Preventive Medicine 86 (2016) 64–69

Contents lists available at ScienceDirect

Preventive Medicine

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

A high level of household physical activity compensates for lack of leisure time physical activity with regard to deficit accumulation: Results from the KORA-Age study☆

Anna-Janina Stephan [a,b,]*, Ralf Strobl [a,b], Martin Müller [a,b], Rolf Holle [c], Christine S. Autenrieth [d], Barbara Thorand [d], Birgit Linkohr [d], Annette Peters [d], Eva Grill [a,b]

[a] Institute for Medical Information Processing, Biometrics and Epidemiology, Ludwig-Maximilians-Universität München, Munich, Germany
[b] German Center for Vertigo and Balance Disorders, Ludwig-Maximilians-Universität München, Munich, Germany
[c] Institute of Health Economics and Health Care Management, Helmholtz Zentrum München, German Research Center for Environmental Health (GmbH), Neuherberg, Germany
[d] Institute of Epidemiology II, Helmholtz Zentrum München, German Research Center for Environmental Health (GmbH), Neuherberg, Germany

ARTICLE INFO

Available online 5 February 2016

Keywords:
Aged
Health status
Protective factors
Exercise

ABSTRACT

Introduction. Aging is associated with increasing loss of physiological resilience and successive accumulation of physiological deficits. This can be measured through a frailty index which sums up symptoms, health conditions and impairments. One possible factor in preventing or delaying deficit accumulation is physical activity. The effect of leisure time physical activity on health is well investigated; however, the effect of household physical activity is less clear. The objective of this cross-sectional study was to examine the association of household physical activity with deficit accumulation while controlling for level of leisure time physical activity.

Methods. Data originates from the 2008 baseline assessment of the KORA (Cooperative Health Research in the Region of Augsburg)-Age study from Southern Germany. A frailty index of deficit accumulation (Deficit Accumulation Index, DAI) was constructed from 31 age-related health deficits. Physical activity was measured with the Physical Activity Scale for the Elderly (PASE). The association of deficit accumulation and physical activity was analyzed using negative binomial regression analysis.

Results. The participants' ($n = 960$, mean age 76 years, 49.0% female) DAI ranged from 0.00 to 0.68. Higher levels of both types of physical activity were statistically significantly associated with less deficit accumulation. Participants in the highest household (leisure time) physical activity quartile had 29% (30%) less deficits than participants in the respective lowest quartiles.

Conclusion. High levels of household physical activity might compensate for low levels of leisure time physical activity in the prevention of deficit accumulation. Further research efforts investigating the temporal sequence of this association are needed.

Introduction

Age-associated decline in health status constitutes a substantial organizational and financial challenge for most industrialized countries. Thus, investigating modifiable factors which may prevent this decline is crucial for researchers, policy makers, health practitioners, and the aging individuals themselves.

Aging results in successive accumulation of physiological deficits. As a consequence, body and brain may be less resilient towards stressors. Subsequent maladjustment of physiological homeostasis increases the risk for disease and injury, and, ultimately, for disability and death (Carlson et al., 1998). Therefore, processes that lead to the disruption of homeostasis increasingly attract attention.

To quantify the impact of these processes, a Deficit Accumulation Index (DAI) can be constructed that sums up information on physiological deficits (Mitnitski et al., 2001). It has been shown that such a DAI predicts relevant health outcomes in the aged, e.g. institutionalization and death. Interestingly, the DAI seems to converge to a maximum level beyond which the disruption of homeostasis has catastrophic consequences for the individual, thus marking a salient health transition towards death (Rockwood and Mitnitski, 2006). The DAI is therefore a single "macroscopic variable" acting as proxy indicator of aging and subsequent mortality risk (Mitnitski et al., 2001).

☆ FundingThis study was funded by the German Research Foundation (Deutsche Forschungsgemeinschaft) (GR 3608/1-1). The KORA-Age project was financed by the German Federal Ministry of Education and Research (BMBF FKZ 01ET0713 and FKZ 01ET1003A, C) as part of the 'Health in old age' program.

* Corresponding author at: Institute for Medical Information Processing, Biometrics and Epidemiology, Ludwig-Maximilians-Universität München, Marchioninistraße 17, 81377 Munich, Germany.
E-mail address: anna_janina.stephan@med.uni-muenchen.de (A.-J. Stephan).

http://dx.doi.org/10.1016/j.ypmed.2016.01.021
0091-7435/

One of the factors that may play a crucial role in preventing or delaying deficit accumulation is physical activity (PA) (Hubbard et al., 2009). There is abundant evidence that PA contributes to healthy aging (Tak et al., 2013). However, PA in the aged can often not simply be equated with physical exercise (NERI New England Research Institutes, 1991) but may also include tasks like household chores, yard work, outdoor gardening, and caring for another person. This is of high relevance because even persons who are less inclined to exercise might still engage in household chores. Household PA was found to be inversely associated with mortality in aged individuals regardless of other activity types (Autenrieth et al., 2011), and regardless of time spent sedentary (Martinez-Gomez et al., 2014). Strenuous household PA may affect cardiovascular risk factors (Fransson et al., 2003), DNA methylation (White et al., 2013), and inflammatory markers (Reuben et al., 2003). However, to date, the effect of household PA on deficit accumulation has found little attention. It is also not clear if there are sex-specific differences.

The objective of this study was to investigate the association of household physical activity with deficit accumulation as a measure of health status, controlling for level of leisure time physical activity, socio-demographic, socio-economic and behavioral factors in a population of 960 people aged 65 and older.

Methods

Study design, participants and data collection procedures

Data for this study was obtained from the KORA (Cooperative Health Research in the Region of Augsburg)-Age study which includes all participants of the MONICA (Monitoring of Trends and Determinants in Cardiovascular Diseases)/KORA Surveys S1–S4 (1984–2001), aged 65 years or older on December 31st 2008. Out of a total of 17,607 former MONICA/KORA participants, 9197 fulfilled this criterion. 2734 of these had died before the KORA-Age study, 45 had moved away and 427 had withdrawn their consent to participate.

A self-administered health questionnaire was mailed to the remaining 5991 eligible persons and completed by 4565 persons in 2008/2009 (response 76.2%). Additionally 5986 eligible persons were contacted by trained interviewers with medical background to complete an extended telephone interview in which 4127 persons (response 68.9%) participated. An age- and sex-stratified randomly drawn sub-sample ($n = 1079$) additionally underwent medical examinations and personal interviews in 2009. For a flow chart of participant recruitment please see Appendix A1 in the online supplementary data. Details about study design, sampling method and data collection can be found elsewhere (Holle et al., 2005; Peters et al., 2011). Written informed consent was obtained from all participants. Approval for the KORA-Age study was obtained from the Ethics Committee of the Bavarian Medical Association.

Deficit Accumulation Index

As summary measure for deficit accumulation, a Deficit Accumulation Index (DAI) was constructed according to the procedure proposed by Searle et al. (2008). The index should contain at least 30 different deficits to be valid. Each deficit should be associated with health and its prevalence should increase with age, but should not reach 100% in younger age groups. Combined, these deficits should cover a broad range of health aspects.

Association with health status was confirmed if an item had either already been used in other Deficit Accumulation Indices, could be linked to a health domain of the International Classification of Functioning, Disability and Health (ICF) (Cieza et al., 2005, 2008; Stucki, 2005; World Health Organization, 2001) or could be categorized according to the 10th version of the International Classification of Diseases (ICD-10) (World Health Organization, 2012). Prevalence increase with age was verified by plotting deficit prevalence for each age category. If an item did not increase in prevalence with age in the KORA-Age sample, an additional literature research was conducted to establish if the plot results were a specific characteristic of the study sample (e.g. due to mortality or sampling effects) or if in general no prevalence increase with age could be assumed. Early saturation of deficit prevalence was graphically assessed.

Additionally we excluded items with a deficit prevalence less than 1% or more than 5% missing values (Searle et al., 2008).

Signs and symptoms, diseases, functional impairments and activity restrictions can be defined as deficits (Searle et al., 2008). Each deficit is coded as a value between 0 (absent) and 1 (fully present). The DAI for a person is the number of the person-specific deficits divided by the total number of listed deficits. The resulting DAI scores range from 0 (= no deficits present) to 1 (= all deficits present). If a participant scores missing on one or more of the deficit items, the denominator of the DAI is reduced accordingly.

We identified 31 deficits fulfilling these criteria. The deficits included 13 measures of disability derived from the Health Assessment Questionnaire Disability Index (HAQ-DI) (Fries et al., 1981), nine self-reported chronic diseases (Chaudhry et al., 2005), seven signs and two symptoms. Depression and anxiety were assessed using the Geriatric Depression scale (GDS-15) (Sheikh and Yesavage, 1985) and Generalized Anxiety Disorder Scale-7 (GAD) (Spitzer et al., 2006). Cognitive functioning was assessed by the Telephone Interview for Cognitive Status-modified (TICS-m) (Knopman et al., 2009). Malnutrition was assessed by the short version of "Seniors in the community: risk evaluation for eating and nutrition, Version II" (SCREEN II) (Keller et al., 2005). Walking speed was assessed using the timed-up-and-go test (TUG). TUG values above the sex-specific 80th percentile (adjusted for height) were rated as a deficit according to Fried (Fried et al., 2001). Grip strength was assessed as the mean value of three measurements in kg with a dynamometer. Values below the sex-specific 20th percentile (adjusted for BMI) were rated as a deficit.

All candidate variables for the DAI were recoded. Variables that had already been binary were recoded as 0 or 1. Ordinal-scaled variables with more than two categories were equidistantly recoded through the formula ((Individual Score − Theoretical Minimum) / (Range)), if higher scores indicated a higher deficit. If higher scores indicated a lower deficit, the formula used for recoding was ((Theoretical Maximum − Individual Score) / (Range)). Variables without linear deficit increase (e.g. hypertension) were recoded according to literature.

In order to check for validity of the DAI, we plotted DAI values against age, visually compared the histogram of the KORA-Age DAI to a gamma distribution, and calculated a bivariate linear regression of the log DAI to base 10 against age and plotted the 99th percentile of the DAI against five-year age groups. Additional material on the extensive identification process can be found in the electronic supplement, Appendix A2.

Table 1 gives an overview of all deficits contributing to the DAI and their final coding.

Physical activity

Physical activity (PA) was assessed through the Physical Activity Scale for the Elderly (PASE) during standardized face-to-face interviews. The PASE includes measures of activity levels for leisure time and household activity. Activity items on leisure time PA represented questions on walking outside home, light, moderate and vigorous activities, and on endurance exercises. Household items incorporated light and heavy household chores, home repairs, yard work, outdoor gardening and caring for another person (NERI New England Research Institutes, 1991). The PASE household score ranges from 0 to 171, and the PASE leisure time score ranges from 0 to 502 with higher scores indicating more frequent and/or more vigorous activity (NERI New England Research Institutes, 1991).

PASE scores were categorized into quartiles following previous KORA-Age research (Autenrieth et al., 2013), with higher PASE quartiles indicating more frequent/vigorous PA. We chose categorization over the continuous variable to be able to identify high risk groups and to compare those groups with regard to their health status.

Covariates

We included demographic (age, sex, marital status) and socioeconomic (education, household and per capita income) variables as well as health risk behaviors (smoking status, daily alcohol intake, body mass index [BMI]) as covariates. These variables were included as potential confounders since they have been shown to be related to both PA and the constituents of deficit accumulation (Kaplan et al., 2001; Harris et al., 2009; Romero-Ortuno, 2013; Hubbard et al., 2010; Stenholm et al., 2014; Mello et al., 2014).

Participants were classified according to their smoking habits as smokers, ex-smokers and never-smokers. Age was defined as age at reference date (December 31st 2008) and categorized into five groups (<70, 70–74, 75–79, 80–84, >84) (Peters et al., 2011). Number and type of alcoholic drinks consumed during the last working-day and last weekend were self-reported and