Physical activity and health characteristics

A survey among Dutch elderly women and men

Carla E.J. van den Hombergh

1. Lichamelijke activiteit op oudere leeftijd is belangrijk voor het behoud van gezondheid en onafhankelijkheid.
(dit proefschrift)

2. Het uitvoeren van zorgtaken op jongere leeftijd door zowel vrouwen als mannen zal hun onafhankelijkheid op hogere leeftijd positief beïnvloeden.
(dit proefschrift)

3. Meetinstrumenten ontwikkeld voor jong-volwassenen zijn niet altijd zonder meer toepasbaar bij oudere mensen.
(dit proefschrift)

4. Zowel het belang als de arbeidsintensiteit van het opschonen van databestanden wordt door velen onderschat.

5. De term "caregiver burden" in relatie tot zorg voor ouderen, waar eigenlijk sprake is van "social support" werkt stigmatiserend.
(naar: Hagestad GO. In: Deeg DJH et al. 1993)

6. Bij sollicitatie moeten AIO's eerder navraag doen naar de persoon en de werkwijze van de promotor dan naar de functie van AIO.

7. NS-dubbeldekkers zijn spierverrekkers.

8. De huidige beperkte ouderschapsverlofregeling tot de eerste vier levensjaren van het kind gaat uit van de onjuiste veronderstelling dat scholen een taak hebben in de kinderopvang.

9. Verplichte verkorting van de werkweek tot 32 uren kan zowel een bijdrage leveren aan het oplossen van het werkloosheidsprobleem, als aan de herverdeling van betaalde en onbetaalde arbeid tussen vrouwen en mannen.

10. Laatbloeiers kleuren de herfst.

Stellingen behorende bij het proefschrift "Physical activity and health characteristics. A survey among Dutch elderly women and men" van Carla E.J. van den Hombergh. Wageningen, 23 juni 1995.

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Physical activity and health characteristics.

A survey among Dutch elderly women and men

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ter verkrijging van de graad van doctor
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Voorwoord

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Abstract

Physical activity and health characteristics. A survey among Dutch elderly women and men.

PhD Thesis, Department of Epidemiology and Public Health, Wageningen Agricultural University, Wageningen, The Netherlands, June 1995.

Carla E.J. van den Hombergh

To study physical activity of elderly people and its relationship with health characteristics, a cross-sectional study was conducted in 1991/1992 in Arnhem, the Netherlands, among 515 women and 497 men, aged 65 to 85 years. Habitual physical activity was assessed with a questionnaire, previously validated for elderly, and including questions on household activities, sports and other physically active leisure time activities like walking, bicycling and gardening. Health characteristics were assessed by interview (reported disability, chronic diseases, perceived health and respiratory complaints) and physical examination (anthropometry, blood pressure measurements, electrocardiography, and spirometry).

Light housework was carried out by 90% of the women and 61% of the men. 87% of the women and 91% of the men were involved in sports or other physically active leisure time activities. Physical activity (including household activities) is related to favorable health characteristics e.g. absence of disability and chronic diseases, and high subjective health in both women and men. Only in men it is as well associated with high heart rate variability, high forced vital capacity and high forced expiratory volume in one second. Performance of household activities might be regarded as an indicator of independence. We found non-performers to be characterized by high age, high socio-economic status, unfavorable reported health, and living with someone else, the latter only for men.

Our findings suggest that physically inactive elderly are in general characterized by older age and a less favorable health. From this cross-sectional study it is not clear whether physical activity may positively affect health, or the reverse or whether both effects are present. Independence, represented by performance of household activities, probably is primarily influenced by health. Longitudinal studies are needed to clarify the direction of causal pathways. For reasons of maintaining health, well-being and independence, we recommend promotion of physical activity in old age. In addition we suggest to stimulate independence of men by training them in preparing cooked meals and doing other traditionally "female" housework.

1. Introduction

During centuries people have sought for eternal youth in good health. From many studies risk factors for functional loss, disease and death, which often accompany old age, have emerged. As training helps to maintain functions and prevents rapid declines, an active life style seems to contribute to the deceleration of the aging process, and to the maintenance of good health and independence. In the near future more people will reach old age, and experience functional loss and dependency. This will increase health care costs. Knowledge of factors associated with health and independence can be used for planning preventive measures aiming at prolongation of independence of elderly people. This thesis gives a description of the habitual physical activity of elderly people, and its association with some indicators of health.

Physical activity, independence and health

A sedentary lifestyle is a risk factor for morbidity and mortality, especially from cardiovascular diseases [1,2,3,4,5]. On the other hand, habitual physical activity has many positive effects on physical, social and emotional functioning of individuals. Studies, mostly conducted among younger adults, have revealed that physical activity increases maximal oxygen uptake, cardiac output, and High Density Lipoprotein concentration in blood [1,6]. It counteracts obesity [1,7] and osteoporosis [1,5], can normalize disturbed glucose tolerance [1] and prevent non-insulin dependent diabetes mellitus [8]. Even elderly people may gain most of the above mentioned benefits from habitual physical activity or exercise programs [5,6,9,10]. With increasing age changes in habitual physical activity patterns occur. Occupational activities cease while household activities become relatively important. Of the Dutch women and men aged 65 years and over and living alone 27% and 22% respectively do actively participate in sports, of women and men who do not live alone 30% and 32% respectively are active in sports [11]. In the Euronut-SENECA study among elderly people born between 1913 and 1918 from 18 different European towns and cities, 30% of the Dutch women and men was participating in sport activities, whereas participation varied between centers from 0% in Greece and Poland to 43% in Switzerland [12]. The low values in Greece

and Poland were due to continuing performance of physically heavy work. Involvement in physical activities, mostly defined as sports or other leisure time physical activities, decreases with advancing age [9,13,14,15], which may have a deteriorating effect on health. Physical activity of the general population of 65 years and over, and its relationship to health has hardly been studied. This study provides additional information based on a considerable number of elderly women and men.

A considerable part of the habitual physical activities of elderly people consists of household activities. Actual performance of these activities might be regarded as an indicator of independence. The aim of the Dutch government is to improve elderly people's quality of life, to enable them to live independently in their own homes, and to prevent a further rise of the costs of care [16]. This study gives information, which can be of use for the planning of preventive measures to promote independence of elderly people.

Objective of the study

The aim of our study is to describe physical activity of elderly people and its association with a number of health aspects. In this study physical activities of elderly people comprise household activities, sports and other leisure time recreational physical activities. Perceived health, disability in activities of daily living (ADL) and instrumental activities of daily living (IADL), presence of chronic diseases, heart rate variability, and lung function have been chosen as indicators of health. The purposes of the reported study among non-institutionalized Dutch women and men, aged 65 to 85 years, were:

1. To give a description of habitual physical activities of these elderly, and of health and socio-demographic characteristics of physically inactive compared to physically active persons.
2. To study short term heart rate variability in elderly women and men, and the association with physical activity.
3. To investigate the prevalence of respiratory conditions in elderly, and associations of respiratory symptoms and spirometric lung function with physical activity.
4. To determine what household activities are actually performed by these elderly, and how this relates to sociodemographic and health characteristics, and the use of formal and informal care.

Outline of the thesis

In this thesis the results of studies on physical activity of non-institutionalized Dutch women and men, aged 65 to 85 years, and its association with indicators of health are presented. The second chapter gives a detailed description of the cross-sectional study "Lifestyle and Health of the Elderly". Data collected in this study have been used to answer the research questions in this thesis. Habitual physical activities of non-institutionalized elderly, and a profile of inactive elderly is addressed in chapter 3. Short term heart rate variability, and its relationship with physical activity are described in chapter 4. In chapter 5 the prevalence of respiratory conditions, and associations of respiratory symptoms and spirometric function with smoking habits and physical activity are presented. Chapter 6 involves the household activities these elderly actually perform, and the association with sociodemographic and health characteristics, and the use of formal and informal care. The general discussion (chapter 7) gives an integration of the results, and a review of methodological considerations concerning selection bias, information bias and confounding, and discusses the implications of the findings. The chapters 3 through 6 are written as articles, and submitted or accepted for publication in relevant international journals.

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2. Design and methods

This thesis is part of the project "Lifestyle and health of the elderly". It was performed at the Department of Epidemiology and Public Health of the Wageningen Agricultural University and financially supported by the Dutch Ministry of Health, Welfare and Sports. The aim of this project was to describe the health, medical consumption and lifestyle of elderly people, and associations of health with medical consumption and lifestyle, respectively. The first descriptive results have been published elsewhere [1]. Part of the data collected for this project have been used to study research questions related to the purposes of this thesis.

This chapter gives a description of the study design, the study population, its approach and response, the data collection, and details of the measurement instruments which were used.

Study design

The present study was conducted as a cross-sectional study among Dutch elderly people, and included a prestructured interview and a standardized physical examination. The study design has been approved by the independent institutional medical ethical committee.

A random sample of non-institutionalized elderly women and men was provided by the Municipal Register Office of Arnhem, a city of approximately 133,000 inhabitants in the eastern part of the Netherlands. These elderly people were living in 18 districts, which were chosen because of their large number of elderly inhabitants and their prosperity. In this way a broad range of socio-economic status could be covered. The sample was stratified for sex and age (four age groups: 65-69, 70-74, 75-79, and 80-84 years), in order to enable comparison between women and men in all age groups. A two-stage sampling procedure was applied. Because the response in the first months of the data collection was lower for elderly people in the highest age group as compared to the other age groups, we decided to enlarge the sample of the highest age group for the second part of the sampling. Despite of this, in the age group of 80-84 years the number of invited men was smaller than the number of invited women.

The study population

As pointed out earlier, the study has been carried out among non-institutionalized Dutch elderly, aged 65 to 85 years. This age range has been chosen for the following reasons. From the age of 65 years on, work ceases to have a great impact on daily routine, since in the Netherlands 65 years is the age that almost every elderly person starts to receive Old Age Pension. At the other end of the range, the number of people of 85 years and over who live on their own is relatively small. In january 1992 33% of the women and 27% of the men of 85 years and over were institutionalized, compared with 1% of the women and 1% of the men of 65-69 years [2]. Non-institutionalized elderly of 85 years and over form an extremely selected group, and were therefore not included.

Approach and response

Before inviting the eligible elderly, all general practitioners in Arnhem were informed by letter about the aim and methods of the study. This information has also been sent to the Regional Home Nursing Service Arnhem.

All elderly in the sample received a letter with a brief explanation of the study and an invitation to participate. Several days after receipt of this letter they were visited in order to make an appointment for an interview at their homes. When three attempts had been unsuccessful, we tried to contact them by telephone at three different occasions. If this did not succeed, a last attempt was made by sending a letter requesting to contact us by telephone. In case they still did not react, we considered these elderly as non-respondents. All elderly who refused to participate in the study were asked for the reasons. In addition, they were asked four questions about self perceived health (a rating on a scale ranging from 1 (worst) to 10 (best)), relative physical activity (as compared to people of the same age and the same health status), living situation and marital status.

A total of 1793 elderly people were invited to participate in the study. Forty nine elderly were excluded since they were institutionalized, had moved elsewhere or had died. Seven hundred thirty two elderly (42% of the eligible elderly) refused participation for several reasons. A total of 1012 elderly subjects (58% of those eligible) have participated in the interviews and 685 (39% of those eligible) of them had a medical examination. Table 2.1 shows the number and percentages of participants for women and men in different age groups.

Table 2.1 Distribution of interviewed and examined participants.

		Interview		Physical examination	
	N*	n	%**	n	%**
Women					
- 65-69 yrs	206	122	59.2	95	46.1
- 70-74 yrs	206	116	56.3	77	37.4
- 75-79 yrs	204	118	57.8	72	35.3
- 80-84 yrs	329	159	48.3	83	25.2
Men					
- 65-69 yrs	211	147	69.7	113	53.6
- 70-74 yrs	199	129	64.8	97	48.7
- 75-79 yrs	189	113	59.8	86	45.5
- 80-84 yrs	199	108	54.3	62	31.2
Total	1743	1012	58.1	685	39.3

* number of invited and eligible elderly people, data of one person are missing
** % of the invited and eligible elderly people.

Table 2.2. Reasons for non-participation (N=732)

	%*
Not at home	8.9
No time or interest	29.1
Illness	16.6
Privacy	9.3
Frequent medical examinations	4.5
Unknown or does not know	7.4
Partner ill	2.2
Study makes no sense	2.3
Other reasons	25.6

* more than one answer possible

Table 2.3 Comparison of participants and non-participants.

	Interviewed		Interviewed & physical examination		Non-participants	
	%	N	%	N	%	N
Sex		1012		685		731
- Female	51		48		59	
- Male	49		52		41	
Age (yrs)		1012		685		731
- 65-69	27		30		20	
- 70-74	24		25		22	
- 75-79	23		23		22	
- 80-84	26		21		36	
Physical activity*		980		667		223
- Much more active	20		21		18	
- More active	37		38		36	
- Equally active	33		32		31	
- Less active	8		8		12	
- Much less active	2		1		4	
Living situation		1010		682		314
- Living alone	40		36		40	
Marital status		1012		683		302
- Married	57		61		55	
- Single	8		8		9	
- Divorced	5		4		3	
- Widowed	31		27		33	
Perceived health score†	7.3±1.5	1003	7.3±1.6	677	7.3±1.6	224

* compared to people of the same age and the same health status.
† rating on a scale ranging from 1 (worst) to 10 (best), mean ± SD

Of the 732 non-participants, 65 (8.9%) could not be contacted at home at repeated attempts. For 54 persons the reasons for refusals are unknown. The other non-participants gave one or more reasons why they decided not to participate in the study. These reasons are shown in table 2.2. Twenty one percent of the eligible

elderly did not participate for health related reasons (illness or frequent medical examinations).

A comparison of characteristics of respondents and non-participants is shown in table 2.3. More women than men and more people from the highest age groups refused to participate. Four questions on perceived health, relative physical activity, marital status and living situation were answered by 31%, 31%, 41% and 43% respectively of the non-participants. No major differences in these characteristics were found between participants and non-participants. The persons who had an interview, but refused to take part in the physical examination were not asked for their reasons.

Data collection

Data were collected by means of face-to-face interviews and by physical examination. Both the interview and the physical examination on average took 60 minutes. At the end of the interview subjects were given oral and written information on the physical examination and were invited to participate in this part of the study. Written informed consent was obtained 1. for the physical examination, 2. to inform the general practitioner in case of unfavorable findings, and 3. for obtaining medical data from treating physicians.

For the physical examination an appointment was made at the end of the interview or, if subjects wanted to think it over, four weeks later. To limit travelling time for the participants, the physical examinations were carried out in health centers near their homes. When necessary participants were transported by minibus.

The data were collected between October 28th 1991 and April 6th 1992, with a two weeks break around Christmas and New Year. Prior to the data collection interviewers and examiners were trained extensively. Blood samples were taken by two qualified medical assistants under responsibility of a general practitioner. During the whole period of the data collection medical doctors in the neighborhood of the research locations were stand-by for possible emergencies.

Outline of the study variables

In this section a description will be given of the way the concepts mentioned in the aim of the project were operationalized. These concepts were translated into variables to be measured. As far as possible existing questionnaires or protocols have been used. The final questionnaire consisted mainly of questions with precoded answers. Answers to open questions were noted and scored afterwards. Data on the physical functioning of the participants were gathered by interview and by physical examination. Table 2.4 presents an outline of the concepts, the variables and the sources of measurement instruments. Where the name of the authors is marked with an asterisk (*) the instruments have been slightly adapted or completed. In the next paragraphs the measurement instruments which were used to assess life style, health, medical consumption and personal characteristics, respectively will be described in more detail in the order they appear in table 2.4.

Life style

Physical activities

To assess habitual physical activity in the past year a validated questionnaire on household activities, sports and other physically active leisure time activities, developed for free living elderly people, was used [3]. The participants were asked to report on ten household activities. For these activities four or five ratings, ranging from very active to inactive, were possible. In addition time per year spent at different sports and other physically active leisure time activities was asked for. The full questionnaire is presented in appendix I. Additional questions were asked on physical activity as compared to people of the same age and health, and on the reasons for not being physically active.

From the physical activity questionnaire a total activity score has been calculated. Each activity was classified according to work posture and movements, using an intensity code based on net energetic costs of activities. According to this intensity code and the time per year spent on an activity a score has been calculated (see appendix I). The scores for household and recreational activities were summarized, resulting in a total activity score. We used quintiles of total activity score to divide subjects into three levels of physical activity: low being the lowest quintile, moderate comprising the second, third and fourth quintile, and high

representing the highest quintile. In this way the extreme groups, the physically inactive and physically very active elderly, had sufficient numbers of subjects for analyses, and were clearly distinguished. Because levels differed according to sex, cut-off points were different for women and men.

Table 2.4 Assessment of health, medical consumption, life-style and personal characteristics.

Concept	Variable	Source
Life style		
Physical activities	- household activities, sports and other physically active leisure time activities	- [3]
Food habits	- meal patterns, diets, use of alcohol, restorative tonics or drugs, and tobacco preparing meals	- pilot study, [4*,5,6,7,8]
Health		
Perceived health	- subjective health score	- [5]
Physical functioning	- height, weight, blood pressure, heart function, lung function	- measurements according to standardized protocols
	- disability	- [5]*
Mental functioning	- subjective well-being	- [9]
Social functioning	- contacts	- [10*]
	- support	
Diseases	- chronic diseases	- [11*]
	- respiratory symptoms	- [12]
Medical consumption		
Services	- use of primary health care	- [13*]
Drugs	- use of prescribed drugs	- [5*]
	- self medication	- [5*]
Personal characteristics		
Socio-demographic characteristics	- age, sex	- known from sample
	- marital status	- [13]
	- living situation	- [14*]
	- education and occupation	- [15]
Other characteristics	- income	- [16*]
	- other resources	- [4*]
	- type of housing	- known
	- distance to shops	- [4]

* slightly adapted or completed

Food habits
Questions were asked about: 1. meal patterns (omitted meals, eating alone, time of eating a cooked meal, frequency of eating at home or outdoors), 2. diets, 3. use of restorative tonics/drugs (like vitamins or minerals), 4. preparing meals (shopping, cooking), and 5. consumption of alcohol and tobacco.

Where possible we used the questionnaires from the Euronut-SENECA study [4] and the Dutch Food Consumption Survey [7] or similar questions [17]. Based on the findings of a pilot study, questions regarding substitutes for own activities (e.g. help of others, prepared meals, home delivery services) have been added.

For the measurement of alcohol consumption questions of the Dutch Food Consumption Survey have been used [7]. The following items have been addressed: 1. type of alcoholic beverages subjects drink, 2. the numbers of glasses drunk during weekdays (monday till thursday) and during weekend days (friday till sunday), and 3. the frequency of drinking more than 6 glasses of alcohol at one day, during the past half year prior to the interview.

Present and past tobacco consumption both were assessed. Current smokers were asked how many cigarettes, pipes or cigars a day they usually smoke, and for how many years they have been smoking. Former smokers were asked when they quit smoking, and for how many years and how many cigarettes, pipes or cigars a day they smoked.

Health

Perceived health
Subjects were asked to score their health on a 10-point scale for perceived health ranging from 1 (worst) to 10 (best) [5].

Physical functioning
Physical functioning has been assessed by means of a physical examination, and by means of questions on disability. The physical examination included standardized measurements of height, weight, blood pressure (three times), electrocardiographic characteristics and spirometric function. In addition, blood samples were taken using a standardized protocol. The measurements were performed in the order as described below. After this description details will be given on the questions on disability.

Height and weight

First, standing height was measured (to the nearest 0.5 cm) using a wall-mounted measuring tape. The subject was standing without shoes and with heels together. Body weight was measured to the nearest 0.5 kilogram with the subject clothed in their normal clothing and without shoes. A daily calibrated weighing scale was used for the measurements.

Blood pressure

Systolic and diastolic blood pressure were measured in supine position with a Random-Zero Sphygmomanometer (Hawksley, England). Blood pressure was taken twice after a period of minimal 2 and 7 minutes of rest in supine position. It was measured a third time after the ECG recordings (after six minutes of standing). The mean of the first two measurements has been used as the value for systolic and diastolic blood pressure, respectively.

Electrocardiography

After 10 minutes of rest in supine position a 12-lead ECG recording on holter tape was made during 13 minutes using a MAC-12 electrocardiograph (Marquette Electronics, Bilthoven, the Netherlands). Participants were asked to relax, to breath if possible in a frequency of 16 breaths per minute (indicated on an audiotape), and not to speak during recording. Simultaneously two 12-lead electrocardiograms (ECG's) of 10 seconds were made 4 and 5 minutes after the start of this recording. Six minutes after the beginning of the ECG registration participants were asked to rise. During this standing-up procedure a 3-lead ECG was recorded for 40 seconds. Both one and two minutes after rising two more 12-lead ECG's of 10 seconds were made in standing position. After six minutes of standing the ECG recording on holter tape was stopped. Participants were asked to reassume a recumbent position to disconnect the electrodes, and blood pressure was measured once more as described above.

Spirometric function

Spirometric tests were performed according to the protocol of the ECCS [18]. A rolling dry spirometer (Vicatest 5, Mijnhardt, Bunnik, the Netherlands) coupled with automatic data acquisition software has been used. From a minimum of three valid expiratory maneuvers the highest forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1.0}$) and peak flow (PEF) were selected. The highest maximal midexpiratory flow (MMEF) was selected from a maneuver with a FVC within 300 ml of the highest FVC. Consequently, the selected spirometric values could be obtained from different curves. All respiratory function data fulfilling the general acceptability criteria of the ECCS (such as no hesitant start and no early

termination of the maneuver) were used in the analysis. Subjects with less than 3 acceptable tests or differences between the highest and the second highest forced vital capacity (FVC) of more than 300 ml were excluded from the analyses. All spirometric results were adjusted to body temperature and pressure saturated with water vapor (BTPS), using the air temperature of the test room and the mean air pressure of the measurement day. Spirometry was performed between 8.40 am and 5.40 pm by trained technicians. Spirometers were checked for leaks with a 3 liter syringe daily, before the start of the physical examinations. Tests were done without a noseclip while participants were seated.

Blood sample

Blood samples were taken to measure iron parameters, calcium, potassium and sodium concentrations, and for blood cell counts per liter. For future use sera were stored at -80 degree Celsius.

Disability

Questions on disabilities included vision, hearing, Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) [5]. Table 2.5 shows the ADL and IADL items in the questionnaire. Subjects were asked if they could perform certain activities without difficulty, with some difficulty, with great difficulty or not at all.

Table 2.5 Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) items.

ADL	IADL
to eat	to carry an object of 5 kilo for 10m
to bite and chew tough food	to do heavy housework
to cut food (like meat)	to do one's shopping
to lean down and pick something from the floor	to wash dishes
to cut toenails	to prepare breakfast and lunch
to dress and undress	to make coffee and tea
to climb in and out of bed	to lay and clear the table
to move from one room to another (on the same level)	to prepare a cooked meal
to walk 400m without standing still	
to walk a staircase up and down without standing still	
to get seated and to get out of a chair	
to leave and enter the house	
to wash oneself	
to use the toilet	

Mental functioning
To assess mental functioning the Scale Subjective Well-being Older persons (SSWO) has been used [9]. This scale consists of 30 items. It has been developed and validated for elderly subjects. The SSWO has 5 subscales namely Health, Self-Respect, Morale, Optimism and Contacts, consisting of 5, 7, 6, 6 and 6 items respectively. For each item scores could range from 0 to 2. Besides scores on the subscales, a total score is calculated. The total score can range from 0 to 20.

Social functioning
The questions regarding social functioning are concentrated on the frequency of contacts with family members and others. The slightly adapted questionnaire of Perenboom and Schroots [10] has been used. A distinction is made between contacts with people of the same age and contacts with people of another age group. Because the frequency of contacts gives no information about their meaning, questions regarding the need of assistance and availability of help have been added. In addition subjects were asked about the actual use of help they received (because of health problems) from family or friends in the three months prior to the interview.

Diseases
The presence of diseases has been assessed by a slightly modified questionnaire of van den Bos [11], which included a list of chronic diseases and conditions. Subjects were asked if they suffered one or more of these diseases, and whether they visited a doctor (either general practitioner or specialist) in the period of 3 months prior to the interview for a particular disease. Respiratory symptoms have been addressed in separate questions, based on the questionnaire of the British Medical Research Council [8,12].

Medical consumption

The study has been limited to the use of primary care services and the use of prescribed drugs and self medication. For the assessment of the use of health care services a list with frequently used services has been put together with help of the Department of Well-being and Health of the city of Arnhem, and based on their Health Survey in 1989 [13]. Based on findings of a pilot study [19] we decided to pay attention to the use of prescribed drugs and self medication, and questions

from the Dutch Health Survey [5] have been slightly modified and included in our interview. For all the items on medical consumption we used a reference period of 3 months prior to the interview.

Personal characteristics

Socio-demographic characteristics

These characteristics include age, sex, marital status, household size, education and former occupation. For the assessment we used existing questionnaires [13,14,15]. Four age groups were distinguished: 65 to 69, 70 to 74, 75 to 79 and 80 to 84 years. Marital status was divided in four classes (married or living together, single, divorced and widowed). Household size has been defined as living alone or living with some-one else. Education has been divided into three levels: low (basic education and low vocational training), middle (middle general education or middle vocational training), and high (high school or university). Socio-economic status (SES) has been assessed based on occupation and subdivided in three classes: low (housewives, unskilled and skilled workers and lower employees), middle (small businessmen and employees), and high (higher professions). Married, widowed or divorced women were classified according to the SES of their (ex)partners.

Other characteristics

Questions on income and other possible confounders regarding the household activities have been included. Subjects were asked to classify the annual income of the household [16]. A division has been made into 5 classes of income: Dfl.18.000 or more, Dfl.18.000 to Dfl.22.000, Dfl.22.000 to Dfl.28.000, Dfl.28.000 to Dfl.40.000, and Dfl.40.000 or more. Housekeeping facilities (like refrigerator, oven, microwave-oven, storage, car, telephone) and living environment have been assessed with existing questionnaires from the Euronut-SENECA study [4], completed with extra questions.

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Appendix I

Questionnaire, codes and method of calculation of scores on habitual physical activity in elderly people [3]*.

Household activities.

1) Do you do the light household work? (dusting, washing dishes, repairing clothes etc.)?

   0. Never (< once a month) |_|
   1. Sometimes (only when partner or help is not available)
   2. Mostly (sometimes assisted by partner or help)
   3. Always (alone or together with partner)

2) Do you do the heavy housework? (washing floors and windows, carrying trash disposal bags, etc.)?

   0. Never (< once a month) |_|
   1. Sometimes (only when partner or help is not available)
   2. Mostly (sometimes assisted by partner or help)
   3. Always (alone or together with partner)

3) For how many persons do you keep house? |_|
   (including yourself; fill in "0" if you answered "never" in Q1 and Q2.)

4) How many rooms do you keep clean, including kitchen, bedroom, garage, cellar, bathroom, ceiling, etc.)? (Fill in "0" if you answered "never" in Q1 and Q2.)

   0. Never do housekeeping |_|
   1. 1 - 6 rooms
   2. 7 - 9 rooms
   3. 10 or more rooms

5) If any rooms, on how many floors?
   (fill in "0" if you answered "never" in Q4.) |_|

6) Do you prepare warm meals yourself, or do you assist in preparing?

   0. Never |_|
   1. Sometimes (once or twice a week)
   2. Mostly (three to five times a week)
   3. Always (more than five times a week)

7) How many flights of stairs do you walk up per day?
(one flight of stairs is 10 steps.)

0. I never walk stairs |_|
1. 1-5
2. 6-10
3. More than 10

8) If you go somewhere in your hometown, what kind of transportation do you use?

0. I never go out |_|
1. Car
2. Public transportation
3. Bicycle
4. Walking

9) How often do you go out for shopping?

0. Never or less than once a week |_|
1. Once a week
2. Twice to four times a week
3. Every day

10) If you go out for shopping, what kind of transportation do you use?

0. I never go out for shopping |_|
1. Car
2. Public transportation
3. Bicycle
4. Walking

Household score = (Q1+Q2+....+Q10)/10

Sport activities

Do you play a sport?

Sport 1: name
intensity (code) _____ (1a)
hours per week (code) _____ (1b)
period of the year (code) _____ (1c)

Sport 2:	name		
	intensity (code)	_____	(2a)
	hours per week (code)	_____	(2b)
	period of the year (code)	_____	(2c)

Sport score: $\sum_{i=1}^{2}$ **(ia * ib * ic)**

Leisure time activities

Do you have other physically active activities?

Activity 1:	name		
	intensity (code)	_____	(1a)
	hours per week (code)	_____	(1b)
	period of the year (code)	_____	(1c)

Activity 2 till 6 as activity 1.

Leisure time activity score: $\sum_{j=1}^{6}$ **(ja * jb * jc)**

Questionnaire score = household score + sport score + leisure time activity score.

Codes:

Intensity code[1]:

0: lying , unloaded	code 0.028
1: sitting, unloaded	code 0.146
2: sitting, movements hand or arm	code 0.297
3: sitting, body movements	code 0.703
4: standing, unloaded	code 0.174
5: standing, movements hand or arm	code 0.307
6: standing, body movements, walking	code 0.890
7: walking, movements arm or hands	code 1.368
8: walking, body movements, cycling, swimming	code 1.890

Hours per week:

1: less than one hour/week	code 0.5
2: [1,2> hours per week	code 1.5
3: [2,3> hours per week	code 2.5
4: [3,4> hours per week	code 3.5
5: [4,5> hours per week	code 4.5
6: [5,6> hours per week	code 5.5
7: [6,7> hours per week	code 6.5
8: [7,8> hours per week	code 7.5
9: more than 8 hours per week	code 8.5

Months a year:

1: less than one month per year	code 0.04
2: 1-3 months	code 0.17
3: 4-6 months	code 0.42
4: 7-9 months	code 0.67
5: more than 9 months per year	code 0.92

[1] unitless intensity code, originally based on energy costs.

3. Physical activities of non-institutionalized Dutch elderly and characteristics of inactive elderly*

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Abstract

For preventive purposes habitual physical activity was investigated in non-institutionalized elderly and a profile was composed of the most inactive among them. In a cross-sectional study conducted in 1992 in Arnhem, 503 women and 493 men, aged 65-84 years, were interviewed. Habitual physical activities and total activity scores were assessed with a questionnaire, previously validated for elderly. Among other things, our findings revealed that light housework (e.g. dusting, washing dishes) was carried out by 90% of the women and 61% of the men. Thirteen percent of the women and 9% of the men had no recreational physical activities (sports or other physically active leisure time activities). Physical activity level seems to be associated with age, socio-economic status (only for men), marital status (only for women), disability, subjective health, presence of chronic diseases, living in houses with stairs and living close to shops (only for men). For example: age-adjusted odds ratios for being physically inactive were 28.6 and 7.1 respectively for women and men with disabilities (95% confidence intervals: 6.4-127.0 and 2.7-18.3 respectively). Our findings suggest physically inactive elderly are mainly characterized by older age and a less favorable health. Physical activity of these elderly deserves special attention, to prevent further deterioration and loss of independence.

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Introduction

Habitual physical activity has positive effects on morbidity, especially cardiovascular, and mortality [1,2,3,4,5]. It increases maximal oxygen uptake, cardiac output, and high density lipoprotein concentrations in blood, and it reduces heart rate and blood pressure [1,4,6]. It counteracts obesity [1,7] and osteoporosis [1,5,6] and can normalize glucose tolerance [1,8]. Health benefits of habitual physical activity or exercise programs are mostly studied in young and middle-aged individuals, but there is evidence that elderly people can also improve their functional capacities and prevent disability, disease and loss of independence by regular exercise [5,6,9,10]. However, with advancing age the involvement in physical activities decreases [9,11,12]. As observed in other Western countries, Dutch surveys reveal declines in participation in sports and other recreational physical activities with increasing age and differences between women and men regarding the kind of activities they are involved in or the time spent at these activities [13,14,15,16]. Most studies focus on physical activity patterns, or on effects of specific exercise programmes. Information on habitual physical activity patterns of elderly and a profile of physically inactive elderly is limited [11,17]. This information can be used to identify and characterize vulnerable groups with regard to health and independence, and to contribute to preventive programs. The aim of our study is to describe habitual physical activities of non-institutionalized elderly persons, and to characterize physically inactive elderly persons compared with physically active elderly. Therefore the associations between the level of physical activity and selected sociodemographic, health related, and situational factors have been studied in 996 non-institutionalized Dutch elderly.

Population and methods

Study population

From October 1991 until April 1992 a random sample of 1793 non-institutionalized elderly residents of Arnhem, a city of approximately 133,000 inhabitants, were invited to take part in a study of lifestyle and health. The sample, provided by the Municipal Register Office of Arnhem, was stratified for gender and age, with almost equal numbers of women and men in four age groups (65 - 69, 70 - 74, 75 - 79 and 80 - 84 years) except for females in age group 80 - 84 years, who were slightly over-represented. All eligible elderly received a letter providing the aims and

procedures of the project and an invitation to participate in the study. Forty nine subjects were excluded from the study: they were institutionalized, had moved to other places or had died. Of the remaining 1744 elderly 732 refused participation for different reasons (21% because of illness or several medical examinations in the recent past, 29% had no time or interest). A total of 1012 elderly (58%) were interviewed and 685 (68%) of those had a physical examination. Written informed consent was obtained from the subjects prior to the physical examination.

Data collection

For the interviews the participants were visited at home by 23 trained interviewers. Interview topics were: physical activity, food patterns, drinking and smoking habits, perceived health, (instrumental) activities of daily living, subjective well-being, social functioning, chronic diseases, use of health care, medication and personal characteristics. The interview took on average about 60 minutes.

To assess habitual physical activity in the past year a validated questionnaire for free living elderly people was used. The validation of this questionnaire consisted of determination of test-retest reliability (Spearman's correlation coefficient was 0.89), and comparison with results of 24-hour activity recalls and pedometer measurements (Spearman's correlation coefficients were 0.78 and 0.73, respectively) [18]. The participants were asked to report on ten household activities. For these activities four or five ratings, ranging from very active to inactive, were possible. In addition time per year spent at different sports and other physically active leisure time activities was asked for.

To assess perceived health, (instrumental) activities of daily living (ADL), chronic diseases and socio-economic status (SES) validated and sometimes slightly modified questionnaires were used [19,20,21,22].

Data analysis

From the physical activity questionnaire a total activity score has been calculated. Each activity was classified according to work posture and movements, using an intensity code based on net energetic costs of activities. According to this intensity code and the time per year spent on an activity, a score has been calculated. The scores for household and recreational activities were summarized, resulting in a total activity score. We used quintiles of total activity score to divide subjects into three levels of physical activity: low being the lowest quintile, moderate comprising the second, third and fourth quintile, and high represents the highest quintile. For women and men the total activity score has been calculated in the same way,

using the same questionnaire. Because levels differed according to sex, cut-off points were 2.34 and 9.40 for women, and 3.06 and 15.17 for men. In this way the extreme groups, the physically inactive and physically very active elderly, had sufficient numbers of subjects for analyses, and were clearly distinguished.

Low subjective health was defined as a reported score of 7 or lower on a 1 to 10 scale (1=worst 10=best) for perceived health status. Mean health score for women was 7.2 (SD 1.4, n=496) and for men 7.4 (SD 1.5, n=492). Physical disability was defined as having some or great problems with one or more of 22 (instrumental) activities of daily living or being not capable to perform one or more of these activities. Lung disease was defined present when subjects reported one or more of the following diseases: asthma, bronchitis, emphysema or other lung diseases.

Houses with stairs were defined as houses with floors or apartments on the second floor or higher with no elevator in the building.

Socio-economic status was subdivided into three classes: low (housewives, unskilled and skilled workers and lower employees), middle (small businessmen and employees), and high (higher professions). Married, widowed or divorced women were classified according to the SES of their (ex)partner.

All analyses were carried out for subjects with complete data on their physical activity (n=996) and for women and men separately. Descriptive statistics of sociodemographic, health related and situational characteristics by level of activity were calculated. Trend with age was tested based on likelihood ratio statistics, age groups scored 1 - 4. Multivariate logistic regression models were constructed with level of activity as dependent variable (low activity versus moderate and high activity combined, and low activity versus high activity only). Odds ratio were calculated using beta coefficients from the logistic regression [23]. These models were based on the results of the descriptive analyses. For reasons of multicollinearity and the apparently weaker association with chronic disease, physical disability and subjective health were not included in the multivariate models to see whether the associations with these diseases persisted. Categories of several characteristics have been treated as separate (dummy) variables. Only the results of the multivariate logistic regression with low versus high active subjects were presented. Because of missing values for some variables the number of subjects available for the analyses varied. Maximum number of missing values for women was eight, for men seven.

Results

Characteristics of the study population

Complete data on habitual physical activity were available for 503 women and 493 men. Table 3.1 shows their personal characteristics and physical activities.

Table 3.1 Distribution (%) of sociodemographic characteristics and physical activities of elderly citizens of Arnhem

	Women (n=503)		Men (n=493)	
	%	p-values*	%	p-values*
Sociodemographic characteristics				
Age (years)				
- 65-69	23		30	
- 70-74	23		26	
- 75-79	23		22	
- 80-84	31		22	
Marital status				
- single	11	0.06	3	0.18
- married	36	0.00	80	0.07
- divorced	5	0.27	4	0.73
- widowed	48	0.00	13	0.01
SES				
- high	25	0.52	28	0.76
- middle	30	0.60	35	0.38
- low	45	0.30	36	0.25
Household activities				
Light housework†	90	0.01	61	0.46
Heavy housework†	50	0.00	43	0.00
Regular cooking§	90	0.03	38	0.70
Regular shopping¶	64	0.00	60	0.89
Walks stairs	61	0.01	74	0.00
Recreational activities				
None	13	0.00	9	0.00
Walking**	34	0.11	40	0.00
Cycling**	5	0.00	14	0.02
Gardening††	5	0.32	15	0.48
Gymnastics§§	16	0.29	11	0.24
Swimming§§	6	0.00	8	0.00

* p-values for trend over age groups. † most of the times or always. § 3 or more times a week. ¶ 2 or more times a week. ** ≥ 3 hours/week for at least 6 months. †† ≥ 2 hours/week for at least 6 months. §§ ≥ 1 hours/week for at least 6 months. Gymnastics: non-competitive athletic exercise.

Table 3.2 Distribution (%) of sociodemographic, health related and situational characteristics in physical activity categories

	Women			Men		
	Activity level			Activity level		
	Low (n=100)	Moderate (n=302)	High (n=101)	Low (n=99)	Moderate (n=295)	High (n=99)
Age (years)						
- 65-69	10	21	44	16	32	36
- 70-74	18	24	25	19	26	34
- 75-79	28	22	19	25	22	19
- 80-84	44	33	13	39	20	10
Marital status						
- single	3	10	23	4	3	3
- married	34	37	37	77	81	79
- divorced	5	5	3	4	4	3
- widowed	58	48	38	15	11	15
SES						
- high	26	23	30	30	30	23
- middle	26	32	29	28	34	45
- low	49	45	40	41	36	32
Physical disability*	98	77	58	94	73	59
Heart disease*	23	19	8	24	20	25
Hypertension*	37	30	31	21	13	11
Lung disease*	13	8	8	35	10	10
Arthritis*	37	27	21	17	11	10
Back pains*	36	22	18	19	14	12
Low subjective health score*	75	54	32	70	44	29
Housing without stairs*	61	52	43	59	33	32
Shops within 500m*	33	34	51	35	36	51

* present versus absent.

Table 3.3 Odds ratios (OR) and 95% confidence intervals (CI) for low versus high activity of sociodemographic, health related and situational characteristics

	Women (n=201)		Men (n=198)	
	OR*	CI	OR*	CI
Age (years)				
- 65-69	1		1	
- 70-74	3.2	1.3 -7.9	1.3	0.6 - 2.8
- 75-79	6.5	2.6 - 16.0	3.0	1.3 - 6.8
- 80-84	14.9	5.9 - 37.5	8.8	3.5 - 21.8
Marital status				
- married	1		1	
- single/widowed/divorced	0.5	0.2 - 0.9	0.9	0.4 - 1.9
SES				
- high	1		1	
- middle	0.9	0.4 - 2.1	0.4	0.2 - 1.0
- low	1.5	0.7 - 3.1	0.8	0.4 - 1.8
Physical disability†	28.6	6.4 - 127.0	7.1	2.7 - 18.3
Heart disease†	2.7	1.1 - 6.9	0.8	0.4 - 1.7
Hypertension†	1.6	0.8 - 3.2	1.9	0.8 - 4.6
Lung disease†	1.7	0.6 - 4.9	5.8	2.5 - 13.3
Arthritis†	2.0	1.0 - 4.1	1.7	0.7 - 4.2
Low back pains†	3.1	1.4 - 6.8	2.1	0.9 - 4.9
Low subjective health†	7.6	3.7 - 15.7	6.8	3.4 - 13.6
Housing without stairs†	2.0	1.1 - 3.8	2.2	1.2 - 4.2
Shops within 500m†	0.5	0.3 - 1.0	0.4	0.2 - 0.8

* all odds ratios are age adjusted, except those of age. † present versus absent

Almost all elderly are in some way physically active. Total activity score ranges from 0.00 (no household and recreational physical activity) to 38.82 (mean 6.37, SD 5.03) in women, and from 0.00 to 53.95 (mean 9.57, SD 7.89) in men. Women are more involved in household activities than men, and they are less involved in recreational activities. Sixty four women and 45 men did not report any recreational physical activities. Their household scores were significantly lower than the household scores of elderly who did have recreational physical activities. These 64 women and 45 men were in the lowest quintiles of activity score, and had the characteristics of inactive elderly.

Table 3.4 Multivariate odds ratios (OR) and 95% confidence intervals (CI) for low versus high activity of sociodemographic characteristics, chronic diseases and situational characteristics

	Women (n=195)		Men (n=195)	
	OR	CI	OR	CI
70-74 years†	4.4	1.5 - 12.8	1.6	0.6 - 4.5
75-79 years†	8.6	2.9 - 25.3	3.2	1.1 - 9.1
80-84 years†	27.9	8.4 - 92.9	20.2	6.0 - 67.9
Single/widowed/divorced§	0.3	0.1 - 0.8	0.8	0.3 - 2.0
Middle SES¶	0.5	0.2 - 1.3	0.4	0.2 - 1.0
Low SES¶	1.3	0.5 - 3.0	0.6	0.2 - 1.5
Heart disease§	2.6	0.9 - 7.6	0.7	0.3 - 1.6
Hypertension§	0.9	0.4 - 2.0	2.9	1.0 - 8.4
Lung disease§	2.8	0.8 - 9.4	6.3	2.4 - 16.3
Arthritis§	2.4	1.1 - 5.3	1.8	0.6 - 5.2
Low back pains§	2.5	1.0 - 6.0	2.7	0.9 - 7.6
Housing without stairs§	2.4	1.1 - 5.1	2.7	1.2 - 5.9
Shops within 500m§	0.5	0.3 - 1.1	0.3	0.1 - 0.7

† versus 65-69 years. ¶ versus high SES. § present versus absent

Profile of inactive elderly

Results in table 3.2 indicate that physical activity level is associated with age group, marital status, socioeconomic status, health, and living close to shops and living in houses without stairs. In tables 3.3 and 3.4 odds ratios for being physically inactive are presented. After adjusting for age the associations with marital status and SES do not persist significant, except for women who are not married and for men with middle SES (table 3.3). Old age, physical disability and a low subjective health score are strongly related to a low physical activity level, especially for women. Sex differences also occur in age-adjusted odds ratios for being physically inactive of specific diseases in women and men. Women reporting heart disease, arthritis or low back pains and men reporting lung disease have significantly higher odds ratios for being physically inactive than elderly without these diseases. After combining age and sociodemographic factors, chronic diseases and situational factors into a multivariate logistic model, odds ratios remained almost similar (table 3.4). In men odds ratios of hypertension increased slightly.

Discussion

One of the main objects of our study was to identify factors that discriminate between the inactive and active elderly. The findings suggest that age and health are the main discriminating characteristics. Older age and a less favorable health are associated with lower levels of physical activity. These findings are in accordance with results of others [9,11,12,14,15,16]. Moreover, we found a middle SES (only in men), marital status (only in women), living in houses without stairs and not living within 500m from shops (only in men) to be associated to level of physical activity.

Women are more active in household activities than men, which has been reported before by others [13,16]. Frequent recreational activities of elderly are walking, gymnastics, gardening, cycling and swimming. Participation in recreational physical activities seems high (87% women, 91% men) compared with other studies which report 29 - 50% participation in sports or in leisure time physical activities [15,24,25]. This might be due to the inclusion of non-vigorous physical activities in our study.

Habitual physical activities have been assessed with the validated questionnaire developed by Voorrips [18]. The mean activity scores she observed were higher compared with our findings. This is probably a result of a healthier and younger study population than ours. Although problems with long-term memory might cause under- or overreporting, and the questionnaire does not produce an estimate of absolute energy expenditure, individuals can be reliably classified in relation to each other. Therefore the categorization in three activity groups, based on quintiles, is expected to be valid. In the Euronut SENECA study [25] the same questionnaire has been used to assess physical activity of elderly people in 12 different European communities, but no activity scores were calculated. Findings of this study are comparable to ours. Although in the Euronut SENECA study gardening and other leisure time activities were more common among men than women, the latter spent more hours at leisure time activities. In the Minnesota Heart Survey [12] also type, frequency and duration of physical activities performed during the previous 12 months were asked for. This information was used to calculate physical activity intensity and to categorize subjects in three groups of activity level: light, moderate and heavy. Greater reported leisure time activity was among others being associated with male sex, younger age and higher education. In the Zutphen Study [14] questions were asked about selected physical activities, not about frequency and duration of these activities. Physical activity of the

participating men decreased as age increased. In other research [26] more simple approaches have been applied.

Logistic regression models were analysed both for low activity versus moderate and high activity combined, and for low versus high activity only. These models showed the same results, however the former were somewhat less pronounced, so we presented the results of the latter.

We used a stratified sample of people aged 65 - 84 years, to be able to make comparisons between women and men in different age groups. Nonparticipants were significantly more often female and of the highest age group compared with participants. Of the nonparticipants only 30%-43% answered four additional questions. There were no significant differences in percentages of elderly living alone or being married, in subjective health score, and in physical activity level as compared with people of the same age with the same health between participants and nonparticipants. Because of the low number of nonparticipants giving information on these topics, no definite conclusion can be drawn from these results. In our study population there were somewhat fewer men than women of 80 - 84 years. However, in the total elderly Dutch population, independently living men of this age category are underrepresented. With regard to marital status, elderly in our study population do not differ much from the total population aged 65 years and over (including institutionalized and independently living elderly) in Arnhem and the Netherlands [24,27]. As there might be differences in habitual physical activity patterns of rural and urban elderly and between regions [15] our findings may be representative for elderly residents of Arnhem, but not for urban elderly in all regions of the Netherlands.

The relationships between age, physical activity and health are complex. Confounding, cohort effects and the aging proces may play important roles. Studies presented in literature concentrate on the effects of physical activities on health [2,3,8,10,28]. There is no systematic evaluation of the effects of health on physical activities. Using cross-sectional data, like in our study, precludes statements about the direction of the association. We speculate that physical activity may affect health, but the reverse may be the cause as well and might become more important with increasing age. Prospective studies are needed to separate cohort effects from the effects of aging.

There is limited information on characteristics of physically inactive and very active elderly. In a study among German elderly, three clusters of elderly were identified according to the type of activities they were involved in, but elderly people within these clusters were not further characterized [17]. Voorrips made a

comparison of physically active and inactive elderly women, but she used other characteristics than we did to compare both groups, for example: weight related to body height, body fat, blood levels of ß-carotene [29] and several aspects of physical fitness [30].

Inactivity may lead to a less favorable health and this may lead to physical inactivity, altogether resulting in loss of independence. So, inactive elderly might form a vulnerable group for losing independence. Therefore we suggest that prevention programs should aim at all elderly, especially those with few physical activities or with health problems, in order to stimulate them to be physically active. This might prevent loss of independence and might benefit their health in general. According to our results it is not necessary to direct these programs to specific sociodemographic groups.

Conclusions

Physically inactive elderly are mainly characterized by high age and a less favorable health. For the prevention of health problems and loss of independence, promotion of physical activity should be aimed at all elderly, in particular elderly with poor health and who are physically inactive. More information about characteristics of inactive elderly will be useful for concentrating preventive measures to the most vulnerable groups. Longitudinal research is needed to solve questions of cohort effects, and of causational relations between physical activity, health and aging.

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4. Short term heart rate variability and physical activity in Dutch women and men aged 65 to 85 years*

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Abstract

Physical activity is generally recognized for its positive effects on the risk of cardiovascular morbidity and mortality. It has been reported to increase resting heart rate variability (HRV), whereas low HRV is an important predictor for risk of sudden death in myocardial infarction patients. The aim of our study is to describe short term HRV in elderly women and men, and its relationship with physical activity. In a cross-sectional study data were collected by interview and physical examination. HRV was defined as the standard deviation of all normal RR-intervals in 20 sec ECG recordings in both supine and standing position. Habitual physical activity over the past year was assessed by a validated questionnaire. Data of 288 women and 307 men were suitable for analysis (regression analysis and analysis of variance). Elderly women and men had similar HRV. The mean in supine position was 21 and 22 msec resp., in standing position 23 and 22 msec resp.. Subjects with premature ventricular complexes had higher HRV than subjects without ($p \leq 0.01$). The former subjects were excluded from further analysis. In men, but not in women, a positive association between HRV in supine position and physical activity score was observed ($\beta=0.19$ $p=0.03$). We found low levels of HRV. In men HRV-supine was positively associated with physical activity. Possibly physical activity levels in the elderly are too low to have a substantial effect on HRV.

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Introduction

There is overwhelming evidence that physical activity has positive effects on cardiovascular disease risk and mortality. One of the mechanisms behind this protection might be by influencing autonomic cardiac control. Autonomic cardiac control is reflected in certain periodical fluctuations of heart rate. The fluctuation of heart frequency associated with breathing is mainly determined by parasympathetic activity [1,2]. This so called respiratory sinus arrhythmia has been used as an indicator of autonomic function in diabetic patients [3]. Several studies have now reported that reduced heart rate variability (HRV) is accompanied by an increased risk of sudden death [4,5] and of ventricular tachycardia [5] in myocardial infarction patients. Patients with congestive heart disease and hypertension have reduced HRV [6] and HRV is inversely correlated with the degree of severity of coronary atherosclerosis in patients referred for coronary angiography [7].

Physical activity has been reported to increase HRV. In 140 healthy subjects aged 40-77 years, high physical training level was associated with higher HRV [8]. HRV is reported to decrease with advancing age [9,10,11,12]. Other factors which seem to reduce HRV levels are smoking [8,13,14,15], presence of cardiac disease [6,16], high blood pressure [6], diabetes [3], and the use of certain drugs [16].

Until now, most research on HRV has been performed in adult male patients, aged up to 70 years, rarely older, in relatively small study populations, and mostly with data of 24 hour ECG recordings. For epidemiologic studies in larger populations short term measures of HRV would be more practical. Therefore the aim of our study is to describe short term HRV in elderly women and men, and to verify whether the expected relationship with physical activity can be observed.

Population and methods

Study population and data collection

A cross sectional study was conducted in 1992 in Arnhem, a city of approximately 133,000 inhabitants, in the Netherlands. A random sample of 1,793 non-institutionalized elderly, stratified for sex and age, was provided by the Municipal Register Office. These elderly, aged 65-84 years, were invited to participate in a study of lifestyle and health. Forty nine elderly who were institutionalized, moved to other places or were deceased, were excluded. Of the remaining 1,744 elderly 732

refused participation for several reasons. A total of 1,012 (58%) elderly was interviewed of whom 685 (68%) participated in a physical examination.

Participants were visited at home for a one-hour interview about lifestyle, health and socio-demographic characteristics. Habitual physical activity in the past year was assessed with a questionnaire, which was designed and validated for free living elderly people [17]. Involvement in ten household activities and time spent at recreational physical activities (e.g. sports and other physically active leisure time activities) were asked for. The presence of chronic diseases and the use of prescribed drugs were determined using validated questionnaires [18,19]. At the end of the interview participants were invited to visit a health center for a physical examination, including measurements of height, weight and blood pressure and electrocardiography. At the physical examination two 12-lead electrocardiograms (ECG's) of 10 seconds were made on a Marquette MAC-12 electrocardiograph after 14 and 15 minutes of rest in supine position. Participants were asked to relax, to breath, if possible, in a frequency of 16 breaths per minute (indicated on an audiotape), and not to speak during recording. After these recordings another two 12-lead ECG's of 10 seconds were made in standing position after one and two minutes of standing. Systolic and diastolic blood pressure were measured in supine position with a Random-Zero Sphygmomanometer (Hawksley, England). Blood pressure was taken twice, twelve and seven minutes before the start of the ECG recordings, and once after six minutes of standing.

Six hundred eighty five participants had both an interview and a physical examination. Ninety of them were excluded from the analysis because of arrhythmia, abnormal AV-conduction, having a pacemaker or having missing data for heart rate variability in both supine and standing position. This resulted in a study population of 595 subjects, 288 women and 307 men.

Data analysis

Heart rate variability (HRV) was defined as the standard deviation of all normal RR-intervals in two consecutive ECG's in the same position (supine or standing). It was assessed both in supine (HRV-supine) and in standing position (HRV-standing) by computerized measuring of RR-intervals in the digital ECG recordings. Intervals which differed more than 20% from the preceding interval were considered abnormal. Abnormal beats and the following beat were excluded. Resting heart rate (beats per minute) was defined as the mean heart rate of the two 10 seconds ECGs in supine position.

Systolic blood pressure (mm Hg) was defined as the mean of the first and second measurement of systolic blood pressure.

From the physical activity questionnaire a total activity score has been calculated. Each activity was classified according to work posture and movements, using an intensity code based on net energetic costs of activities. According to this intensity code and the time per year spent on an activity a score was calculated. The scores for household and recreational activities were summed, resulting in a total activity score. These scores ranged from 0 to 27 for women and from 0 to 39 for men. We used quintiles of total activity scores to categorize subjects into three levels of physical activity: low being the first, moderate the second, third and fourth, and high being the fifth quintile. Women and men were categorized separately. Cut-off points for the lowest and highest quintiles were 2.74 and 10.04 respectively for women, and 3.68 and 15.62 for men.

Heart disease was considered present in subjects reporting heart disease, or the use of drugs for diseases of heart, vessels or blood pressure, or having electrocardiographic signs of myocardial infarction or ischaemia (according to the Minnesota code); hypertension in subjects reporting hypertension, or the use of diuretics, or having a systolic blood pressure ≥160 mm Hg; lung disease in subjects reporting asthma, bronchitis, emphysema or other lung diseases, or the use of drugs for asthma; and diabetes in subjects reporting diabetes, or the use of drugs for diabetes.

Data were analysed using SAS statistical software [20]. Results are presented as relative frequency distributions or as mean values ± standard deviation. After comparison of subjects with and without abnormal beats, subjects with any abnormal beat were excluded from further analysis. Differences of HRV between categories of health and lifestyle characteristics were evaluated by analysis of variance. Regression analysis was performed with HRV as dependent variable and physical activity score as independent variable. P-values less than 0.05 were considered to indicate statistical significance. The levels of significance were not adjusted for multiple comparison. Because individual variables have missing data, the number of subjects under study may vary slightly between the analyses.

Results

Table 4.1 shows some characteristics of the study population. Women had significantly lower physical activity scores and significantly higher systolic blood

Table 4.1 Characteristics of the female and male study population* N=595

	Women (n=288)	Men n=(307)	p
Age (years)	74±6	73±5	0.12
HRV† (msec)			
- supine	21±14	22±15	0.78
- standing	23±16	22±21	0.56
Heart rate (beats/min)			
- supine	72±11	72±11	0.58
- standing	80±12	80±13	0.80
Physical activity score	7±5	10±8	0.00
Systolic blood pressure (mm Hg)	153±21	148±21	0.01
Body Mass Index (kg/m^2)	27±5	25±3	0.00
Use of tobacco (g tobacco/day)‡	11±8	14±11	0.10

* Values given are mean ± SD. p P-values ANOVA for differences between women and men.
† Heart rate variability: standard deviation of 20 seconds normal RR intervals (msec).
‡ Among smokers only: women n=40, men n=105. 1 g of tobacco is equivalent to 1 cigarette.

pressure and body mass index than men. Mean HRV-supine was 21 msec for women and 22 msec for men, mean HRV-standing was 23 msec and 22 msec respectively, and mean physical activity scores were 7 and 10 respectively. HRV-supine and HRV-standing were significantly ($p \leq 0.01$) higher for subjects with abnormal beats, even when excluding those beats as well as the following.

For women without abnormal beats mean HRV-supine was 19 ± 10 msec, and mean HRV-standing 22 ± 14 msec. In women with abnormal beats these values were 29 ± 21 msec and 27 ± 20 msec respectively. For men without abnormal beats we observed mean HRV of 18 ± 10 msec and 18 ± 12 msec respectively in supine and standing position, and for men with abnormal beats 29 ± 21 msec and 30 ± 30 msec. Further analysis was performed among subjects without any abnormal beat.

Comparison of HRV in different categories of age, health and lifestyle characteristics is presented in table 4.2. No differences were observed for HRV-supine or HRV-standing between categories of age, health or lifestyle characteristics, except for differences in HRV-standing between men with low physical activity levels as compared to men with moderate physical activity levels.

The results of univariate and multivariate regression models of physical activity scores and HRV are shown in table 4.3. Physical activity score was related to HRV-supine in men only. Again, in women no association between HRV and

physical activity score was found. No associations were found between HRV and systolic blood pressure, body mass index or use of tobacco.

Table 4.2 Heart rate variability (HRV) for different age groups and some health and lifestyle characteristics of women (N=219) and men (N=206) without abnormal beats*

	Women (N=219)		Men (N=206)	
	HRV† supine	HRV† standing	HRV† supine	HRV† standing
Age (years)				
- 65-69	20±10	21±9	19±11	17±9
- 70-74	18±11	21±17	17±8	18±10
- 75-79	19±10	23±14	19±11	18±10
- 80-85	17±10	23±16	18±11	20±22
Heart disease				
- present	18±10	23±16	17±11	19±14
- absent	19±11	21±13	19±9	17±11
Hypertension				
- present	19±11	23±16	17±11	18±14
- absent	19±10	21±12	19±10	18±11
Lung disease				
- present	21±14	21±14	18±9	16±9
- absent	18±10	22±14	18±10	18±12
Diabetes				
- present	19±12	22±18	21±9	16±7
- absent	19±10	22±14	18±10	18±12
BMI (kg/m^2)				
- ≥ 27 kg/m^2	19±10	22±15	18±9	17±10
- < 27 kg/m^2	19±11	21±13	18±10	18±13
Systolic blood pressure				
- > 160 mm Hg	19±11	23±16	18±10	19±15
- ≤ 160 mm Hg	19±10	21±13	18±10	17±10
Smoking habits				
- smoker	20±9	20±12	18±9	18±13
- former smoker	19±12	21±12	18±11	18±12
- never smoked	18±10	22±15	18±8	17±6
Physical activity level				
- low	17±10	23±19	15±7	15±7¶
- moderate	18±10	20±12	18±10	20±14
- high	20±11	24±14	20±12	15±8

* Values given are mean±SD. † Heart rate variability: standard deviation of 20 seconds normal RR-intervals (msec). ¶ p=0.03 p-values ANOVA

Table 4.3 Association between HRV and physical activity score, before and after adjustment for age and for age and possible other confounders*. Data for women and men without abnormal beats.

	HRV-supine†			HRV-standing†		
	ß	SE	p	ß	SE	p
Women (N=219)						
- crude	0.11	0.14	0.45	0.05	0.19	0.78
- adjusted for age	0.05	0.14	0.74	0.12	0.20	0.53
- adjusted for age + other possible confounders*	0.03	0.15	0.84	0.15	0.20	0.47
Men (N=206)						
- crude	0.19	0.09	0.03	0.01	0.11	0.93
- adjusted for age	0.20	0.09	0.03	0.03	0.11	0.79
- adjusted for age + other possible confounders*	0.19	0.09	0.03	0.03	0.11	0.78

* systolic blood pressure (mm Hg), body mass index (kg/m^2) and use of tobacco (g/day) (former smokers and non smokers: 0 g/day). † Heart rate variability: standard deviation of 20 seconds normal RR-intervals (msec). ß regression coefficient, SE: standard error, p: p-value from the regression model

Discussion

In the present study among elderly women and men, HRV on average was higher in subjects with extra-systoles. These subjects were excluded from further analysis. In men only, HRV-supine was significantly and positively associated with physical activity score. In women there was no apparent association. Furthermore no association between HRV and systolic blood pressure, body mass index or use of tobacco was found.

The study population can be regarded as a relatively healthy selection of home-dwelling elderly. Nonparticipants were significantly more often female and of the highest age group compared to participants (all subjects who were interviewed). When we compared subjects who participated in the physical examination with subjects who participated in the interviews only, the former had higher scores for subjective health and physical activity.

Habitual physical activities have been assessed with a questionnaire, developed and validated by Voorrips et al. [17]. Mean activity scores observed in their study were higher compared to our findings. This is probably a result of a healthier and younger study population than ours. In the present study ranges of physical activity score were larger (0-27 for women and 0-39 for men). Although

the questionnaire does not produce an estimate of absolute energy expenditure, and is meant to classify elderly, we did use the total activity score itself in regression analysis. Results from covariance analysis, using categories of physical activity, confirmed our findings from these regression models.

In epidemiologic studies with large populations 24 hour ECG recordings are not feasible. In order to get an impression of autonomic balance short ECG recordings may suffice [21,22,23]. Moreover, these short recordings are less off a burden to subjects and investigators, and faster and cheaper to analyze than long ECG recordings. However, 20 second ECG recordings as used in the present study, preclude frequency power spectrum analysis. Therefore, standard deviation of RR interval duration was used as a measure of HRV. It is the most commonly used time domain index of HRV, and has been shown to be highly correlated with frequency domain indexes based on 10 minute recordings [24].

The HRV measured by standard deviation of RR interval duration can be affected by artifacts or by beats that do not originate in the sinus node [25,26], and therefore do not reflect normal autonomic control. In the present study all beats were individually checked, and abnormal beats and the RR interval following these beats were excluded. Nevertheless, subjects with abnormal beats present still had higher HRV. Heart rate was similar between elderly with and without abnormal beats, so bradycardia does not seem to be an explanation for this observation. A possible explanation may be, that it is the result of variations in cardiac output because of premature beats, leading to compensatory reflex actions. Moreover, the vasodynamic effects of abnormal beats may have a longer duration than the subsequent beat. Because in subjects with abnormal beats a reliable HRV assessment may not be possible from these 20 seconds ECG recordings, these subjects were excluded from further analyses. Another explanation for a higher HRV in subjects with abnormal beats might be a suboptimal sinus function, occurring frequently in the very old. In this age category SD of RR interval length might not be a good indicator of autonomic regulation. Spectral analysis in which only regular fluctuations are measured, may be a better alternative, however requiring longer ECG recordings.

In our study, as in other studies [23] HRV is correlated to heart rate. To evaluate whether difference in heart frequency was the major determinant of the association between HRV and physical activity, we calculated the coefficient of variation of HRV (the SD of all normal RR intervals divided by the mean of all normal RR intervals). After this correction the results still showed the same trends.

In standing position the relative influences of sympathetic and vagal activities and baroreceptor reflexes on HRV are not clear. We found higher HRV in standing position compared to HRV in supine position, like others have found in subjects aged 60-81 years [27] and in young sedentary subjects, aged 23-32 years [28]. Interestingly, in their study Schwartz et al. [27] found opposite results among young participants, aged 20-40 years.

It may be questioned whether in elderly people the HRV in standing position is affected by the duration of the adjustment reflex, which may be longer than in younger individuals, and the effort of standing still. However, a period of delay of 1 minute between the end of the procedure of standing up and the start of the ECG recordings in standing position seems sufficient for complete adjustment, as the standing procedure itself lasted for a minimum period of 40 seconds, but often longer.

As the scientific purpose of our study was to describe HRV, and significant as well as non-significant results are presented, it was judged not appropriate to adjust levels of significance for the number of comparisons [29].

Results from several studies show that heart rate variability is higher in people with higher levels of physical activity. Adamopoulos [30] reported a decrease of heart rate and an increase of HRV after eight weeks of physical training at home in 25 congestive heart failure patients aged 61±2 years. Dixon et al. [28] compared young male athletes and sedentary controls (22-33 years). They found higher HRV (coefficient of variation of heart rate) for athletes. Also male and female subjects aged 25 - 70 years who were physically active had higher HRV when compared to sedentary subjects [15]. In our study only in men HRV-supine was associated with physical activity scores. The difference between women and men can possibly be explained by the significantly higher physical activity scores and the larger range of these scores in men compared with women. Maybe the absolute level in the high physical activity category in women and the contrast in physical activity levels between subjects was too low to affect HRV substantially.

HRV is decreasing with age. Like Schwarz et al. [27] we found low HRV in elderly subjects as compared to HRV of younger individuals in their study. Because of the high prevalence of abnormal beats in the very old, SD of RR intervals based on 20 second ECG recordings might not be a good indicator of autonomic cardiac control in elderly persons, aged 65-85 years. Spectral analysis of two to 15 minutes recordings might be more suitable [21] for epidemiologic studies.

We conclude that in our study population elderly women and men had similar, low HRV. Subjects with premature ventricular complexes had higher HRV than

subjects without these complexes. In men, but not in women without abnormal beats there was a positive association between HRV in supine position and physical activity score. We suggest to use longer ECG recordings for the assessment of HRV in epidemiologic studies among elderly people.

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5. Respiratory function and physical activity in Dutch elderly people, aged 65 to 85 years*

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Abstract

Information on respiratory function and associated lifestyle factors is scarce for elderly people in the general population. We studied respiratory function and its relationship with physical activity in non-institutionalized Dutch elderly, aged 65-85 years. We obtained cross-sectional interview and acceptable spirometric data of 230 women and 294 men. Another 90 women and 61 men could not perform three technically acceptable and two reproducible tests. Compared to subjects who produced reproducible spirometric tests, women with test failure were older, had lower physical activity scores, and more often reported daily cough, whereas men with test failure were older, and reported more dyspnea. Logistic regression analysis including adjustment for pack-years, revealed that physical activity was negatively associated with presence of dyspnea in both women and men (OR=0.87 (95%CI: 0.80-0.96) and OR=0.85 (0.78-0.93) respectively for 1 unit of physical activity score) and with daily cough in men (OR=0.93 (0.88-0.99)). Results of multivariate regression analysis including age, height, weight, and pack-years showed a positive association of physical activity with all lung function parameters. Physical activity was statistically significantly associated with MMEF in women (β=0.0234 p=0.01), and with FVC (β=0.0127 p=0.01), $FEV_{1.0}$ (β=0.0129 p=0.01) and PEF (β=0.0400 p=0.05) in men. We conclude that lung function and physical activity are positively associated in elderly individuals.

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* Submitted for publication

Introduction

Obstructive pulmonary disease is an important cause of disability and death in old age [1,2]. Impaired lung function has been shown to be a predictor for cardiovascular diseases [3,4] and to be associated with cardiovascular and all cause mortality [5,6,7,8,9]. The association of physical activity with lung function has rarely been investigated. Regular exercise may positively influence respiratory function [10], whereas impaired lung function can be a limiting factor for physical activity [11].

Information on respiratory function and associated lifestyle factors is scarce for samples in the general population of women and men, aged 65 years and over. We conducted a cross-sectional study of lifestyle and health in 1,012 non-institutionalized women and men, aged 65 to 85 years. In this paper, we give a description of respiratory conditions in this population and of associations of respiratory symptoms and spirometric lung function with physical activity after correction for relevant confounders.

Population and methods

Study population

The study was carried out among women and men aged 65 to 85 years, living in Arnhem, a city of approximately 133,000 inhabitants in the eastern part of the Netherlands. A random sample of 1,793 non-institutionalized elderly, stratified for sex and age, provided by the municipal Registry Office of Arnhem, was invited by letter to participate in a study of lifestyle and health. Forty nine elderly were excluded since they were found to be institutionalized, had moved to other places or had died. Seven hundred thirty two elderly refused participation for several reasons; the most frequent reasons for non-participation were recent illness or frequent medical examinations in the recent past (21% of the non-participants), and no time or interest (29% of the non-participants). A total of 1,012 elderly (58%) were visited at home for a one-hour interview about lifestyle, health and socio-demographic characteristics. At the end of the interview subjects were asked to participate in a physical examination, including measurements of height, weight, blood pressure, and respiratory function. Written informed consent was obtained from all the subjects prior to this examination. The study design has been approved by the independent institutional medical ethical committee.

Of the 1,012 elderly who were interviewed, 685 (68%) had a physical examination. Subjects who participated in the interviews but not in the physical examination were more often female and of the highest age group, and had lower scores for subjective health and physical activity than those who did participate in both parts of the study.

Interview

A short Dutch version of the British Medical Research Council questionnaire has been used to assess the presence of respiratory symptoms [12]. Questions were asked about chronic cough and chronic phlegm (daily for at least three months during the previous two years), shortness of breath (dyspnea), ever wheezing and recent wheezing (for at least one week during the previous two years). Additional questions were included about respiratory diagnoses (including asthma, bronchitis and emphysema) and smoking habits. When subjects reported current smoking or had smoked in the past year, they were defined as smokers. Former smokers were defined as those who had quit smoking more than a year ago. Never smokers were those who reported never to have smoked in their lives. Pack-years of tobacco consumption were calculated as 0.05 times grams of tobacco used per day times the number of years the subject had smoked (1 cigarette=1 g of tobacco, 1 pipe or cigar = 3 g of tobacco).

To assess the habitual physical activity level in the past year, we used an existing Dutch questionnaire based on the Baecke questionnaire [13,14]. Involvement in ten household activities, and time spent at recreational physical activities (e.g. sports and other physically active leisure time activities) were asked for. Each reported activity was classified according to work posture and movements, using an intensity code based on the net energetic costs of the particular activity. According to this intensity code and the time per year spent on an activity, scores for each activity were calculated and summarized, resulting in a total activity score. Mean total activity score for women was 7.00 (SD 4.81 range: 0.50 - 27.19) and for men 10.32 (SD 7.84 range: 0.10 - 53.95). We used quintiles of total activity scores to categorize subjects into three levels of physical activity: low being the lowest quintile, moderate being the second, third and fourth quintile, and high being the highest quintile. Women and men were categorized separately. Cut-off points for the lowest and highest quintiles were 2.93 and 10.30 respectively for women, and 3.80 and 15.50 respectively for men.

Physical examination

Respiratory function tests were performed according to the protocol of the ECCS [15]. A rolling seal dry spirometer (Vicatest 5, Mijnhardt, Bunnik, the Netherlands) coupled with automatic data acquisition software was used. All respiratory function data fulfilling the general acceptability criteria of the ECCS (such as no hesitant start, no early termination of the maneuver) were used in the analysis. Subjects with less than three acceptable tests or differences between the highest and the second highest FVC of more than 300 ml were excluded from the analyses (N=151). From a minimum of three valid expiratory maneuvers the highest forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1.0}$) and peak flow (PEF) were selected. The highest maximal midexpiratory flow (MMEF) was selected from a maneuver with a FVC within 300 ml of the highest FVC. Thus, the selected spirometric values could be obtained from different curves. All spirometric results were adjusted to body temperature and pressure saturated with water vapor (BTPS), using the air temperature of the test room and the mean air pressure of the measurement day. Spirometry was performed from the 5th of November 1991 to the 6th of April 1992 between 8.40 am. and 5.40 pm. by well trained technicians. Each day spirometers were checked for leaks with a three liter syringe. Tests were done without a noseclip while participants were sitting. Prior to the lung function tests, standing height and weight were measured without shoes.

Statistical analyses

Differences in age, height, weight, lifestyle characteristics and respiratory conditions between the study population and elderly in the test failure group who did not meet the criteria of the ECCS [15], and between women and men were analysed by unpaired t-tests and chi-square tests. Trends with physical activity were tested based on likelihood ratio statistics or linear regression, physical activity level scored 1 to 3. Predicted values for FVC and $FEV_{1.0}$ were calculated from linear regression models using the data of the study population, adjusting for age, height and weight. Logistic regression analysis was performed to study the association of respiratory symptoms with smoking habits and physical activity. Multivariate linear regression analysis was used to calculate regression coefficients of FVC, $FEV_{1.0}$, $FEV_{1.0}$/FVC%, PEF and MMEF for physical activity stratified for smoking habits, and for physical activity adjusted for age, height, weight and pack-years of smoking. All analyses were carried out for women and men separately, using SAS statistical software [16]. P-values <0.05 were considered to indicate statistical significance.

Because of missing values for some variables the number of subjects available for the analyses varied.

Results

Test failure

Interview data and acceptable spirometric data were available for 524 participants (230 women, 294 men). Three subjects refused to perform a lung function test, data of five subjects were lost and two subjects had no lung function test because of technical problems with the spirometers. A total of 151 (29%) subjects were not

Table 5.1 Characteristics of the study population and two test failure groups

	3 Successful maneuvers mean ± SD	Test failure 0 maneuvers* mean ± SD	Test failure 1-3 maneuvers† mean ± SD
Women	n=230	n=42	n=48
Age, yr	73.7 ± 5.8	75.5 ± 6.0	75.7 ± 5.5
Height, cm	161 ± 6	157 ± 6	160 ± 7
Weight, kg	68.1 ± 12.1	66.4 ± 10.9	69.7 ± 12.1
Smoking status			
- current smoker	14%	26%	16%
- former smoker	28%	14%	27%
- never smoker	58%	60%	58%
Smoking years, yr	10.8 ± 17.1	10.7 ± 18.8	12.2 ± 17.4
Pack-years tobacco	4.9 ± 10.8	9.0 ± 22.4	5.31 ± 13.2
Physical activity score	7.00 ± 4.81	5.33 ± 4.18	5.73 ± 4.31
Men	n=294	n=23	n=38
Age, yr	73.1 ± 5.3	75.6 ± 6.0	75.3 ± 6.1
Height, cm	174 ± 6	174 ± 9	173 ± 7
Weight, kg	77.3 ± 9.9	77.5 ± 13.7	74.5 ± 10.9
Smoking status			
- current smoker	35%	30%	26%
- former smoker	56%	52%	58%
- never smoker	9%	17%	16%
Smoking years, yr	36.4 ± 19.4	37.3 ± 25.8	35.5 ± 21.9
Pack-years tobacco	32.6 ± 29.4	33.8 ± 42.1	27.9 ± 26.1
Physical activity score	10.32 ± 7.84	8.74 ± 7.67	10.08 ± 8.29

* Including subjects with no acceptable maneuvers. † Including subjects with 1-3 acceptable maneuvers.

able to perform three acceptable maneuvers (test failure). Sixty five of them (42 women, 23 men) could not perform any acceptable test (for reasons like stopping too early, not understanding the instructions, inspirations during the tests). Three women could only perform one, 25 women and 18 men two tests. Forty subjects (20 women, 20 men) had three tests, but the difference in FVC between the highest and the second highest tests were > 0.3 liter. Table 5.1 shows age, height,

Table 5.2 Prevalence (%) of respiratory conditions and lung function values (mean ± SD) in 524 Dutch elderly

	Low*	Moderate*	High*	Total
Women	n=44	n=134	n=45	n=230
Daily cough	11	10	4	10
Daily phlegm	11	6	4	7 †
Dyspnea	32	19	11 ‡	20 †
Recent wheezing	16	10	7	11
Ever wheezing	27	21	24	23
Bronchitis	5	6	9	7
Asthma	0	0	4	1
Emphysema	2	1	2	2
%predFVC§	100 ± 20	100 ± 19	101 ± 16	100 ± 18
%pred $FEV_{1.0}$§	100 ± 23	100 ± 24	101 ± 25	100 ± 24
$FEV_{1.0}$/FVC%§	70 ± 10	71 ± 10	71 ± 12	70 ± 10
Men	n=58	n=174	n=59	n=294
Daily cough	24	13	8 ‡	14
Daily phlegm	26	7	14 ‡	12
Dyspnea	34	6	7 ‡	12
Recent wheezing	17	9	10	11
Ever wheezing	31	23	24	24
Bronchitis	14	3	7	6
Asthma	3	2	2	2
Emphysema	7	2	2	3
%predFVC§	96 ± 20	100 ± 17	103 ± 16 ‡	100 ± 18
%pred$FEV_{1.0}$§	93 ± 32	101 ± 24	105 ± 26 ‡	100 ± 26
$FEV_{1.0}$/FVC%§	65 ± 15	68 ± 11	69 ± 10	67 ± 12

* Low, moderate or high physical activity level. † P-value X^2-test <0.05 for differences between women and men. ‡ P-value <0.05 for trend over categories of physical activity. § Mean ± SD.

weight and lifestyle characteristics of the study population and two groups of subjects with test failure. Subjects in the study population (e.g. women and men fulfilling all criteria) differed in all these features from subjects with test failure, except for mean age. Test failure was significantly more frequent in women than in men, and in older compared to younger subjects. Women and men without any acceptable test had higher mean values for smoking years and pack-years and lower physical activity scores than women and men in the group with one to three acceptable, but not reproducible maneuvers, and in the study population.

Women with test failure had higher prevalence of cough (18%), and men with test failure had higher prevalence of dyspnea (21%) than women and men with reproducible tests (10% and 12% respectively, $p < 0.05$). Percentage predicted FVC, % predicted $FEV_{1.0}$ and $FEV_{1.0}$/FVC% in elderly with three acceptable, but not reproducible maneuvers were 112 ± 29, 103 ± 21 and 67 ± 10 for women (n=20), and 101 ± 16, 92 ± 20 and 61 ± 11 for men (n=20).

Respiratory function and physical activity

In table 5.2 the prevalence of respiratory symptoms and diseases and mean lung function values in categories of physical activity have been presented for the subjects in the study population. The most frequently reported respiratory symptoms were wheezing, dyspnea and daily cough. Daily phlegm was more frequently reported by men than women, and shortness of breath was more frequently reported by women as compared to men. Thirty seven percent of the women and men had at least one of these five symptoms, while 30% women and 27% men had at least one of the first four symptoms (ever wheezing excluded).Three out of the five symptoms were statistically significantly associated with physical activity level. In the low physical activity category, more men reported daily cough and phlegm, and both women and men more frequently reported complaints of dyspnea as compared to subjects in the moderate and high physical activity category. In men there was a positive association of % predicted FVC, % predicted $FEV_{1.0}$ and $FEV_{1.0}$/FVC% with physical activity level.

Results of logistic regression analyses for daily cough, daily phlegm, dyspnea and recent wheezing are presented in table 5.3. In female never smokers and male former smokers with dyspnea odds ratios for physical activity score were statistically significantly lower than in subjects without dyspnea. This association between presence of dyspnea and low physical activity scores was also seen after adjustment for pack-years. In men, physical activity was also negatively associated with the presence of reported daily cough.

Table 5.3 Odds ratio and 95% confidence intervals for respiratory symptoms of physical activity and smoking in 524 Dutch elderly

	Physical activity score*						Pack-years†		Physical activity score‡	
	Current smokers		Former smokers		Never smoked					
	OR	95%ci	OR	95%ci	OR	95%ci	OR	95%ci	OR	95%ci
Women	n=31		n=64		n=128		n=222		n=222	
Cough§	1.09	0.89-1.35	0.42	0.17-1.02	0.92	0.79-1.08	0.99	0.94-1.03	0.91	0.81-1.03
Phlegm§	1.06	0.86-1.30	0.78	0.55-1.12	0.95	0.78-1.15	1.02	0.98-1.06	0.95	0.84-1.08
Dyspnea§	0.87	0.70-1.08	0.91	0.78-1.05	0.85	0.74-0.99	1.00	0.96-1.03	0.87	0.80-0.96
Wheezing§	0.94	0.77-1.15	0.89	0.74-1.07	0.92	0.76-1.10	1.02	0.99-1.05	0.92	0.82-1.03
Men	n=102		n=162		n=27		n=289		n=289	
Cough§	0.92	0.84-1.00	0.94	0.86-1.03	0.75	0.47-1.21	1.01	1.00-1.02	0.93	0.88-0.99
Phlegm§	0.96	0.88-1.04	0.95	0.87-1.04	1.05	0.95-1.17	1.01	1.00-1.02	0.98	0.93-1.03
Dyspnea§	0.90	0.81-1.00	0.82	0.72-0.94	-	-	1.00	0.99-1.02	0.85	0.78-0.93
Wheezing§	0.96	0.87-1.05	0.98	0.90-1.06	1.03	0.93-1.14	1.00	1.00-1.02	0.98	0.93-1.04

* Crude odds ratio (OR) and 95% confidence interval (95%ci) of 1 unit of physical activity score in categories of smoking habits. † OR and 95%ci of 1 unit of pack-years, adjusted for physical activity score. ‡ OR and 95%ci of 1 unit of physical activity score, adjusted for pack-years. § Daily cough, daily phlegm, dyspnea and recent wheezing: present versus absent. - Too small numbers (n=3).

Table 5.4 Linear regression coefficients and p-values for respiratory function of physical activity and smoking in 524 Dutch elderly

	Physical activity score*						Pack-years†		Physical activity score‡	
	Current smokers		Former smokers		Never smoked					
	β	p	β	p	β	p	β	p	β	p
Women	n=30		n=62		n=125		n=218		n=218	
FVC	-0.0022	0.86	+0.0007	0.96	+0.0132	0.21	-0.0032	0.29	+0.0064	0.38
$FEV_{1.0}$	-0.0025	0.86	+0.0111	0.37	+0.0133	0.15	-0.0041	0.14	+0.0094	0.15
$FEV_{1.0}$/FVC%	-0.0603	0.89	+0.3441	0.21	+0.2007	0.35	-0.0535	0.42	+0.1908	0.22
PEF	+0.0086	0.89	-0.0012	0.98	+0.0215	0.49	-0.0028	0.77	+0.0157	0.50
MMEF	-0.0059	0.81	+0.0191	0.26	+0.0346	0.01	-0.0030	0.45	+0.0234	0.01
Men	n=101		n=161		n=26		n=288		n=288	
FVC	+0.0132	0.15	+0.0110	0.12	+0.0306	0.05	-0.0045	<0.01	+0.0127	0.01
$FEV_{1.0}$	+0.0208	0.01	+0.0091	0.20	+0.0184	0.29	-0.0053	<0.01	+0.0129	0.01
$FEV_{1.0}$/FVC%	+0.3579	0.04	+0.0419	0.70	-0.1776	0.56	-0.0532	0.02	+0.1100	0.22
PEF	+0.1022	<0.01	+0.0065	0.81	+0.0449	0.52	-0.0124	0.02	+0.0400	0.05
MMEF	+0.0147	0.24	+0.0067	0.55	+0.0029	0.91	-0.0059	<0.01	+0.0087	0.27

* Linear regression coefficient (β) and p-values of 1 unit of physical activity score in categories of smoking habits. † β and p-values of 1 unit of pack-years adjusted for age, height, weight and physical activity score. ‡ β and p-values for 1 unit of physical activity score adjusted for age, height, weight and pack-years.

Relationships between lung function and physical activity adjusted for confounders (age, height, weight, and pack-years) are given in table 5.4. When stratifying for smoking habits a predominantly positive association between physical activity and lung function variables was found. In female never smokers, in male current smokers and in male never smokers physical activity was statistically significantly and positively associated with MMEF, with $FEV_{1.0}$, $FEV_{1.0}$/FVC% and PEF, and with FVC respectively. In multivariate linear regression models physical activity was positively associated to all lung function variables. In women this association was statistically significant for MMEF and in men for FVC, $FEV_{1.0}$ and PEF.

Discussion

This study has shown that there was a high prevalence of test failure in this population of elderly subjects. Physical activity was negatively associated with reported daily cough and daily phlegm in men, with dyspnea both in women and men, and positively with spirometric function both in women and men. These associations were found in strata of smoking habits and were independent of pack-years and other confounders.

Comparison with other studies

Comparison of the presence of respiratory symptoms in our study with results of other studies is difficult because different methods were used to assess respiratory conditions, and because data in elderly are scarce. Findings for reported bronchitis, asthma and emphysema were similar to those of other Dutch studies among people of 55 years and over [2,17,18].

Like others [19,20,21], we found a negative association between pack-years of smoking and respiratory function. The differences between women and men might be caused by a much lower percentage of women who (ever) smoked, and an earlier cessation of smoking - resulting in lower pack-years - as compared to men. Smokers who quit smoking before the age of 40 years have been shown to have similar $FEV_{1.0}$ levels to never smokers [21].

The association of lung function with physical activity has mainly been investigated in young adults. Studies in elderly are scarce. In the Framingham Study population (30-59 years) which was largely sedentary, no correlation between the Physical Activity Index and vital capacity was found [22]. In an

Australian follow-up study 66 women of 60 to 70 years completed a 26 weeks progressive walking program. The FVC, $FEV_{1.0}$, $FEF_{25\% \text{ to } 75\%}$ and $FEV_{1.0}$/FVC all remained unchanged and no time effects were observed [23]. However, Persson et. al. [24] found in a study in Swedish women of the general population (38-60 years) a positive association between physical activity and PEF at base-line, after adjusting for age. Marcus et. al. [3] found a positive association at base-line between $FEV_{1.0}$/FVC% and physical activity in smokers, and in the total study population of Japanese-American men, aged 45-68 years, participating in the Honolulu Heart Program. In a German cross-sectional study elderly people aged 55 and over who regularly did endurance training, had higher vital capacity and $FEV_{1.0}$ as compared to sedentary elderly of the same age group [10]. Similar results have been found in a cross-sectional study among 18 physically well-trained men (mean age 65 years) and 644 controls, 67-68 years of age [25]. Cook et. al. [26] found a positive association of PEFR with measures of physical activity in a cross-sectional study among elderly people, aged 65 years and over. Our findings also suggest a positive association between physical activity and lung function. The difference in findings for women and men might be explained by the lower physical activity levels in women as compared to men. Probably only high physical activity levels are associated with good ventilatory function [25].

Possible mechanisms

Our cross-sectional data preclude statements about the direction of the associations found. It has been suggested that large vital capacity may be explained as a result of physical training. However, it could also be a result of selection of persons with original high vital capacities who become good in sports or work where high physical activity is required [27]. Longitudinal studies including measurements of lung function and physical activity, could reveal possible mechanisms. With increasing age a combination of reduction of vital capacity and increase of dyspnea [11] or other symptoms of poor health might limit the exercise potential of older individuals. Therefore, we think the major explanation for our findings is that physical activity of elderly is highly affected by their health status, including lung function.

Test failure

In our study we found a high prevalence of spirometric test failure (29%). Results of other studies are not consistent. Some investigators find relatively high percentages of test failure in elderly, whereas others find much lower percentages.

In a study among 65 independently living elderly of 65 years and over, Sherman et. al. [28] found 8 (12%) individuals unable to perform at least three acceptable forced expiratory maneuvers, and another 18 (28%) who failed to meet reproducibility criteria of the ATS, which are even more stringent than the ECCS criteria of 1983. In a sample of 394 elderly people out of the general population, aged 55 to 86 years, 10% of the participants were unable to perform "satisfactory" tests according to the ATS criteria [29]. Tockman [30] reported 78% of 639 participants of the Baltimore Longitudinal Study of Aging could perform acceptable spirograms, and 91% of the acceptable spirograms were reproducible maneuvers according to the ATS criteria. Other investigators found low percentages of test failures. Horsley et. al. [31] found only three women (aged 88,89,93) having difficulties with performing spirometry out of 180 participants of over 65 years. These 180 participants were recruited from four groups: one group with no respiratory symptoms and three other groups with different types of respiratory symptoms. This may have caused a high motivation to succeed or a high level of experience in lung function testing. In a study of 4,966 participants aged 65 to 85 years, 145 (3%) could not perform three acceptable and reproducible FVC maneuvers according to the ATS criteria [32]. The latter study probably included healthier subjects than in our study. This may have caused the lower percentage of test failure as compared to our findings.

We conclude that in our study there was a relatively high prevalence of test failure. Like in other studies we found a positive association of test failure with increasing age [30,33,34], with respiratory symptoms [35], and with female sex [33]. Performance of forced spirometry might require too much energy for elderly people. Therefore we suggest the use of vital capacity instead of forced vital capacity measurements, or analysis of all subjects with test failure as a separate group should be considered among elderly subjects.

Selection

The studied population can be regarded as a relatively healthy selection of elderly people, because of the selective non-participation in the interviews and the physical examination, and the exclusion of subjects with test failure for spirometric lung function tests. In all these cases of selection, the participating subjects tended to be younger, more often male, healthier and with a higher level of physical activity than the non-participants or the subjects with test-failure. Thus we believe the lung function of elderly in the general population might be less favorable than appears from the present study.

Conclusions

We conclude that lung function and physical activity are positively associated in elderly individuals. A major explanation for this finiding might be a decrease in the capacity to exercise in those having a poor lung function. From this study it cannot be concluded that physical activity enhances pulmonary function in elderly women and men. However, it is still important to be physically active for other reasons like maintaining health, well-being and independence.

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6. Performance of household activities of Dutch elderly people. Associations with socio-demographic characteristics, health and use of care*

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Abstract

To give a description of performance of household activities and associated characteristics of non-institutionalized elderly people, a cross-sectional study was carried out in 1991-1992, and 515 women and 497 men (65-85 years) were interviewed. Cooking, shopping, light and heavy housework were performed by 90%, 89%, 91% and 50% respectively of the women, and 38%, 83%, 61% and 43% of the men. Non-performers were characterized by high age (80-84 years), high socio-economic status, low subjective health, disability and chronic disease, and only for men living with someone else; e.g.: odds ratios and 95%-confidence intervals (CI) of these characteristics (including living alone) for performing heavy housework are 0.2(CI:0.1-0.4), 0.5 (CI:0.3-0.8), 0.2 (CI:0.2-0.4), 0.1 (CI:0.0-0.2), 0.2(CI:0.1-0.4) and 0.8(CI:0.6-1.2) for women and 0.4(CI:0.2-0.7), 0.5(CI:0.3-0.8), 0.5(CI:0.4-0.7), 0.3(CI:0.2-0.5), 0.5(CI:0.3-0.8) and 1.4(CI:0.9-2.2) for men. Women and non-performers more frequently used formal and informal care than men and performers. Elderly people living alone and elderly men living with someone else are especially vulnerable for loosing independence.

Introduction

The number of elderly is growing in Western societies [1,2,3]. Increasing age is often associated with a decline in physical health and with functional disability [4,5]. The aim of the Dutch government is to improve elderly people's quality of life, to

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* Submitted for publication

enable them to live independently in their own homes, and to prevent a further rise of the costs of care [6].

Independent living involves actual performance of basic tasks that need to be carried out (almost) every day. Household activities form an important part of these basic tasks. In research, usually the focus is on physical ability to perform activities of daily living. Although physical ability and good health are important for levels of functioning [1] and many of the activities are essential to independent living, this does not necessarily imply actual performance of activities [7]. Other factors, like socio-demographic characteristics, might also be involved [5,8,9,10]. When people need help with activities of daily life, both formal and informal care can be provided to prevent institutionalization.

The aim of our study is to describe the actual performance of household activities and its relationship with socio-demographic and health characteristics, and the use of formal and informal care in a sample of non-institutionalized Dutch elderly women and men. This information can be of use for the planning of preventive measures to promote independence of elderly people.

Methods

Population

From October 1991 until April 1992 a random sample of 1793 non-institutionalized elderly residents of Arnhem, a city of approximately 133,000 inhabitants, was invited to take part in a study of life-style and health. The sample drawn from the municipal register office, was stratified for sex and age. Age groups were 65-69, 70-74, 75-79 and 80-84 years. Forty nine elderly were excluded from this study because they were institutionalized, had moved elsewhere or had died. Of the remaining elderly 732 refused to participate for several reasons. The most frequently reported reasons of non-participation were recent illness or medical examination (21%) and no interest or time (29%). A total of 1012 elderly people (58%) participated in this study.

Questionnaires

Data used for this analysis were derived from interviews in the homes of the participants. The questionnaire included questions on performance of household activities, socio-demographic and health characteristics, and use of formal and informal care.

Performance of household activities was assessed by 4 questions on cooking, shopping, light and heavy housework [11]. These four activities were distinct from each other. Light housework included activities such as dusting, washing dishes and making beds. Heavy housework included among other activities cleaning windows, vacuum cleaning and mopping. Subjects were defined performers of these household activities when they were cooking 3 times a week or more, shopping once a week or more, doing light housework most of the times or always, and doing heavy housework most of the times or always.

Socio-demographic characteristics included in the analysis were age group (65-69, 70-74, 75-79, 80-84 years), living situation (living alone, not living alone) and socio-economic status (low, middle, high). Socio-economic status (SES) was based on questions about occupation [12]. For married, divorced or widowed women the SES of their (ex-)partner was used.

Three dimensions of health were used for analysis: perceived health, disability, and prevalence of chronic diseases. Perceived health was assessed by asking subjects to rate their own health on a scale ranging from 1 (worst) to 10 (best) [13]. These ratings were divided in 2 categories according to the sample median. High subjective health was defined as ratings of 8 or higher; low subjective health as ratings of 1 to 7. Disability was assessed using a questionnaire of 8 items on instrumental activities of daily living (IADL) [13]. These items were *ability* to carry a heavy object (5 kg) over 10 m, to do heavy housework, to shop, to wash dishes, to prepare breakfast or lunch, to make tea or coffee, to lay or clear the table and to cook. Subjects were asked whether they were *able* to perform these activities. If a subject reported to have some or great difficulties with any of these activities, or could not perform these activities, this was defined as disability. Chronic diseases were assessed using a list of 23 diseases [14]. Prevalence of chronic disease was defined when a subject reported to suffer from 1 or more of these 23 diseases.

Use of formal care was assessed by questions with respect to organized home help and meal provision, use of informal care by questions about appeal to family and friends, and help of others with shopping (shopping help).

Data analysis

Statistical analysis was carried out for women and men separately, using SAS statistical software [15]. The X^2-test was used for study of homogeneity of frequency distributions between sexes and between subjects who did or did not perform household activities. Associations of performance of household activities with socio-demographic and health characteristics were studied using logistic

regression. The dependent variable was performance of household activities (yes versus no). Independent variables were socio-demographic characteristics and health characteristics. The associations of performance of household activities with health characteristics were multivariately adjusted for age group, SES and living situation. Regression coefficients were calculated by the Maximum Likelihood method. Odds ratios (OR) were calculated as the anti-logarithm of the estimated regression coefficients, and 95% confidence intervals (CI) were computed. Because of missing values for some variables the number of subjects available for analysis differs. The maximum number of missing values was 15 for women and 8 for men.

Results

Socio-demographic and health characteristics, and performance of household activities of the study population are shown in table 6.1. Women more often had a low SES, lived alone, reported disability and chronic disease, and had lower subjective health scores than men. All household activities were more frequently performed by women than by men, especially cooking and light housework. A majority of the participants were doing their shopping themselves, whereas 50% of the women and 57% of the men did not perform heavy housework.

Disability in women is mainly related to problems with carrying an object (Spearman's $r=0.71$ $p<0.05$) and having problems with heavy housework (Spearman's $r=0.82$ $p<0.05$), and in men to problems with cooking (Spearman's $r=0.70$ $p<0.05$) and problems with heavy housework (Spearman's $r=0.59$ $p<0.05$). Performance of household activities is strongly associated with IADL-problems. Subjects with an IADL-problem are less likely to perform household activities than subjects without these problems (table 6.2).

The OR's and 95% CI of socio-demographic and health characteristics on performance of housework are presented in table 6.3. For age, SES and living situation crude OR's are given, whereas the odds ratios of health characteristics were adjusted for age, socio-economic status and living situation. For women, aged 80-84 years performance of shopping, light and heavy housework are less prevalent than in women aged 65-69 years (OR=0.3(CI:0.1-0.6), OR=0.3(CI:0.1-0.8) and OR=0.2(CI:0.1-0.4), respectively). For men aged 80-84 years performance of heavy housework is less prevalent than for men aged 65-69 years (OR=0.4(CI:0.2-0.7). Light housework was less frequently performed by men with a high SES (OR=0.5(CI:0.3-0.7), and heavy housework by both women and men with

a high SES (OR=0.5(CI:0.3-0.8)), as compared to subjects with a low SES. In women living alone was not associated with household activities, whereas men living alone more frequently performed household activities than men living with some one else. For cooking and light housework women living alone had OR's of 0.8(CI:0.5-1.5) and 0.7(CI:0.4-1.4), respectively, whereas men living alone had OR's of 4.3(CI:2.7-7.0) and 2.5(CI:1.5-4.2), respectively, as compared to subjects living with someone else. Subjects with a low subjective health, with disability or

Table 6.1 Distribution (%) of socio-demographic and health characteristics, and performance of household activities of Dutch elderly women and men

	Women (N=515)	Men (N=497)
Age (years)		
- 65-69	24	30
- 70-74	23	26
- 75-79	23	23
- 80-84	31	22 *
SES		
- low	45	36 *
- middle	30	36
- high	26	28
Living alone	60	18 *
High subjective health	46	54 *
Physical disability	67	61 *
Chronic disease	87	77 *
Performance of household activities		
- cooking	90	38 *
- shopping	89	83 *
- light work	91	61 *
- heavy work	50	43 *

* P-values X^2-test < 0.05, for differences between women and men

Table 6.2 Distribution (%) of performance of household activities among Dutch elderly women and men with or without IADL-problems

	Actual performance of household activities ‡			
	Cooking %	Shopping %	Light work %	Heavy work %
Women (N=515)				
Problems with cooking				
- absent (93%)	95	92	94	54
- present (7%)	78 *	49 *	49 †	6 *
Problems with carrying				
- absent (50%)	95	96	97	69
- present (50%)	85 *	82 *	84 *	32 *
Problems with shopping				
- absent (71%)	95	98	96	64
- present (29%)	78 *	66 *	78 *	16 *
Problems with heavy housework				
- absent (43%)	95	97	99	83
- present (57%)	86 *	83 *	85 *	26 *
Physical disability				
- absent (33%)	94	97	98	83
- present (67%)	26 †	85 *	87 *	34 *
Men (N=497)				
Problems with cooking				
- absent (57%)	56	86	69	49
- present (43%)	16 *	79 *	51 *	35 *
Problems with carrying				
- absent (85%)	38	85	64	48
- present (15%)	39	69 *	44 *	19 *
Problems with shopping				
- absent (86%)	40	89	65	48
- present (14%)	30	49 *	36 *	14 *
Problems with heavy housework				
- absent (65%)	39	87	68	56
- present (35%)	39	74 *	49 *	20 *
Physical disability				
- absent (39%)	51	88	73	60
- present (61%)	30 *	79 *	53 *	32 *

‡ % of subjects who actually performed cooking, shopping, light and heavy housework
* P-value X^2-test < 0.05, for differences between subjects without and with IADL-problems
† To small numbers in one or more cells for X^2-testing

Table 6.3 Odds ratios and 95% confidence intervals of socio-demographic and health characteristics for performance versus non-performance of household activities in Dutch elderly women and men

	Women (N=515)				Men (N=497)			
	Cooking OR CI	Shopping OR CI	Light work OR CI	Heavy work OR CI	Cooking OR CI	Shopping OR CI	Light work OR CI	Heavy work OR CI
Age (years)*								
- 65-69	1	1	1	1	1	1	1	1
- 70-74	1.8 (0.6-5.1)	0.8 (0.3-2.3)	0.6 (0.2-1.8)	0.5 (0.3-0.9)	1.2 (0.8-2.0)	1.1 (0.6-2.1)	1.2 (0.7-1.9)	1.1 (0.7-1.8)
- 75-79	0.9 (0.4-2.1)	0.5 (0.2-1.4)	0.5 (0.2-1.4)	0.6 (0.4-1.0)	0.9 (0.6-1.5)	0.9 (0.4-1.7)	1.0 (0.6-1.6)	0.7 (0.4-1.1)
- 80-84	0.6 (0.3-1.2)	0.3 (0.1-0.6)	0.3 (0.1-0.8)	0.2 (0.1-0.4)	1.0 (0.6-1.7)	0.7 (0.4-1.3)	0.9 (0.5-1.4)	0.4 (0.2-0.7)
SES*								
- low	1	1	1	1	1	1	1	1
- middle	1.4 (0.7-3.0)	0.7 (0.4-1.4)	1.4 (0.7-2.8)	0.8 (0.5-1.2)	0.8 (0.5-1.2)	1.3 (0.8-2.3)	0.7 (0.4-1.1)	0.9 (0.6-1.4)
- high	1.0 (0.5-1.9)	1.3 (0.6-2.7)	1.3 (0.6-2.7)	0.5 (0.3-0.8)	0.7 (0.4-1.1)	1.6 (0.9-3.0)	0.5 (0.3-0.7)	0.5 (0.3-0.8)
Living situation*								
- not living alone	1	1	1	1	1	1	1	1
- living alone	0.8 (0.5-1.5)	0.8 (0.4-1.5)	0.7 (0.4-1.4)	0.8 (0.6-1.2)	4.3 (2.7-7.0)	1.4 (0.7-2.5)	2.5 (1.5-4.2)	1.4 (0.9-2.2)
Low subjective health**	0.5 (0.3-0.9)	0.5 (0.3-0.9)	0.3 (0.1-0.6)	0.2 (0.2-0.4)	0.8 (0.6-1.2)	0.7 (0.4-1.1)	0.7 (0.5-1.0)	0.5 (0.4-0.7)
Physical disability**	0.4 (0.1-0.9)	0.2 (0.1-0.6)	0.1 (0.0-0.4)	0.1 (0.0-0.2)	0.4 (0.2-0.6)	0.5 (0.3-0.9)	0.4 (0.3-0.6)	0.3 (0.2-0.5)
Chronic disease**	0.6 (0.2-1.7)	0.9 (0.4-2.2)	0.1 (0.0-1.0)	0.2 (0.1-0.4)	0.7 (0.4-1.0)	0.7 (0.4-1.2)	0.5 (0.3-0.8)	0.5 (0.3-0.8)

* crude OR's

** present versus absent, OR's adjusted for age group, SES and living situation

Table 6.4 Distribution (%) of use of care by Dutch elderly women and men performing or not performing household activities

	Formal care		Informal care	
	Home help %	Meal provision %	Family & friends %	Shopping help %
Women (N=515)	18 †	6	16 †	24 †
Cooking				
- performers (90%)	16	2	14	21
- non-performers (10%)	38 *	42 *	30 *	49 *
Shopping				
- performers (89%)	14	4	13	16
- non-performers (11%)	50 *	17 *	36 *	86 *
Light housework				
- performers (91%)	15	5	14	20
- non-performers (9%)	48 *	17 *	31 *	60 *
Heavy housework				
- performers (50%)	3	1	9	10
- non-performers (50%)	34 *	11 *	23 *	37 *
Men (N=497)	10	5	7	17
Cooking				
- performers (38%)	12	1	8	13
- non-performers (62%)	8	7 *	7	19 *
Shopping				
- performers (83%)	9	4	6	6
- non-performers (17%)	13	8	15 *	67 *
Light housework				
- performers (61%)	7	4	6	11
- non-performers (39%)	13 *	5	9	26 *
Heavy housework				
- performers (43%)	3	1	5	7
- non-performers (57%)	14 *	7 *	9	24 *

† P-value X^2-test < 0.05, for differences between women and men
* P-value X^2-test < 0.05, for differences between performers and non-performers

chronic disease more often did not perform one or more household activities than healthier subjects; statistically significant OR's for women ranged from 0.1 to 0.5 and for men from 0.3 to 0.7.

Table 6.4 describes the use of formal and informal care by elderly women and men who did and did not perform specified household activities. Elderly men less often used these types of care. Home help, help of family and friends and shopping help was statistically significantly more often used by women (18%, 16% and 24% respectively) than by men (10%, 7% and 17% respectively). Performers of household activities less often made use of formal and informal care than non-performers, especially in women.

Discussion

The aim of our study was to describe factors associated with actually performed household activities of elderly women and men. Our results showed that women more often performed household activities than men, and that non-performers were characterized by older age, higher SES, low subjective health, disability and chronic disease, and for men also living together with someone else. Non-performers of household activities more frequently used home help, assistance from family and friends, and shopping help from others.

For the assessment of performed household activities we used the physical activity questionnaire of Voorrips et al. [11]. This questionnaire was developed to categorize elderly people into levels of physical activity. It was validated for elderly women by comparison of the total activity scores with pedometer scores and scores based on three 24 hours-recalls of total physical activities. Spearman's correlation coefficient of pedometer versus questionnaire scores was 0.72 and of recall versus questionnaire scores 0.78 [11]. Although household activities were not validated separately, we assume the validity will be reasonable, as the 24 hours-recalls which were used included all household activities.

The proportions of subjects performing light and heavy housework were somewhat higher than proportions found in the Dutch sample of the Euronut-SENECA study. This difference could be due to the fact that the Euronut-SENECA study was conducted in elderly aged 70 to 75 years, and included institutionalized elderly [16], while the elderly from our study were 65 to 85 years old and non-institutionalized.

With increasing age physical activity is reduced, which is reflected in a higher prevalence of non-performance of household activities in the older age groups. People with a high SES performed less frequently household activities, this might be due to the fact that they are able to pay for private home help. Unfortunately no

questions were asked about this possibility. Our finding that men performed less household tasks than women is in accordance with findings of others [17,18,19]. Possibly traditional role patterns might play a role [20]. Of the men in our study population 82% was living with someone else, and only 38% of the men cooked, 61% did light housework and 43% did heavy housework. Therefore we expect that usually household activities were performed by their wives or other household members, except maybe for shopping (83% of the men shopped). This would also explain the finding that in men, but not in women, performance of household activities was positively associated with living alone. However, no data on the role of partners or other household members played in household activities were available to support this.

The association of performance of household activities with disability was stronger than associations with other health characteristics. This could be expected, because in this study only items on IADL were used to assess disability. However, the associations with the 3 dimensions of health were consistent, except for prevalence of chronic diseases, which was not associated with cooking and shopping. Odds ratios of health characteristics on performance of household activities were adjusted for age, socio-economic status and living situation. Crude odds ratios hardly differed from adjusted odds ratios.

Formal and informal care were more often used by women compared to men and by non-performers compared to performers. The former could be due to traditional role patterns and a low percentage of men living alone, as mentioned earlier. Relatively few subjects used meal provision. Maybe people are not acquainted with this service [21], or are reluctant to ask for help or have no adequate economic resources to pay for it [22]. Shopping help on the other hand was often used, which was also found for elderly from the United States [23]. Frederiks et al. [5] found that appeal to family and friends and use of organized home help was somewhat lower for men than women, as was found in our study.

The following limitations of our study might influence the interpretation of the results. Selection bias because of non-participation of elderly with a less favourable health compared to participating subjects is likely, and no general descriptive statements for the general population can be made. Frederiks et al. [5] found lower percentages for the use of help from family and relatives and for the use of home help than we did, but their study population was younger (55 years and over) than ours. Like we found, results of others revealed that higher age and living alone are positively associated with more IADL-problems and use of care in elderly people [9,10]. Therefore we think the associations we found might be generalized to the

Dutch elderly population living at home. Another limitation of our study was the lack of data on paid private home help and the role of partners or household members played in the performance of household activities. Moreover, it was not clear if elderly participants used help of family and friends for other reasons than assistance with cooking, shopping, light or heavy housework. Future studies should include questions about who is performing household activities and for what reasons help of others has been used.

In summary female sex, younger age, low SES and a good health are positively associated with performance of household activities of Dutch non-institutionalized elderly people, as is living alone in elderly men. Those elderly people who do not perform household activities more often rely on the use of services or the help of others than elderly people who do household activities themselves. Health, traditional role patterns, living situation and socio-economic status might influence performance of household activities and use of care in elderly women and men. Elderly women and men living alone are especially vulnerable of loosing independence when health problems arise. Therefore, prevention of disability and chronic disease is important. Elderly men living with someone else are also vulnerable for loosing independence when their partners or other household members cannot perform household tasks any more. Specific programs, such as training of young and older men in preparing cooked meals and performing other traditionally "female" household activities can help to overcome problems and might prevent dependence on formal and informal care.

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7. General discussion

Introduction

The number of elderly people is increasing and in the future more people will suffer functional limitations and dependence. Knowledge of factors involved might be useful for preventive measures aiming at maintaining good health and independence as long as possible. One important factor relevant in elderly people is physical activity. It has positive effects on mortality and on morbidity, especially from the cardiovascular system. These effects have mostly been studied in young and middle-aged individuals, but there is evidence that elderly people may also gain health benefits from regular exercise. In old age a considerable part of physical activities of elderly people consists of household tasks. Actual performance of these tasks may not only give meaning and regularity to life, but is an indicator for independence as well.

In a cross-sectional study among 1012 non-institutionalized Dutch women and men, 65 to 85 years of age, we studied habitual physical activity and its association with health characteristics. Habitual physical activities comprised household activities, sports and other physically active leisure time activities. The health characteristics involved were; physical (dis)ability, presence of chronic diseases, heart rate variability (HRV), respiratory function and level of subjective health. High heart rate variability and high spirometric values are considered to be favorable health characteristics.

A summary of the results for total physical activity (including household activities) is given in table 7.1. Low physical activity was found to be associated with unfavorable health characteristics. Associations with disability, with low subjective health and with complaints of dyspnea were statistically significant for women and men. However, associations of physical activity with heart disease, arthritis, and low back pains were only in women statistically significant, while associations with lung disease, complaints of daily cough, high HRV in supine position, high Forced Vital Capacity (FVC) and high Forced Expiratory Volume in one second $FEV_{1.0}$ were only statistically significant in men. Only for dyspnea, cough and for arthritis the strength off the associations was comparable for women and men, for the other health characteristics there were differences between women and men in the strength of the observed associations.

Table 7.1 Summary of the results for total physical activity.

Health characteristics	Association with physical activity*		Adjusted for:
	♀	♂	
Interview (N=1012)			
Disability	neg	neg	age
Heart disease	neg	-	age
Hypertension	-	-	age
Lung disease	-	neg	age
Arthritis	neg	-	age
Low back pains	neg	-	age
Low subj. health	neg	neg	age
Physical examination (N=585)			
HRV†-supine	-	pos	age, systolic blood pressure, BMI¶, g tobacco/day
HRV†-standing	-	-	age, systolic blood pressure, BMI¶, g tobacco/day
Daily cough	-	neg	pack-years
Daily phlegm	-	-	pack-years
Dyspnea	neg	neg	pack-years
FVC‡	-	pos	age, height, weight, pack-years
$FEV_{1.0}$ **	-	pos	age, height, weight, pack-years

* - = no, pos. = positive, neg. = negative statistically significant association ($p<0.05$) with total physical activity (including household activities, sports and other physically active leisure time activities), continuously or categorical † Heart Rate Variability ¶ Body Mass Index ‡ forced vital capacity ** forced expiratory volume in one second

Because unfavorable health is a risk factor for loosing independence, we studied the association between actually performed household activities and health characteristics. After correction for possible confounders (age group, socio-economic status and living situation) we found performers of household activities to have a lower prevalence of disability and of any chronic disease, and higher subjective health scores than non-performers. Performers were on average younger, had lower socio-economic status and were more frequently living alone (the latter only for men). Women more frequently used formal and informal care

than men; the same goes for performers of household activities compared with non-performers.

In this chapter methodological considerations concerning selection bias, information bias and confounding will be addressed. This will be followed by interpretation of the results. Finally, conclusions and implications for prevention and further research will be discussed.

Methodological considerations

Selection

Cross-sectional studies are especially prone to selection bias, which mean a threat to the validity of the results. In general, participation rates in studies decrease with increasing age, and are therefore expected to be associated with health status. Subjects in our study were recruited from the population of non-institutionalized elderly women and men, who are in general healthier than individuals living in health care institutions. Because of this selection and because of the stratification of the sample, the study population does not represent the general population of elderly people. Probably it is a healthier subpopulation. In the interpretation of the data this should be taken into account. Furthermore, the types of activities people are involved in might differ according to urbanization level and region [1]. For example: the proportions of subjects cycling and gardening were higher in Culemborg (a small city in the center of the Netherlands) [2] as compared to our findings in Arnhem (a larger city in the eastern part of the Netherlands). Therefore the *generalizability* may be limited, as far as the descriptive findings are concerned. With regard to specific recreational physical activities (sports or other physically active leisure time activities) elderly people are involved in, we expect that there may be large differences between elderly people living in different places. For household activities we do not expect large differences, as these form basic tasks for every individual. For unfavorable health characteristics the prevalence in the general population of Dutch elderly people might be higher than observed in our study population. Despite problems with the generalizability of the *descriptive* characteristics, we assume that the direction of the *associations* we have observed is valid for the non-institutionalized population of Dutch elderly women and men.

The validity of the reported associations can be affected when selection is associated with both the dependent and the independent variables, but independently of each other. This is called differential selection, which is leading to

selection bias [3]. Depending on the distribution of the error over dependent and independent variables, it may strengthen, weaken or even reverse the measure of association. In the present study, the following hypothetical situation would have caused bias: when persons with low lung function values but nevertheless high physical activity level were more inclined to participate in our study than persons with both low lung function values and low physical activity level. In such a situation, we expect the association between physical activity and lung function to be weakened or even reversed. A similar bias is expected when persons with high lung function values and low physical activity level were more likely to participate than persons with high lung function values and high physical activity levels. However, because non-respondents rated both their relative physical activity (as compared to people of the same age and health status) and their subjective health lower than respondents, this type of selectivity has probably not occurred in our study. Since the associations of physical activity with several health indicators were all in the expected direction, we assume that at least the direction of the associations we found is valid and that differential selection was not a serious problem in our study.

Information bias

Differential and non-differential errors in the information can influence the associations observed. In the next paragraph possible measurement errors will be discussed for our main variables in the study, starting with the physical activity questionnaire which was used. The measurement instruments used to assess subjective health, (dis)ability and chronic diseases were based on widely used questionnaires. Because the measurement of heart rate variability and spirometry until recently were not often used in studies among elderly people in the general population, we further concentrate our discussion on measurement errors in these two methods to assess health. Finally, possible implications of information bias for the observed associations are addressed.

Measurement errors

To assess habitual physical activity of free living elderly people and to categorize them, we used a questionnaire developed by Voorrips et. al. [4]. The validation of this questionnaire consisted of determination of test-retest reliability (Spearman's correlation coefficient was 0.89), and comparison with results of 24-hour activity recalls and pedometer measurements (Spearman's correlation coefficients were 0.78 and 0.73, respectively), indicating a reasonable relative validity to classify apparently healthy elderly people into extremes of physical activity. The

questionnaire does however not produce an estimate of absolute energy expenditure. Due to limited numbers of participants Voorrips et al. used categories based on tertiles and quartiles to categorize the subjects. We used quintiles of total activity score to divide subjects into three levels of physical activity: low being the lowest quintile, moderate comprising the second, third and fourth quintile, and high representing the highest quintile. In this way the extreme groups had sufficient numbers of subjects for analysis, and were clearly distinguished. As the questionnaire can be used to classify individuals reliably in relation to each other, the categorization based on quintiles is also expected to be valid.

For the assessment of independence by actual performance of household activities we used four items from the questionnaire. These activities are important time consuming household tasks [5], however, they were not validated separately. We consider it far more easy for subjects to reliably categorize the time they were involved in household activities into four time-categories (always, most of the times, sometimes and never), than to precisely indicate how many minutes per day were spent at these activities. Based on practical experience we think that it is very likely that the classification of performers (always or most of the time) and non-performers (sometimes or never) of household activity is valid.

Heart rate variability (HRV) is an indicator of autonomic control. Low HRV is an important predictor for risk of sudden death in myocardial infarction patients. In our study HRV was defined as the standard deviation of all RR intervals in two consecutive electrocardiograms (ECG's) in the same position (supine or standing). It was assessed by computerized measuring of RR intervals in the digital recordings. In this way a reliable and valid method was used to measure HRV, and no important measurement errors are expected. However, standard deviation of RR interval length might not be a good indicator of autonomic regulation in elderly people because of the high prevalence of abnormal beats and the high HRV that was observed in subjects with abnormal beats even after exclusion of these beats from the calculation of HRV. Power spectral analysis of two to 15 minutes recordings, in which only regular fluctuations are measured, may be more suitable [6] for epidemiologic studies in elderly populations.

To assess respiratory function we used spirometry. Only subjects fulfilling the reproducibility criteria of the European Community of Coal and Steal (ECCS) [7] were included in the study. This way, reliable and valid spirometric data were obtained for subjects who were able to perform three acceptable spirometric tests, of which two were reproducible. However, in our study we found a relatively high prevalence of subjects who could not fulfil these criteria (29% test failure). Results

of other studies are not consistent. Some investigators find relatively high percentages (10%-40%) of test failure in elderly people [8,9,10], whereas others find much lower percentages (<5%) [11,12]. But, like in other studies we found an increasing percentage of test failure with increasing age [10,13,14], with respiratory symptoms [15], and with female sex [14]. The high proportion of test failure for spirometry might indicate that performance of forced spirometry requires too much energy for some elderly people. The use of vital capacity instead of forced vital capacity measurements, or analysis of all subjects with test failure as a separate group might be better procedures to apply in research among elderly subjects.

Associations

The validity of the reported associations may have been affected by non-differential and differential errors in the information. Non-differential errors usually cause a weakening of the associations because of bias to the null. This can be compensated for by restricting measurement errors or by taking a larger sample size. Differential errors in the information might happen in our study when physically active participants would underreport health problems (for example, respiratory complaints) compared with sedentary people, or when healthy subjects overreport their physical activity compared with subjects with a less favorable health. Both types of differential error would result in a strengthening of the associations. Such differential errors can be expected if people are aware of a possible positive association of physical activity with good health, or when they are inclined to give socially desirable answers. However, elderly people might as well feel they have deserved a "quiet" old day, and are not expected to be physically active anymore, so they might not be inclined to overreport physical activity. We can only speculate about the possible net effect of these influences.

Confounding

A confounder is a variable which is independently related to both the exposure and the outcome, but not involved in the causal pathway [16]. In observational studies confounding is a potential source of bias, towards the null as well as away from the null. In this paragraph we will discuss for each research question the completeness of relevant and important confounders to be included in the analysis.

For all research questions gender and age or age group appeared to be the major confounders in our study. We have stratified all our analyses according to gender, and we adjusted all our analyses for age or age-group, to correct for their confounding effects.

For the association between physical activity and reported health characteristics, age, marital status, living situation, socio-economic status, and housing situation were considered as potential confounders. Other lifestyle characteristics, like tobacco and alcohol consumption, might be associated to both physical activity level and certain of the health characteristics, but have not been adjusted for. However, additional analyses showed that these two possible confounders did not markedly change the reported associations.

In the association of physical activity with heart rate variability, age, systolic blood pressure, body mass index and use of tobacco were considered important confounders. We did not make adjustments for the presence of diabetes mellitus, because of the small number of subjects with this disease and the absence of an association with heart rate variability.

The associations of physical activity with respiratory function were adjusted for the widely used confounders age, height, weight and pack-years of smoking.

When studying performance of household activities and associations with reported health characteristics, adjustments were made for age group, socio-economic status and living situation.

We conclude that, because we were able to adjust for the most important relevant confounders which are commonly described in the literature, we think confounding will not seriously affect the reported results. Some residual confounding (incomplete adjustments) because of imperfect measurement of confounders cannot be excluded. In some occasions the variables adjusted for may have been antecedent or intermediary variables in the causal pathway. For instance; it may be questioned whether adjustments for systolic blood pressure and body mass index when analyzing the association of physical activity with HRV, are appropriate as these variables might as well be part of the causal pathway linking physical activity with health. However, these risk factors for cardiovascular disease have been included, since they are usually considered as confounding factors in cardiovascular epidemiology.

Interpretation of the findings

Our results suggest that among elderly people physical activity is associated with favorable health characteristics. We found differences between women and men in the strength of the associations between physical activity and heart rate variability and spirometric function, although the direction of the associations were the same

for both. Moreover, only in men these associations were statistically significant. These findings might be due to the power of the study, but also to the range of physical activity scores. Women had lower means and a smaller range of physical activity scores than men. In future research it might be desirable to include more physically active elderly women, for example recruited by advertisements in local newspapers or among members of sports clubs.

Findings based on cross-sectional data, like in our study, preclude statements about causes and effects. The relation of physical activity with health characteristics we found, can be the result of an effect of health on physical activity, the reverse, or, most probably, an effect in both directions. In elderly persons a vicious circle can easily occur, leading to a continually decreasing physical activity in combination with worsening health status. In breaking this circle, encouraging physical activity among elderly people may play an important role.

For independence, assessed by performance of household activities, the association with favorable health characteristics is likely to be mainly in one direction; e.g. we assume that independence is primarily determined by health status, and not the reverse, although some effect of performance of household activities on health cannot be ruled out.

Conclusions and implications for prevention and future research

The results of the cross-sectional study presented in this thesis show that (total) physical activity and independence (assessed by performance of household activities) are associated with favorable health characteristics among elderly non-institutionalized women and men.

Our results are in line with results of others [17,18,19,20,21] who have shown positive effects of physical activity on the risk of morbidity. It seems important to promote physical activity in old age. Minimal levels of training might already have positive effects on physiologic parameters [22] and successful aging [17]. When designing exercise programs for older adults safety should be considered, including personal advice and prior medical examination [21]. We suggest to stimulate independence of men by training them in preparing cooked meals and doing other traditionally "female" housework, like doing the laundry and cleaning.

To solve questions of causality, prospective or longitudinal research is needed. Measurement instruments used in studies among younger adults might not be suitable for studies in older populations; e.g. standard deviation of RR intervals to

assess heart rate variability, and forced spirometry to measure lung function. Therefore the use of adapted or alternative measurement instruments or protocols is recommended for research among elderly women and men.

Insight in the interaction between health and physical activity is important for prevention policies. This study shows that associations between physical activity and health characteristics are present among elderly women and men, and that they are complex. Further elucidation of the effect of physical activity on health of elderly, based on detailed longitudinal research, is needed. From our findings and those in the literature we conclude that promotion of physical activity in old age seems important for reasons of maintaining health and independence.

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Summary

In our society the number of elderly people is increasing and in the future more people will suffer functional limitations and dependence. In order to maintain good health and independence as long as possible, knowledge of factors involved might be useful for preventive measures. One important factor relevant in elderly people is physical activity, which is generally recognized for its positive effects on morbidity and mortality, especially from the cardiovascular system. Its effects are mostly studied in young and middle-aged adults, but there is evidence that elderly people can also improve their functional capacities and prevent disability, disease and loss of independence by regular exercise. In old age a considerable part of physical activities of elderly people consists of household tasks. Actual performance of these tasks may be regarded as an indicator for independence. To study physical activity (household activities, sports and other physically active leisure time activities) of *elderly* people and their association with health characteristics, a cross-sectional study was carried out.

This study is part of the project "Lifestyle and health of the elderly". In **chapter 2** the study population and the methods of this project are described. The study was conducted late 1991 and begin 1992 in Arnhem, a city of approximately 133,000 inhabitants in the eastern part of the Netherlands. A random sample of 1793 non-institutionalized women and men, aged 65 to 85 years, stratified for age and sex, was provided by the Municipal Register Office. A total of 49 of them were not eligible and 732 did not participate for several reasons. The most frequent reasons for non-participation were recent illness or frequent medical examination in the recent past (21% of the non-participants), and no time or interest (29% of the non-participants). More women than men and more people from the highest age groups refused to participate. A total of 515 women and 497 men was interviewed, 327 of the women and 358 of the men had a physical examination. Subjects who participated in the interviews but not in the physical examination were more often female and of the highest age group, and had lower scores for subjective health and physical activity than those who did participate in both parts of the study. Subjects were visited at home for a one-hour interview about lifestyle, health, medical consumption and socio-demographic characteristics. Habitual physical

activities and total activity scores were assessed with a questionnaire, previously validated for elderly. At the end of the interview subjects were asked to participate in a physical examination, including measurements of height, weight, blood pressure and respiratory function, electro-cardiography and blood collection.

In **chapter 3** a description is given of habitual physical activities of elderly people and a profile of the most inactive among them. Our findings showed that light housework (e.g. dusting, washing dishes) was carried out by 90% of the women and 61% of the men. Thirteen percent of the women and 9% of the men had no recreational physical activities (sports or other physically active leisure time activities). Physical activity level seemed to be lower for those with high age, middle socio-economic status (SES) as compared to high SES (only for men), for those being married (only for women), disabled, having a low subjective health, or chronic diseases, living in houses without stairs or not close to shops (only for men). Our findings suggest physically inactive elderly are mainly characterized by older age and a less favorable health.

Low heart rate variability (HRV) is an important predictor for risk of sudden death in myocardial infarction patients, and physical activity has been reported to increase resting HRV. Therefore, we studied short term HRV and its relationship with physical activity in elderly people (**chapter 4**). Data of 288 women and 307 men were suitable for analysis. HRV was defined as the standard deviation of all normal RR-intervals in 20 sec ECG recordings in both supine and standing position. Elderly women and men had similar low HRV. The mean in supine position was 21 and 22 msec respectively, in standing position 23 and 22 msec respectively. Subjects with premature ventricular complexes had higher HRV than subjects without ($p \leq 0.01$), but their HRV probably does not reflect normal autonomic control. The former subjects were excluded from further analysis. In men, but not in women, a positive association between HRV in supine position and physical activity score was observed ($\beta=0.19$ $p=0.03$). Possibly physical activity levels in the elderly are too low to have a substantial effect on HRV.

As information is scarce for elderly people in the general population, we studied respiratory function and its relationship with physical activity in elderly participants (**chapter 5**). We obtained interview and acceptable spirometric data of 230 women and 294 men. Another ninety women and 61 men could not perform three technically acceptable and two reproducible tests. Compared to subjects who produced reproducible spirometric tests, women with test failure were older, had lower physical activity scores, and more often reported daily cough, whereas men with test failure were older, and reported more dyspnea. Logistic regression

analysis for subjects with successful spirometric tests (N=525) including adjustment for pack-years of smoking, revealed that physical activity was negatively associated with presence of dyspnea in both women and men (Odds ratio OR=0.87 (95% confidence interval CI: 0.80-0.96) and OR=0.85 (0.78-0.93) respectively for 1 unit of physical activity score, ranging from 0-39 for women and from 0-54 for men) and with daily cough in men (OR=0.93 (0.88-0.99)). Results of multivariate regression analysis including age, height, weight, and pack-years showed a positive association of physical activity with all lung function parameters. Physical activity was statistically significantly associated with maximal midexpiratory flow (MMEF) in women (β=0.0234 l/sec p=0.01), and with forced vital capacity (FVC) (β=0.0127 liter p=0.01), forced expiratory volume in one second ($FEV_{1.0}$) (β=0.0129 l/sec p=0.01) and peak flow (PEF) (β=0.0400 l/sec p=0.05) in men. We conclude that lung function and physical activity are positively associated in elderly individuals.

Independence involves actual performance of basic tasks that need to be carried out (almost) every day, including household activities. Health and socio-demographic characteristics might be important for the capability to carry out and for the actual performance of these activities. **Chapter 6** gives a description of performance of household activities and its association with health and socidemographic characteristics of non-institutionalized elderly people. Cooking, shopping, light and heavy housework were performed by 90%, 89%, 91% and 50% respectively of the women, and 38%, 83%, 61% and 43% of the men. Non-performers were characterized by high age (80-84 years), high socio-economic status, low subjective health, disability and chronic disease, and living with someone else, the latter only for men. Women and non-performers more frequently used formal and informal care than men and performers.

In the general discussion (**chapter 7**) methodological considerations concerning selection bias, information bias and confounding have been addressed. The generalizability might be limited, as far as the descriptive findings are concerned. We expect that there may be large differences in recreational activities among elderly from different places, and that the prevalence of unfavorable health characteristics in the general population of Dutch elderly people might be higher than observed in our study population. However, we assume that the direction of the associations we have observed are valid for the non-institutionalized population of Dutch elderly women and men. Some measurement instruments might not be suitable for research among elderly people; e.g. for forced spirometry and for standard deviation of RR-intervals in ECG's as measure for heart rate variability. Because we were able to adjust for the most important relevant confounders which

are commonly described in the literature, we think confounding will not seriously have affected the reported results.

It is concluded that the results of the cross-sectional study presented in this thesis show that among non-institutionalized elderly women and men (total) physical activity and independence (assessed by performance of household activities) are associated with favorable health characteristics.

Physical activity may positively affect health, but the reverse may be the cause as well, and the effects can be in both directions. For independence, assessed by performance of household activities, the direction of the observed association with favorable health characteristics is likely to be mainly in one direction; e.g. we assume that independence is determined by health status. Longitudinal studies are needed to clarify the direction of causal pathways. We recommend to promote physical activity for all elderly people for reasons of maintaining health, well-being and independence. In addition, we suggest to stimulate independence of men by training them in preparing cooked meals and doing other traditionally "female" housework.

Samenvatting

Het aantal oudere mensen neemt toe in onze samenleving en in de toekomst zullen meer mensen te maken krijgen met lichamelijke beperkingen en verlies van onafhankelijkheid. Kennis van factoren die hierbij een rol spelen, kan gebruikt worden voor preventieve maatregelen gericht op het zo lang mogelijk handhaven van een goede gezondheid en onafhankelijkheid. Een belangrijke relevante factor hierbij is lichamelijke activiteit, een erkende risicofactor voor ziekte (met name hart en vaatziekten) en sterfte. De effecten van fysieke inspanning zijn voornamelijk bestudeerd bij volwassenen van jonge en middelbare leeftijd. Er zijn echter aanwijzingen dat oudere mensen eveneens hun functionele vermogens kunnen verbeteren en lichamelijke beperkingen, ziekte en daarmee gepaard gaand verlies van onafhankelijkheid kunnen voorkomen door regelmatige lichamelijke inspanning. Een dwarsdoorsnede onderzoek is uitgevoerd bij 1012 personen om de lichamelijke activiteit van ouderen en de relatie met gezondheidskenmerken te bestuderen.

Het onderzoek en de resultaten zoals beschreven in dit proefschrift vormen een onderdeel van het project "Leefwijze en gezondheid van ouderen" dat is uitgevoerd bij de vakgroep Humane Epidemiologie en Gezondheidsleer van de Landbouwuniversiteit Wageningen. In **hoofdstuk 2** worden de onderzoekspopulatie en de gebruikte onderzoeksmethoden beschreven. Het onderzoek is uitgevoerd eind 1991 en begin 1992 in Arnhem. Een a-selecte steekproef van 1793 oudere zelfstandig wonende vrouwen en mannen, gestratificeerd voor geslacht en leeftijd, werd door de afdeling Bevolking van de gemeente Arnhem ter beschikking gesteld. Uiteindelijk hebben 1012 ouderen deelgenomen aan het onderzoek. De meest voorkomende redenen om niet deel te nemen waren: recente ziekte of veelvuldig medisch onderzoek in het nabije verleden (21% van de niet-deelnemers) en geen tijd of interesse (29% van de niet-deelnemers). Er waren procentueel meer vrouwen dan mannen en meer mensen uit de groep van 80 tot 85 jarigen dan uit de overige leeftijdgroepen die niet aan het onderzoek deelnamen. Uiteindelijk zijn 515 vrouwen en 497 mannen geïnterviewd en hiervan hebben 327 vrouwen en 358 mannen een lichamelijk onderzoek ondergaan. Deelnemers zijn thuis bezocht voor een interview. Er is gevraagd naar hun leefwijze (lichamelijke activiteit en voedingsgewoonten, gebruik van alcohol en tabak), hun gezondheid (chronische ziekten, klachten van longen en luchtwegen, beperkingen bij dagelijkse

(huishoudelijke) levensverrichtingen), medische consumptie (gebruik van medicijnen en gezondheidszorgvoorzieningen) en sociaal-demografische kenmerken (zoals burgerlijke staat, opleiding, beroep en inkomen). Dit interview duurde ongeveer een uur. Het gebruikelijke lichamelijke activiteitenpatroon en een totaal score voor lichamelijke activiteit zijn bepaald aan de hand van antwoorden op een voor ouderen gevalideerde vragenlijst. Aan het einde van het interview is de deelnemers gevraagd mee te doen aan een lichamelijk onderzoek, waarbij lengte, gewicht, bloeddruk en longfunctie zijn gemeten. Bovendien zijn een elektrocardiogram (ECG) gemaakt en bloedmonsters verzameld.

In **hoofdstuk 3** wordt een beschrijving gegeven van gebruikelijke lichamelijke activiteiten van oudere mensen en wordt een profiel geschetst van de minst actieven onder hen. Hieruit blijkt dat licht huishoudelijk werk door 90% van de vrouwen en 61% van de mannen is verricht. Van de vrouwen deed 13% en van de mannen 9% aan geen enkele vorm van sport of andere lichamelijk actieve vrijetijdsbesteding zoals fietsen, wandelen of tuinieren. Een laag niveau van lichamelijke activiteit bleek samen te hangen met een hoge leeftijd (voor vrouwen en mannen), met sociaal economische status (midden klasse ten opzichte van hoge klasse, alleen voor mannen) en met gehuwd zijn (alleen voor vrouwen). Voorts hing het samen met het voorkomen van lichamelijke beperkingen, met een als minder goed ervaren (subjectieve) gezondheid, met de aanwezigheid van chronische ziekten, en tenslotte met het wonen in een huis zonder trappen en met een grote afstand tot winkels (dit laatste alleen voor mannen). Deze resultaten suggereren dat oudere mensen met weinig lichaamsbeweging vooral gekenmerkt worden door een hoge leeftijd en een minder goede gezondheid.

Een geringe variatie in de hartfrequentie is een belangrijke risicofactor voor plotse dood in patiënten die een hartinfarct hebben doorgemaakt. Lichamelijke activiteit zou hartfrequentie variabiliteit in rust kunnen verhogen. Daarom hebben we hartfrequentie variabiliteit en de relatie met lichamelijke activiteit bestudeerd bij 288 oudere vrouwen en 307 oudere mannen (**hoofdstuk 4**). Hartfrequentie variabiliteit is gedefinieerd als de standaardafwijking van alle normale RR-intervallen in elektrocardiogrammen van 20 seconden, gemeten in liggende en in staande positie. Oudere vrouwen en mannen hadden vergelijkbare lagere niveaus van hartfrequentie variabiliteit vergeleken met jongere volwassenen. De gemiddelde waarden hiervoor in liggende positie waren 21 respectievelijk 22 msec, in staande positie 23 respectievelijk 22 msec. Deelnemers met abnormale slagen, premature

ventriculaire complexen, hadden een hogere hartfrequentie variabiliteit dan deelnemers zonder abnormale slagen. ECG's waarin dergelijke complexen voorkomen geven echter geen goede indruk van de normale autonome controle, daarom zijn personen met abnormale slagen van verdere analyses uitgesloten. Bij mannen is een positieve samenhang gevonden tussen hartfrequentie variabiliteit in liggende positie en totale lichamelijke activiteitscore (β=0,19 p=0,03). Bij vrouwen is geen statistisch significant verband aangetroffen. Mogelijk is de mate van lichamelijke activiteit van oudere mensen te gering om een wezenlijk effect te hebben op de hartfrequentie variabiliteit.

Omdat gegevens hierover schaars zijn voor oudere mensen, is ook de longfunctie en het verband met lichamelijke activiteit onderzocht bij oudere mensen (**hoofdstuk 5**). In ons onderzoek is de hoeveelheid lucht gemeten die iemand na maximaal diepe inademing kan uitademen en de snelheid waarmee dat is gebeurd. Hiervoor moest men drie technisch goede tests doen, waarvan er twee reproduceerbaar waren. Negentig vrouwen en 61 mannen konden niet aan deze voorwaarden voldoen (= afgekeurde test). Uiteindelijk waren er 230 vrouwen en 294 mannen met geslaagde longfunctietests en beschikbare interviewgegevens. Vergeleken met deelnemers die dat wel konden, waren vrouwen met een afgekeurde test ouder, hadden zij lagere lichamelijke activiteitscores en rapporteerden zij vaker klachten van dagelijks hoesten. Mannen met een afgekeurde test waren ouder en rapporteerden vaker klachten van kortademigheid. Uit logistische regressie analyse bij deelnemers die wel drie geslaagde longfunctie tests konden volbrengen bleek, dat zowel meer vrouwen als mannen met kortademigheid en meer mannen die last hadden van dagelijks hoesten tot de groep van de minst actieven behoorden. Dit was ook het geval nadat er gecorrigeerd was voor roken uitgedrukt in pakjaren (aantal gerookte pakjes sigaretten per dag maal het aantal jaren dat men rookt/gerookt heeft). Resultaten van multivariate regressie analyse met correcties voor leeftijd, lengte, gewicht en pakjaren wezen op een positieve samenhang van lichamelijke activiteit met alle longfunctie parameters, dat wil zeggen hoe hoger het niveau van lichamelijke activiteit, hoe hoger de longfunctie waarden. Deze samenhang was statistisch significant voor MMEF (geforceerde maximale midexpiratoire volumestroom) bij vrouwen en voor FVC (geforceerde vitale capaciteit), $FEV_{1.0}$ (geforceerd expiratoir secondevolume) en PEF (expiratoire piekstroom) bij mannen. Hieruit concluderen wij dat longfunctie en lichamelijke activiteit bij oudere personen positief samenhangen.

Onderdeel van onafhankelijkheid van mensen is het uitvoeren van een aantal (vrijwel) dagelijks terugkerende basistaken, waaronder huishoudelijke activiteiten. Gezondheids- en sociaal-demografische kenmerken kunnen van belang zijn voor het vermogen tot het verrichten van deze activiteiten respectievelijk het daadwerkelijk uitvoeren ervan. **Hoofdstuk 6** geeft een beschrijving van het uitvoeren van huishoudelijke taken en ermee samenhangende kenmerken van zelfstandig wonende ouderen. Koken, boodschappen doen, licht en zwaar huishoudelijk werk werden door respectievelijk 90%, 89%, 91% en 50% van de vrouwen gedaan en door 38%, 83%, 61% en 43% van de mannen. Degenen die bepaalde huishoudelijke taken niet zelf deden werden gekenmerkt door: 1. een hoge leeftijd (80 tot 85 jaar), 2. een hoge sociaal-economische status, 3. lage ervaren gezondheid, 4. lichamelijke beperkingen en chronische ziekte en 5. (alleen bij mannen) samen met anderen wonen. Vrouwen maakten vaker gebruik van formele en informele hulp dan mannen. Dit gold ook voor degenen die niet zelf bepaalde huishoudelijke activiteiten verrichtten in vergelijking met degenen die dat wel deden.

In de algemene discussie (**hoofdstuk 7**) zijn mogelijke methodologische beperkingen van het onderzoek besproken. De generaliseerbaarheid van de beschrijvende resultaten is beperkt. Het is waarschijnlijk dat grote verschillen kunnen bestaan in recreatieve activiteiten van oudere mensen uit verschillende woonplaatsen. Daarnaast kan een hogere prevalentie van ongunstige gezondheidskenmerken in de algemene bevolking van Nederlandse ouderen worden verwacht. We nemen echter aan dat de gevonden richting van de verbanden geldt voor de groep van zelfstandig wonende oudere Nederlandse vrouwen en mannen in het algemeen. Sommige meetinstrumenten lijken minder geschikt voor gebruik in onderzoek bij oudere mensen. Dit geldt bijvoorbeeld voor de standaarddeviatie van RR-intervallen als maat voor hartfrequentie variabiliteit en voor geforceerde longfunctietests. Omdat er gecorrigeerd is voor de belangrijkste relevante confounders die bekend zijn uit de literatuur, wordt verwacht dat de beschreven resultaten niet in ernstige mate zijn vertekend door confounding.

Geconcludeerd wordt dat uit de resultaten van dit dwarsdoorsnede onderzoek blijkt dat bij zelfstandig wonende oudere vrouwen en mannen de (totale) lichamelijke activiteit en de onafhankelijkheid (bepaald via huishoudelijke activiteiten) samenhangen met gunstige gezondheidskenmerken.

Lichamelijke activiteit kan de gezondheid positief beïnvloeden, maar het omgekeerde of een wederzijdse beïnvloeding is ook mogelijk. Wij nemen aan dat

onafhankelijkheid, bepaald via het uitvoeren van huishoudelijke activiteiten, vooral beïnvloed wordt door gezondheid en dat in mindere mate sprake zal zijn van beïnvloeding in omgekeerde richting. Via dwarsdoorsnede onderzoek is weinig inzicht te krijgen in oorzaak en gevolg, daarvoor is vervolgonderzoek nodig.

Teneinde een goede gezondheid en onafhankelijkheid te behouden, wordt aanbevolen om preventieve maatregelen te richten op het stimuleren van lichamelijke activiteit voor alle oudere mensen. Met betrekking tot het bevorderen van de onafhankelijkheid van oudere mannen lijkt het bovendien van belang hen te leren koken en andere traditioneel "vrouwelijke" huishoudelijke werkzaamheden te verrichten.

Curriculum vitae

Carla E.J. van den Hombergh werd geboren op 17 juli 1954 te Velden. In 1971 behaalde zij het HBS-B diploma aan de Rijkshogereburgerschool te Venlo. In 1973 studeerde zij af als HBO-A zoölogisch laboratoriumassistente aan het Centrum voor Opleiding van Assisterend Laboratoriumpersoneel te Utrecht. Van 1972 tot 1978 was zij werkzaam bij N.V. Organon in Oss, aanvankelijk als zoölogisch laboratoriumassistente en later als assistent "Hoofd Publikaties". Vervolgens werkte zij gedurende twee jaar als tandartsassistente bij de Jeugdtandverzorging Noord-Oost Noord-Brabant in Oss.

In 1980 begon zij aan de studie Huishoudkunde en Gezondheidskunde aan de Nieuwe Leraren Opleiding, Interstudie in Nijmegen. In 1984 behaalde zij het diploma en vervolgde haar opleiding met de studie Huishoudwetenschappen aan de Landbouwuniversiteit in Wageningen. Als bijvakken koos zij Methoden en Technieken van Sociaal Wetenschappelijk Onderzoek en Algemene Onderwijskunde en Didaktiek. In 1986 liep zij in het kader van deze studie enkele maanden stage bij de "Union Internationale des Organismes Familiaux" in Parijs. In 1988 sloot zij deze studie af met het doctoraal examen.

Van 1988 tot in 1994 werkte zij als Assistent in Opleiding bij de vakgroep Humane Epidemiologie en Gezondheidsleer van de Landbouwuniversiteit Wageningen. In deze periode voerde zij het onderzoeksproject "Leefstijl en Gezondheid van Ouderen" uit. Een gedeelte van de resultaten van dit onderzoek zijn in dit proefschrift beschreven.

Sinds 1 januari 1995 werkt zij als onderzoeker aan de "Longitudinal Aging Study Amsterdam" (LASA) bij de vakgroep Psychiatrie van de Vrij Universiteit in Amsterdam.