# Cardiovascular risk in young apparently healthy descendents from Asian Indian migrants in the Netherlands: the SHIVA study

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***Background.*** **Asian Indian migrants in the Western world are highly susceptible for ischaemic heart disease (IHD). Until now, most IHD risk studies were performed in first and second generation Asian Indian expatriates. For optimal prevention, knowledge of the cardiovascular risk profile of younger generations is crucial.**

***Method.*** **In a cross-sectional study we assessed the prevalence of conventional IHD risk factors and Framingham risk score in asymptomatic third to seventh generation Asian Indian descendants, compared with Europeans. Subjects were classified as asymptomatic if they did not have documented IHD, diabetes, hypertension or high cholesterol.**

***Results.*** **A total of 1790 Asian Indians (45% men, age 35.9±10.7 years) and 370 native Dutch hospital employees (23% men, age 40.8±10.1 years) were recruited. Asian Indians had higher levels of total cholesterol, low-density lipoprotein, triglycerides, and lower high-density lipoprotein levels than the Dutch. Glucose intolerance was present in 7.1 vs. 0.5% men, and in 6.1 vs. 1.4% women (both p<0.001). Asian Indian women were more frequently obese (12 vs. 5%; p<0.001), and centrally obese (44 vs. 25%; p<0.001) as compared with the Dutch women. Prevalence of most of the conventional and modifiable cardiovascular risk factors in each ten-year age group was higher in Asian Indians compared with controls, which reflected in higher Framingham risk scores.**

***Conclusion.*** **This study demonstrates the persistence of an unfavourable cardiovascular risk profile in young, third to seventh generation migrated Asian Indians and supports an aggressive screening and intervention strategy. (*Neth Heart J* 2009;17:155-61.)**

Keywords: Asian Indians, cardiovascular risk, Framingham risk score

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Asian Indian people exhibit a high risk for the development of ischaemic heart disease (IHD).[1,2] This increased risk has been reported in emigrated Asian Indians as well as in Asian Indians living in urban areas of their native countries.[1-3] In addition, IHD becomes manifest at a younger age and is more often fatal, especially in young Asian Indian men, as compared with other ethnic groups.[1,2,4]

The underlying mechanism of the higher risk of IHD in Asian Indians compared with other ethnic groups is unclear. Conventional risk factors alone cannot explain this excess risk, and other biological and environmental factors seem to play an important role.[5] For example, although generally the degree of sub-clinical atherosclerosis is related to clinical cardiovascular events, Asian Indians appear to have less atherosclerosis, yet they have more events.[5] Furthermore, clinical manifestations of insulin resistance are consistently reported to be more frequent in Asian Indians compared with other ethnic groups, irrespective of their geographical location.[6,7] Insulin resistance is associated with the development of IHD and manifests as a constellation of interrelated risk factors as notably elevated triglycerides levels, reduced high-density lipoprotein (HDL) levels, central obesity, hyperinsulinaemia and an increased prevalence of diabetes type 2.[8] At a genetic level, explanations can be found in adverse gene-environmental interactions and the thrifty gene hypothesis.[9] Furthermore, the rural-urbanisation shift in South Asia has the same deteriorating effects on the risk profile and prevalence of IHD as the migration of Asian Indians to Western countries.[3,10]

There is a large Asian Indian community in the Netherlands (approximately 200,000 persons). This community mainly consists of migrants from Surinam, a former South American Dutch colony. Historically, the abolishment of slavery in 1863 was the start of migration of Asian Indians from India to Surinam. These migrants were contract workers on former plantations and were almost exclusively recruited from the Indian state Bihar. The declaration of independence of Surinam in 1975 initiated a second wave of migration of these Asian Indians, this time to the Netherlands. Nowadays, these immigrants and their offspring form a third to seventh generation of Asian Indians. As in other Western countries, these young generation Asian Indian descendants also exhibit higher rates of early onset cardiovascular morbidity and mortality in comparison with the native Dutch population.[11]

Until now, most IHD risk studies in Asian Indians were performed in first and second generation Asian Indian expatriates.[5,6,10,12,13] To optimise preventive strategies in younger generations of this high-risk population, knowledge of the current cardiovascular risk profile is crucial. Hence, we performed the SHIVA study (**S**creening of **HI**ndustans for cardio**VA**scular risk factors).

## Methods

### *Design*

SHIVA is a cross-sectional study, designed to assess the prevalence of conventional IHD risk factors and the ten-year Framingham risk scores of asymptomatic third to seventh generation Asian Indian migrants in the Netherlands.[14] All data were compared with a control group comprising healthy native Dutch hospital employees. Every participant provided written informed consent. The institutional ethical committee approved the study protocol.

### *Study population*

Asian Indian subjects (aged 18 to 60 years) were recruited at the Milan cultural festival held in The Hague in the Netherlands, in July 2004. This festival is organised annually and attended by 50,000 to 60,000 Asian Indians. Subjects were classified as Asian Indians if at least one parent's ancestor originated from the Indian subcontinent. Considering the ancestors emigrated from South Asia in the latter part of the 19th century, and based on one generation of 20 years, this group forms a third to seventh generation of Asian Indian migrants. Asian Indians born in the Indian subcontinent were excluded. The control group comprised healthy Dutch hospital employees (Medical Center Haaglanden, The Hague, the Netherlands). Dutch origin was defined as both parents being Dutch from European origin. Subjects were classified as asymptomatic when they did not have documented IHD, diabetes, hypertension or high cholesterol and were not receiving any form of treatment for any of these conditions. All others were excluded.

A total of 2102 study participants and 560 controls were screened. Of them 502 subjects (19%) were excluded; 120 due to unknown or neither Asian Indian nor Dutch origin; 122 Asian Indians because of unknown place of birth or born in the Indian subcontinent; 214 participants for not being asymptomatic; and 46 subjects who did not match the age range of interest (18 to 59 years). This left 1790 Asian Indians and 370 native Dutch subjects who were included in this analysis.

### *Procedures*

Similar procedures were performed in both study and control group. The participants completed a short questionnaire, including age, sex, medical history, family history of cardiovascular disease, the use of medication, smoking habits, alcohol intake and time of last meal. A positive family history was defined as a father, mother, brother or sister who suffered from cardiovascular disease before the age of 60 years. Current smoking was defined as using tobacco in the previous six months before participating in the SHIVA project.

Standardised anthropometric measurements, including height, weight and waist circumference, were performed by trained nurses. The waist circumference was defined as the narrowest circumference above the iliac crest and below the ribs. A waist circumference of ≥94 cm (men) and ≥80 cm (women) was considered as outsized, a waist circumference of ≥102 cm (men) and ≥88 cm (women) was considered as central obesity. Body mass index (BMI) was calculated (kg/m$^2$), and overweight was defined as a BMI ≥25 kg/m$^2$ and obesity as a BMI ≥30 kg/m$^2$.

Blood pressure was measured using an appropriately sized cuff in a sitting position. Hypertension was defined as a systolic blood pressure ≥160 mmHg and/or a diastolic blood pressure ≥90 mmHg. The cut-off value for systolic hypertension was set at 160 mmHg, while due to the setting, blood pressure measurements could be performed only once instead of serially. In addition, we also estimated the prevalence of subjects with the commonly used definition hypertension (systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg).[15]

Laboratory measurements were performed using the Cholestech LDX® analyser (Cholestech Corporation, Hayward USA). From 35 µl of blood, drawn from the finger, non-fasting total cholesterol, HDL cholesterol, triglycerides and glucose were measured. Low-density lipoprotein (LDL) cholesterol was estimated using Friedewald formula.[16] Very-low-density lipoprotein (VLDL) was estimated by dividing the triglycerides value by a factor of 2.2. A total cholesterol of ≥6.5 mmol/l was considered too high, and an HDL cholesterol ≤0.9 mmol/l too low. A non-fasting glucose of ≥7.8 mmol/l and ≤11 mmol/l was defined as impaired glucose tolerance. A non-fasting glucose of >11 mmol/l was defined as diabetes mellitus.

*Data collection*

All data were entered into a customised database, and the ten-year Framingham risk scores were calculated.[14] All participants received a printed copy of their risk assessment and, if necessary, personal lifestyle recommendations.

*Data analyses*

Prevalence and mean of each risk factor were calculated for both groups. Since the age distribution was different between control group and study group, risk factor data of the control group were standardised for age by using the size of each five-year age group of the study population as weights. Standard errors of these standardised values were obtained by calculation of a weighted average of the variances in the age groups with the squared size of the age groups in the study population as weights. 95% confidence intervals (CI) of the differences between the two groups were calculated using the standard normal distribution.

To identify potentially modifiable risk factors in each age group, we assessed the prevalence of risk factors in

**Table 1.** Cardiovascular risk factors of the Asian Indians and the Dutch control group by sex.

| | **Men** | | | | **Women** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Asian Indian** | | **Dutch*** | | **Asian Indian** | | **Dutch*** | |
| | **(n=813)** | **95% CI†** | **(n=85)** | **95% CI†** | **(n=977)** | **95% CI†** | **(n=285** | **95% CI†** |
| Family history of: | | | | | | | | |
| Cardiovascular disease, n (%) | 259 (32) | 29-35 | 19 (19)§ | 11-27 | 297 (30) | 28-33 | 58 (19)″ | 14-24 |
| Hypertension, n (%) | 354 (44) | 40-47 | 22 (24)″ | 13-34 | 487 (50) | 47-53 | 122 (41)¶ | 35-47 |
| Hyperlipidaemia, n (%) | 111 (14) | 11-16 | 14 (19) | 9-30 | 183 (19) | 16-21 | 67 (24) | 18-29 |
| Diabetes, n (%) | 380 (47) | 43-50 | 14 (15)″ | 7-22 | 497 (51) | 48-54 | 48 (15)″ | 11-20 |
| Smokers, n (%) | 241 (30) | 27-33 | 19 (28) | 18-39 | 132 (14) | 11-16 | 61 (22)§ | 16-27 |
| Body mass index (kg/m²) | 25.0 | 24.8-25.3 | 24.1¶ | 23.4-24.9 | 24.9 | 24.6-25.2 | 23.2″ | 22.8-23.6 |
| BMI ≥25 kg/m², n (%) | 386 (47) | 44-51 | 34 (35)¶ | 25-45 | 445 (46) | 42-49 | 79 (25)″ | 20-30 |
| BMI ≥30 kg/m², n (%) | 59 (7) | 5-9 | 6 (5) | 0.4-10 | 116 (12) | 10-14 | 13 (5)″ | 2-7 |
| Waist circumference | 92.1 | 91.4-92.9 | 90.5 | 87.8-93.1 | 86.4 | 85.7-87.1 | 81.6″ | 80.3-82.8 |
| ≥94 cm for men or | 361 (44) | 41-48 | 36 (38) | 28-48 | - | - | - | - |
| ≥80 cm for women, n (%) | - | - | - | - | 705 (72) | 69-75 | 167 (54)″ | 48-61 |
| ≥102 cm for men or | 135 (17) | 14-19 | 13 (13) | 6-21 | - | - | - | - |
| ≥88 cm for women, n (%) | - | - | - | - | 429 (44) | 41-47 | 77 (25)″ | 20-31 |
| Systolic blood pressure (mmHg) | 136.8 | 135.6-138.0 | 138.0 | 133.7-142.3 | 125.3 | 124.2-126.4 | 126.0 | 124.2-127.9 |
| Diastolic blood pressure (mmHg) | 79.1 | 78.3-80.0 | 79.0 | 76.1-81.9 | 78.1 | 77.4-78.9 | 77.3 | 76.1-78.4 |
| SBP ≥160 and/or DBP ≥90 mmHg, n (%) | 168 (21) | 18-24 | 17 (16) | 9-23 | 163 (17) | 14-19 | 44 (13) | 9-17 |
| SBP ≥140 and/or DBP ≥90 mmHg, n (%) | 340 (42) | 39-45 | 38 (47) | 34-60 | 239 (25) | 22-27 | 71 (22) | 17-26 |
| Cholesterol (mmol/l) | 5.01 | 4.95-5.08 | 4.4″ | 4.2-4.6 | 4.75 | 4.69-4.80 | 4.6¶ | 4.5-4.7 |
| ≥6.5 mmol/l, n (%) | 42 (5.2) | 3.6-6.7 | 0 (0)″ | 0.0-4.3 | 33 (3.4) | 2.2-4.5 | 3 (0.5)″ | 0.0-1.1 |
| HDL cholesterol (mmol/l) | 1.01 | 0.99-1.03 | 1.20″ | 1.13-1.26 | 1.24 | 1.23-1.26 | 1.42″ | 1.38-1.45 |
| ≤0.9 mmol/l, n (%) | 291 (36) | 33-40 | 12 (16)″ | 8-24 | 102 (10) | 9-12 | 3 (0.8)″ | 0.0-1.8 |
| LDL cholesterol (mmol/l) | 2.9 | 2.82-2.94 | 2.6§ | 2.4-2.7 | 2.73 | 2.68-2.78 | 2.62¶ | 2.53-2.70 |
| Triglycerides (mmol/l) | 2.6 | 2.5-2.7 | 1.6″ | 1.3-1.9 | 1.72 | 1.66-1.77 | 1.26″ | 1.18-1.34 |
| VLDL (mmol/l) | 1.0 | 0.98-1.06 | 0.66″ | 0.58-0.75 | 0.77 | 0.74-0.79 | 0.58″ | 0.54-0.61 |
| Total cholesterol/HDL | 5.3 | 5.2-5.4 | 3.9″ | 3.6-4.1 | 3.98 | 3.92-4.05 | 3.3″ | 3.2-3.4 |
| >5, n(%) | 420 (52) | 49-56 | 17 (20)″ | 13-28 | 160 (16) | 14-19 | 12 (3)″ | 1-5 |
| Non-fasting glucose | 5.9 | 5.8-6.0 | 5.1″ | 4.8-5.3 | 5.86 | 5.77-5.94 | 5.3″ | 5.1-5.4 |
| ≥7.8 mmol/l, n(%) | 58 (7.1) | 5.4-8.9 | 1 (0.5)″ | 0.03-6.4 | 59 (6.1) | 4.6-7.6 | 4 (1.4)″ | 0.0-2.9 |
| >11 mmol/l, n(%) | 6 (0.7) | 0.1-1.3 | 0 (0)¶ | 0.0-4.3 | 9 (0.9) | 0.3-1.5 | 0 (0)§ | 0.0-1.3 |

* In the Dutch control group: Means, % and 95% confidence intervals (CI) are standardised according to the age distribution of the Asian Indians. †95% CI of the mean in continuous variable and 95% CI of the percentage in categorical variable, ¶p<0.05, §p<0.01, ″p<0.001, BMI=body mass index, DBP=diastolic blood pressure, SBP=systolic blood pressure.

each ten-year age group. Moreover, as healthcare workers may be more health conscious, we also mirrored our ten-year age group risk factor data with a Dutch population survey conducted on municipal health services in 2001 ('Regenboog' project).[17] Individual estimated Framingham risk scores of the Asian Indians were categorised as >10%, >15% and >20% for each five-year age group, and for smokers and non-smokers.[14] All data were analysed with SPSS v 12.0.1 (SPSS Inc., Chicago, Ill).

### Results

Asian Indians on average were younger than Dutch subjects (men 35.8 years, 95% CI 35.1 to 36.5 vs. 40.7 years, 95% CI 38.4 to 43.0, and women 36.0 years, 95% CI 35.3 to 36.7 vs. 40.8 years, 95% CI 39.7 to 42.0), although the age range was similar (18 to 59 years). The groups were different with respect to sex distribution (men 45.4% in Asian Indians vs. 23.0% in the control group).

#### *Prevalence of risk factors*

Cardiovascular risk factors and blood chemistry measurements for both groups are shown in table 1. Asian Indians had a higher prevalence of a positive family history of cardiovascular disease, hypertension and diabetes compared with the control group. Fewer Asian Indian women smoked compared with Dutch women. Both Asian Indian men and women were more overweight compared with the control group. Asian Indian women were more frequently obese and had more central obesity. These differences were not seen in men.

In both Asian Indian men and women elevated cholesterol levels ≥6.5 mmol/l were more prevalent compared with the controls. Asian Indians more frequently had a low high-density lipoprotein (HDL). Mean low-density lipoprotein (LDL), triglycerides and very-low-density lipoprotein (VLDL) levels were all higher in Asian Indians. Impaired glucose tolerance was more common in Asian Indians compared with the controls. Among the Asian Indians 0.7% men and 0.9% women were diagnosed as de novo diabetes mellitus versus none in the control group.

#### *Prevalence of risk factors per ten-year age group*

To study the distribution of risk factors in each age group, prevalence of risk factors for each decade was determined in Asian Indians and Dutch subjects (table 2). Several risk factors were already present in a considerable proportion of subjects before the age of 30 years. Overweight, elevated cholesterol, low HDL and impaired glucose tolerance were all more prevalent in Asian Indians compared with the Dutch controls for both sexes regardless of age. Above the age of 40 years hypertension was more prevalent in Asian Indians. Asian Indian men smoked more frequently before the age of 50 compared with the control group. Asian Indian women had more (central) obesity as compared with Dutch women in each age category.

**Table 2.** Modifiable risk factors per ten-year age group by sex.

| | Asian Indian | | | | Dutch control group | | | | 'Regenboog' project* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age group (years)** | **20-29** | **30-39** | **40-49** | **50-59** | **20-29** | **30-39** | **40-49** | **50-59** | **20-29** | **30-39** | **40-49** | **50-59** |
| **Men** | n=217 | n=234 | n=225 | n=94 | n=18 | n=20 | N=31 | n=16 | n=75 | n=151 | n=176 | n=192 |
| Smokers (%) | 34 | 25 | 31 | 29 | 17 | 20 | 23 | 31 | NA | NA | NA | NA |
| SBP ≥140 and/or DBP ≥90 mmHg (%) | 35 | 36 | 47 | 67 | 56 | 45 | 36 | 50 | 13 | 17 | 38 | 48 |
| Body mass index ≥30 kg/m² (%) | 4 | 10 | 8 | 7 | 0 | 10 | 7 | 13 | 6 | 8 | 15 | 15 |
| Waist circumference ≥102 cm (%) | 9 | 20 | 22 | 20 | 6 | 21 | 19 | 13 | 4 | 19 | 26 | 33 |
| Cholesterol ≥6.5 mmol/l (%) | 2 | 6 | 8 | 7 | 0 | 0 | 0 | 0 | 5 | 4 | 11 | 19 |
| HDL cholesterol ≤0.9 mmol/l (%) | 38 | 42 | 37 | 27 | 6 | 30 | 13 | 6 | 17 | 24 | 20 | 18 |
| Glucose >11 mmol/l (%) | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0* | 2* | 4* | 5* |
| **Women** | n=243 | n=251 | n=310 | n=106 | n=53 | n=59 | N=115 | n=56 | n=89 | n=177 | n=159 | n=180 |
| Smokers (%) | 19 | 12 | 12 | 9 | 19 | 20 | 24 | 20 | NA | NA | NA | NA |
| SBP ≥140 and/or DBP ≥90 mmHg (%) | 9 | 18 | 39 | 46 | 15 | 22 | 30 | 29 | 7 | 12 | 26 | 46 |
| Body mass index ≥30 kg/m² (%) | 11 | 10 | 15 | 15 | 6 | 7 | 4 | 2 | 9 | 11 | 10 | 14 |
| Waist circumference ≥88 cm (%) | 26 | 45 | 55 | 64 | 15 | 25 | 35 | 26 | 17 | 30 | 36 | 48 |
| Cholesterol ≥6.5 mmol/l (%) | 2 | 2 | 3 | 12 | 0 | 0 | 0 | 5 | 2 | 3 | 9 | 20 |
| HDL cholesterol ≤0.9 mmol/l (%) | 9 | 12 | 14 | 7 | 0 | 2 | 1 | 2 | 2 | 6 | 8 | 2 |
| Glucose >11 mmol/l (%) | 1 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0† | 0† | 0† | 2† |

*Viet AL, et al.[17] DBP=diastolic blood pressure, HDL=high density lipoprotein, NA=data not available, SBP=systolic blood pressure. †Prevalence of fasting glucose ≥7.0 mmol/l in 50% of the men and 54% of the women.

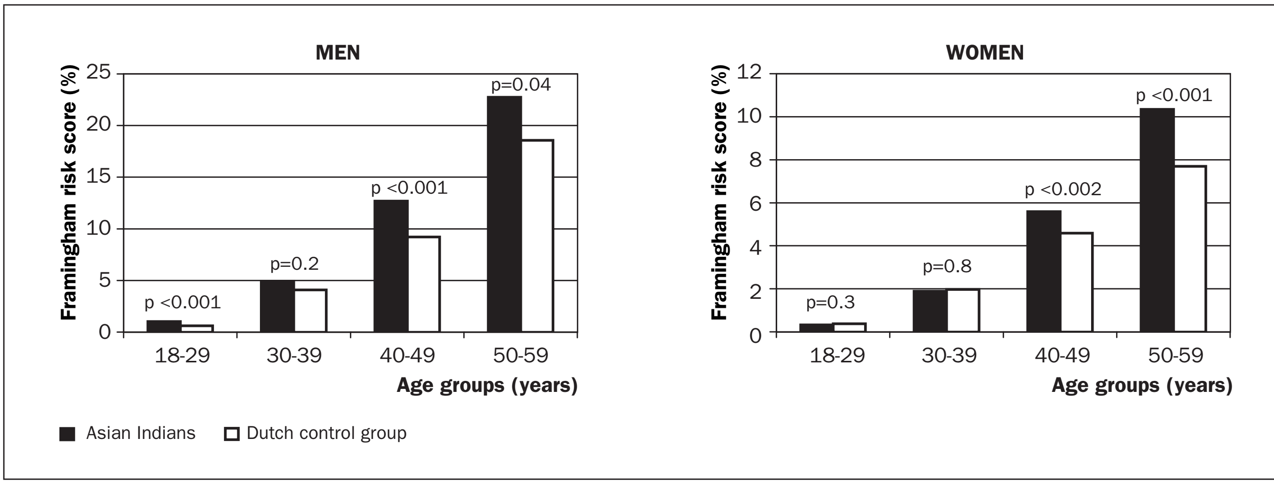


*Figure 1. Framingham risk score in men and women.*

Comparing 'Regenboog' data with data of Asian Indians, Asian Indian men had more hypertension and lower HDL regardless of age, and in the youngest age group central obesity was more prevalent. Asian Indian women exhibited more obesity between the age of 40-49 years; more central obesity and low HDL in all age groups; more hypertension between 30-49 years, and more diabetes de novo between 20-29 years and 40-49 years.[17]

*Framingham risk scores*

In figure 1 the mean ten-year Framingham risk scores for each ten-year age group are shown. Asian Indian men exhibited higher Framingham risk scores in all age groups as compared with the controls. In Asian Indian women the same trend was found.

Figure 2 presents the prevalence of increased ten-year Framingham risk (>10%) in each five-year age group for smoking and non-smoking Asian Indians. As many as 23% of smoking Asian Indian men aged 30-35 years had a risk >10%, whereas non-smokers all had a risk $\leq$10%. In the age group 50-54 years all of the smoking men had a ten-year risk >10%, and 77% had a risk >20%. In smoking Asian Indian women between 40 and 44 years 29% had a ten-year risk >10%; this was all above the age of 50 years.

## Discussion

The key finding of this study is the striking unfavourable IHD risk profile present in young, apparently healthy third to seventh generation Asian Indians. Most of the earlier studies of cardiovascular risk in Asian

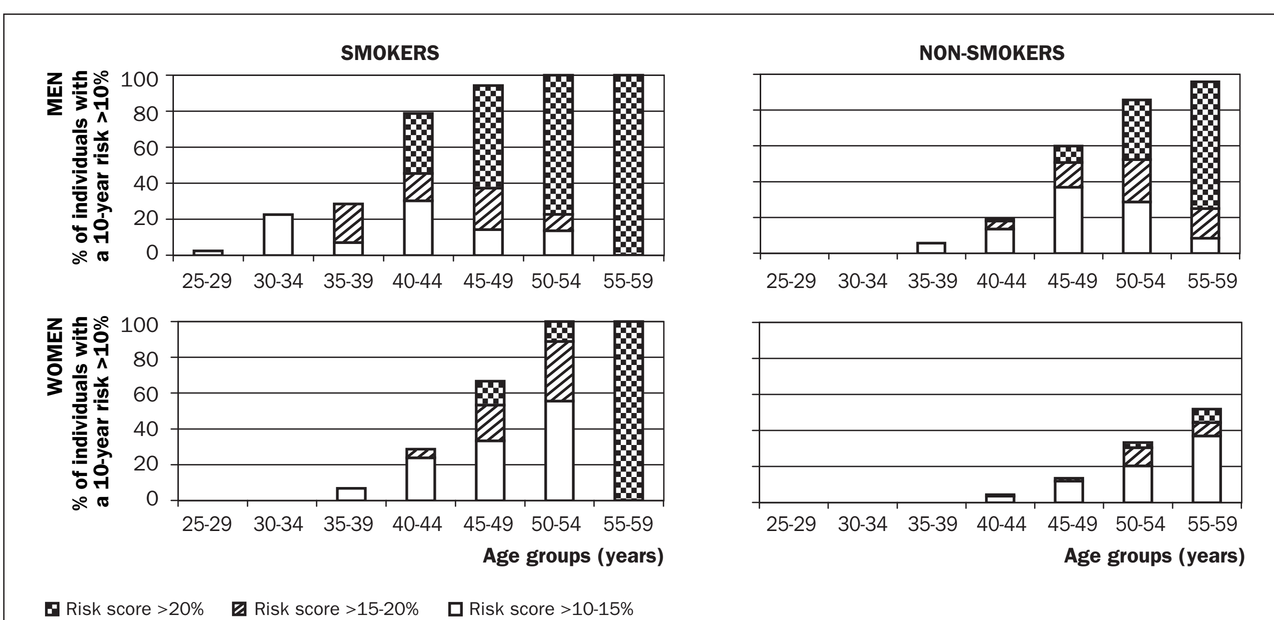


*Figure 2. Prevalence of increased Framingham risk (>10%) in smoking and non-smoking Asian Indians.*

Indians involved first and second generation migrants who were older than the subjects in this study.[5,6,10,12,13] However, knowledge of the IHD risk profile of younger generations is of utmost importance both for the development of prevention strategies and for the insight into the aetiology of IHD disease in this high-risk population.

*Prevalence of risk factors*

In comparison with the Dutch control group, Asian Indians more often had a positive family history for cardiovascular disease, hypertension, and diabetes. Furthermore, levels of total cholesterol, VLDL and triglycerides were higher, HDL levels were lower, and impaired glucose intolerance was more prevalent. These findings correspond with prior studies reporting a high prevalence of insulin resistance in Asian Indians.[18,19] Glucose intolerance, a predisposition to develop type 2 diabetes mellitus, was diagnosed 14 times more often in Asian Indian men and four times more often in Asian Indian women compared with Dutch controls.

Overweight was more common in both Asian Indian men and women compared with the Dutch controls. With regard to the prevalence of (central) obesity a sex difference was observed. In line with previous studies, Asian Indian women suffered significantly more from obesity and central adiposity as compared with the control group; no differences were found among men.[12,13,19] Furthermore, despite equal proportion of (central) obesity in Asian Indian and Dutch men, Asian Indian men exhibited higher rates of dyslipidaemia and glucose intolerance. This is in agreement with the observation of Chandalia et al.[20] who reported that insulin resistance in Asian Indian men is commonly present even in the absence of excessive body fat content or abdominal obesity. Moreover, using the population specific cut-off points from the International Diabetes Federation, the Asian Indian men had more central obesity compared with the Dutch controls (59 vs. 38%), which suggests that Asian Indians may easily be overlooked for adequate prevention interventions.[21]

*Prevalence of risk factors with respect to age*

Multiple modifiable risk factors were already present in a large number of Asian Indians before the age of 30 years. Furthermore, prevalence of most risk factors was higher in Asian Indians as compared with Dutch controls in each age group. Despite the fact that 11% of the 'Regenboog' participants were known with hypertension and 3% with diabetes, important differences in the prevalence of risk factors remained between our Asian Indians and the 'Regenboog' population.[17] As modification of these cardiovascular risk factors affects long-term outcome, prevention strategies in Asian Indians should focus on the younger age groups. Main targets should be to revert conditions as overweight, dyslipidaemia and glucose intolerance, which can be achieved by effective lifestyle changes and, if necessary, additional drug therapy.[8] Adequate interventions can decrease the high prevalence of hypertension in Asian Indians above the age of 40 years.[8,15] In addition, among Asian Indian men smoking is an important issue to address.

*Framingham risk score*

The Asian Indians exhibited higher ten-year Framingham risk scores compared with the control groups. Grundy et al.[22] stressed the importance of also focussing on long-term risk (>10 years), which is especially interesting in young and middle-aged adults. A risk score of 10% in a 30-year asymptomatic adult may still be considered of limited clinical importance for the short-term; however, it will inevitably lead to a risk >20% before the age of 50 years.[22] The guidelines of the joint European societies have not defined a specific age threshold for screening.[23] In the Dutch guidelines, an age of 50 years in smoking men and 55 years in smoking women is recommended.[24] This is based on the chance to identify an individual with a ten-year risk of IHD >10%.[24] Our prevalence data of Asian Indian subjects with a Framingham risk >10% indicate that on the same basis, screening may be justified in smoking Asian Indian men at the age of 30 and smoking Asian Indian women at the age of 40. These screening time points can be extended with five years in the non-smoking Asian Indian population. However, further study is necessary to assess the health benefits and cost-effectiveness of this approach.

## Limitations

There are some limitations to be discussed. First, persons with cardiovascular disease in the family might have been keener to participate than those without, hence attracting volunteers with a higher risk profile for IHD than non-volunteers. A sub-analysis in those without a known family history of cardiovascular disease resulted in similar results with slight variations due to the smaller sizes of the groups.

Second, due to the setting, non-fasting blood samples were used for chemistry measurements in most of the study and control subjects. This affected the VLDL, LDL and triglycerides measurements.[25] Slight underestimation or overestimation of the prevalence of glucose intolerance and de novo diabetes can not be excluded. In addition, blood pressure measurements were performed only once instead of serially, and white-coat effect also varies between different ethnicities.[26] Although the cut-off value for systolic hypertension was chosen higher than commonly used, overestimation of hypertension prevalence may have occurred.

Lastly, a recalibrated model for IHD risk prediction specified to Asian Indians does not exist. Small sample size studies revealed that the Framingham model seems to predict IHD outcomes in this group fairly well, whereas the SCORE model does not.[27] Others recommend adjusting the underestimation of risk in Asian

Indians by multiplying IHD risk with factor 1.79 or to lower the risk threshold, which seems reasonable regarding the higher prevalence of IHD in Asian Indians.[28,29] Additionally, risk factors such as obesity, a family history of premature cardiovascular disease and elevated triglyceride levels are common in our study population, but not included in the Framingham assessment.[22] Nevertheless, these risk function models are still the best guiding tools for risk reduction management in daily clinical practice.[22,23]

## Conclusions

The results of this study demonstrate that conventional and modifiable risk factors are already present at a young age in a significant number of apparently healthy third to seventh generation Asian Indians. In order to modify this risk profile, and thereby to decrease the chance of subsequent early onset of cardiovascular events, screening followed by adequate treatment should start at a younger age than recommended in the current guidelines.

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