30). Moreover, it appeared stronger in Caucasians than in Hindustani-Surinamese (OR 1.43, 95%CI 0.78-2.63) and African-Surinamese (OR 1.13, 95%CI 0.58-2.19), although p-value for interaction was not significant.

Conclusions
Physical inactivity was associated with type 2 diabetes in the total group after adjustment for multiple risk factors, but this association was only significant in Caucasians. Also, it appeared stronger in Caucasians than in Hindustani and African-Surinamese, but formal testing for interaction provided no further evidence. These findings confirm the importance of exercise, but suggest that potential health gain may differ between ethnic groups. It should be noted though, that -in general- promotion of physical activity in populations with an increased a-priori risk of type 2 diabetes, remains of the utmost importance.
Introduction

In several studies that have shown an independent relationship between physical inactivity and type 2 diabetes, the focus has mainly been on Caucasians (1-3). It is well-known that the prevalence of type 2 diabetes varies among ethnic groups (4-7). Also, level of physical activity differs between ethnic groups; it has been reported that South-Asians in particular are less physically active than Caucasians in the UK (8-10). Our aim was to study differences in the association between physical inactivity and type 2 diabetes among individuals of South-Asian, African and European origin.

Patients and methods

Study population

The study population consisted of participants in the SUNSET study (Surinamese-in-the-Netherlands-Study-on-health-and-Ethnicity). Around 1975, almost half the population of the former Dutch colony Surinam migrated to the Netherlands. It is estimated that approximately 36% of these immigrants were Hindustani-Surinamese (originally from the Indian subcontinent) and 41% African-Surinamese (predominantly of African origin) (11). Currently, approximately 340,000 Surinamese are living in the Netherlands (12).

The study was based on a random sample of 35-60 year old, non-institutionalized people in Amsterdam, as previously described (13). Ethnicity was classified based on self-identification. In the present study, we included 339 Hindustani-Surinamese, 596 African-Surinamese and 508 Dutch-Caucasians who completed an interview and underwent a medical examination. All participants signed an informed-consent form. The Medical-Ethical-Committee of the Amsterdam Academic Medical Centre approved the study protocols.

Measurements

Type 2 diabetes was defined as fasting glucose≥7.0 mmol/l (HK/Glucose-6-P-dehydrogenase test; Roche-Diagnostics) and/or self-reported type 2 diabetes, excluding gestational diabetes. Blood pressure and resting heart rate measurements were obtained using an OMRON-M4-semi-automatic sphygmomanometer. Hypertension was defined as a systolic blood pressure≥140 mmHg, or diastolic blood pressure≥90 mmHg, or being on antihypertensive therapy. Educational level was determined by the highest education achieved and was grouped as: secondary school and below i.e.≤12 years of education (low), and vocational school and above i.e.≥13 years of education (high). Educational level has proven to be the best indicator of socio-economic status in the Netherlands (14). Physical activity level was measured using the ‘Short-Questionnaire-to Assess-Health-enhancing-Physical-Activity’ (SQUASH), which has been validated for the Dutch population and requires participants to...
recall their habitual physical activity in an average week from the past few months (15). It covers physical activity for four ‘domains’: commuting, occupational/school related, household, and leisure-time. For the purpose of this study, we also took into account other types of activity (such as yoga and dancing), because these activities are considered habitual in the study population. Participants were asked to indicate the frequency, self-reported intensity (light, moderate, vigorous) and average duration of the activity per day for each domain. The SQUASH was not translated or simplified, as the Surinamese population in the Netherlands has good understanding of the Dutch language and most participants had lived in the Netherlands for more than 20 years. In order to minimise interpretation problems, the questionnaire was interviewer-administered. Furthermore, interviewers were matched by ethnicity.

A total physical activity score was calculated based on type of activity, frequency, duration, self-reported intensity and age. We classified participants in quartiles of the calculated physical activity score. The lowest quartile was defined as ‘physical inactivity’.

**Statistical analysis**

Baseline data were expressed as percentages, means and standard deviations (SD) or medians and interquartile-range (IQR). Differences were determined using Chi-squared, one-way-ANOVA or Kruskal-Wallis tests. We calculated odds ratios (OR) with corresponding 95% confidence-intervals (95%CI) for the association between physical inactivity and type 2 diabetes, stratified by ethnicity. We adjusted for sex, age, obesity, resting heart rate, first-degree relative with type 2 diabetes, hypertension and history of cardiovascular disease, as these factors were previously associated with type 2 diabetes in the SUNSET study (13). We also took into account smoking and education-level, as these factors are known to be associated with type 2 diabetes (16,17). Subsequently, we tested formally for (multiplicative) interaction between physical inactivity and ethnicity. After adjusting for BMI as an indicator of obesity first, we adjusted for waist circumference in a second analysis. P-values<0.05 were considered statistically significant. All analyses were performed using SPSS 16.0 (Illinois, USA).

**Results**

Caucasians were older than Hindustani-Surinamese and African-Surinamese (47.8, 44.7 and 43.7 years, p<0.05) (Table 1). Hindustani-Surinamese were more frequently inactive than Caucasians and African-Surinamese (31.6, 25.2 and 20.5%, p<0.05). Median total physical activity score was highest in African-Surinamese, followed by Caucasians and Hindustani-Surinamese (p<0.05). Among the physically inactive, there was no significant difference in median physical activity score between ethnic groups, but the contrast of median physical activity scores between the physically inactive and all others was lower among Caucasians.
The prevalence of type 2 diabetes was highest in Hindustani-Surinamese followed by African-Surinamese and Caucasians (25.4, 12.4 and 6.7%, p<0.05).

The association of physical inactivity and type 2 diabetes in the total group and stratified by ethnicity is shown in Figure 1. Physical inactivity was associated with type 2 diabetes in the total group, both after adjustment for sex and age only (Model 1: OR2.15, 95%CI 1.56-2.98), and after adjustment for sex, age, obesity, ethnicity, resting heart rate, hypertension, current smoking, history of cardiovascular disease, having a first-degree relative with type 2 diabetes and education level (Model 2: OR1.63, 95%CI 1.12-2.38). After stratification by ethnicity, a significant association between physical inactivity and type 2 diabetes was only seen in Caucasians (Model 2: OR3.17, 95%CI 1.37-7.30) Furthermore, the association appeared stronger in Caucasians than in Hindustani (OR1.43, 95%CI 0.78-2.63) and African-Surinamese (OR1.13, 95%CI 0.58-2.19). However, the p-value for interaction was not significant.

Similar results were obtained when adjusting for waist circumference instead of BMI (data not shown).

Conclusions and Discussion

Physical inactivity was associated with type 2 diabetes after adjustment for multiple risk factors in the total group. However, this association was only significant in Caucasians and appeared stronger than in African and Hindustani-Surinamese. Our results underscore the importance of exercise, but suggest a potentially differential effect of physical inactivity between ethnic groups.

There are limitations to this study. First, there is a discrepancy between self-reported and actual physical activity (18). Furthermore, the discrepancy might differ between ethnic groups. This might have affected the association between physical inactivity and type 2 diabetes in the ethnic groups. Second, the SQUASH has been validated for the Dutch population, but not for Surinamese populations specifically. Although the Surinamese population has good understanding of the Dutch language and we tried to minimise interpretation problems by matching interviewers and participants by ethnicity, this could still have influenced our outcomes. Furthermore, as an unhealthy diet is associated with type 2 diabetes and diet behaviours vary between ethnic groups (19,20), we regret not being able to adjust for diet in our analyses, due to limited data on diet in the SUNSET study. Last, this study is based on cross-sectional data. This could have biased the results through behavioural factors if persons with type 2 diabetes changed their lifestyle as a part of treatment. However,
this is likely to result in underestimation of the contribution of physical inactivity to type 2 diabetes.

The finding of an association between physical inactivity and type 2 diabetes after adjustment for multiple risk factors is consistent with findings of other studies (1-3). Although observational in nature, this study underscores the importance of physical activity for preventing type 2 diabetes and related diseases.

To our knowledge, there is hardly any evidence for a differential effect of physical inactivity on the development of type 2 diabetes between ethnic groups. Consistent with our findings, Hsia et al. reported that physical activity predicts a lower risk for type 2 diabetes in Caucasian women, but found no significant relationship between type 2 diabetes risk and physical activity in African-American, Hispanic, or Asian women. However, the magnitude of the association between physical activity and type 2 diabetes was not dramatically different among the ethnic groups (21). Our finding that the association between physical inactivity and type 2 diabetes was only significant in Caucasians and appeared stronger in Caucasians than in Hindustani and African-Surinamese, could not be explained by differences in median activity score between ethnic groups. This finding is difficult to interpret due to the cross-sectional nature of our study, but suggest a potential difference in pathophysiology. For example, insulin resistance might be more determined by environmental factors in Caucasians, and by genetic factors in Hindustani and African-Surinamese. Misra et al. stated that progressive resistance-exercise training may be more effective on insulin sensitivity in Asian-Indians than in Caucasians, although they did not focus on any other form of physical activity (22). This suggests that, apart from activity-level itself, different types of activity might have differential effects among ethnic groups as well.

In conclusion, physical inactivity was associated with type 2 diabetes after adjustment for multiple risk factors. This confirms the importance of regular exercise for all. However, the results suggest that potential health gain may differ between ethnic groups. Longitudinal studies may bring more clarity concerning this matter. It should be noted though, that -in general- promotion of physical activity in populations with an increased a-priori risk of type 2 diabetes for whatever reason, remains of the utmost importance.
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Reference List

14. van Berkel-van Schaik AB, Tax B: Towards a standard operationalisation of socioeconomic status for epidemiological and socio-medical research [in Dutch]. *Ministerie van VWC* 1990
Table 1. Characteristics of the study population stratified by ethnicity

<table>
<thead>
<tr>
<th></th>
<th>Hindustani-Surinamese (N=339)</th>
<th>African-Surinamese (N=596)</th>
<th>Caucasians (N=508)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (years)</td>
<td>44.7 (6.7)</td>
<td>43.7 (5.9)</td>
<td>47.8 (6.8)*</td>
</tr>
<tr>
<td>Mean BMI (kg/m²)</td>
<td>27.7 (5.2)</td>
<td>28.4 (5.4)</td>
<td>26.1 (4.8)*</td>
</tr>
<tr>
<td>Mean waist circumference (cm)</td>
<td>94.4 (12.5)</td>
<td>93.5 (14.5)</td>
<td>91.7 (14.1)*</td>
</tr>
<tr>
<td>Mean resting heart rate (beats/minute)</td>
<td>74 (11)</td>
<td>73 (11)</td>
<td>69 (11)*</td>
</tr>
<tr>
<td>Hypertension (yes)*</td>
<td>33.9</td>
<td>37.6</td>
<td>25.6*</td>
</tr>
<tr>
<td>Current smoking (yes)</td>
<td>35.7</td>
<td>39.9</td>
<td>44.3*</td>
</tr>
<tr>
<td>History of cardiovascular disease (yes)*</td>
<td>15.6</td>
<td>9.4</td>
<td>8.1*</td>
</tr>
<tr>
<td>First degree relative with DM (yes)*</td>
<td>81.1</td>
<td>62.5</td>
<td>42.2*</td>
</tr>
<tr>
<td>Education (high)*</td>
<td>30.6</td>
<td>51.4</td>
<td>65.9*</td>
</tr>
<tr>
<td>Median physical activity score*</td>
<td>7020 (4530-11290)</td>
<td>8130 (5820-12078)</td>
<td>7425 (5284-10204)*</td>
</tr>
<tr>
<td>Physically inactive (yes)*</td>
<td>31.6</td>
<td>20.5</td>
<td>25.2*</td>
</tr>
<tr>
<td>Diabetes (yes)</td>
<td>25.4</td>
<td>12.4</td>
<td>6.7*</td>
</tr>
<tr>
<td>Physically inactive group: median physical activity score*</td>
<td>3540 (2520-4290)</td>
<td>3350 (2259-4560)</td>
<td>3657 (2220-4740)</td>
</tr>
<tr>
<td>Others: median physical activity score*</td>
<td>9240 (6900-13046)</td>
<td>9365 (7193-13268)</td>
<td>8565 (6926-11239)*</td>
</tr>
</tbody>
</table>

Data are given as mean (standard deviation), median (interquartile range) or percentages

*P < 0.05 in Kruskal Wallis for comparison between the ethnic groups

a Definition: systolic blood pressure (SBP) ≥ 140 mmHg, or diastolic blood pressure (DBP) ≥ 90 mmHg, or being on antihypertensive therapy.
b Definition: history of myocardial infarction and/or stroke
c Definition: vocational school and above, i.e. ≥ 13 years of education (high)
d Calculation based on reported activity, measured with the 'Short-Questionnaire-to-Assess-Health-enhancing-Physical-Activity', using type of activity, frequency, duration, intensity, and age (unit: intensity x minutes, (15))
e Definition: lowest quartile of reported activity
f Definition others: those who are not physically inactive
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Figure 1. Odds ratios (95% confidence intervals) for the association between physical inactivity* and type 2 diabetes

* Defined as the lowest quartile of reported activity, measured with the "Short-Questionnaire-to-Assess-Health-enhancing-Physical-Activity"

**Model 1 = adjusted for sex and age

**Model 2 = as Model 1 + adjusted for BMI, resting heart rate, hypertension, history of cardiovascular disease, having a first degree relative with type 2 diabetes, current smoking and education level