



Successful aging, dietary habits and health status of elderly individuals: A *k*-dimensional approach within the multi-national MEDIS study



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ABSTRACT

The definition and determinants of successful aging is still controversial. Although dietary habits have long been associated with aging, eating habits and behaviors have rarely been included in various proposed indices of successful aging. The aim of this work was to evaluate determinants of successful aging together with assessment of dietary habits in relation to healthcare facility use among elders living in the Mediterranean basin. During 2005–2011, 2663 elderly (aged 65–100 years) individuals from 21 Mediterranean islands and rural Mani region (Peloponnesus) were voluntarily enrolled in the study. A successful aging index ranging from a score of 0 to a score of 10 was constructed using 10 attributes, i.e., education, financial status, physical activity, body mass index, depression, participation in social activities with friends and family, number of yearly excursions, number of cardiovascular disease risk factors and adherence to the Mediterranean diet. The applied factor analysis on the components of the index extracted three main components for successful aging: psychosocial-economic, bioclinical and lifestyle; confirming the multiple dimensions of aging. After adjusting for confounders, a 1/10-unit increase in the successful aging index was associated with 0.8 less annual visits to healthcare centers (95% CI – 1.3 to –0.2). Stratified analysis by gender revealed heterogeneity of factors predicting successful aging. These findings suggest that successful aging is a multidimensional and complex concept that exhibits gender heterogeneity. Annual use of health care services by the elders was found to be related to level of successful aging.

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1. Introduction

In 2006, the European Commission identified demographic aging as one of the most challenging policy issues of the 21st century (European commission, 2006). The increase in the proportion of older people in Europe is the result of unprecedented economic, social, medical and technological changes that has made it possible for Europeans to live a long and active life. The aging demographic trends are slowly being understood, but the huge social changes that these trends will produce are far less well understood. According to the World Health Organization (WHO), the elderly population will continue to grow, posing a public

health challenge to societies and undermining the importance of a life course approach to 'active aging'. In 2010, globally 524 million people aged over 65 years old and this is estimated to increase to 1.5 billion by 2050 (United Nations, 2010). From public health and policy perspectives, the definition and evaluation of 'aging' is of major importance. The early detection of the population's level of successful aging will help the country to put forward policies for the older population.

Though aging is time dependent (Ressler et al., 2006), there are many factors that influence its rate and as a result, individual aging differs significantly from population to population (Graham et al., 1999; Rockwood et al., 2000). In recent years there have been several attempts to define successful aging (Parslow et al., 2011; Rowe and Kahn, 1997; Von Faber et al., 2001; Bowling and Dieppe, 2005); one of the first ones was proposed by Rowe and Kahn (1997). According to Rowe and

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Kahn (1997), successful aging could be defined through three main components, i.e., low probability of disease and disability, high cognitive and physical capacity, and active participation through social activities (i.e., social relations, productive activities, education etc.). Until now a variety of domains have been used to formulate a definition, such as biomedical, social functioning, psychological and lay (subjective) ones (Bowling and Dieppe, 2005; Bowling and Iliffe, 2006). It has been suggested that a multi-domain approach of successful aging, that incorporates all three of these sub-domains, could better predict different health outcomes than a single domain indicator (Bowling and Iliffe, 2006). Moreover, as the population is getting older, new definitions of health are proposed incorporating individual's adaptations to new conditions and capacity of self management (Huber et al., 2011), or the syndrome of frailty (Rockwood et al., 2000).

Although it is widely accepted that dietary patterns are associated with healthy aging (Mathers, 2013), there is a lack of evidence on the role of dietary habits in successful aging. Moreover, eating patterns and behaviors have rarely been included as a component of successful aging (Depp and Jeste, 2006). One of the dietary patterns that has been extensively studied and associated with longevity is the Mediterranean diet. Recent meta-analyses have indicated that higher adherence to this traditional diet is associated with lower overall mortality, reduced risk of cardiovascular diseases (CVD) and neoplastic diseases (Sofi et al., 2013; Kastorini et al., 2011), implying that this diet may contribute to prevention of non-communicable diseases, and lower use of the health care system (Piscopo, 2009). However, the selected older Mediterranean population that is sharing similar characteristics, has rarely been studied during the last four decades a fact that makes this survey of major importance; notably, in two of the enrolled islands, Corfu and Crete, Ancel Keys and his colleagues from the Seven Countries Study first observed the benefits of Mediterranean diet on health (Keys et al., 1984). This Mediterranean-basin population that had characterized by longevity (Keys et al., 1984; Trichopoulou, 2004), is now accumulating various co-morbidities, and is shifting its lifestyle habits (Tyrovolas et al., 2011; Tyrovolas et al., 2009a,b) but the aging status (degree of heterogeneity among the Mediterranean's characteristics) of these inhabitants has never been explored in the past. Given the aforementioned lack of data, this work aims to evaluate determinants of successful aging together with the assessment of dietary habits, in relation to the use of health care services by elders living in the Mediterranean basin.

2. Methods

2.1. The MEDIS study sample

During the period 2005–2011, a population-based, multi-stage convenience sampling method was used to voluntarily enroll elders from 21 Mediterranean islands: Republic of Cyprus ($n = 300$), Malta ($n = 250$), Sardinia ($n = 60$) and Sicily ($n = 50$), Mallorca and Menorca ($n = 111$), the Greek islands of Mitilini ($n = 142$), Samothraki ($n = 100$), Cephalonia ($n = 115$), Crete ($n = 131$), Corfu ($n = 149$), Limnos ($n = 150$), Ikaria ($n = 76$), Syros ($n = 151$), Naxos ($n = 145$), Zakynthos ($n = 103$), Salamina ($n = 147$), Kassos ($n = 52$), Rhodes and Karpathos ($n = 149$), Tinos ($n = 129$) as well as from the rural region of Mani ($n = 153$) (a southern Greek peninsula), were included. According to the study's protocol, individuals were not eligible for inclusion if they resided in assisted-living centers, had a clinical history established CVD (i.e., stroke, myocardial infarction and angina pectoris) or cancer, or had lived away from the island for a considerable period of time during their lives (i.e., >5 years); these exclusion criteria were applied because the study aimed to assess lifestyle habits that were not subject to modifications due to existing chronic health conditions or by environmental factors, other than living milieu. A group of health scientists (i.e., physicians, dietitians and nurses) with experience in field investigation collected all the required information using a quantitative questionnaire and standard

procedures. A group of health scientists (i.e., physicians, dietitians and nurses) with experience in field investigation collected all the required information using a quantitative questionnaire and standard procedures.

The study followed the ethical considerations provided by the World Medical Association (52nd WMA General Assembly, Edinburgh, Scotland, October 2000). The Institutional Ethics Board of Harokopio University approved the study design (16/19–12–2006). Participants were informed about the aims and procedures of the study and gave their consent prior to being interviewed.

2.2. Evaluation of clinical characteristics

All the measurements taken in the different study centers were standardized and the questionnaires were translated in all the cohorts' languages following the World Health Organization (WHO) translation guidelines for tools assessment (WHO, 2014). Weight and height were measured using standard procedures to attain body mass index (BMI) scores (kg/m^2). A standard procedure was also used for the measurement of waist circumference. Overweight was defined as BMI between 25 and 29.9 kg/m^2 , while obesity was defined as BMI > 29.9 kg/m^2 . Moreover, waist circumference in cm was measured in the middle between the 12th rib and the iliac crest, and hip circumference in cm was measured around the buttocks. Diabetes mellitus (type 2) was determined by fasting plasma glucose tests and was analyzed in accordance with the American Diabetes Association diagnostic criteria (glycated hemoglobin A1C ≥ 6.5 or fasting blood glucose levels greater than 125 mg/dl or 2-h plasma glucose > 200 mg/dl during an oral glucose tolerance test-OGTT- or a random plasma glucose > 200 mg/dl, or by a prior diagnosis of diabetes). Participants who had blood pressure levels $\geq 140/90$ mm Hg or used antihypertensive medications were classified as hypertensive. Fasting blood lipid levels (HDL-, LDL-cholesterol and triglycerides) were also recorded and hypercholesterolemia was defined as total serum cholesterol levels >200 mg/dl or the use of lipid-lowering agents according to the NCEP ATPIII guidelines (NCEP, 2001). A cumulative variable (range 0–4) indicating the overall burden of classical cardiovascular disease (CVD) risk factors (i.e., obesity and history of hypertension, diabetes and hypercholesterolemia) was developed (participants having none of the aforementioned risk factors received score 0, having one factor score 1, etc.).

2.3. Evaluation of dietary habits, socio-demographic and other lifestyle characteristics, and health care system

Dietary habits were assessed through a semi-quantitative, validated and reproducible food-frequency questionnaire (Tyrovolas et al., 2010). To evaluate the level of adherence to the Mediterranean diet, the MedDietScore (theoretical range 0–55) was used (Panagiotakos et al., 2006). Higher values for this diet score indicate greater adherence to the Mediterranean diet. Moreover, the tertiles of the MedDietScore, i.e., 34/55, 35–38/55 and $\geq 39/55$ were used as cutoffs to classify participants as low, moderate or high adherers. Moreover, consumption of various alcoholic beverages (i.e., wine, beer, whiskey, vodka, and the traditional ouzo, tsipouro and retsina) was measured in terms of wine-glasses per day, adjusted for ethanol intake (e.g., one 100 ml glass of wine was considered to have 12% ethanol) and classified for the present analyses, into 0 for no alcohol consumption, 1 for alcohol consumption of at least 1 glass/week. A similar dichotomized coding followed for the tea and coffee consumption.

Basic socio-demographic characteristics such as age, gender, years of education, financial status, and lifestyle characteristics, such as smoking habits and physical activity status, were also recorded. Regarding financial status, participants were asked to report their mean income during the previous three years using a four-point scale (low, inadequate to cover daily expenses = 1, medium, trying hard to cover daily expenses = 2, good, adequate to cover daily expenses = 3, very good, very adequate to cover daily expenses = 4); this scale was decided to

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