European Journal of Internal Medicine 26 (2015) 211–216

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original Article

Clinical and lifestyle-related risk factors for incident multimorbidity: 10-year follow-up of Finnish population-based cohorts 1982–2012

Katja Wikström [a,*], Jaana Lindström [a], Kennet Harald [a], Markku Peltonen [a], Tiina Laatikainen [a,b,c]

[a] National Institute for Health and Welfare, Department of Chronic Disease Prevention, PO Box 30, 00271 Helsinki, Finland
[b] Institute of Public Health and Clinical Nutrition, University of Eastern Finland, PO Box 1627, Kuopio, Finland
[c] Hospital District of North Karelia, Tikkamäentie 16, Joensuu, Finland

ARTICLE INFO

Available online 3 March 2015

Keywords:
Multimorbidity
Risk factors
Cardiovascular disease
Diabetes

ABSTRACT

Background: Multimorbidity is a huge burden to individuals and societies and more attention should be paid on its risk factors and prevention possibilities. The aim of this study was to investigate which clinical and lifestyle characteristics predict the development of multimorbidity both among initially disease-free people and among people who have diabetes or CVD.
Methods: Data comprised 25–64 year old, randomly selected men and women (n = 32,972) who participated in one of the five national FINRISK surveys between 1982 and 2002 in Finland. The surveys included anthropometric measurements, blood samples and structured questionnaire. Data on incident diagnoses of the five most common chronic diseases during 10 years were received from the national registers on mortality, hospitalizations, and reimbursement rights.
Results: Predisposing factors for multimorbidity among disease-free population were smoking, physical inactivity, and BMI. Among men also systolic blood pressure and low education predicted multimorbidity. Among men with DM at baseline, high blood pressure, physical inactivity, and smoking increased the likelihood of incident multimorbidity. Among women, significant predictors of multimorbidity were high BMI and smoking. Among men and women with CVD, the only baseline factor that was significantly associated with the development of multimorbidity in the multivariate prediction model was low fruit and vegetable consumption.
Conclusion: Several modifiable clinical and lifestyle risk factors were found to predict incident multimorbidity. Better recognition and management of these risk factors could potentially have a large impact on the development of multimorbidity, and consequently, premature mortality and costs of care among the aging populations.

1. Introduction

Aging of the population will be a huge challenge for European countries during upcoming decades. It is well-known that the incidence of many chronic diseases, such as type 2 diabetes mellitus (DM), cardiovascular diseases (CVD) and cancer, increases by age and as a consequence the number of affected people rises [1]. Furthermore, as diseases tend to cluster, increasing numbers of people are found to have multiple diseases or medical conditions at the same time, a phenomenon which is called multimorbidity [2].

Multimorbidity affects more than half of the elderly population and its impact on the burden to individuals and societies is considerable. It is connected with disability and functional decline, poor quality of life and greater use of health services, higher health care costs, and premature mortality [3]. Studies have shown that in addition to age, multimorbidity is associated with female gender and lower education [3,4].

Only a few studies have evaluated the association of modifiable risk factors with multimorbidity, and especially the longitudinal studies are scarce [5–9]. Biological and lifestyle factors such as hypercholesterolemia, hypertension, obesity, smoking, physical inactivity and unhealthy diet are common risk factors for many chronic diseases [1]. Therefore, it is justified to assume that over time, the exposure to these risk factors can lead to multimorbidity, especially among people who already have one chronic disease. To make prevention of multimorbidity possible, better understanding on the predisposing factors of multimorbidity is warranted. In addition, affected people have typically been patients in the primary health care for several years before they become multimorbid. That would offer the "window of opportunity" for primary prevention of multimorbidity, by recognition and better management of its risk factors.

Finland has a very strong history in risk factor monitoring and prevention of chronic diseases [10]. The aim of this study was to investigate which baseline risk factors predispose to multimorbidity, defined by the

Abbreviations: BMI, body mass index; CVD, cardiovascular disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HR (95% CI), hazard ratio (95% confidence interval); ICD, International Classification of Diseases; SES, socioeconomic status.

* Corresponding author. Tel.: +358 29 524 8181.
E-mail address: katja.wikstrom@thl.fi (K. Wikström).

http://dx.doi.org/10.1016/j.ejim.2015.02.012
0953-6205/

time of the diagnosis of the "second" common chronic disease, during 10-year follow-up of population-based cohorts. The risk factors for multimorbidity were investigated separately for people without diagnosis of DM, CVD, asthma/chronic obstructive pulmonary disease (COPD), cancer or rheumatoid arthritis at baseline (referred to as initially disease-free) and also for people with either DM or CVD at baseline. DM and CVD were selected as "index diseases" because they are among the most common and costly chronic diseases on population level.

2. Materials and methods

2.1. Study population

The study population comprised people who were randomly selected for the population-based FINRISK surveys in 1982, 1987, 1992, 1997 and 2002 in five areas of Finland (North Karelia, Northern Savo, cities of Turku and Loimaa, cities of Helsinki and Vantaa and Oulu province). Detailed descriptions of the National FINRISK Study methodology have been published previously [11]. The common age range for all surveys was 25 to 64 years and for this age group the total sample size for all surveys was 49,198, out of which 36,684 (75%) participated in surveys with health check-up. If subjects participated, by chance, in multiple FINRISK surveys (n = 1024), only data from the earliest survey was used.

FINRISK survey examinations are conducted by trained study nurses and consist of a self-administered questionnaire, health check-up with anthropometric measures and collection of blood samples. The structured questionnaire includes questions on participants' sociodemographic background, health status, risk factors for chronic conditions, and health behavior. For each survey, ethics approvals were obtained according to existing regulations. The latest approvals were issued by the Coordinating Ethics Committee of the Hospital District of Helsinki and Uusimaa.

2.2. Register data

The National Hospital Discharge Register in Finland includes the dates of hospital admission and discharge, and the causes of the hospital stay. The National Register of Causes of Death contains data on the date and causes of death. Both registers used codes of the International Classification of Diseases (ICD) and the reliability of these registers has been documented previously [12,13]. In addition, registers of the Finnish Social Security Institute contain data on reimbursement rights and drug purchases, using ATC codes for diagnoses. These registers were used to compile the dataset that included baseline diagnoses as well as data on incident DM, CVD, asthma/COPD, cancer and rheumatoid arthritis during 10-year follow-up period. These diseases were selected as they were the most common chronic diseases within this study population.

Supplementary Appendix Table 1 presents specific details about the selection of the chronic disease from the registers.

2.3. Definition of multimorbidity

Multimorbidity in our analyses was defined as the co-existence of two or more of the selected chronic diseases, DM, CVD, asthma/COPD, cancer and rheumatoid arthritis. Follow-up of each individual continued until the diagnosis of the second disease (defined as the occurrence of multimorbidity), death from any cause, or end of the ten-year follow-up period.

Participants with multimorbidity at baseline were excluded from the analyses. Men and women who were free from all these 5 diseases at baseline were defined as "initially disease-free". They were followed up until they had got diagnoses of two of the selected diseases. In addition, we created two cohorts with one common baseline disease, either DM or CVD which were analyzed as separate cohorts. The final study population included altogether 32,972 men and women (see Table 1).

2.4. Clinical and lifestyle risk factors

Some items of FINRISK questionnaire have been modified during decades to ensure the relevancy of the collected data, and these modifications set some limitations for the selection of predictor variables in this study. Variables which were kept as consistent as possible over time were selected as predictor variables. Background characteristics included age, study cohort and geographic region of residence. Educational level was classified as low, middle and high by dividing self-reported years of formal education within each birth cohort into cohort-specific tertiles. Systolic blood pressure and serum total cholesterol were used as clinical variables. The categorization of clinical variables is described as a part of the statistical analysis. Body mass index (BMI), physical inactivity, low fruit and vegetable consumption, and smoking were included as lifestyle variables.

BMI was calculated as weight (measured in light indoor clothing, kg) divided by square of height (m^2). Physical activity in leisure time was measured with a four-category question about usual physical exercise. Those who chose the option "In my leisure time I read, watch TV, and do household tasks which do not make me move much and which do not physically tax me" were defined as physically inactive. People eating fruits and vegetables 3–5 times a week or less were defined as low consumers. The dietary questions varied between surveys, with the question about fruit and vegetable consumption being the only one in

Table 1
Clinical and lifestyle characteristics among men and women without disease [a] or with diagnosed DM or CVD at baseline.

	Men			Women		
	Initially disease-free	DM at baseline	CVD at baseline	Initially disease-free	DM at baseline	CVD at baseline
	n = 14,923	n = 586	n = 395	n = 16,284	n = 663	n = 121
Age, mean	43.7	52.5***	55.7***	43.7	50.3***	57.3***
Systolic blood pressure (mm Hg), mean	139.4	145.5***	142.8***	133.2	143.1***	144.9***
Blood cholesterol (mmol/l), mean	5.9	5.9	6.0	5.7	6.1***	6.2***
Body mass index (kg/m^2), mean	26.6	28.8***	28.2***	25.7	29.5***	28.3***
Smoking, % [b]	36.4	32.7	31.9	20.4	15.0***	14.4
Physical inactivity, % [c]	25.3	31.0***	27.8	28.7	35.9***	37.6*
Low fruit and vegetable consumption, % [d]	52.9	50.3	56.2	34.4	37.4	45.4*
Low education, % [e]	28.3	30.5	31.5	30.6	32.8	43.0**

Values are unadjusted. Asterisks are used to denote statistical significance as follows: *** denotes $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$. Comparisons were made between the initially disease-free people and people with DM or CVD at baseline, with initially disease-free as reference category.

[a] People without register-based diagnosis of DM, CVD, asthma/COPD, cancer or rheumatoid arthritis.

[b] Smoking was defined as current smokers.

[c] Physical inactivity was defined by participants who reported that they participated in activities which do not cause physical strain.

[d] Low fruit and vegetable consumption was defined as eating fruits and vegetables less than 3–5 times a week.

[e] Educational level was classified as low, middle and high by dividing self-reported years of formal education within each birth cohort into cohort-specific tertiles.