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Lifestyle behaviour and lifetime incidence of heart diseases

Alessandro Menotti [a], Paolo Emilio Puddu [b,*], Giuseppe Maiani [c], Giovina Catasta [c]

[a] Association for Cardiac Research, Rome, Italy
[b] Department of Cardiovascular, Respiratory, Nephrological, Anesthesiological and Geriatric Sciences, Sapienza University of Rome, Rome, Italy
[c] CRA Agricultural Research Council — Research Centre on Food and Nutrition (CRA-NUT), Rome, Italy

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ABSTRACT

Objectives: Investigate the relationship of some behavioural characteristics of a male population with lifetime incidence of heart diseases.
Material and methods: In the Italian Rural Areas of the Seven Countries Study of Cardiovascular Diseases, 1677 heart disease-free men aged 40–59 years were followed up during 50 years for lifetime incidence of heart disease up to the age of 90 years. They were classified as coronary heart disease (CHD) and heart diseases of uncertain etiology (HDUE). Baseline cigarette smoking habits (non-smokers and ex-smokers, moderate smokers, heavy smokers), physical activity (sedentary, moderate, vigorous) and eating habits (non-Mediterranean Diet, Prudent Diet and Mediterranean Diet) were related to incidence of heart disease.
Results: Incidence of CHD and HDUE up to the age of 90 years was 28.8 and 17.7%, respectively. Univariate and multivariate analyses showed strong association of behavioural characteristics with CHD incidence, but not with HDUE incidence. Cox proportional hazard rates for CHD were 1.45 (95% confidence intervals, CI: 1.11–1.90) for heavy smokers versus non-smokers; 0.67 (CI 0.50–0.89) for vigorous activity versus sedentary habits and 0.62 (CI 0.47–0.83) for Mediterranean Diet versus non-Mediterranean Diet. Combining CHD cases with HDUE cases made the predictive picture similar to that of CHD. When some basic risk factors were added to the model results remained substantially unaltered, despite the existence of some correlations of behaviours with risk factors.
Conclusions: Behavioural factors including cigarette smoking, physical activity and diet are strong predictors of lifetime incidence of common heart diseases even adding other traditional risk factors.

1. Introduction

Some lifestyle behaviours are considered possible determinants and con-cause not only of coronary heart disease (CHD) and other cardiovascular diseases, but also of cancer, all-cause mortality and indirect expectancy of life. This applies at least to cigarette smoking, physical activity and dietary habits. Investigations on these habits started several decades ago and findings were documented in different ways. Many reports dealt with single behaviour, i.e., cigarette smoking, physical activity and dietary habits, some with multiple behaviour considered together [1–11]. However, most contributions were limited to relatively short duration of follow-up in the study populations.

More recently, some studies that started in the past century did reach extremely long follow-up observation allowing the production of estimates of the relations of entry characteristics with health and disease projected along several decades [12–18]. Observations of this type are sometimes defined as lifetime estimates although studies with complete extinction of the original cohorts are rare [19]. The Italian Rural Areas (IRA) of the Seven Countries of Cardiovascular Diseases have reached 50 years of follow-up and some reports on that duration have been already published [18,20–22].

In the present analysis, the attempt was made to associate baseline lifestyle habits with lifetime incidence of heart diseases occurred within the age of 90 years, along a 50-year follow-up of middle aged men. The null hypothesis is that lifestyle habits are not associated with heart disease incidence in such a long follow-up period.

2. Material and methods

2.1. Study population and data collection

The epidemiological material used for this analysis derives from the Italian Rural Areas of the Seven Countries Study of Cardiovascular Diseases first examined in 1960 and made of 1712 men aged 40–59 years representing 98.5% of defined samples. Details on their characteristics were given elsewhere [18]. Three lifestyle behaviours were considered as follows:

a) cigarette smoking was derived from a standard questionnaire and three classes of smoking habits were used for analysis: non-smokers (including ex-smokers), moderate smokers (less than 20 cigarettes per day), heavy smokers (20 or more cigarettes per day); these data refer only to base-line examination;

* Corresponding author at: Laboratory of Biotechnologies Applied to Cardiovascular Medicine, Department of Cardiovascular, Respiratory, Nephrological, Anesthesiological and Geriatric Sciences, Sapienza University of Rome, Viale del Policlinico, 155, Roma 00161, Italy.
E-mail address: paoloemilio.puddu@uniroma1.it (P.E. Puddu).

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b) physical activity was derived from a questionnaire that matched some simple questions with the declared profession. Therefore three levels of physical activity at work were defined, i.e., sedentary, moderate and vigorous. The actual energy expenditure of these three levels was roughly estimated by a parallel study where ergonometric measurements were taken [23] and independently by the caloric intake measured on the diet [10,24]. The mean values of these estimates are reported in Table 1;

c) dietary habits were measured using the dietary history administered by experienced dietitians [25] and the outcome was converted into 18 food groups. Factor analysis was carried out and one of the three explored factors (factor 2) was chosen to produce factor score estimates for each subject. Details on the procedure are reported elsewhere showing also significant relationship with several morbid and fatal endpoints [10,24]. Since the questionnaires were administered a few years after the baseline examination, factor scores were regressed on age to reach the entry baseline value, while for 25% of subjects it was imputed by multivariate normal procedure using as reference 30 other personal characteristics [20]. No significant difference was found between the mean of the original values and that of the imputed values. Moreover, Cox model for the prediction of events with and without the imputed values of factor score 2 produced similar coefficient for the dietary indices. Factor score was divided into quintiles and, arbitrarily, quintile 1 was defined non-Mediterranean Diet, quintiles 2, 3 and 4 were defined Prudent Diet, and quintile 5 was defined Mediterranean Diet. The term Prudent Diet was assigned to the intermediate category after the end of the analysis when it was shown that it was beneficial versus the one called non-Mediterranean Diet.

In the original factor analysis the following ratios were found between the class called Mediterranean Diet and non-Mediterranean Diet for food groups that were critical in the definition of the identification of factor score 2 [24]: bread 2.07; cereals 2.6; potatoes 3.80; vegetables 4.21; sugar 0.71; oils 1.79; fish 3.70; and milk 0.40.

For part of the other traditional risk factors' analysis the following were considered: a) body mass index (in kg/m^2) derived from height and weight measured following the technique described in the WHO Cardiovascular Survey Methods Manual [26]; b) systolic blood pressure (in mm Hg) measured in supine position with mercury sphygmomanometers, following the technique described in the WHO Cardiovascular Survey Methods Manual [26] using the average of two measurements; c) serum cholesterol (in mmol/L) measured in casual blood sample, following the technique of Anderson and Keys [27]; d) vital capacity (in L/m^2) following the technique described in the WHO Manual [26] and using the best of three measurements.

2.2. Incidence

Incidence of common heart diseases was measured exploiting all possible information collected at baseline, at periodical re-examinations, at special search at hospitals, clinics and general practitioners, interviews with relatives and data from causes of death as described elsewhere [21,22]. Diagnoses were based on history, physical examination, ECG tracings, causes of death and occasionally reported diagnoses. Mortality data were complete for the duration of 50 years and causes of death were coded, following defined criteria, using the WHO-ICD-8 [28]. Heart diseases were classified into two large groups following analyses presented elsewhere [21], as follows: a) CHD were manifested as sudden death (when other causes could be reasonably excluded), fatal and non-fatal myocardial infarction, and other fatal and non-fatal acute ischemic syndromes; b) HDUE were manifested only as heart failure, severe chronic arrhythmia (such as atrial fibrillation), heart blocks, documented diagnoses of hypertensive heart disease or "chronic CHD". Subjects with these latter manifestations who in addition had *angina pectoris* were classified as CHD due to reasons documented and explained elsewhere [21,22]. The two groups defined in this way were mutually exclusive. These two groups were the most common heart diseases and represented, in terms of mortality, about 93% of all fatal heart diseases in this population during a 50-year follow-up.

At baseline, 35 subjects were already carrier of either condition: accordingly, these prevalence cases were excluded from incidence analysis, thus reducing the denominator from 1712 to 1677. Each individual could suffer none, one or more episodes of the disease, but only the first that occurred with its date was considered for analysis.

Incidence was truncated at the age of 90 for all subjects, arbitrarily adopting this time limit to define lifetime incidence. This means that, the exposure to follow-up was a maximum of 50 years for subjects initially aged 40, 49 years for those aged 41 and so on until 31 years for those aged 59.

The baseline examination was held in 1960 well before the era of the Helsinki Declaration. At subsequent examinations verbal consent was obtained to collect and use follow-up data.

2.3. Analysis

The distribution of the three lifestyle behaviours, each subdivided into three classes, was computed and presented as proportions. The relationship of the three levels of each lifestyle behaviour with the two types of heart disease was studied in a univariate way by plotting events versus the age of occurrence using Kaplan–Meier curves and computing the log rank test. Subjects who did not develop the specific event were considered censored at death or at the age of 90 years. Similar analysis was run for the pool of CHD plus HDUE called total heart disease (THD).

Multivariate analysis was carried out computing Cox proportional hazard models with CHD and HDUE separately as end-point and the three lifestyle behaviours subdivided into three classes. One class of each behaviour was used as reference, i.e., non-smokers for smoking habits, sedentary habits for physical activity and non-Mediterranean Diet for eating habits. Subjects who did not develop the specific event were considered censored at death or at the age of 90 years. The age at event was used as time variable following the principles and applications suggested by other investigators [29,30]. Individual estimates of survival for a given entry age, and for the desired length of follow-up, could be easily made dividing the survival at the end of follow-up by that of the entry age.

Similar models were computed for events occurring up to the age of 70 years in order to compare with a shorter follow-up period. Multivariate coefficients for the two end-points were compared by t test. Similar analysis was run for the pool of CHD plus HDUE called THD.

3. Results

Table 1 provides a description of distribution of cigarette smoking, physical activity and dietary habits, each subdivided into three arbitrary classes. They reflect the habits of rural populations in the mid of the past century, with relatively high smoking prevalence, tendency towards a vigorous physical activity and overall a diet not too far from what is defined a Mediterranean Diet as reported elsewhere [31].

Within the age of 90 years, when only 9.2% of all men had survived, incidence of first CHD episode was recorded in 28.8% of men, while the correspondent incidence of HDUE was of 17.7%.

Kaplan–Meier survival curves were computed for CHD and HDUE as a function of three classes of each behavioural characteristic. They are reported in Figs. 1, 2 and 3 together with the corresponding chi square of the log rank test. Note that the time variable is the age at event, from 40 to 90 years. In particular, for CHD no smoking, vigorous activity and a Mediterranean Diet were beneficial or protective, while the reverse was true for heavy smoking, sedentary habits and non-Mediterranean Diet. An intermediate role was played by moderate smokers, moderate physical activity and Prudent Diet. These differences

Table 1
Characteristic of lifestyle behaviour in the study population.

Lifestyle behaviour	Method	Classes	Notes
Cigarette smoking	Standard questionnaire	1. Non-smokers 38.8% 2. <20 cigarettes/day 46.9% 3. ≥20 cigarettes/day 14.3%	Non-smokers include also ex-smokers
Physical activity	Standard questionnaire matched with working activity	1. Sedentary 9.7% 2. Moderate 22.0% 3. Vigorous 62.8%	Mean estimated energy expenditure Sedentary 2500 kcal Moderate 2700 kcal Vigorous 3100 kcal
Dietary habits	Dietary history	1. Non-Mediterranean 19.6% 2. Prudent 60.2% 3. Mediterranean 20.2%	Derived from factor score of factor analysis, divided in quintile classes and taken as: 1 = quintile 1, 2 = quintiles 2, 3, 4 3 = quintile 5