HYPERGLYCEMIA AND CORONARY RISK FACTORS
RESULTS FROM WESTERN AUSTRIA

B. SCHWARZ*, H.P. BISCHOF** and M. KUNZE*

*Institut für Sozialmedizin, University Vienna, Alserstrasse 21/12 - A-1080 Vienna - Austria.
**Internal Department State Hospital Bregenz - Austria

Key words: Coronary risk - Hyperlipidemia - Hypertension - Hyperglycemia - Overweight - WHO-CINDI - Epidemiology

We investigated mean levels and prevalences of total cholesterol, HDL cholesterol, triglycerides, fasting blood glucose, systolic blood pressure and body mass index in adults aged 25 to 64 years participating in the WHO Country-wide Integrated Noncommunicable Diseases Intervention (CINDI) Programme in Vorarlberg, western Austria. According to the Austrian expert panel and based upon the above age standardized risk factors 50.9% of the male and 29.3% of the female population were at high risk for developing coronary heart disease. Risk factor levels were further compared between euglycemic and hyperglycemic participants. After adjusting for age hyperglycemia was associated with higher body mass index in men (p = 0.026) and women (p < 0.001), higher systolic blood pressure in men (p < 0.001) and women (p = 0.003), and higher levels of triglycerides in women (p = 0.008). No significant differences were observed in total and HDL cholesterol in either sex. When controlling for age and body mass index, fasting blood glucose levels had significant associations only with systolic blood pressure in men (p = 0.001). But, with respect to all risk factors, hyperglycemic participants had an age-adjusted adverse coronary risk profile both in men (p = 0.002) and in women (p < 0.001).

INTRODUCTION

Cardiovascular diseases are the main cause of morbidity and mortality in developed countries (36). A number of studies have associated hyperglycemia with other coronary risk factors such as hyperlipidemia, hypertension, and overweight (21, 24, 34). A cumulation of coronary risk factors is additive or even multiplicative (14, 29). Therefore the presence of only small abnormalities of these risk factors significantly increases coronary risk. Further more, some studies indicate that hyperglycemia has an independent effect on coronary heart disease (13, 17, 31).

The purpose of the present study was to collect descriptive data on risk factors for coronary heart disease in Vorarlberg, Austria, and to compare coronary risk factor profiles of euglycemic and hyperglycemic adults. Coronary risk factors included in the analysis were total cholesterol, high-density lipoprotein (HDL) cholesterol, fasting blood glucose, triglycerides, systolic blood pressure, and body mass index.

POPULATION AND METHODS

Vorarlberg is the westernmost state of Austria located on the border of Switzerland and the Federal Republic of Germany. In 1986, a sample of 2,400 men and women between 25 and 64 years of age (300 per ten-year age group per sex) was randomly selected from electoral lists for the WHO Country-wide Integrated Noncommunicable Diseases Intervention.
(CINDI) Programme. The sample was drawn from 31 communities with a total number of inhabitants of 124,000 aged 25 to 64 years. Details of the protocol and guidelines have already been published (16) as well as specific results of the survey (27).

In brief, the selected individuals were invited to a general practitioner for a medical examination. The examination consisted of measuring height and weight, after the participants had removed shoes and upper garments, with body mass index calculated as weight in kilograms divided by height in meters squared (kg/m²). Blood pressure was measured with standard sphygmomanometers in the sitting position and samples of fasting blood were taken. People on dietary or drug treatments were not excluded from the survey.

Blood samples were measured with an automatic analyzer. The following methods were used: total cholesterol was determined by means of the enzymatic colorimetric test CHOD–PAP (28), triglycerides by means of an enzymatic method TRIG GPO PAP (6) high density lipoprotein (HDL) cholesterol by enzymatic means, after precipitation with phosphotungstic acid and magnesium chloride (4), and fasting blood glucose level by the hexokinase method (23). External quality assessment was performed in accordance with the research center of the World Health Organization in Prague.

1,372 participants, 57.2%, were included in the analysis of the descriptive data and 1,351 participants, 56.3%, in the comparison between euglycemic and hyperglycemic participants. The response varied by sex and ten-year age group from 47.0% to 71.0% and 46.7% to 69.7% respectively. The low response rate was mainly due to financial limitations which prohibited a more intensive invitation procedure.

We computed mean values and standard deviations of total cholesterol, HDL cholesterol, triglycerides, fasting blood glucose, systolic blood pressure, and body mass index in both sexes for each ten-year age group, and age-standardized to the SEGI world population (5) for the total age range (25–64). This age standard is almost equal to the age standard of the population of Vorarlberg based on the last population census in 1981. Means of the above risk factors were also calculated by adjusting for age for euglycemic (fasting blood glucose levels below 100 mg/dl) and hyperglycemic participants (fasting blood glucose levels equal or greater 100 mg/dl). This benchmark was chosen following the recommendations of the WHO (35). Age-adjustment was performed with the direct method (22) by giving equal weight to each ten year age group.

To compare the age-adjusted risk factor means of euglycemic and hyperglycemic participants the two-tailed paired t-test was performed (22). As a consequence of significant differences in body mass index between euglycemic and hyperglycemic men and women we performed multiple regression analysis with fasting blood glucose, age and body mass index as independent variables and risk factors as dependent variables. For both procedures risk factors were log-transformed and tested for normal distribution.

In addition, sex-specific prevalences of coronary risk factors was calculated by sex and ten-year age group, and age-standardized to the SEGI world population (5) in the total age range. An age-adjusted prevalence was then calculated in participants with normal and elevated fasting blood glucose levels. Age-adjustment was performed as previously mentioned. The definitions of risk factors were chosen according to major expert statements. Total cholesterol levels of 200 mg/dl or more, HDL cholesterol levels below 35 mg/dl and triglyceride levels of 200 mg/dl or more were defined as lipid disorders following the NIH recommendations (19), the recommendations of the European Atherosclerosis Society (8) and the guidelines of the Austrian expert panel (15). Hypertension was defined as systolic blood pressure above 140 mmHg according to the WHO (36). Overweight was defined as a body mass index greater than 27.8 kg/m² in men and a body mass index greater and 27.3 kg/m² in women, following the NIH recommendations (20). To compare the sex-specific age-standardized prevalence of risk factors among participants with normal and elevated fasting blood glucose levels the chi-square test was performed (22).

For comparison of coronary risk factor patterns of euglycemic and hyperglycemic participants we calculated the age-adjusted percentage of participants with 0 to 5 of the above risk factors by fasting blood glucose level and sex. Differences in risk profiles between participants with normal and elevated fasting blood glucose level were tested with the chi-square test (22). As a consequence of expected frequencies below 5 in the category “5 risk factors”, this category was pooled with the category “4 risk factors” in the chi-square test.

RESULTS

Table 1 shows mean levels and standard deviations of total cholesterol, HDL cholesterol, triglycerides, fasting blood glucose, systolic blood pressure, and body mass index by sex and age. The age-standardized mean of total cholesterol was 224 mg/dl in men and 221 mg/dl in women, age-standardized mean of HDL cholesterol was 57 mg/dl in men and 66 mg/dl in women.

Age-adjusted means of coronary risk factors by categories of fasting blood glucose level and sex are presented in Table 2. Log-body mass index was higher among hyperglycemic in men (p = 0.026) and women (p < 0.001). Log-triglyceride levels were significantly higher only among hyperglycemic women (p = 0.008). Means of log-systolic blood pressure were significantly higher both in males (p < 0.001) and in females (p = 0.003) with elevated fasting blood glucose level. In both sexes no significant differences were found in log-total cholesterol and log-HDL cholesterol. In multivariate analysis when controlling for age and