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Research paper

Stable kidney function indicates healthy ageing – a population-based 20-year follow-up study

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ABSTRACT

Background: The concept of healthy ageing has become particularly important as life expectancy increases. Identifying trajectories of functional ability will help to guide health-care resources to maximize well-being in old age.
Objective: To study kidney function in well-aged home-dwelling old people.
Design: Prospective, population-based 20-year follow-up study.
Setting: Community.
Subjects: A birth cohort of 1032 non-institutionalized people aged 70 years at baseline.
Methods: Estimated glomerular filtration rate (eGFR) was determined using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) and the four-variable Modification of Diet in Renal Disease (MDRD) equations. Assessment of healthy ageing included evaluation of diseases, functional ability, perceived health status, subjective life satisfaction, basic and instrumental activities of daily living, psychological and cognitive functions.
Results: Glomerular filtration rate estimates remained stable at the level of 60 mL/min/1.73 m^2 in older people who were able to maintain their functional ability, general welfare and life satisfaction despite increased disease burden. Increased mortality seen in older adults with high GFR estimates was not associated with frailty.
Conclusions: The ability to maintain stable kidney function is important for healthy ageing.

Key points

- Stable kidney function was associated with functional ability and life satisfaction in old people.
- The CKD-EPI equation gave more reliable GFR estimates than the MDRD equation in very old persons.
- Increased mortality seen in older adults with high GFR estimates was not associated with frailty.

1. Introduction

Old persons are the fastest growing subset of the population in many countries. The quality of the gained years has become a concern both in individual and in public perspectives. It has been suggested that health care programs and investments should lead not only to a better survival but also to a significantly better functional ability and quality of life. WHO has released the first world report on ageing and health [1]. The key defining factor for healthy ageing in this report is functional ability that consists of the intrinsic capacity of the individual, relevant environmental characteristics, and the interactions between the individual and these characteristics.

As life expectancy increases, it will become more and more important to identify both optimal and less optimal trajectories of intrinsic capacity in order to maximize the functional ability of all older people with appropriate care and support. Older adults with a better than average life expectancy and functional ability may, for example, benefit from preventive screening programs and medical treatment. Patients with limited functional ability and life expectancy may benefit more from living in a supportive environment, advanced care planning and discussions on the goals of care.

Chronic kidney disease is a major health problem disproportionately affecting the old people [2]. In addition, kidney

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dysfunction is known to lead to several co-morbidities and functional decline similar to those seen in frail old persons [3]. These shared problems include malnutrition, reduced muscular mass, functional disability, increased risk of falls and bone fractures, cardiovascular diseases, cognitive impairment and depression. Previous studies have shown that high cystatin C associates with unsuccessful aging in a community-based cohort study of older adults (≥ 65 years) [4]. The aim of this study was to investigate kidney function in a prospective, population-based 20-year follow-up cohort study designed to identify determinants of healthy ageing.

2. Materials and methods

2.1. Characteristics of study population

All home-dwelling citizens who were born 1920 and were living in the city of Turku, Southwestern Finland were offered the possibility to participate a survey investigating the health of old people [5]. The participants were 70 years old at baseline and the follow-up time was 20 years (1991–2011). The whole birth cohort consisted of Caucasians. In 1991, 1530 persons were originally considered eligible for the study. However, 264 people died, moved or were institutionalized before the first invitation was sent, resulting in 1239 possible participants at the baseline. Only those who both returned mailed questionnaires and participated in clinical examinations at each phase of the study (1032 individuals of the original birth cohort, 83%) were considered eligible for the follow-up. The study population and the characteristics of the participants at the age of 70, 80, 85 and 90 years of age are described in Fig. 1 and in Table 1.

To investigate the determinants of healthy aging, the participants returned postal questionnaires, gave blood samples for laboratory tests and were examined and interviewed by a physician and a study nurse to assess health history, health behavior, cardiovascular risk factors, medical treatment, physical, social, psychological and cognitive functioning at the age of 70, 80, 85 and 90 years. Clinical examinations and interviews were carried out according to a pre-specified list containing items needed for a comprehensive geriatric assessment. Medication data based of self-report were confirmed by reviewing the prescriptions history. All eligible participants signed a written informed consent and the study protocol was approved by the ethical committee of the Hospital District of Southwestern Finland.

Prevalent cardiovascular disease included a history of myocardial infarction, symptomatic peripheral vascular disease, transient ischemic attack or stroke. The diagnosis of coronary artery disease (CHD) was mainly based on previous diagnosis. In addition, pathologic q-waves in the current EKG and history of typical exercise-induced angina pectoris were considered indicative of CHD. The diagnosis of peripheral artery disease was based on previous diagnosis or vascular procedures; however, signs of weakened blood flow in the lower extremities (cold, atrophic skin, no pulses palpable) together with a typical gait pain (claudication) were considered diagnostic as well.

2.2. Assessment of kidney function

Each participant who was considered to be at a steady state health condition gave a single blood sample after an overnight fast at the age of 70, 85 and 90 years. Regularly taken medicines including diuretics were taken after the laboratory tests. Plasma creatinine was measured immediately after the samples were drawn. Plasma samples for creatinine measurements were available in 955/1,032 (92%), 269/276 (97%) and 109/114 (96%) of the 70-, 85- and 90-year old participants, respectively. The original enzymatic creatinine values measured 1991 were recalibrated providing isotope dilution mass spectrometry traceable values. We estimated GFR (eGFR) using the four-variable Modification of Diet in Renal Disease (MDRD) equation and by an equation developed by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) [6,7].

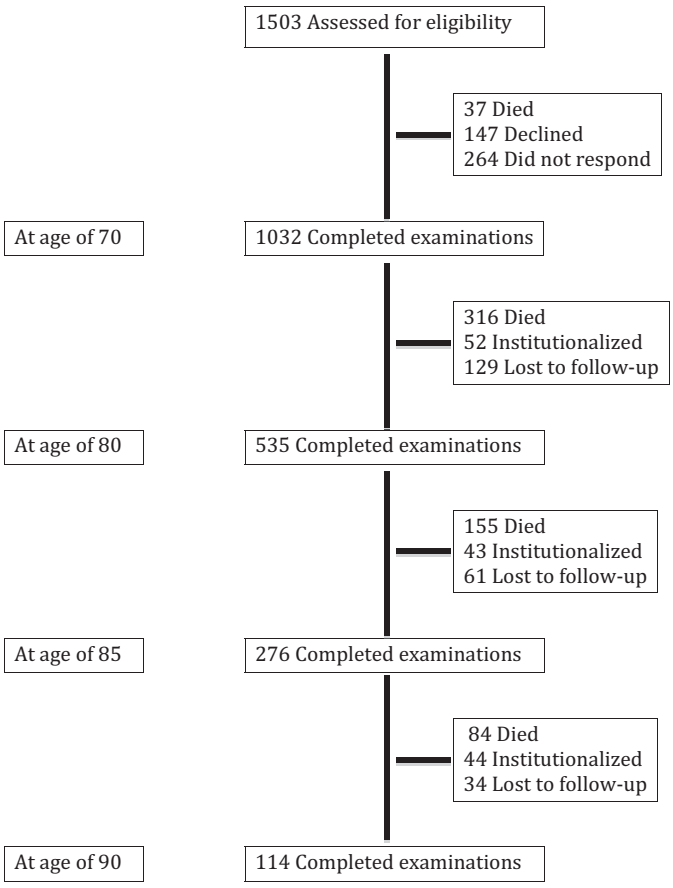

Fig. 1. Flow chart of the participants.

2.3. Assessment of frailty

Thirty-six variables assessing health status at baseline, including medical conditions, health attitudes, symptoms, and functional impairments, were used in the analysis (Table A.1) as described [8]. We substituted migraine headache, cataracts and glaucoma of the original variables published by Song et al. with recent falls, hip fractures and impaired cardiorespiratory capacity (NYHA class 2–4) because these medical conditions have been shown to important in accumulation of adverse outcomes [9]. Multilevel variables were dichotomized according to the problem's severity.

For any individual, the Frailty Index was calculated as the number of deficits divided by the number of items considered (n = 36) [10]. For the level of frailty, 3 groups were identified using previously described cut points: Participants with 3 or fewer deficits (Frailty Index ≤ 0.08) were considered non-frail, participants with 4 to 8 deficits were considered pre-frail, and participants with 9 or more deficits were considered frail (Frailty Index ≥ 0.25) [8,10].

2.4. Determination of healthy aging

Maintenance of healthy aging included assessment of physical and psychocognitive functioning as well as perceived health status