# Research

## Theme Paper

# Levels of cardiovascular disease risk factors in Singapore following a national intervention programme

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**Objective** To evaluate the impact of the National Healthy Lifestyle Programme, a noncommunicable disease intervention programme for major cardiovascular disease risk factors in Singapore, implemented in 1992.

**Methods** The evaluation was carried out in 1998 by the Singapore National Health Survey (NHS). The reference population was 2.2 million multiracial Singapore residents, 18–69 years of age. A population-based survey sample ($n = 4723$) was selected by disproportionate stratified and systematic sampling. Anthropometric and blood pressure measurements were carried out on all subjects and blood samples were taken for biochemical analysis.

**Findings** The 1998 results suggest that the National Healthy Lifestyle Programme significantly decreased regular smoking and increased regular exercise over 1992 levels and stabilized the prevalence of obesity and diabetes mellitus. However, the prevalence of high total blood cholesterol and hypertension increased. Ethnic differences in the prevalence of diabetes mellitus, hypertension, and smoking; and in lipid profile and exercise levels were also observed.

**Conclusion** The intervention had mixed results after six years. Successful strategies have been continued and strengthened.

**Keywords** Cardiovascular diseases/etiology/; Risk factors; Diabetes mellitus/epidemiology/ethnology; Hypertension/epidemiology/ethnology; Obesity/epidemiology/ethnology; Smoking/epidemiology/ethnology; Exercise; Ethnic groups; Life style; National health programs; Cross-sectional studies; Singapore (*source: MeSH*).

**Mots clés** Cardiovasculaires, Maladies/étiologie; Facteur risque; Diabète/épidémiologie/ethnologie; Hypertension artérielle/épidémiologie/ethnologie; Obésité/épidémiologie/ethnologie; Tabagisme/épidémiologie/ethnologie; Exercice physique; Groupes ethniques; Style vie; Programme national santé; Etude section efficace; Singapour (*source: INSERM*).

**Palabras clave** Enfermedades cardiovasculares/etiología; Factores de riesgo; Diabetes mellitus/epidemiología/etnología; Hipertensión/epidemiología/etnología; Obesidad/epidemiología/etnología; Tabaquismo/epidemiología/etnología; Ejercicio; Grupos étnicos; Estilo de vida; Programas nacionales de salud; Estudios transversales; Singapur (*fuente: BIREME*).

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*Voir page 914 le résumé en français. En la página 914 figura un resumen en español.*

## Introduction

The island of Singapore has undergone rapid socio-economic development since independence in 1965.

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For example, the per capita gross national product, adjusted to 1998 prices, rose from S$ 1618 in 1965 to S$ 38 170 in 1998 (US$ 1.0 = S$ 1.70). In 1998, the infant mortality rate was 4.1 per 1000 live births and life expectancy at birth was 79 years for females and 75 years for males. Other 1998 indicators include an adult literacy rate of 93% and 13 doctors per 10 000 population (*1*). The total population of Singapore in 1998 was 3.87 million and it had the second highest population density in the world (after Hong Kong Special Administrative Region of China) at 5965 people per km². The resident population consisted of 77% Chinese, 14% Malay, 7.6% Indian,

and 1.4% other ethnic groups. The main causes of mortality in Singapore mirrored those of developed countries, with cancer, ischaemic heart disease, and cerebrovascular disease responsible for 57% of all deaths in 1998 (2). These three diseases have been the main causes of death in Singapore since the 1970s.

In 1991, a national committee was appointed to review the national health plan for the 1990s, and one of the key recommendations emphasized health promotion and disease prevention (3). This was followed by the National Healthy Lifestyle Programme in 1992, which adopted a multisectoral approach involving government ministries and organizations, health professionals, employers, unions, and community organizations. These sectors worked together to provide information, skills training, and the social and physical environment necessary to encourage healthy living by Singaporeans. The programme included extensive use of the mass media to promote healthy lifestyles, legislative measures to discourage smoking, and widespread school, workplace, and community health promotion programmes. The programmes emphasized healthy diets, regular physical exercise, and measures to discourage smoking.

In 1992, the Ministry of Health also conducted the first National Health Survey (NHS), a population-based cross-sectional survey to measure the prevalence of diabetes mellitus, hypertension, obesity, smoking, physical inactivity, and hypercholesterolaemia — all cardiovascular disease risk factors. Findings from the survey provided baseline data for subsequent evaluation of the effectiveness of the National Healthy Lifestyle Programme. In 1998, six years after the launch of the National Healthy Lifestyle Programme, a second NHS was conducted to determine whether the risk factors in the population had changed.

## Methods

The NHS was a cross-sectional survey conducted between September and November, 1998. The reference population was 2.16 million Chinese, Malay, and Indian Singapore residents aged 18–69 years. Six centres around the island of Singapore were selected as field sites for the survey. Details of the survey methodology have been described elsewhere (4).

### Determination of sample size

We calculated that a sample size of 5000 respondents would be required to detect a 10–15% change from baseline for most of the diseases and risk factors with 80% power. The prevalence of diabetes mellitus, hypertension, and other cardiovascular risk factors (obesity, smoking, and physical inactivity) measured in the 1992 NHS was used as baseline levels. To account for potential non-response during the survey, we estimated that at least 10 000 households would need to be approached to obtain the target sample size.

### Sample selection

The sample selection was divided into two phases. In phase I, a sample of 11 200 household addresses was selected from the National Database on Dwellings. The sample selection was based on a modified two-stage stratified design. For the first stage, sampling divisions close to the six selected survey centres were chosen and households within each division were stratified by house type (a proxy for socioeconomic status) and systematically selected in the second stage. The final sample of 11 200 addresses represented the housetype distribution for the entire Singapore housing population. This was followed up by house visits to enumerate all household members aged 18–69 years.

In phase II, a random sample of 7500 people was selected by disproportionate stratified and systematic sampling of household members identified in phase I. The Malays and Indians were oversampled, to ensure that prevalence estimates for these minority groups were reliable. The ethnic composition of the sample was 64% Chinese, 21% Malays, and 15% Indians.

### Survey protocol and procedures

The survey protocol closely followed that of the 1992 NHS to ensure comparability. The NHS protocol was based on the WHO-recommended model for field surveys of diabetes and other noncommunicable diseases (5) and the WHO MONICA (Multinational Monitoring of Trends and Determinants in Cardiovascular Disease) protocol for population surveys (6). Subjects were instructed to fast overnight for at least 10 hours before coming to the designated survey centre. A fasting blood sample was collected and all subjects, except diabetics on medication, had an oral glucose tolerance test (7). Other procedures included measuring blood pressure, height, weight, waist and hip circumference, and the administration of a structured questionnaire.

The 1985 WHO diagnostic classification criteria (7) were used to classify glucose tolerance. Self-reported diabetics on medication were also taken to be diabetics. Blood-pressure measurements followed procedures prescribed in the WHO MONICA protocol (6). Carefully trained observers took two measurements in a quiet room after the subjects were rested. Hypertension was defined according to WHO criteria: mean systolic pressure $\geq 140$ mmHg; or diastolic pressure (phase V) $\geq 90$ mmHg; or both; or self-reported current use of antihypertensive medication (8).

Smoking status and level of physical activity were determined by questionnaires, which were administered by interviewers according to WHO guidelines (9) and the American College of Sports Medicine's classification (10). Body mass index (BMI) was measured as weight (kg)/height (m)$^2$. The WHO classification of weight status and abdominal fatness was used (11). The means of two readings of height and weight, as well as waist and hip circumferences, were used to calculate the body mass index and waist:hip ratio, respectively. Cholesterol

level was classified according to that set by the United States National Institutes of Health (*12*).

Information recorded on the questionnaires was manually checked for missing values, data-entry errors, and inconsistency. Data anomalies were checked and amended following direct contact with the participants by telephone. The survey database was subjected to further consistency and verification checks built into the computer system.

### Laboratory methods

All blood specimens for plasma glucose measurement were collected in fluoride/oxalate tubes, centrifuged on site, and sent to the Biochemistry Laboratory of the Department of Pathology, Singapore General Hospital for analysis on the same day. Specimens for cholesterol measurement were collected in plain tubes. Plasma glucose levels, total blood cholesterol, and high-density-lipoprotein (HDL)-cholesterol were measured on a BM/Hitachi 747/737 analyser by the enzymatic colorimetric method. Low-density-lipoprotein (LDL)-cholesterol was measured by the homogenous turbidimetric method. Because different methods were used to assay HDL-cholesterol in 1992 and 1998, the 1998 measurements were adjusted downwards using a regression equation. In 1992, HDL-cholesterol was measured by first precipitating LDL-cholesterol and very-low-density-lipoprotein (VLDL)-cholesterol, and then assaying HDL with a Kodak 700 analyser. In 1998, in contrast, HDL-cholesterol was measured directly using a BM/Hitachi 747/737 analyser.

### Statistical analysis

Statistical analyses were performed using the Statistical Analysis System (*13*). The survey data were weighted by the age, ethnic group, and sex distribution of the 1998 Singapore resident population. Prevalence was age-standardized directly, using the 1990 Singapore resident population as the standard (as 1990 was a census year). Changes in age-standardized prevalence levels between 1992 and 1998 were tested for statistical significance using the $\chi$-test (*14*) and 95% confidence limits were calculated.

### Survey subjects

From the original sample of 7500 adults, 175 people had to be excluded due to pregnancy, death, or being overseas during the survey period. The survey yielded a response rate of 64.5% (4723/7325). A comparison of respondents and non-respondents showed that respondents had a higher representation of females and Chinese, a lower proportion of young adults in the 18–29-year age group, and a lower proportion of people living in smaller public flats (Table 1).

### Weighting the survey sample

To correct for oversampling of minority ethnic groups in the survey and differential response levels, the survey sample was weighted to the age, ethnic group, and gender distribution of 1998 resident population estimates (*1*). This ensured that the survey results were representative of the general population in terms of age, ethnic group, and gender distribution. In Table 2, the socio-economic characteristics (in terms of house type) of the weighted survey sample are compared with those of the 1998 Singapore resident population. This showed that the weighted survey sample contained proportionately fewer people who lived in the smaller public flats.

## Results

Prevalence levels of cardiovascular disease risk factors are reported for the population aged 18–69 years, except the prevalence for hypertension, which is reported for the population aged 30–69 years.

### Diabetes mellitus and hypertension

The age-standardized prevalence of diabetes mellitus among Singapore residents aged 18–69 years did not change significantly between 1992 (8.4%) and 1998 (8.1%) (*P* >0.05; Table 3). Nor was there any change in the prevalence of impaired glucose tolerance (13.9%). However, the prevalence of hypertension increased in the population aged 30–69 years, from 22.5% in 1992 to 26.6% in 1998 *(P* <0.001).

### Obesity and lipid levels

The prevalence of obesity (BMI $\geqslant 30 \text{kg/m}^2$) was unchanged between 1992 (5.1%) and 1998 (5.9%; *P* = 0.076). In contrast, the prevalence of high total blood cholesterol ($\geqslant 6.2$ mmol/l) increased from 19% in 1992 to 23.5% in 1998 (*P* <0.001), and was greater for men (a 30% rise) than women (17% rise). For both men and women, the mean total blood cholesterol also increased from 5.3 mmol/l to 5.5 mmol/l. In the same period, the prevalence of high LDL-cholesterol ($\geqslant 4.1$ mmol/l) increased from 22.7% to 24.6% (*P* = 0.044), while the prevalence of low HDL-cholesterol (<0.9 mmol/l) was essentially unchanged (1992: 6.0%; 1998: 5.2%; *P* = 0.084).

### Cigarette smoking

The prevalence of regular cigarette smoking (at least once a day) by men decreased from 33.5% in 1992 to 26.5% in 1998 (*P* <0.001). Although no significant change was observed for women, the prevalence of regular cigarette smoking was already very low (1992: 2.9%; 1998: 3.2%; *P* >0.05). For both men and women combined, the prevalence of regular smoking decreased from 18.4% to 15.0% between 1992 and 1998 (*P* <0.001). In contrast, regular smoking among young women aged 20–24 years increased almost threefold, from 2.5% to 6.7% (*P* <0.05).

## Regular exercise

The proportion of Singapore residents who exercised regularly (at least three times a week for at least 20 minutes per session) increased from 13.6% to 16.9% between 1992 and 1998 ($P$ <0.001). The change was attributed to an increase in the proportion of women who exercised regularly (1992: 8.1%; 1998: 13.2%; $P$ <0.001). There was no significant change for men (1992: 19.0%; 1998: 20.5%; $P$ >0.05).

## Ethnic differences

Differences were observed in the prevalence of all cardiovascular disease risk factors studied among the three major ethnic groups, Chinese, Malays, and Indians (Table 4). Indians had the highest prevalence of diabetes mellitus (age-standardized prevalence: 14.5%; 10.7% in Malays; 7.0% in Chinese), while Malays had the highest prevalence of hypertension (age-standardized prevalence: 32.3%; 26.0% in Chinese; 23.7% in Indians). Obesity prevalence was low among the Chinese (3.8%), compared to Malays (15.3%) and Indians (12.3%). Malay and Indian women had an especially high prevalence of obesity (22.0% and 17.5%, respectively), compared to Chinese women (3.0%).

High total blood cholesterol was more prevalent in Malays (34.0%), compared to Chinese (21.8%) and Indians (23.0%). Malays also had the highest prevalence of cigarette smoking (men: 42.9%; women: 3.7%; Chinese men: 23.4%; Chinese women: 3.3%; Indian men: 29.3%; Indian women: 0.8%). On the other hand, more Indians (25.0%) and Malays (19.3%) exercised regularly compared to Chinese (15.8%).

Between 1992 and 1998, the prevalence of hypertension and high total blood cholesterol rose significantly among the Chinese and Malays, but not the Indians. Likewise, the prevalence of regular smoking decreased significantly only among the Chinese and Malays. All three ethnic groups recorded significant increases in regular exercise, and only in Malays was there a significant increase in the prevalence of obesity.

# Discussion

## Validity of the study

The number of subjects was close to the sample size needed to detect a 10–15% change from baseline, even though the response rate was only 65%. This was achieved by factoring in the likely response rate, based on the 1992 survey. Among survey respondents, there were higher proportions of females and Chinese, a lower proportion of young adults (aged 18–29 years) and a lower proportion of people living in smaller public flats, compared to non-respondents. The survey sample was weighted to the population age, sex, and ethnic group distribution. After weighting, the proportion of people in the sample who lived in smaller public flats (22.4%) was lower

Table 1. **Comparison of the unweighted survey sample, non-respondents, and the 1998 resident Singapore population**

| Characteristics | Survey respondents (unweighted %) $n = 4723$ | Survey non-respondents (%) $n = 2602$ | Mid–1998 resident population (%) $n = 2\,155\,600$ |
|---|---|---|---|
| **Sex** | | | |
| Male | 46.2 | 54.2 | 50.1 |
| Female | 53.8 | 45.8 | 49.9 |
| **Age (years)** | | | |
| 18–29 | 25.5 | 32.3 | 26.1 |
| 30–39 | 32.0 | 31.5 | 28.0 |
| 40–49 | 24.6 | 9.5 | 24.3 |
| 50–59 | 10.6 | 9.2 | 13.4 |
| 60–69 | 7.3 | 7.5 | 8.2 |
| **Ethnic group** | | | |
| Chinese | 68.3 | 57.4 | 79.9 |
| Malay | 18.0 | 26.1 | 12.7 |
| Indian | 13.7 | 16.5 | 7.4 |
| **House type** | | | |
| Public flat (1–3 rooms) | 23.5 | 33.2 | 30.5 |
| Public flat (4 rooms) | 37.4 | 33.9 | 33.6 |
| Public flat ($\geqslant$ 5 rooms) | 23.3 | 17.0 | 19.4 |
| Private houses and flats | 15.8 | 15.9 | 16.5 |
| **Total** | **100.0** | **100.0** | **100.0** |

Table 2. **Comparison of house type of survey respondents (weighted) and 1998 resident population**

| House type | Respondents (weighted %) $n = 4723$ | 1998 resident population[a] (%) |
|---|---|---|
| Public flat (1–3 rooms) | 22.4 | 30.5 |
| Public flat (4 rooms) | 36.7 | 33.6 |
| Public flat ($\geqslant$ 5 rooms) | 23.6 | 19.4 |
| Private houses and flats | 17.3 | 16.5 |
| **Total** | **100.0** | **100.0** |

[a] Data from the house-type distribution of the random sample of eligible household units selected in the enumeration phase of the National Health Survey in 1998.

than in the resident population (30.5%). As this difference was not large, it is likely that this introduced minimal bias into risk factor prevalence estimates.

There may have been underreporting of cigarette smoking and overreporting of physical exercise, as these measures were self-reported. To minimize these potential biases, the same questions relating to these measures were used in both the 1992 and 1998 surveys and interviewers were carefully trained. Misclassification of blood pressure status was minimized by using a standard protocol and repeat measurements, and the same carefully trained nurses measured blood pressure throughout the survey.

Table 3. **Age-standardized[a] prevalence of major factors influencing cardiovascular disease risk, 1992 and 1998**

| Risk factor | Prevalence[b] (%) | | | | | | | | | Significance[c] | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Men | | | Women | | | Total | | | Men | Women | Total |
| | 1992 $n = 1803$ | 1998 $n = 2181$ | Difference | 1992 $n = 1765$ | 1998 $n = 2542$ | Difference | 1992 $n = 3568$ | 1998 $n = 4723$ | Difference | | | |
| Diabetes mellitus | 8.6 | 7.7 | −0.9 | 8.1 | 8.4 | 0.3 | 8.4 | 8.1 | −0.3 | NS | NS | NS |
| Impaired glucose tolerance | 13.9 | 14.0 | 0.1 | 13.9 | 13.7 | −0.2 | 13.9 | 13.9 | 0.0 | NS | NS | NS |
| Hypertension[d] | 26.2 | 30.2 | 4.0 | 18.7 | 23.0 | 4.3 | 22.5 | 26.6 | 4.2 | * | ** | *** |
| Obesity[e] | 4.0 | 5.2 | 1.2 | 6.2 | 6.6 | 0.4 | 5.1 | 5.9 | 0.8 | NS | NS | NS |
| High total blood cholesterol level[f] | 19.7 | 25.6 | 5.9 | 18.2 | 21.3 | 3.1 | 19.0 | 23.5 | 4.5 | *** | ** | *** |
| Smoking[g] | 33.5 | 26.5 | −7.0 | 2.9 | 3.2 | 0.3 | 18.4 | 15.0 | −3.4 | *** | NS | *** |
| Regular exercise[h] | 19.0 | 20.5 | 1.5 | 8.1 | 13.2 | 5.1 | 13.6 | 16.9 | 3.3 | NS | *** | *** |

[a] Age-standardized to the 1990 Singapore resident population.

[b] The prevalence of all risk factors is for people aged 18–69 years, except for hypertension which is for people aged 30–69 years.

[c] NS = not significant at the $P = 0.05$ level; * $0.01 < P < 0.05$; ** $0.001 < P < 0.01$; *** $P < 0.001$.

[d] Blood pressure $\geqslant 140/90$ mmHg.

[e] BMI $\geqslant 30$ kg/m$^2$.

[f] Total blood cholesterol $> 6.2$ mmol/l.

[g] At least 1 cigarette a day.

[h] At least 3 times a week; 20 minutes per session.

Table 4. **Age-standardized[a] prevalence of major factors influencing cardiovascular disease risk in 1998 by ethnic group**

| Risk factor | Prevalence[b] (%) | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Chinese | | | Malay | | | Indian | | |
| | Men $n = 1470$ | Women $n = 1758$ | Total $n = 3228$ | Men $n = 404$ | Women $n = 445$ | Total $n = 849$ | Men $n = 307$ | Women $n = 339$ | Total $n = 646$ |
| Diabetes mellitus | 7.0 (5.7–8.2)[c] | 7.1 (5.9–8.3) | 7.0 (6.2–7.9) | 8.5 (6.1–10.8) | 12.9 (10.2–15.7) | 10.7 (8.9–12.5) | 14.5 (11.3–17.6) | 14.6 (11.6–17.6) | 14.5 (12.4–16.7) |
| Impaired glucose tolerance | 13.4 (11.7–15.2) | 12.7 (11.2–14.2) | 13.1 (11.9–14.2) | 19.3 (15.5–23.2) | 19.0 (15.5–22.5) | 19.2 (16.6–21.8) | 10.5 (7.5–13.5) | 15.6 (11.7–19.6) | 13.0 (10.6–15.5) |
| Hypertension[d] | 30.9 (28.3–33.4) | 20.9 (18.9–23.0) | 26.0 (24.3–27.6) | 28.6 (23.8–33.5) | 36.0 (31.5–40.4) | 32.3 (29.0–35.5) | 26.3 (21.1–31.4) | 21.1 (17.1–25.1) | 23.7 (20.4–27.0) |
| Obesity[e] | 4.5 (3.4–5.6) | 3.0 (2.2–3.8) | 3.8 (3.1–4.4) | 8.7 (6.0–11.4) | 22.0 (18.2–25.8) | 15.3 (12.9–17.6) | 7.2 (4.1–10.3) | 17.5 (13.4–21.5) | 12.3 (9.7–14.8) |
| High total blood cholesterol[f] | 23.3 (21.3–25.4) | 20.2 (18.4–21.9) | 21.8 (20.4–23.1) | 38.4 (33.7–43.1) | 29.4 (25.7–33.1) | 34.0 (31.0–36.9) | 26.7 (21.8–31.7) | 19.1 (14.9–23.3) | 23.0 (19.7–26.2) |
| Smoking[g] | 23.4 (21.2–25.7) | 3.3 (2.4–4.2) | 13.5 (12.3–14.7) | 42.9 (37.8–48.0) | 3.7 (2.0–5.5) | 23.6 (20.9–26.3) | 29.3 (23.6–35.0) | 0.8 (0.0–1.8) | 15.3 (12.3–18.2) |
| Regular exercise[h] | 19.1 (17.0–21.1) | 12.4 (10.9–14.0) | 15.8 (14.5–17.1) | 23.5 (19.2–27.8) | 14.9 (11.5–18.2) | 19.3 (16.5–22.0) | 31.2 (25.3–37.0) | 18.7 (14.3–23.0) | 25.0 (21.3–28.7) |

[a–b] See footnotes a–b, Table 3.

[c] Figures in parentheses are 95% confidence intervals.

[d–h] See footnotes d–h, Table 3.

## Intervention programme

The goals of the 1992 National Healthy Lifestyle Programme in Singapore were to reduce smoking prevalence, increase exercise participation, and promote healthy diets among the population. An intensive month-long healthy lifestyle campaign, with activities in community venues, schools, and workplaces was held annually to supplement ongoing programmes. The Prime Minister led thousands of Singaporeans in mass exercise events in launching these campaigns and the mass media promoted healthy lifestyles throughout the year. To harness greater community involvement, a civic committee was appointed to oversee the National Healthy Lifestyle Programme from 1996, and was composed of members from both the public and private sectors, as well as voluntary organizations.

## Successes and failures

Singapore's approach in targeting the population at large appears to have had mixed results after six years. Notable successes were in reducing the rate of cigarette smoking among men, and increasing the proportion of people who exercised at least three times a week. However, smoking prevalence among young women aged 20–24 years rose, this being probably part of a trend seen in many countries. Increases in the prevalence of cigarette smoking among young women have been reported in Japan (15) and the USA (16). It is possible that smoking prevalence rose in this group as more young women rebelled against pervasive anti-smoking messages.

The programme was unsuccessful in reducing total blood cholesterol levels. The 1998 National Nutrition Survey reported that the dietary habits of Singaporeans changed between 1993 and 1998 (17). In 1993, only 72% of adult Singaporeans trimmed some or all visible fat when eating meat, compared to 87% in 1998. More people also partly or completely trimmed poultry skin in 1998 (81% vs 60% in 1993). However, the proportion consuming deep-fried foods three or more times a week remained about the same (approximately 45%). There was also no change in the pattern of cooking oil use. In 1998, the proportions of people who used either blended cooking oils, polyunsaturated oils, or monounsaturated oils most of the time were about the same as in 1993 (43%, 42%, and 13%, respectively).

The apparent success of the programme in reducing smoking and increasing exercise could be due to the multipronged strategy in these two areas, especially for smoking. Besides the mass media blitz, the smoking control programme employed legislative measures. A ban on all forms of cigarette advertising was continued and the number of public places where smoking was banned was also increased. In 1994, for example, smoking was banned in all air-conditioned offices and factories, and in taxi and bus queues in 1995. Fiscal measures (i.e. increasing tobacco taxes) increased the price of cigarettes and well-known sportsmen and television personalities were used as role models to discourage smoking. Messages in the mass media to exercise regularly were reinforced by mass exercise events, such as the annual Great Singapore Workout, led by the Prime Minister. On the other hand, public education to adopt healthier diets relied mainly on messages in the mass media and on exhibitions. Public education efforts to reduce cholesterol intake, for example, focused on substituting or eliminating foods high in fat or cholesterol from the diet.

## Similar interventions elsewhere

Multipronged strategies have also been successful in Finland and Mauritius. Between 1972 and 1992, dietary changes in the North Karelia province of Finland reduced the mean total serum cholesterol level in men by 16% (a decrease of 1.07 mmol/l). For example, the prevalence of high-fat milk consumption dropped from 70% to 14% among men and from nearly 60% to 10% among women. The North Karelian project was successful because the programmes were carefully monitored and were responsive to changing community situations. The project also stressed efforts to teach practical skills for change, such as ways of buying and cooking healthier foods. The food and retail industries were also involved in producing and marketing healthier foods, thereby increasing their availability to the general public (18).

In Mauritius, the mean population serum cholesterol level fell from 5.5 mmol/l in 1987 to 4.7 mmol/l in 1992, after five years of a nationwide noncommunicable disease intervention programme coordinated by the Mauritius Ministry of Health. The improvement in the population lipid profile was attributed to a change from using a local cooking oil rich in palm oil to one with almost 100% soybean oil, with its lower saturated fat content (19). This demonstrated that dramatic effects could be brought about by measures other than public health education.

In most countries, healthy lifestyle programmes, such as those aimed at stopping smoking and adopting regular exercise, are based on public education without intensive annual campaigns, such as those carried out in Singapore. This may be due to the logistical difficulties of organizing annual campaigns in large countries. Nonetheless, smoking rates among adults in the USA declined steadily from the mid-1960s through to the 1980s, before levelling off in the 1990s at about 25% (20). The proportion of adults in the USA who engaged in vigorous physical activity at least three times a week also rose from 15% in 1991/92 (21) to 23% in 1997 (22). In England, the prevalence of cigarette smoking among people aged 16 years or older fell from 31% in 1991/92 (23) to 27% in 1999 (24). Over the same period, the mean total blood cholesterol level in the population also fell from 5.8 mmol/l to 5.5 mmol/l in men, and from 5.9 mmol/l to 5.6 mmol/l in women (23, 24).

## Current interventions in Singapore

The Ministry of Health in Singapore has reviewed the strategies used between 1992 and 1998 to reduce the prevalence of cardiovascular disease risk factors in the population. Successful strategies have been continued and strengthened. New strategies have included targeting higher-risk groups for education and other intervention programmes, increasing community participation, and intensifying programmes to promote health in the workplace. The food industry has been involved to a greater extent to help promote healthier dietary habits, such as by providing nutritional information at the point of sale, including nutrition labels and nutrition information at eateries. The promotion of healthier food choices in eateries has also been expanded. Media messages on healthy lifestyles have continued, but have been more focused. ∎

**Conflicts of interest:** none declared.

## Résumé

### Evolution des facteurs de risque cardio-vasculaire à Singapour à la suite d'un programme national d'intervention

**Objectif** Evaluer l'impact du National Healthy Lifestyle Programme, un programme d'intervention contre les maladies non transmissibles axé sur les principaux facteurs de risque de maladie cardio-vasculaire à Singapour, mis en œuvre en 1992 dans le but de promouvoir des modes de vie favorables à la santé.

**Méthodes** L'évaluation a été réalisée en 1998 dans le cadre d'une enquête nationale sur la santé (Singapore National Health Survey). La population de référence, multiraciale, se composait de 2,2 millions d'habitants de Singapour âgés de 18 à 69 ans. Pour l'enquête en population, un échantillon ($n =$ 4723) a été constitué selon une méthode d'échantillonnage systématique de type stratifié non proportionnel. Les paramètres anthropométriques et la tension artérielle ont été mesurés sur tous les sujets et des prélèvements de sang ont été réalisés pour les analyses biochimiques.

**Résultats** Les résultats de 1998 laissent à penser que le National Healthy Lifestyle Programme a réduit de façon significative le tabagisme régulier et augmenté la pratique régulière de l'exercice physique par rapport aux valeurs de 1992, et stabilisé la prévalence de l'obésité et du diabète sucré. En revanche, la prévalence de l'hypercholestérolémie (cholestérol total) et de l'hypertension a augmenté. Des différences interethniques au niveau de la prévalence du diabète sucré, de l'hypertension et du tabagisme ainsi qu'au niveau du profil lipidique et de l'exercice physique ont également été observées.

**Conclusion** Six ans après le début de l'intervention, les résultats sont variables. Les stratégies réussies seront poursuivies et renforcées.

## Resumen

### Magnitud de los factores de riesgo cardiovascular en Singapur tras un programa nacional de intervención

**Objetivo** Evaluar el impacto del Programa Nacional de Modos de Vida Sanos, una intervención emprendida en 1992 en el ámbito de las enfermedades no transmisibles con objeto de controlar los principales factores de riesgo de enfermedad cardiovascular en Singapur.

**Métodos** La evaluación se llevó a cabo en 1998 como parte de la Encuesta Sanitaria Nacional (NHS) de Singapur. La población de referencia estaba constituida por 2,2 millones de residentes en Singapur de diversas etnias entre 18 y 69 años de edad. Se seleccionó una muestra encuestal basada en la población ($n = 4723$) mediante técnicas de muestreo estratificado y sistemático no proporcional. Se efectuaron mediciones antropométricas y de la tensión arterial en todos los individuos y se tomaron muestras de sangre para someterlas a análisis bioquímicos.

**Resultados** Los resultados de 1998 parecen indicar que el Programa Nacional de Modos de Vida Sanos redujo significativamente el tabaquismo regular y aumentó la práctica habitual de ejercicio respecto a los niveles de 1992, y además estabilizó la prevalencia de obesidad y de diabetes mellitus. Sin embargo, aumentó la prevalencia de colesterolemia y de hipertensión. Se observaron asimismo diferencias étnicas en cuanto a la prevalencia de diabetes mellitus, hipertensión y tabaquismo, perfil lipídico y niveles de ejercicio.

**Conclusión** Al cabo de seis años los resultados de la intervención eran dispares. Se mantendrán y reforzarán las estrategias exitosas.

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