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The association between lifestyle and overall health, using the frailty index

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ABSTRACT

Objective: To evaluate the associations of four individual lifestyle factors with frailty.
Methods: We used cross-sectional data from 11,539 participants of the Rotterdam Study, a population-based cohort, running from 1990 till now. A frailty index was used with a range from 0 to 100 (higher values indicating increasing frailty). We examined physical activity, dietary quality, alcohol intake, and smoking and calculated a sum-score of these, with a range from 0 (lowest) to 8 (highest). The associations between each lifestyle factor and the lifestyle score with frailty were evaluated.
Results: Each lifestyle factor was independently associated with frailty. Participants with high physical activity levels had lower frailty scores than participants with low physical activity (β = −4.70,95%CI = −5.10,−4.30). High diet quality, compared to low diet quality was associated with less frailty (β=-0.88,95%CI = −1.35,−0.42). Low alcohol intake was associated more frailty (β = 0.84, 95%CI = 0.39, 1.29). Never-smokers or former smokers had on average 1.15 (95%CI = −1.60,−0.69) and 1.28 (95%CI = −1.78,−0.79) better frailty scores than smokers. A one-unit increment of the lifestyle score was associated with lower frailty (β = −0.62;95%CI = −0.84,−0.53).
Conclusions: The prevention of frailty can lead to lower health care costs and a higher quality of life among the growing group of elderly people. Our results emphasize that there is an urgent need for preventions that combine several lifestyle factors to improve healthy ageing.

1. Introduction

The rapidly ageing population has led to an increased interest to promote health and healthy ageing, for example via a healthy lifestyle (Manuel, Perez, & Sanmartin, 2016). An approach often used to study health and the ageing process is via the concept of frailty (Clegg, Young, Iliffe, Rikkert, & Rockwood, 2013). Frailty has been defined as a state of increased vulnerability to adverse health outcomes, caused by an age-related decline in multiple physiological body systems (Clegg et al., 2013). One generally accepted operationalization of frailty is the frailty index (FI) (Mitnitski, Mogilner, & Rockwood, 2001), based on the accumulation of a wide-range of health problems, including symptoms, signs, diseases, and functional impairments, which can be interpreted as a proxy for overall health. The FI appears to be a valid construct and has been shown to predict adverse health outcomes, including functional decline, hospitalization, institutionalizing, morbidity and death (Theou & Rockwood, 2015). In addition to other frailty measures (e.g. more physical-health oriented operationalizations), the FI takes into account different aspects of health including diseases, physical functioning, cognitive functioning and disabilities (Searle, Mitnitski, Gahbauer, Gill, & Rockwood, 2008). Although the predictive value of frailty for age-related poor health is well established, research on effective prevention strategies is still in its infancy (Fairhall, Kurrle, & Sherrington, 2015).

Lifestyle factors that were previously identified as major determinants of poor health include poor diet, physical inactivity, tobacco use, and alcohol abuse (WHO, 2015). Together, these lifestyle factors explain more than one third of the global burden of chronic diseases (WHO, 2015). However, most studies evaluating the effect of lifestyle are largely focused on single negative health outcomes such as specific morbidities, functional decline, or mortality, and less often on overall health measures. Furthermore, although a few strong examples exist (Peel, McClure, & Bartlett, 2005; de Groot et al., 2004), the independent and combined effect of lifestyle on overall health, have not been studied extensively. People that engage in multiple unfavorable lifestyle

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behaviors have a higher risk for mortality and incidence of chronic diseases than people who have no unfavorable lifestyle behaviors or only one and the sum of these single components might be more important than the single components itself. To our knowledge, no study has reported on the association between individual lifestyle factors or on their combined effect and frailty.

Therefore, we aimed to examine the association between several *independent* lifestyle factors (dietary quality, physical activity, smoking status, and alcohol intake) and the FI conceived as a proxy of overall health, among Dutch middle-aged and elderly individuals; in addition we examined the combined effect of these four lifestyle factors on the FI.

FI = Frailty index

2. Methods

2.1. Study design

Data of the present study originate from the three subcohorts of the Rotterdam Study (RS), an ongoing prospective population-based cohort among subjects aged 45 years and over, living in Ommoord, a suburb of Rotterdam, the Netherlands (Ikram, Brusselle, & Murad, 2017). The first cohort (RS-I) started between 1990 and 1993, when all residents aged 55 years and over were invited (n = 10,215), of whom 7983 (78%) agreed to participate. In the year 2000, 3011 participants who had become 55 years of age (n = 4472 invitees, 67%) were recruited for the second cohort (RS-II). Further extension of the cohort took place in 2006 when 3932 participants between the ages of 45 and over were recruited (n = 6057 invitees, 65%) for the third cohort (RS-III). Data collection is performed at follow-up visits repeated every three to four years. For the present study, we used data from the third visit of the first subcohort (RS-I-3) and baseline data from both the second (RS-II-1) and third subcohort (RS-III-1). Participants were excluded for the current analyses if no FI was available (2%), resulting in a study population of 11,539 participants, of whom 8264 to 11,495 had data available on the individual lifestyle factors (Fig. 1). The Rotterdam Study has been approved by the institutional review board (Medical Ethics Committee) of the Erasmus Medical Center and by the review board of The Netherlands Ministry of Health, Welfare and Sports. The approval has been renewed every 5 years, as well as with the introduction of major new elements in the study (e.g., MRI investigations).

2.2. Definition of overall health: the frailty index

We used a FI that was specifically designed and validated for the Rotterdam Study (Schoufour, Erler, & Jaspers, 2017). Briefly, deficits were included in the FI if they fulfilled all of the following standardized criteria (Searle et al., 2008): (1) the deficit is associated with health, (2) the deficit prevalence or severity generally increases with age (3) the deficit is not rare (less than 5% prevalence) or too common (over 80% prevalence), and (4) together the deficits must cover multiple health systems (e.g., diseases, disabilities, laboratory measures, physical and mental health) (Searle et al., 2008). Following these criteria, 45 deficits were included (Appendix A). A frailty score was calculated as the total number of deficits present divided by the total number of deficits measured multiplied by 100, resulting in a score between 0 and 100 with higher values indicating more frailty.

2.3. Definition of lifestyle factors

2.3.1. Dietary quality

Dietary intake was assessed with a Food Frequency Questionnaire (FFQ) (Voortman, Kiefte-de Jong, & Ikram, 2017). For RS-I and RS-II, a previously validated, two-step dietary assessment was used that comprised a simple self-administered questionnaire followed by a structured interview with a trained dietitian based on the completed questionnaire (Klipstein-Grobusch, den Breeijen, & Goldbohm, 1998). For RS-III, a validated FFQ based on 389 items was used (Goldbohm, van den Brandt, & Brants, 1994). Follow-up data from RS-I-3 did not include measurement of dietary intake, therefore data from RS-I-1 were used as a proxy. Participants' dietary quality was defined as adherence to the Dutch dietary guidelines, as previously applied to the Rotterdam Study (Voortman et al., 2017) (Appendix B). For all participants, we examined adherence (yes/no) to fourteen items of the guidelines: vegetables, fruit, whole-grains, legumes, nuts, dairy, fish, tea, whole-grains, fats and oils, red and processed meat, sugar-containing beverages, alcohol, and salt. Total adherence was calculated as sum-score of the adherence to the individual items (0–14). For the analyses, we divided the dietary quality score into tertiles (low [0–6], medium [6–8] and high adherence [8–14]).

2.3.2. Physical activity

Physical activity was measured using two different questionnaires. For RS-I and RS-II, a validated adapted version of the Zutphen Physical Activity Questionnaire (ZPAC) was used (Caspersen, Bloemberg, Saris, Merritt, & Kromhout, 1991) and for RS-III the validated LASA Physical Activity Questionnaire (LAPAQ) (Stel et al., 2004). Both questionnaires included items regarding walking, cycling, gardening, sports, hobbies and housekeeping activities. Participants' physical activities were weighted by their intensity with the use of metabolic equivalent of task (MET). Questionnaire-specific tertiles of MET hours per week (low [< 57MET/h for RS-I-1 and RS-II-1; < 27MET/h for RS-III-1], moderate [57–93MET/h for RS-I-1 and RS-II-1; 27–65MET/h for RS-III-1] and high physical activity [> 93MET/h for RS-I-1 and RS-II-1; > 65MET/h for RS-III-1]) were calculated.

2.3.3. Alcohol intake

Alcohol intake was measured using the previously described FFQ. Data were collected as the number of glasses consumed per week in a wide-range of alcoholic beverages. Alcohol consumption was divided into three sex-specific categories: (1) low alcohol intake (< 2 glasses per day for men and < 1glass per day for women), (2) moderate alcohol intake (2 to < 4 glasses per day for men, 1to < 3 glasses per day for women) and (3) harmful alcohol intake (≥ 4 glasses per day for men and ≥ 3 glasses per day for women). Harmful alcohol intake was defined according to the Dutch diagnostic classification system for mental disorders (DSM-IV-TR) (van't Hoff, 2011).

2.3.4. Smoking status

Smoking status was determined by self-report during the home interview. Smoking status was categorized into current smoking, former smoking and never smoking and included the use of cigarettes, cigars, and/or pipes.

2.3.5. Lifestyle score

An overall lifestyle score was calculated by combining dietary quality, physical activity, alcohol intake and smoking into one score. All four individual lifestyle variables were divided into three categories. The unhealthiest category was coded as 0, the middle as 1, and the healthiest category as 2. Scores for all these individual lifestyle variables were summed up for each participant, resulting in a combined lifestyle score ranging from 0 to 8. We calculated the lifestyle score for participants of whom data on at least two lifestyle variables were known (n = 10,642).

2.4. Covariates

Weight and height were measured at the research center, and BMI (kg/m^2) was calculated. Household income, occupation, living situation, and education was asked for in the home interview Total energy