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The Seychelles Cardiovascular Diseases Survey 1989

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Cardiovascular diseases are becoming increasingly important in developing countries and will be the leading cause of death in many of them by the year 2000[1]. This transition to chronic disease is due to a combination of the aging of these populations, the improved control of infectious disease, and detrimental changes in diet, smoking and other lifestyle factors[2]. These issues should receive appropriate attention because strategies for limiting the impact of cardiovascular diseases have been formulated[3] and could, if introduced promptly, be effective and less demanding on the limited resources of developing countries than focusing solely on the presently promoted therapeutic approach.

High rates of cardiovascular diseases were observed in the Seychelles. Cardiovascular diseases were attributable for as many as 39.5% of all deaths in 1989 according to the official mortality statistics (using the 9th version of the international classification of diseases). Hypertensive disease, myocardial infarction and cerebrovascular disease were attributable for 8.4, 8.0 and 5.9% of all deaths, respectively.

It has therefore appeared mandatory to survey the current levels of risk factors for cardiovascular diseases in the population of the Seychelles in order to provide substantial information for planning in the health field. Other data of major public health interest could be obtained incidentally from this population based survey and are also briefly described.

Organizational framework of the survey

The Seychelles Cardiovascular Survey was initially designed as a collaborative project of the Ministry of Health of the Seychelles and the Department of Cooperation of the Jura Canton (Switzerland), which has been regularly providing technical assistance to the Seychelles for the last decade. Extensive expertise and laboratory assistance were provided by many departments of the University of Lausanne (Medical Policlinic, Institute of Physiology, Department of Immunology and Institute for Social and Preventive Medicine). Expertise was also obtained from the Cardiovascular Unit of the World Health Organization in Geneva (Switzerland). Within the Seychelles, this nation wide survey involved personnel, expertise, and services from many departments of the Ministry of Health (Epidemiology and Research Unit, Victoria Hospital, District Clinics), as well as from other organisms (Information and Systems Division, National Journal and Radio Television, etc.).

General description of the Seychelles

The Republic of the Seychelles is a group of 115 islands, located in the Indian Ocean and lying between longitudes 46° and 56° E and latitudes 3° and 10° S, approximately 1800 km east of Kenya and 1800 km north east of the island of Mauritius. The main islands are granitic and rise rather steeply out of the sea, leaving only a narrow coastal shelf. The temperature ranges on the coast from 21 to 34° Celsius (mean 26.1). The average rainfall varies from 1800 to 3000 mm yearly. Humidity averages 80%.

The total population of the Seychelles was 66,370 in 1987. Less than 20 islands are permanently inhabited. The most populated islands are Mahé (with 59,000 people from which 16,000 live in the capital, Victoria), Praslin (5000) and La Digue (1800). The outlying islands (mostly of coraline formation) are either uninhabited or inhabited only by a more or less mobile labour population. 36% of the population were under 15 years and 58% under 25 years in 1987.

The islands had no indigenous population until 1771 when French settlers arrived and were joined later by people of African, Indian and Chinese origin. Seychelles colonial era stretched for 205 years from 1771 to 1976. It spanned the rule of the French until 1814 and of the British until political independence in 1976. Since 1977, the Seychelles have been politically organized as a one party socialist state, with a mixed economy.

Although no census of the different ethnic groups is available and a great deal of intermarriage has blurred racial differences for many Seychellois, it

was considered from the survey that around 68% are of predominantly black African origin, 7% of predominantly Caucasian origin, 3% of Indian or Chinese origin, the remaining 22% being obviously mixed between these various groups. The national language of the Seychelles is creole, while english and french are official languages. The main religions are roman catholic (more than 80% of the population) and anglican.

The Seychelles is a country with few natural resources except for the richness of its seas. On land, the main economic activity has traditionally been in the production of copra and cinnamon bark. Since the opening of the international airport in 1971, tourism (mostly from European countries) has become the major industry of the Seychelles and nearly 60% of the income of the goods and services account was represented by tourism in 1988. The material standard of living has dramatically improved within the last decade and the gross national product per capita in constant prices rose from 2260 to 3452 US dollars between 1983 and 1987. The World Bank suggested that the Seychelles has now become a middle level income country[4].

Education is free of charge at all levels. Crèche education (pre-school) starts at age of 3½ and enrolment exceeds 95%. Formal schooling starts at the age of 5½ to 6. Primary education consists of a 9 year elementary and compulsory schooling and enrolment ratio exceeds 95%. The 2 first years of secundary education are provided in the National Youth Service during which students are boarders in one of the 4 National Youth Service Villages and enrolment also exceeds 95%. A following 2–3 year specific professional training is provided in Polytechnic School and is achieved by around 40–50% of adolescents. Many students are yearly offered a further training in abroad Universities or other professional institutions.

The Seychelles benefit of a fairly elevated standard of health care, and the medical services are available at no cost to every inhabitant since 1979. There are 17 community clinics with around one doctor for 3000 persons and one nurse for every 500 persons. There are 2 Cottage Hospitals staffed by community doctors and a 250 beds General Hospital in the capital which has Consultants in the main broad speciality areas. Mean life expectancy is 65 years for men and 71 years for women; infant mortality rate has been reduced below 20 per 1000 live births in the past decade; immunization coverage is higher than 95%[5]. The major tropical scourges, such as malaria, leishmaniasis, yellow fever, sleeping sickness, and bilharziasis are unknown in the Seychelles.

Population and methods

The survey was designed as a cross-sectional study. The study area was located to the main island of the archipelago, Mahé, whose size is 25 by 10 km and counts for 90% of the total population of the Seychelles. Computed data from a national census carried out in 1987 were used for the sampling. A simple age- and sex-stratified random sample was drawn from the population of 19,130 inhabitants aged 25–64 and residing in Mahé. Foreigners were excluded. The sampling was performed as illustrated in Figure 1. Thus, the study population was represented by 1251 people consisting of eight 10-year age-sex strata with 130 to 171 people each. Among the 1251 individuals (615 men, 636 women) eligible to take part in the survey, the response rate was 83.4% for men and 89.3% for women (Figure 2). For 52.9% of the non participants were both convocation letter and recall letter returned unopened, due to inadequate available address (Table 1).

The data gathered through interview and physical examination followed the general guidelines of the international MONICA (MONItoring trends and determinants of CArdiovascular diseases) Project launched by the World Health Organization (WHO)[6,7].

Data gathering

The data gathering phase lasted from April to September 1989. All sampled people were sent a personal letter inviting them to attend the survey at a specified date around 2 weeks later. If certain people were not present on examination day, every effort was made to trace them somehow, at least through one telephone call (when available) and a second letter. Ten examination centers were organized in succession throughout the island so that most people could reach their allocated center within 30 minutes walk (or less by bus for which fares were refunded). Extensive information on the survey was repeatedly given within the whole survey period through the national newspaper, radio and television.

People were asked to come between 8 and 9 a.m. After a rest of at least 15 minutes, they had to submit in succession to a first blood pressure (BP) measurement, a drawing of blood, another rest of at least 15 minutes together with a snack, the recording of weight and height and a standardized interview followed by 2 more BP measurements (Figure 2). Around 15 persons were convoked every day. The same medical team collected the data during the entire survey period, i.e., one doctor, three nurses and one dietician.

Interview

All the participants were subjected to an interview in a quite and secluded place. All the participants were asked a total of 130 questions according to a standardized questionnaire. The questions covered the following topics: sociodemographic variables, history of hypertension, attitudes and knowledge concerning hypertension, smoking habits, history of diabetes, asthma, physical activity, medication history, self-evaluation of health status, use of medical care and food and drinking habits. The whole interview could be completed within 15 to 30 minutes.

Smoking habits. As cigar or pipe smokers are rare in the Seychelles, data on smoking focussed on cigarette smoking and were assessed by standard questions[7,8]. A "current cigarette smoker" was a participant who admitted smoking at least 1 cigarette per day on average. A "non-smoker" was a participant who reported smoking less than 1 cigarette per day on average. An "ex-smoker" was a participant who reported currently smoking less than 1 cigarette per day on average but used to smoke at least 1 cigarette per day in the past.

Diet and alcohol habits. For consumption of fish, meat and eggs, questions applied to the estimated weekly average consumption, assessed separately for lunch and dinner ("Did you have fish for lunch: almost every day, about every other day, 1–2 times per week, less than once per week?"). Questions on consumed fruit, vegetables snacks and non alcoholic drinks applied to the day preceding the interview (i.e., "Did you have any of the following fruit (...) yesterday?"). Questions on alcohol consumption were asked at the end of the interview. Six different varieties of alcohols are available in Seychelles, either commercially marketed (beer, spirit and wine) or home brewed (fermented palm sap juice [kalou], fermented sugar cane juice [baka] and fermented juice of various vegetables or fruit [lapire]). These drinks are available in standard measures so that an estimation of the alcohol intake could be obtained. The consumption of alcohol was assessed separately in regard to these various types and in regard to weekdays and weekend consumption (i.e., "How many bottles of beer do you usually drink on weekdays [respectively on weekends]"?).

Ethnic origin

Because of a great deal of intermarriage having blurred racial differences for many Seychellois, an appreciation regarding the ethnic origin of participants was not based on questions but on an arbitrary assessment done by the same person throughout the survey. The considered groups were "predominantly black", "predominantly white", "mixed", "Indian looking", "Asiatic looking".

Physical examination

Body mass index. Body-mass index (BMI) was calculated as weight divided by height squared (kg/m^2) to characterize the relative weight of responders. Height and body weight were measured with the subject in a standing position, without shoes and heavy outer garments. Height was measured to the nearest 0.5 cm. Weight was measured with an electronic balance scale (Seca Model 708, Germany) and recorded to the nearest 100 g. The scale was checked for accuracy by the Seychelles Bureau of Standards. Obesity was defined as a BMI > 30[9].

Blood pressure. Mercury sphygmomanometers were used for BP measurements. One first BP measurement was determined around 15 minutes after arrival of the patient. Two other BP recordings were taken at 2 minute interval after completion of the interview without the subject having moved from his chair, so that each person had been in the same sitting position for at least 15 minutes and in a quiet environment (mostly sitting) for at least 1 hour before the 2 last BP were measured. Blood pressure was measured to the nearest 2 mm Hg, on the right arm, in a sitting position, under standardized conditions[7,8]. Two cuff sizes (bladder width 12 and 14 cm) were used, the bigger cuff being used for those subjects whose middle arm circumference exceeded 34 cm. All results concerning BP values were based on the first and fifth phase of Korotkoff sounds and on the calculation of the average of the second and third BP regardings. Hypertension was defined according to the WHO criteria, i.e., systolic blood pressure (SBP) $\geqslant 160$ and/or diastolic blood pressure (DBP) $\geqslant 95$ mm Hg. Actual hypertension comprised the categories hypertension and controlled hypertension. Controlled hypertension applied to participants who knew about their elevated BP, who were on antihypertensive medication, and whose BP values at the survey examination were below 160 mm Hg SBP and 95 mm Hg DBP.

Blood analyses

Blood samples were obtained from all patients after an overnight fast. Collection was made between 8 and 10 a.m. and were taken from the antecubital vein after a rest of at least 20 minutes. All samples were tested for glucose, insulin,

total cholesterol, HDL-cholesterol, triglycerides, apoprotein Al, apoprotein B, lipoprotein (a), simple blood count and anti-HTLV-1 antibody. Except for blood sugar and simple blood count measurements which were determined in the Seychelles and for which whole blood was used, all the other analyses were done on serum and analyzed in Switzerland. Serum was obtained within 6 hours of blood drawing and immediately stored at $-20°$ Celsius. All the serum samples were regularly sent to Switzerland in dry-ice cooled containers through 9 hour direct flights and were kept frozen throughout the whole period preceding the analyses. Blood sugar was measured immediately, full blood count was analyzed within 24 hours, lipid determinations were performed within 3 months, HTLV-1 within 4 months and insulin within 6 months after drawing blood. Analysis could not be made because of inadequate storage procedures or shortage of serum in 26 cases for HTLV-1, 32 cases for cholesterol, HDL-cholesterol and triglycerides, 43 cases for apolipoproteins and lipoprotein (a), 110 cases for simple blood count and 208 cases for insulin.

Cholesterol and triglycerides. Total cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides were determined in the Medical Policlinic, University of Lausanne, Switzerland. Total cholesterol and triglycerides were determined by enzymatic-kit-methods (MA-Kit 30 Cholesterol MAP, Roche; Glycerol-3-Phosphate-Oxydase, Peroxydase, PAP, Wako). HDL-cholesterol was similarly quantified in the supernatant obtained after precipitation of lipoproteins other than HDL using a standardized phosphotungstic acid and $MgCl^2$ precipitation method (HDL Reagent, Roche). A Cobas Bio auto-analyzer was used. Monthly external controls were performed by the Swiss Quality Control Center for Lipids in La Chaux-de-Fonds. Means ($\pm$ SD) differed from controls by 5.1% ($\pm$ 5.5) for cholesterol and 3.7% ($\pm$ 5.0) for triglycerides.
Elevated cholesterol was defined as values of total cholesterol $>$ 5.2 mmol/l (200 mg/dl) while hypercholesterolemia was defined as total cholesterol values $\geqslant$ 6.5 mmol/l (250 mg/dl)[10]. Atherogenic index was calculated as total cholesterol divided by HDL-cholesterol to characterize the individual cholesterol risk profile. Values lower than 5.0 characterized low risk individuals while values greater than 6.5 defined subjects with elevated risk. Low density lipoprotein (LDL) cholesterol was calculated according to the formula of Friedwald[11]; LDL-cholesterol = total cholesterol – (HDL-cholesterol) – (triglycerides/2.2), all values being expressed in mmol/l. The classification of hyperlipidemias according to Fredrickson followed the criteria described by Manninen[12]; type IIa: LDL-cholesterol $>$ 4.5 mmol/l, triglycerides $<$ 2 mmol/l; type IIb: LDL-cholesterol $>$ 4.5 mmol/l, triglycerides $>$ 2 mmol/l; type IV: LDL-cholesterol $<$ 4.5 mmol/l, triglycerides $>$ 2 mmol/l.

Apolipoproteins and lipoprotein (a). Apolipoprotein Al (apo Al), apolipoprotein B (apo B) and lipoprotein (a) were determined in the Lipid Laboratory of the Tiefenau Hospital, Bern, Switzerland. Apolipoproteins Al and B were measured by a radial immunodiffusion kit (Behring). Lipoprotein (a) was measured by radioimmunoassay (Pharmacia).

Blood sugar. Whole venous blood glucose was determined immediately after blood drawing using a reflectance meter (Reflomat, Boehringer, Mannheim, Germany). Diabetes mellitus diagnosis was based on the criteria of the National Diabetes Data Group[13], modified for measurements of whole blood instead of plasma glucose. One fasting blood glucose $\geqslant$ 10 mmol/l or two fasting whole blood glucose $\geqslant$ 6.7 mmol/l on two separate days were taken as diagnostic of diabetes mellitus. In order to detect falsely elevated blood glucose due to food consumption, the individuals (n = 115) who had a blood glucose $\geqslant$ 6.7 mmol/l at the initial collection had when possible (n = 80) their blood sugar checked again 90 to 120 minutes later. With this procedure, 35 individuals were considered as likely to be in a posprandial state on the basis of an elevated blood glucose which returned to normal after at least 90 minutes and were not considered as diabetics. Individuals (n = 45) with a fasting blood glucose between 6.7 and 9.9 mmol/l were recalled on another day. The second evaluation was performed within 3 months (n = 41) and consisted in the collection of a fasting venous blood sample (obtained after a 20 min resting period) for determination of blood glucose. Patients currently on antidiabetic medication and with fasting blood glucose $<$ 6.7 mmol/l (n = 2) were reassessed at least 3 days after discontinuation of therapy to confirm (n = 0) or refute (n = 2) the diagnosis.

Insulin. Insulin determinations were assayed in the Department of Physiology, University of Lausanne, Switzerland. Insulin concentration was measured in frozen serum using a charcoal-coated radioimmunoassay.

Simple blood count. Hemoglobin and hematocrit were determined in the laboratory of the Victoria Hospital using an automatic cell counter (Minos 7, ABX, France).

HTLV-1 antibodies. Antibody to human T-lymphotropic virus type I (HTLV-1) was determined in the Department of Immunology, Uni-

versity Hospital, Lausanne, Switzerland. A commercially available enzyme immunoassay (Abbott HTLV-1 EIA; Abbott Laboratories, North Chicago, USA) was used.

Data management and statistics

Means, standard deviations, percentiles and prevalences were used to characterize the frequency and distribution of the data, separately for sex and age subclasses. In addition to the crude age- and sex-stratified figures, data was weighted for age separately for men and women in order to get estimates of population parameters for the entire population group aged 25–64 years. Based on the Seychelles demographic data available in 1987[14], the weights attributed to the 25–34, 35–44, 45–54 and 55–64 years age groups were 48/100, 22/100, 17/100 and 13/100 for men, and 42/100, 22/100, 20/100 and 17/100 respectively for women.
Data from other national surveys[15–19] has been provided in order to enable comparison of risk factor levels found in the Seychelles with those of various industrialized and developing countries. When data of the Seychelles was compared with data of countries having participated in the international WHO MONICA Project, world standard population weights were used, respectively 12/31, 10/31, 8/31 for both male and female age groups 35–44, 45–54 and 55–64 years[15].
To further characterize features associated to risk factors, clinical and biological data was determined for subjects with or without definite risk factors (e.g., mean cholesterol level or obesity prevalence in smokers and non smokers). The subjects without the definite risk factor were matched for age. Average means were compared using univariate analysis. Prevalences were compared using Poisson's rates. 95% confidence limits were defined for all statistical procedures. Because of the descriptive nature of the study, no corrections were made for multiple statistical tests.
The statistical package Statgraphics (STSC Inc. Rockville, USA) was used for all statistical procedures.

References

1 *Manton KG.* The global impact of non communicable diseases: Estimates and projections. Wld Hlth Statist Quart 1988; *41*: 190–196.
2 Expert Committee on Prevention of Coronary Heart Disease. WHO Technical Report Serie No 678. World Health Organization, Geneva, 1982.
3 *Omran AR.* The epidemiologic transition: A theory of the epidemiology of population change. Milbank Memorial Fund Quart 1971; *49*: 509–538.
4 Seychelles: Economic Memorandum. I.B.R.D. World Bank, Washington, 1980.
5 Country programme profile: Seychelles. United Nations Children's Fund. Programme Committee. 1984 session.
6 *Tunstall-Pedoe H.* The World Health Organization MONICA Project (Monitoring trends and determinants of cardiovascular diseases): A major international collaboration. J Clin Epidemiol 198; *41*: 105–114.
7 MONICA Manual CVD/MNC/Version 1.1. World Health Organization, Geneva, 1986.
8 *Rose GA, Blackburn H, Gillum RF, Prineas RJ.* Cardiovascular survey methods. WHO monograph series No 56. World Health Organization, Geneva, 1984.
9 *Bray GA.* Classification and evaluation of the obesities. Med Clin North Am 1989; *73*: 161–184.
10 National Diabetes Data Group. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. Diabetes 1979; *28*: 1039–1057.
11 National Cholesterol Education Program. Report of the expert panel on detection, evaluation and treatment of high blood cholesterol in adults. Arch Intern Med 1988; *148*: 36–69.
12 *Friedwald WT, Levy RI, Fredrickson DS.* Estimation of concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; *18*: 499–502.
13 *Manninen V, Flo O et al.* Lipid alterations and decline in the incidence of coronary heart disease in the Helsinky Heart Study. J Amer Med Ass 1988; *260*: 641–651.
14 Population and vital statistics. Statistical abstract 1987. Information Systems Division, Victoria, Seychelles, 1988.
15 WHO MONICA Project. Geographical variation in the major risk factors of coronary heart disease in men and women aged 35–64 years. Wld Hlth Statist Quart 1988; *41*: 115–140.
16 *Gurney M, Gorstein J.* The global prevalence of obesity: An initial overview of available data. Wld Hlth Statist Quart 1988; *41*: 251–254.
17 *Nissinen A, Böthig S, Granroth H, Lopez A.* Hypertension in developing countries. Wld Hlth Statist Quart 1988; *41*: 141–154.
18 *Masironi R, Rothwell K.* Smoking trends and effects worldwide. Wld Hlth Statist Quart 1988; *41*: 228–241.
19 *King H, Zimmet P.* Trends in the prevalence and incidence of diabetes: Non insulin dependent diabetes mellitus. Wld Hlth Statist Quart 1988; *41*: 190–196.