Inequalities in Health among Older Adults in Western Industrialised Countries

Explanations from Gender, Socioeconomic and Time Use Perspectives

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To my family.

Abstract

Gender and socioeconomic inequalities in health persist in high-income countries, even at old age; yet, there is still no consensus about the best indicators of socioeconomic status to be used in health inequalities research among older adults, especially after retirement. Complementary social indicators that have been suggested to assess gender and socioeconomic inequalities in health outcomes at old age are social roles and time use activities. This thesis explores the social and economic inequalities in self-reported health among elderly men and women, using a combined framework of time use activities, socioeconomic status (SES) and family characteristics. It further explains gender and cross-national inequalities in health in some Western industrialised countries.

The thesis is centered around three empirical studies focusing on different dimensions of social inequalities in health among elderly men and women. The studies are based on data from the Multinational Time Use Study (MTUS) on older men and women aged 65 years and above. It also consists of a framework paper with an introductory chapter and a discussion of methodological as well as content issues around the topic.

Study I examined how time use activities, socioeconomic status and family characteristics impact the health of older adults, and the extent to which the associations varied by gender and across countries. It further examined the extent to which various social factors explain the gender inequalities in health at old age. Significant gender differences in self-reported health were found in Germany, Italy and Spain, but not in the United Kingdom and the United States. Further decomposition analysis showed that differences in time allocated to leisure activities and level of educational attainment accounted for the largest health gap between elderly men and women. The results also showed that whereas time devoted to paid work, housework and active leisure activities were positively associated with health, time allocated to passive leisure and personal activities were negatively related to health in both men and women. The magnitude of the associations however varied by gender and country.

Study II investigated the extent to which the association between housework activities and health may be moderated by sleep duration among elderly men and women. The result showed that both short (<7 hours) and long (>8 hours) sleep duration were negatively associated with health for both genders. However, the interactive associations between total productive housework, sleep duration and health status varied considerably between men and women. Among women, long hours of housework combined with either short or long sleep was negatively associated with health.

Study III examined whether stress defined in terms of time pressure plays a mediating role in the relationship between work-related activities (paid work and unpaid work) and health among elderly men and women. The results showed that socioeconomic status, demographic factors, stress and work-related time use activities after retirement had a significant direct influence on health among the elderly. The findings further revealed that although stress has a strong direct negative effect on the health of both genders, it does not indirectly influence the positive effects of work-related time use activities on health among older adults.

The overall conclusion in this thesis is that social patterning of health inequalities persist at older ages in high-income countries. However, the magnitude of these inequalities differ across countries and are shaped by unequal distribution of social and time use resources. The results of this thesis thus demonstrate the need of using an integrated framework of social factors when analysing gender and cross-national inequalities in health among the elderly population.

Abstrakt

Es bestehen noch immer geschlechtsspezifische und sozioökonomische Ungleichheiten in der Gesundheit von älteren Menschen in Ländern mit hohem Einkommen. Derzeit gibt es in der Forschung zu gesundheitlichen Ungleichheiten keinen Konsens hinsichtlich der besten Indikatoren für den sozioökonomischen Status von älteren Erwachsenen, insbesondere nach Eintritt in den Ruhestand. Mögliche zusätzliche soziale Indikatoren zur Bewertung des Einflusses geschlechtsspezifischer und sozioökonomischer Ungleichheiten auf Gesundheitsfolgen im Alter sind soziale Rollen und Zeitnutzungsaktivitäten. Diese Dissertation untersucht die sozialen und wirtschaftlichen Ungleichheiten in der selbstberichteten Gesundheit älterer Männer und Frauen mithilfe eines Forschungsansatzes, welcher Zeitnutzungsaktivitäten, sozioökonomischen Status und Familiencharakteristiken kombiniert. Darüber hinaus werden geschlechtsspezifische und länderübergreifende Ungleichheiten in der Gesundheit in ausgewählten westlichen Industrieländern erläutert.

Die Dissertation beruht auf drei empirischen Studien, die sich auf verschiedene Dimensionen sozialer Ungleichheiten in der Gesundheit älterer Männer und Frauen konzentrieren. Die Studien basieren auf Daten einer Zeitnutzungsstudie, der so genannten Multinational Time Use Study (MTUS), bei älteren Männern und Frauen ab 65 Jahren. Des Weiteren beinhaltet die Dissertation ein Rahmenpapier mit einem einleitenden Kapitel und einer Diskussion zu methodischen und inhaltlichen Aspekten des Themas.

In Studie I wurde untersucht, wie sich Zeitnutzungsaktivitäten, sozioökonomischer Status und Familiencharakteristiken auf die Gesundheit älterer Menschen auswirken und inwieweit diese nach Geschlecht und Ländern variieren. Ferner wurde untersucht, inwieweit verschiedene soziale Faktoren geschlechtsspezifische Unterschiede in der Gesundheit älterer Menschen erklären. Signifikante geschlechtsspezifische Unterschiede in der selbstberichteten Gesundheit wurden in Deutschland, Italien und Spanien, nicht aber in Großbritannien und den USA festgestellt. Dekompositionsanalysen zeigen, dass Unterschiede in der Zeit, die für Freizeitaktivitäten aufgewendet wird, und dem Bildungsniveau am meisten für den Unterschied in der Gesundheit zwischen Männern und Frauen beitrugen. Die Ergebnisse zeigen auch, dass die Zeit, die für bezahlte Arbeit, Hausarbeit und aktive Freizeitaktivitäten aufgewendet wurde, positiv mit der Gesundheit von Männern und Frauen assoziiert war, während die Zeit, die für passive Freizeitbeschäftigungen und persönliche Aktivitäten aufgewendet wurde, negativ mit der Gesundheit von Männern und Frauen assoziiert war. Die Stärke der Assoziationen variierte jedoch nach Geschlecht und Land.

In Studie II wurde untersucht, inwieweit die Assoziation zwischen Hausarbeit und Gesundheit durch die Schlafdauer von älteren Männern und Frauen beeinflusst wird. Sowohl kurze (<7 Stunden) als auch lange (>8 Stunden) Schlafdauer war für beide Geschlechter negativ mit der Gesundheit assoziiert. Die interaktiven Assoziationen zwischen gesamter produktiver Hausarbeit, Schlafdauer und Gesundheitszustand variierten jedoch erheblich zwischen Männern und Frauen. Bei Frauen war eine lange Beschäftigung mit Hausarbeit in Kombination mit kurzer oder langer Schlafdauer negativ mit der Gesundheit assoziiert.

In Studie III wurde untersucht, ob Stress, definiert als Zeitdruck, einen moderierenden Einfluss auf arbeitsbezogene Aktivitäten (bezahlte und unbezahlte Arbeit) und die Gesundheit von älteren Männern und Frauen hat. Die Ergebnisse zeigen, dass sozioökonomischer Status, demographische Faktoren, Stress und arbeitsbezogene Zeitnutzungsaktivitäten nach Eintritt in den Ruhestand einen signifikanten direkten Einfluss auf die Gesundheit älterer Menschen haben. Die Ergebnisse zeigen ferner, dass Stress zwar einen starken direkten negativen Einfluss auf die Gesundheit beider Geschlechter hat, aber nicht indirekt die positiven Auswirkungen arbeitsbezogener Zeitnutzungsaktivitäten auf die Gesundheit älterer Erwachsener beeinflusst.

Die allgemeine Schlussfolgerung dieser Dissertation ist, dass soziale Muster von gesundheitlichen Ungleichheiten im höheren Alter in Ländern mit hohem Einkommen fortbestehen. Das Ausmaß dieser Ungleichheiten ist jedoch von Land zu Land unterschiedlich und wird durch die ungleiche Verteilung sozialer und zeitlicher Ressourcen geprägt. Die Ergebnisse dieser Dissertation zeigen somit die Notwendigkeit eines Forschungsansatzes, der soziale Faktoren in die Analyse von geschlechtsspezifischen und länderübergreifenden Ungleichheiten in der Gesundheit der älteren Bevölkerung integriert.

List of publications

This thesis is based on the following original papers, which are referred to in the text by their Roman numerals.

I. **Adjei, N. K.,** Brand, T., & Zeeb, H. (2017). Gender inequality in self-reported health among the elderly in contemporary welfare countries: A cross-country analysis of time use activities, socioeconomic positions and family characteristics. *PloS one*, *12*(9), e0184676.

II. **Adjei, N. K**., & Brand, T. (2018). Investigating the associations between productive housework activities, sleep hours and self-reported health among elderly men and women in western industrialised countries. *BMC public health*, *18*(1), 110.

III. **Adjei, N. K**., Jonsson, K. R., & Brand, T. (2018). Time spent on work-related activities, social activities and time pressure as intermediary determinants of health disparities among elderly women and men in 5 European countries: a structural equation model. *International journal for equity in health*, *17*(1), 121.

List of Abbreviations

ADL	Activities of Daily Living
CFI	Comparative Fit Index
CHD	Coronary Heart Diseases
CI	Concentration Index
COPD	Chronic Obstructive Pulmonary Diseases
CSDH	Commission on the Social Determinants of Health
DALYs	Disability Adjusted Life Years
ESM	Experienced-Sampling Measures
GDP	Gross Domestic Product
HLE	Healthy Life Expectancy
HRV	Heart Rate Variability
LE	Life Expectancy
LTC	Long-term Care
MET	Metabolic Equivalent of Task
MTUS	Multinational Time Use Study
OECD	Organisation for Economic Co-operation and Development
PAEE	Physical Activity Energy Expenditure
RMSEA	Root Mean Square Error of Approximation
SES	Socioeconomic Status
SRH	Self-Reported Health
SEM	Structural Equation Model
TFR	Total Fertility Rate
WHO	World Health Organization
YI	Yesterday Interviews

Foreword

Population ageing - an increase in the proportion of older people aged 65 years or over has been one of the significant global demographic events in both developed and developing countries. For instance, a child born today in Germany or the Netherlands can expect to live 13 years longer than one born 60 years ago; and an older adult who reaches 60 years in one of these countries today can expect to live 6 years longer than 60 years ago. With this change in the world's demographic structure, the question arises whether all population groups benefit in the same way from this transition. In recent decades, research about health inequalities has gained attention from public health and other disciplines following the publication of the Black report in the UK in 1980. This report analysed health inequalities between different social classes in the UK, and concluded that there has been increasing health inequalities among social classes in both men and women at all ages over time. Since the publication of the report, several studies and international comparisons have shown a similar social gradient in health outcomes, and the overall conclusion is that graded patterns of social inequalities in health exist, even in high-income countries. Several potential explanations have been offered including artefact, natural and social selection, material and cultural factors.

Until recently, research about health inequalities has focused on the working population perhaps because of the complexity in the measurement of social class in older age. In this thesis, I adopted a combined framework of both social status and time use activities after retirement to analyse gender and socioeconomic inequalities in health at old age. This integrated approach may help policymakers to better understand the social determinants of health among the elderly population. Moreover, the key question as more and more older adults live longer is, how will the health of the elderly be in later years? Will it improve or deteriorate as life expectancy increases? And what are the key social determinants of health among elderly men and women? The introductory chapter provides a global and regional perspective on population ageing, longevity and the health conditions of older adults. The subsequent chapters include a brief summary of data sources and methods, core results of the published studies constituting this thesis, as well as a discussion and general conclusions.

CONTENTS

1 Introduction

Population ageing is now a major concern globally. Over the past decades, the proportion of children under 15 years decreased from 34 percent in 1950 to 26 percent in 2015 [1], while the percentage of those aged 65 years and above increased from 5 to 8 percent during the same period. Between 2000 and 2015, the total proportion of women and men aged 65 years and over increased by 1.4 percentage points, from 6.9 percent to 8.3 percent. By 2025 and 2050, projections indicate that the proportion of older people will increase rapidly to 10 percent and 16 percent respectively (Fig. 1).

Gender imbalances among the elderly population are also seen in the world's population structure, with the majority being women. In 2015, the proportion of women aged 65 or over was 9.2 percent while the percentage for men was 7.4 percent. This imbalance will even be greater as the projections indicate that by 2050, the proportion of older women will almost double to 17.3 percent, while that of older men will increase to 14.0 percent (Fig. 1). In absolute terms, the population for both older men and older women in 2015 was over 5 times more than that in 1950, with the number of older men reaching more than 250 million in 2015 and that of older women more than 300 million [1].

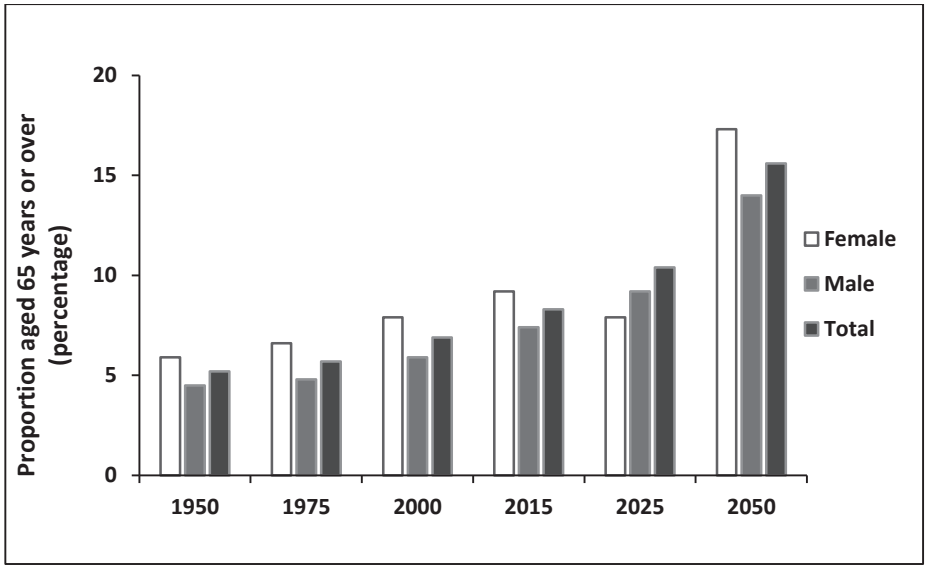

Fig. 1 Percentage of the population 65 years and older, worldwide, 1950-2050
Data Source: United Nations (2017), World Population Prospects: The 2017 Revision

Globally, the pace of the annual growth rate of older people has substantially been faster than the total population. Moreover, the older population is itself ageing (Fig. 2). A trend in the growth rate shows that the "oldest-old" population, those 80 years and over, has increased faster than both the total population and those aged 65 years and over. In 1980, the average annual growth rate of persons aged 65 years and over was similar to those aged 80 years and above. Since then, the "oldest-old" population has increased drastically. According to projections, by 2025-30, the annual growth rate of the "oldest-old" population will be 3.8 percent, more than 4 times that of the total population (0.8 percent) (see, Fig. 2). This implies that the world's population of older persons will outnumber children aged 0-9 years [1]. However, there are regional variations in the proportion of older person aged 65 years and above. Currently, Africa has the lowest percentage of persons in this age-group (3.5 percent) while Europe has the highest share (17.6 percent) [1]. The variations within continents is however also quite broad. Across Europe, Italy has the largest share of older people aged 65 years and over (22.4 percent), followed by Germany (21.1 percent) in 2015. Ireland on the other hand has the lowest share (13.2 percent) [1].

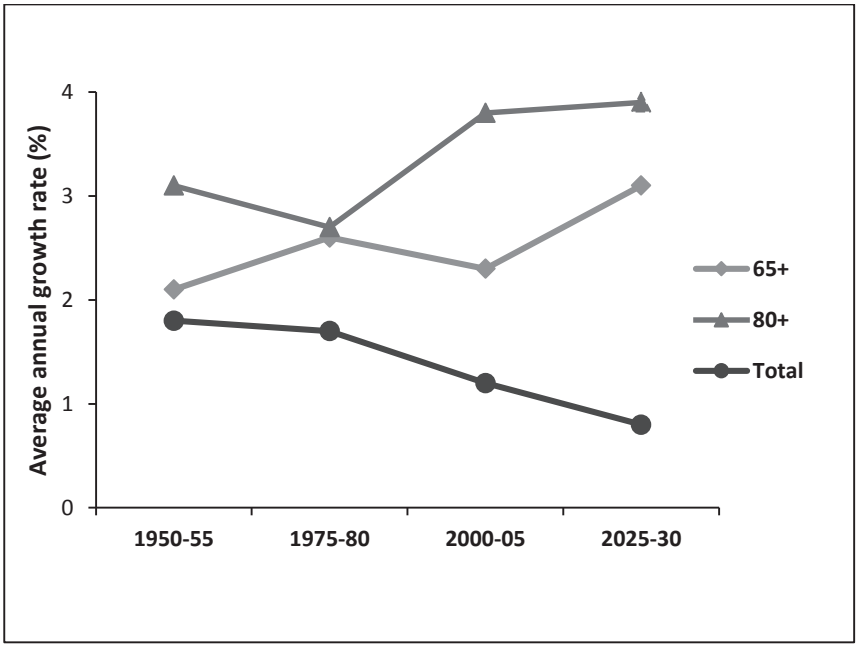

Fig. 2 Annual growth rate of the world's total population, the population aged 65+ and 80+, 1950-2050
Data Source: United Nations (2002), World Population Ageing: 1950-2050

1.1 Drivers of population ageing

The strong shifts over time in the world's age structure from a high proportion of children under 15 years to an increasing share of older people over 65 years is a combination of two factors: falling total fertility rates (TFR) and increasing life expectancy (LE). Declining fertility rates result in age-structural changes where the share of children and younger people decrease in the population, thus also pushing up the percentage of elderly people relative to younger age cohorts. Over the past decades, the global TFR has declined from 5 children per woman in 1950 to 2.5 in 2015 [1] and is projected to decrease further to 2 children per woman by 2050 [2], which is below the replacement level of 2.1 children per woman [3]. This rapid decline in birth rates is however not uniform across all regions. In the past decade Europe has witnessed a trend of unprecedented low fertility levels, with a TFR of or below 1.3 children per women since the early 90s [4, 5]. To stress the implications of the low birth rates in the region, Kohler and colleagues [5] labeled these patterns as 'lowest-low fertility'. The phenomenon is more pronounced in Southern European countries as well as in Western European countries such as the Netherlands, Sweden and Germany. Indeed, from the mid-1980s the TFR in these countries declined drastically below replacement level [1]. Currently, the TFR in Germany is 1.4 children per woman [1], which according to the literature, means that the share of children in the population will halve in the next seven-decades [6], thus accelerating population ageing [7].

Life Expectancy (LE) at birth or age 60 is the average number of years a person at that age can expect to live, assuming that age-specific mortality levels remain constant. Over the past decades, life expectancy among older adults has increased substantially globally [1]. In high-income countries, the significant increase in life expectancy at older ages [8] and the growing share of the elderly population [6] has been attributed to the rapid decline in mortality from cardiovascular diseases and improvements in health care delivery. Since the early 1950s, life expectancy at 60 years in Europe has increased by 5 years, from 16.8 years in 1950-55 to 22.0 in 2010-15 (Table 1).

However, great disparities persist between men and women and across countries. In general, women tend to live significantly longer than men. Currently, women outlive men by almost 4 years in Germany. The gender gap in life expectancy at 60 years is even more pronounced in other Western industrialised countries such as France, Italy, Spain, UK, US and the Netherlands (Table 1).

	1950-55	1975-80	1990-1995	2005-2010	2010-2015
Men					
Germany	16.0	15.8	17.8	20.8	21.4
Italy	16.4	16.8	19.0	21.9	22.6
Spain	15.6	17.6	19.5	21.7	22.7
France	15.2	16.9	19.3	21.9	22.9
Netherlands	17.7	17.2	18.3	21.0	22.0
UK	14.9	15.8	17.9	21.3	22.4
USA	15.9	17.1	18.8	21.2	21.7
Women					
Germany	17.5	19.8	22.2	24.7	25.1
Italy	18.0	20.9	23.6	26.0	26.5
Spain	18.1	21.3	24.0	26.3	27.1
France	18.3	21.8	24.6	26.8	27.3
Netherlands	18.8	22.0	23.1	24.7	25.4
UK	18.3	20.4	22.0	24.3	25.2
USA	19.1	22.1	23.0	24.2	24.7
Europe	**16.8**	**18.3**	**19.3**	**21.1**	**22.0**

Table 1 Life expectancy at age 60 for men and women in some selected countries from 1950-2015
Data Source: United Nations (2017), World Population Prospects: The 2017 Revision

Agreeably, low birth rates and mortality decline at old age have been the primary determinants of population ageing over the past decades. The underlying demographic processes that have resulted in the significant proportion of older people in recent times are however multifaceted and often more than just a linear relationship of increasing life expectancy or persistent fall in fertility levels. Another school of thought suggests that the increase in the global share of older adults in the 21st century can also be linked to the so-called "baby boom" generation of today's cohorts of older adults who were born some 70 years ago after World War II [9]. Furthermore, migration also has the potential of influencing population ageing [10], but because migrants are

usually younger, the influence of change on the host population structure may be less intuitive than that of fertility and mortality.

As noted earlier, death rates have been declining in high-income countries for several decades. This significant demographic and epidemiological trend indicates that older people will live longer than ever before and that the risk of dying will be much lower than in the past. However, the question is, are older adults living longer but having worse health?

1.2 Health of the ageing population

Population ageing may present health care and long-term burdens to individuals as well as society in general [11, 12]. Some of the main challenges have been associated with social care and healthcare expenditure [7, 9, 11, 12]. The prevalence of disability and chronic diseases is expected to increase as old adults get older, possibly resulting in a drastic rise in public expenditure on pensions and long-term care for older people. In Europe, the forecast suggests an increase in long-term care spending from 1.6% gross domestic product (GDP) in 2016 to 2.9% of GDP in 2070 [13].

There are currently two main theories on the question of whether increasing life expectancy will prolong the period of old age disability and ill-health, or increase the number of years older people will live in good health. The expansion of morbidity theory [14] suggests that increase in life expectancy at old age is a result of technological and medical development, thus living longer exposes older adults to additional years of chronic and disabling diseases. The opposing hypothesis is the compression of morbidity theory [15].The proponent of this theory, James Fries [15, 16], suggests that old age disability or ill-health may be compressed into a short period before death if the age of onset of chronic disease or disability in the older population is delayed.

Evidence regarding the two theories is mixed and not consistent across countries [17-19]. In a cohort analysis conducted in Finland, Winblad et al. [18] found that longer expectancy was not accompanied by improving health among older people aged 70 years or older. In contrast, a trend analysis between 1978 and 1998 on life expectancy and old age disability among people aged 60 to 89 years in Austria showed evidence of

healthy life expectancy over time [17]. This is in line with the hypothesis that older people are living healthier for a long time and being disabled for a short time before death. Likewise, evidence on the prevalence of disability among the elderly aged 65 years or older in several European countries such as Denmark, Finland, Italy and the Netherlands as well as from the US also showed a significant decrease in chronic disability [19, 20].

Over the last decade, several measures of chronic morbidity and functional limitations have shown improvements among older adults [19, 21]. This may suggest that older people tend to stay healthy for a long period of time before death. However, recent morbidity and mortality data showed a considerable discrepancy between life expectancy (LE) and healthy life expectancy (HLE) among both men and women [22]. HLE, also called disability-free life expectancy, is the number of years a person is expected to continue to live in a healthy condition. In Europe, life expectancy at 65 was 21.6 years for women and 18.2 years for men in 2016, while healthy life expectancy at 65 was 10.1 years for women and 9.8 years for men [22]. This indicates a large gap, where disability resulted in a loss of nearly 12 years of older women's healthy life and almost 9 years of older men's healthy life. Moreover, whereas older women aged 65 and above could expect to live 3.4 years longer than men in Europe, they could only expect to live 0.3 years longer free from disability than men. The gender gap was smaller in terms of HLE than the overall HE. This male-female gap in HLE further narrowed in favor of men in the Netherlands and Portugal, where older men aged 65 years and above could expect to live 0.4 years and 1.3 years longer free from disability than women, respectively [22]. Overall, although women live longer than men, they tend to experience longer years of ill-health and disability than men. Moreover, the large discrepancies seen between HLE and HE among both older men and women in Europe [22, 23] does not seem to support the compression of morbidity hypothesis.

According to the Global burden of disease study in 2016 [24], the four leading specific causes of disability among older adults aged 70 years and over were Ischaemic heart diseases, Alzheimer disease, dementia and chronic obstructive pulmonary diseases (COPD). The study further noted gender disparities in the global disability adjusted life years (DALYs). Ischaemic heart diseases contribute 17.3% and 16.8% of all total chronic disability among older women and men respectively, followed by stroke (11.5% among women and 11.1% among men), Alzheimer disease (4.8% among women and 7.7% among men), and COPD (8.3% among women and 5.3% among men) (Fig. 3). In general, the percentage of the severe levels of chronic morbidity seems to be higher among older women than older men.

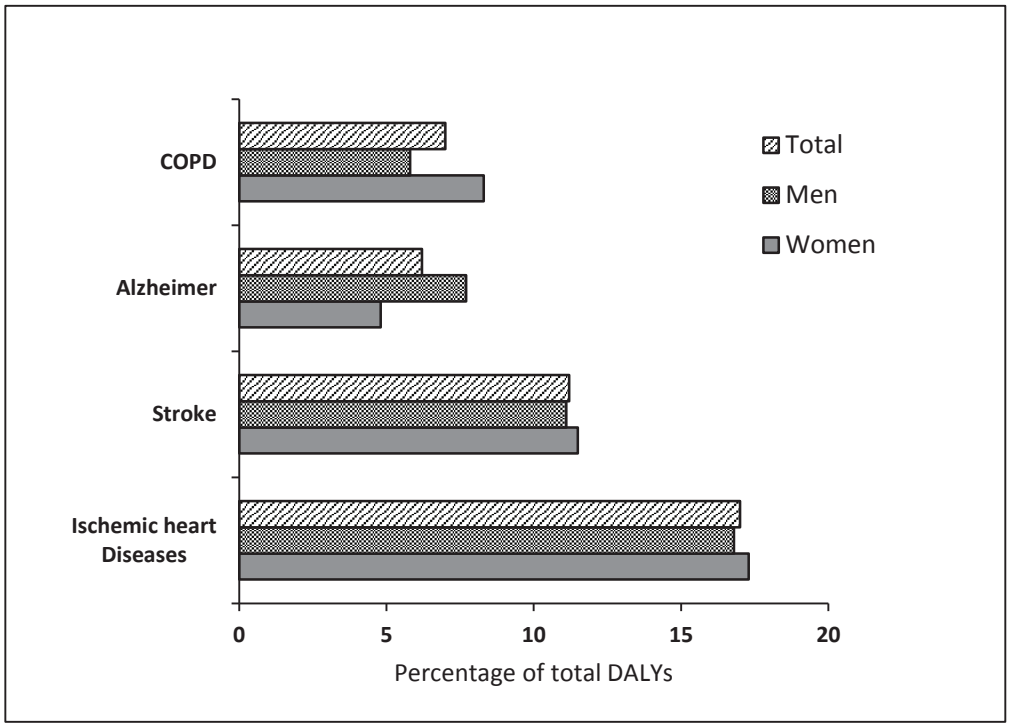

Fig 3 Percentage of global disability adjusted life years (DALYs) among elderly men and women aged 70 years and over, 2016
Data Source: Global Burden of Disease Study (2016), https://vizhub.healthdata.org/gbd-compare

1.3 Healthy ageing

Notwithstanding the functional decline associated with the process of ageing, age-related limitations that contribute to chronic morbidity can be prevented or even delayed into a relatively short period before death by engaging in healthy behaviours [25]. Healthy ageing is one of the concepts that has been associated with active behaviours and practices that can enable older people to remain healthy as they age. This concept is multidimensional and is defined by the World Health Organization (WHO) as the process of developing and maintaining the functional ability that enables the wellbeing in older age [26]. Other related concepts such as successful ageing, positive ageing and ageing reproductively [27, 28] demonstrate that good physical health and high cognitive functional capacity can be maintained at old age.

Since non-communicable diseases are the leading causes of disability and morbidity among older people (Fig. 3), evidence suggests that they can be ameliorated by structural reforms and changes in lifestyle such as engaging in physical activity and dietary modifications [25, 26]. Active participation in physical activity at old age has many benefits, including lower risk of mortality [25, 29]. For example, a recent multinational analysis of a longitudinal data found that physically inactive older people had higher mortality risk with hazard ratios ranging from 1.2 to 2.1. The study further revealed that inactive older people were more likely to have a rapid functional decline in health [25]. Other reviews also stressed the importance of regular moderate physical activity at old age including improvement in mental and physical capacities [25, 26, 30].

Similarly, nutrition has a role in the management of the functional and oral health of older people [26]. A healthy diet has been shown to be effective in the prevention or reduction in the risk of chronic illness and disability in old age. Haveman-Nies and colleagues [25] found that low-quality diet (e.g., high-fat food and a diet low in fruits and vegetables) increases deterioration of health status in older adults. Furthermore, malnutrition, usually referring to undernutrition, has been associated with higher risk of frailty and diminished cognitive functions [26]. While some of the old age health challenges can be related to malnutrition, overnutrition has also become a global health

concern in the past decades [31, 32], leading to a higher prevalence of overweight and obesity in the older population [33, 34].

At older age, elderly people are more likely to be dependent, therefore, interactions with the social and physical environment are critical to healthy ageing [26, 35]. This is particularly important because older people are more likely to experience more than one chronic illness at the same time (multimorbidity) [36]. Thus, to reduce the burden of disease at old age, a holistic or multiple factor approaches should be taken into account. In this view, the WHO 2002 report *Active Ageing: A Policy Framework* recommended a societal and environmental approach to healthy ageing, which includes among others the goal of building an age-friendly environment centered on the needs of older people [35]. Healthy ageing can be enhanced to a larger extent through a reduction in challenges presented by the environment in which older people live.

2 Health inequalities and determinants

Health inequalities between population groups have long been established [37, 38] and the analysis of health differences has thus become a priority in public health [39, 40]. It has been shown that not only top-bottom health inequality in any social class or group exist, but also differences in health on a graded pattern [37, 38]. A classic example is the Whitehall II study, which was conducted in the UK in the late 1980s [37]. This cohort study analysed health inequalities among civil servants in the UK from 1985-1988 and found a graded difference in morbidity or ill-health among office workers, which corresponded to their employment grade [37].

The concepts of "health inequality" and "health inequity" are most often used interchangeably. However, in public health research the concepts have different meanings. Health inequality is descriptive and refers to systematic differences in health between individuals or social groups (e.g., social class, race, religion, gender, etc.), irrespective of any assessment of fairness [41]. The concept of health inequity on the other hand is normative by character, and addresses inequalities in health that may be considered to be unfair and unjust. The latter denotes normative judgment based on theories of justice, theories of society as well as reasoning underlying the causes of health inequalities [41]. Because this concept is largely normative, it is sometimes difficult to determine which inequalities in health constitute unfairness. Nevertheless, it has been noted that most of the health inequalities seen between social groups over time may be seen as unfair, due to unequal access of resources and opportunities (e.g., education and employment) in societies [41, 42]. Hence, this thesis focused on inequalities in health that are (at least) socially produced (such as gender and socioeconomic inequalities), and the term "health inequalities" was used.

Health inequalities are a result of a complex system operating at different levels [43]. Hence several conceptual models have been developed [43-45] to get insight into the mechanisms and pathways through which social factors influence health. The Dahlgren & Whitehead [44] "determinants of health" model was one of the first models that explained the link between social status and health inequalities. In their

'rainbow' model, Dahlgren & Whitehead described the causes of health inequalities in four interactive "layers" (i.e., from a distal to individual level determinants). According to Dahlgren & Whitehead there are structural factors, such as economic, cultural and environmental conditions that prevail in every society. Second, an individual's ability to maintain good health is influenced by living and working conditions such as employment, housing, education and access to goods and services. Third, there are social and community networks such as friends and family, which are influenced by the cultural environment. Finally, the innermost layer of the model represents individual factors such as lifestyle as well as a core that represents fixed factors such as sex and age. Some of these factors have been suggested to have direct effects on an individual's health, while others are seen to influence health indirectly [43, 45]. In view of these complexities, more complex and multi-level explanatory models have since been developed [46-48], in which life-course perspectives and biological pathways have been taken into account.

Recently, the WHO [45] developed a conceptual framework that has widely been accepted to investigate the social determinants of health (Fig. 4). This model comprises two main levels: structural determinants and intermediary determinants. The structural determinants have further been divided into two categories: a) socioeconomic and political context such as social and public policies and b) social status and socioeconomic positions (i.e., education, occupation, income, etc.), that create hierarchies in society. The intermediary determinants are mainly material circumstances and behavioural risk factors such as smoking, alcohol consumption and physical activity. In fact, the model suggests that social cohesion and social capital are linked with both distal and individual level factors, and assumes that structural factors do not have any direct impact on an individual's health but rather through intermediary pathways (Fig. 4).

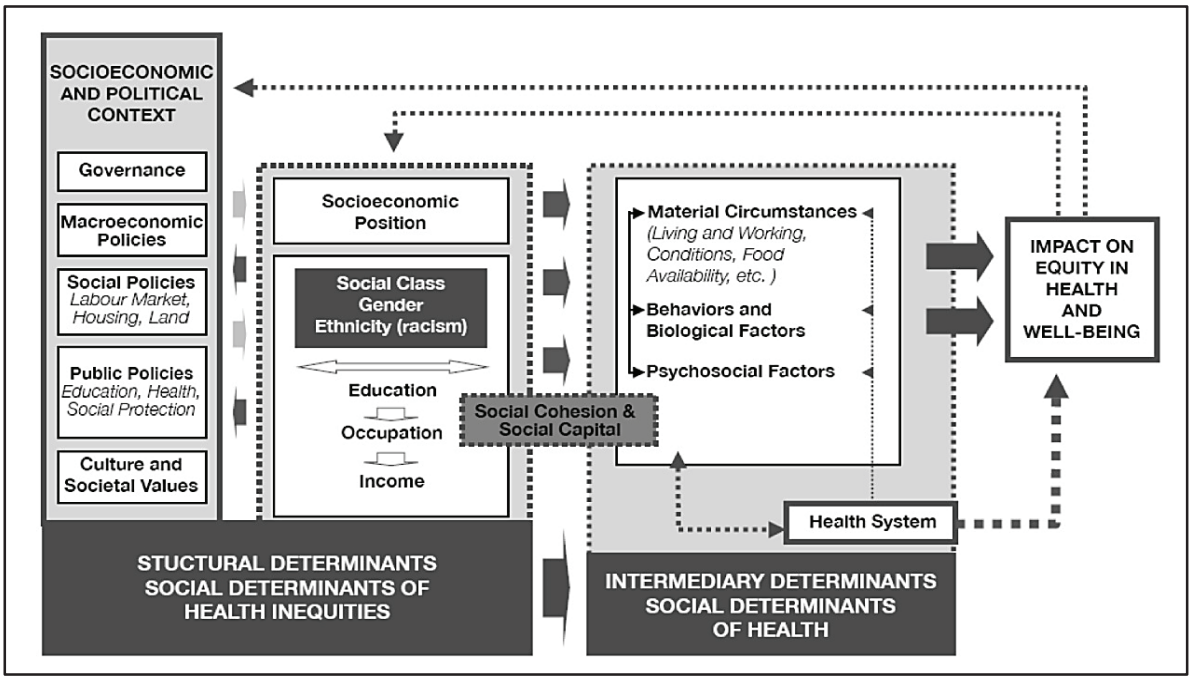

Fig. 4 Final form of the commission on the social determinants of health (CSDH) conceptual model (WHO, 2010)

In spite of the nuances in the conceptual frameworks, the various models agree that structural and individual factors including genetics are central to health inequalities in every society. Thus, an understanding of the relationship between these factors and health would provide a better insight into the health inequalities between individuals or social groups.

2.1 Genetic and biological factors

The genetic and biological contributions to health inequalities stem from physiological differences including genomic variations between individuals in a population [49]. The genetic explanation to health inequalities suggests that some genes may affect health by increasing predisposition to certain diseases while other genes are likely to slow ill-health.

Although the amount of genome that is linked to disease susceptibility is currently unknown [50], relationships between genes and diseases such as breast cancer, prostate cancer, diabetes mellitus, asthma [51-53], Crohn's diseases [54] and factor V Leiden [55] have been determined in subpopulations and ethnic groups. For instance, there is

evidence in the US that racial and ethnic minorities have poorer health compared to majority white population [53], and genetic ancestry has been implicated as a contributing factor to these observed health inequalities [56]. Furthermore, it has been hypothesized that genetics co-determines personal attributes such as intelligence [57, 58], which might influence intergenerational social mobility and health [59]. The genetic contribution to intelligence has been estimated for twins and the general population in previous studies [57, 58], where heritability of intelligence estimates ranged from 35% to 75% throughout the lifespan. It has however been acknowledged that environmental factors also contribute to these explanations [59].

While genes can contribute towards health inequalities in racial and ethnic groups [60], an individual's sex can to some extent explain health differences that are biologically determined [49, 61]. According to experts, sex differences in health may be influenced by fundamental differences in biological composition (chromosomes and hormones) between females and males [62, 63]. Whereas females have 2 X chromosomes, males have 1 X chromosome and 1 Y chromosome. The double set of X chromosomes in females has been analysed to have a protective effect on most X-linked diseases [64], and this biological phenomenon might to some extent explain why woman live longer than men [62, 65]. Paradoxically, women report on average poorer health than men [66], and sex differences in hormones might play a role in this health-survival paradox [65]. Biologists believe that sex hormones regulate the immune response whereby males and females develop different autoimmune conditions, which eventually affect the distribution of chronic conditions both sexes face [66]. Prior evidence has shown that women have higher prevalence rates of autoimmune health diseases and disorders including rheumatoid arthritis [62]. They also experience less life-threatening illnesses such as gallbladder condition, migraines and thyroid conditions which are attributable to autoimmune diseases [67]. In contrast, more life-threatening diseases such as coronary heart diseases (CHD), kidney disease and cerebrovascular disease have been reported to be substantially higher in men [62, 66, 68].

As already noted, there is a paradoxical sex difference in health [61, 62], whereby women have a longer lifespan than men, but experience more ill-health conditions [65]. Further, at older ages, women have a diminished quality of life compared to men [69]. This paradox is multifaceted and neither biological nor genetic factors have so far been considered sufficient to explain the observed sex inequalities in health [49, 70]. Studies analysing various life stages including older age, have suggested that a combination of multiple factors including environmental, social and behavioural risk factors [49, 61, 62, 65, 66, 68, 70] might explain the health inequality between men and women. It has also been postulated that the convergence of "gender-related" social factors and "sex-related" biological factors from early life may result in different levels of accumulated health risk among men and men over the life course [63].

The terms "sex" and "gender" warrant some clarification because the two terms are often used interchangeably in public health research. "Sex" refers to those primary and secondary characteristics (chromosomes, hormones, and sexual and reproductive organs) of males and females that are biologically determined. The concept of "gender" on the other hand emphasises characteristics of men and women, which are socially constructed and which may shape "feminine" and "masculine" roles and behaviours [63]. Because gender is socially produced, it is dynamic and may vary between societies, institutions, culture and across time. For example, given the different societal expectations for masculinity and femininity, distribution of resources and opportunities (e.g., education and employment), roles, activities and risky behaviours that may affect health outcomes might differ for men and women and across countries [42, 45, 49, 61, 63, 66]. In sum, "sex" and "gender" interact, and health inequalities between men and women may be a product of both influences [48, 49, 63]. In this thesis, the term "gender" and its associated roles and behaviours was used, since both terms are interconnected, although distinct [63].

2.2 Gender roles

Previous research has shown that gender roles may protect against or increase vulnerability to illness and diseases among men and women [71, 72]. However, the positive or negative effects of these roles on health by gender vary at any given age [73, 74]. Two competing models dominate the literature on assessing whether gender roles are beneficial or harmful to health. The first model, 'role enhancement', postulates that combining gender roles might be beneficial to the health of both men and women, while the second model 'role overload' proposes that multiple roles may have a negative effect on an individual's health [71]. However, evidence on both models, regarding the three traditional gender roles (marital status, parental status and employment status) is mixed [71, 73-75]. For instance, although findings from epidemiological research have consistently shown that married individuals have better physical health [76], enjoy better mental health [75], and live longer than unmarried individuals [77], there is also evidence that the protective effects of marriage are unequal between men and women [78]. Married men have generally been observed to derive greater health benefits compared to married women [72, 75]. These gender-specific health inequalities findings may support the "role overload" hypothesis, due to possible role conflicts from family responsibilities. Moreover, the combination of gender roles and activities (i.e., both paid market work and domestic work) among women may lead to greater stress and a greater sense of inequity which in turn affect their health negatively [72, 79].

At old age, elderly people may not combine employment and domestic work like working-age adults, therefore, the "role overload" hypothesis might lose its premise in explaining the effect of gender roles on health among older men and women. Combining domestic work and other care activities such as grandparenting [80] can perhaps be beneficial to older men and women's health [81], because they perceive these roles as leisure activities [82]. Nevertheless, as stated before, gender is not static, and the distribution of gendered roles (e.g., domestic work) may vary from society to society due to cultural norms [83]. Therefore, combining two or more roles and

activities at older age might have a differential impact on the health of elderly men and women across countries.

2.3 Lifestyle factors

Lifestyle risk factors, including, inter alia, physical activity (as discussed in section 1.4) tobacco use and alcohol consumption are socially patterned [37, 42], even at older age [25-27]. Prior studies have consistently demonstrated that such social patterning of lifestyle factors tend to partly explain health inequalities in a given population [37, 42, 45], and have been implicated in at least 30% of the total burden of diseases among older people in high-income countries [24].

Globally, tobacco use causes nearly 10,000 deaths a day and approximately 5 million deaths per year [84]. The Global burden of disease study in 2016 revealed that the use of tobacco is a risk factor for the four leading causes of disability and morbidity (Ischaemic heart diseases, Alzheimer disease, dementia and chronic obstructive pulmonary diseases (COPD)) among older adults aged 70 years and above [24]. A recent prospective cohort meta-analysis of the impact of smoking on cardiovascular diseases in older people revealed that smoking is an independent risk factor for cardiovascular deaths and diseases at old age [85]. While gender differences do exist [86], it remains unclear whether older men who smoke are at higher risk of cardiovascular morbidity and mortality than older women [85, 86].

Together with smoking, over-consumption of alcohol has been found to be a significant risk factor for non-communicable diseases (e.g., stroke, heart attack, cancer and diabetes)[87], and it accounts for about 3.3 million deaths every year, worldwide [88]. In the recent Global burden of disease study that has already been mentioned, among older adults aged 70 years and over, 8.06% of disability-adjusted life years (DALYs) due to stroke was attributed to alcohol consumption [24]. A meta-analysis conducted by Reynolds et al. [89] however depicted a U-shape relationship, where consumption of less than 12 g/day was associated with reduced risk of both Ischemic and hemorrhagic stroke compared with non-drinkers and heavy drinkers.

Regarding gender, in a meta-analysis on alcohol consumption and cardiovascular mortality including stroke and cancer, White et al. [90] reported a higher risk of cardiovascular deaths among women than men, even at old age (65 years and above). Although alcohol consumption is an independent behavioural risk factor for non-communicable diseases in the older population, the synergistic effect of drinking and smoking as well as an individual's socioeconomic status in society [91], might partly explain these gender-specific inequalities in health conditions.

2.4 Socioeconomic factors

Over the past decades, epidemiological and biomedical studies have confirmed that socioeconomic status (SES) is linked with a range of health outcomes, even among older people [37, 38, 40, 92-95]. The famous Black report and the Whitehall cohort study made substantial contributions to this aspect of the literature. These reports [37, 38] and subsequent studies concluded that there is an inverse effect of socioeconomic factors on health, where lower levels of SES are generally associated with worse health conditions and higher mortality risk, even among older adults [37, 38, 47, 93]. It has also been established that even though health problems result from a complex interplay of biological, behavioural and social factors [35, 45], the three major components of SES (education, occupation, and income) contribute significantly to health inequalities [42, 44, 47]. These measures are interrelated but underlie different dimensions of socioeconomic status over the life course. They also cannot be used interchangeably as a hypothetical latent social dimension [96, 97].

The component education captures knowledge-related assets as well as access to information and is often used as a generic indicator of SES in health research [45]. Reasons are that it is relatively stable after adulthood and easier to measure compared to occupation and income [93, 94, 98]. Furthermore, educational attainment is known to be correlated with occupation and income as it predicts the likelihood of being employed, as well as the type of occupation and income that a person can get. However, evidence from the literature also suggests that even though these standard measures of SES are correlated, the correlations are generally not enough to justify the

use of education as a proxy for SES [96]. Indeed, educational attainment is a significant single predictor of mortality and morbidity in industrialised countries in the earlier life course and at old age [42, 43, 45, 93-95]. Most prior research concluded that there was a protective effect of educational attainment on health outcomes among older adults, where those with higher education had a lower likelihood of morbidity [94, 98]. In a comparative study in several European countries (Spain, Italy, France, Norway, UK and the Netherland, Finland, Denmark, and Belgium) conducted by Dalstra and colleagues [94], the prevalence of poor health was found to be higher among older men and women with lower education than among those with higher education. This negative association between health and educational level might be explained by material circumstances, as higher educational levels are associated with better economic outcomes such as better job and higher income [97].

Income is the SES indicator that most directly measures material circumstances [96, 97]. Although money in itself is unlikely to influence health directly, the translation of money and available assets into health-enhancing services (access to health services) and commodities (food and shelter) may affect an individual's health. For example, higher income allows access to better housing conditions, quality health care, food, clothing, and better education, which, in turn, may be beneficial to health. These material living conditions may have a direct or an indirect impact on health [45, 99], and might also generate health inequalities in societies [94, 99], where people living in poorer economic conditions may be exposed to higher risk of ill-health and diseases [99]. Among older adults, Arber and Ginn [40] found that elderly men and women who lived in advantaged material conditions in terms of income and housing reported significantly better health than those who were disadvantaged. This measure of SES, unlike education, can significantly change over the life course [99], and sometimes, the relationship between material circumstances and health may be subject to reverse causation (i.e. health determines material resources), where an individual with poor health may suffer a dramatic loss of income. Although the effect of income on health conditions can vary over time, its impact on health outcomes can also accumulate over the life course [99, 100]. For example, in a study on the effects of childhood living

conditions and current material living standards on long-standing illness and self-assessed health, Rahkonen et al. [100] found that economic difficulties during childhood were significantly associated with health in adulthood. The study however also noted that economic resources at old age had the strongest association with health.

Occupation is another distinct measure of SES. It is however known to be strongly related with income and may also serve as a major link between education and income [97]. Occupational based indicators of SES are widely used [47, 96] not only to examine the influence of social class (occupational class, prestige and power) within the social structure on health, but also to assess the impact of physical and environmental hazards of job-related activities on health as well as behavioural risk factors (e.g., smoking, alcohol consumption and physical activities) [99, 101]. As the use of occupation has been criticised for excluding the unemployed, people who are engaged in housework (mostly women) and retired people in the occupation-based classifications [45], employment status (i.e. employed, unemployed and retired) is also widely used to compare the health status of people [47], which may lead to underestimation of social class differentials [102]. Nevertheless, a strong and graded association between occupational status and diverse health outcomes [37, 38, 43, 101] has been consistently reported in prior research. In a longitudinal study of 17,530 civil servants in the UK, Marmot et al. [101] observed that workers in the lowest employment grade had higher risks of coronary heart disease and higher blood pressure than those in the higher grade. Furthermore, research has repeatedly shown a higher prevalence of good health among men and women who are employed than their counterparts who are unemployed [71, 103]. However, this positive association has been found to be less apparent for physical health than psychological health in women [71].

Socioeconomic factors can interact with other social characteristics such as gender to produce different health effects [42, 47, 99]. Consequently, they not only generate socioeconomic inequalities in health, but also gender disparities in health. Prior evidence has demonstrated that SES is often lower among women, resulting in them being exposed to more health adversities than men [72, 73, 99, 104]. In an attempt to

explain this interacting effect of SES and gender on health two general hypotheses have been proposed: the differential exposure hypothesis and the differential vulnerability hypothesis. The differential exposure hypothesis suggests that men and women differ in exposure in terms of access to material conditions and risk factors that ultimately influence health outcomes. For example, women are less likely to have higher education, to be formally employed, to have higher incomes and are more likely to have higher social role demands than men [45, 72, 73]. This unequal distribution of resources and opportunities exposes women to higher levels of stress [104]. Further, elderly women are exposed to a wide range of psychosocial risk factors such as depression [105], which may account for their increased prevalence of ill-health [42, 99]. According to the differential vulnerability hypothesis, the resilience and vulnerability of men and women to similar risk and protective factors is not the same. Women are perceived to be more vulnerable to adverse impacts of life stressors and to have less effective coping mechanisms than men [104, 106, 107]. This was confirmed in a Canadian study conducted by Dental et al. [106] in which the authors concluded that health inequalities among men and women could be attributed to gender differentials in vulnerability to behavioral risk factors (e.g. smoking and drinking) and other psychosocial factors such as stressful life events. Furthermore, in a multi-national study, Lankarani et al. [107] found that compared to men, women were generally more vulnerable to poor health when in low SES.

Notwithstanding these explanations, the use of traditional SES measures (education, occupation, and income) to assess gender and socioeconomic inequalities in health among elderly people have been criticised in health research, because their applications may not be useful at old age [93, 94, 98]. For example, at old age, the use of occupation as an SES indicator may be problematic since the majority of men and women above 65 years are no longer in the workforce. In the EU and the USA for example, less than 5% and 11% of people above 65 years of age were still employed in 2011 [108]. But is the use of occupation as an indicator for the elderly always problematic? A study by Arber & Ginn [40] used older people's last occupation and found a strong association with health for both elderly men and women. Dalstra et al.

[94] however argued that a person's main occupation might not necessarily be the same as the last occupation before retirement and therefore the effect of the main and last occupation on health may not be the same.

Similarly, the use of income as an indicator may be problematic as it correlates highly with employment. Moreover, the source of income among most (non-working) older people is pension funds, state benefits and other sources that are not related to occupation. Thus, among the elderly, wealth has been suggested to be a better measure of economic well-being compared to income, because older people might have accumulated some wealth through savings, investments and other possessions throughout the life course. Other easier measurable proxies for wealth that have been used in Europe are housing tenure and car ownership [40, 94, 98].

On the other hand, education is often seen as a more stable measure among the elderly because it is usually fixed during the early stages in the life cycle and has no problem of reverse causation [94, 98]. Nonetheless, it has been argued that a larger proportion of the older population are, due to changes in education systems, likely to have lower levels of education than the younger generation, hence the distribution is likely to be skewed when this measure is applied in research among the elderly [94]. Despite this observation, Grundy & Holt [98] suggested that the use of education or social class combined with deprivation indicator is the best measure of SES for older adults.

2.5 Psychosocial factors

According to the psychosocial perspective, individuals who are disadvantaged in terms of material conditions and psychosocial conditions (e.g., social network and support, work control and autonomy) may have fewer resources and opportunities to deal with stressful life events and difficult situations [44, 47, 99], and this could in part explain the social and gender inequalities in health in society [47]. It has been recognised that long exposure to negative conditions such as insecurity, loss of self-esteem and low control can influence health directly through psychobiological processes, or indirectly through behavioural risk factors. For example, a systematic

review of prospective cohort studies by Hemingway and Marmot [109] found that low social support, low control at the workplace, anxiety, and depression were positively associated with coronary heart diseases. Stress and other detrimental conditions that are linked with physiological responses have been cited to be behind these adverse health conditions and many somatic illnesses [110]. Indirectly, behavioural factors such as smoking and alcohol consumption have also been shown to be associated with stress and low heart rate variability (HRV) among those in lower SES [111], and many studies have indicated that job demand and job strain are related to chronic stress [109, 110, 112]. Another component of stress that has been linked to work demand and control is time pressure [110, 113]. According to Szollos [113], time pressure makes people perform activities faster, leading to them experiencing a constant feeling of being rushed. This feeling of rashness due to time constraint may expose them to a phenomenological dimension of stress. In fact, an individual may be exposed to time pressure when there are imbalances between the activities one wants to perform and the realisation of those activities.

Although stress in terms of time pressure is positively associated with many adverse health effects such as mental health, depression, increased blood pressure and cardiovascular disease [110, 112], there is also evidence that it can intensify the performance of people to achieve more results than they would have possibly achieved [112]. Regarding gender, while some studies suggest that there is no gender difference in stress [114, 115], others found a significant gender difference [116, 117], with women reporting higher levels of stress and chronic conditions such as depression than men [117]. However, at old age, work-related stress in both genders may be minimal due to time availability after retirement [118]. The type of stress experienced while performing daily routines and activities may differ by age, gender and SES, but social networks and support activities have been hypothesised to buffer the effect of stress on negative health outcomes even among the elderly [110, 119]. The buffering hypothesis claims that social cohesion and network can mediate the relationship between stress and mental health problems. Studies investigating this hypothesis however report contradictory and inconsistent findings, even among the older

population [120-122]. Whereas Krause [122] found no buffering effect in older people, a recent study by Kwag et al. [120] reported that social support predicted lower levels of depression, fatigue and loneliness among older adults. Moreover, results of an 18-year longitudinal study in Taiwan indicated that social participation reduces depressive symptoms among older adults [121]. Despite these inconclusive findings, the importance of older adult's involvement in social support and network activities for psychological wellbeing [121] and increase survival rates [29] has been noted in previous research findings.

2.6 Welfare policies

Health and social care services for populations, including the elderly, are the cornerstones of every state policy. The primary function of these welfare policies is to redistribute income and provide access to health care that can mitigate health inequalities stemming from social class hierarchy [44, 47, 99]. However, social policies for the redistribution of resources may vary from society to society, depending on government political decisions and ideologies [123]. This in turn affects social stratification, and may further generate health inequalities not only between socioeconomic groups within countries, but also across countries [99]. Indeed, several studies have demonstrated that structural determinants such as political factors play an essential role in determining health inequalities at the population level [124-127]. For example, in a multilevel analysis of 21 countries in Europe, Eikemo et al. [126] found that 10 percent of differences in self-reported health was linked with the institutional settings of a country. Navarro and Shi [127] also concluded in a study that state policies determined the level of health inequalities between social groups in a society.

Due to the heterogeneity of chronic diseases and disability at old age, elderly people may often need care services in order to perform basic or instrumental Activities of Daily Living (ADL), such as bathing, dressing and shopping. This type of support, including medical care, is called long-term care (LTC) [128, 129]. A direct implication is that families have to provide informal LTC to assist older adults manage their daily lives. However, because LTC is expensive and individuals in lower SES

cannot afford it, the state intervenes through public financing to help older people and their families avoid catastrophic care expenditures [128].

Over the past years, public expenditure on LTC has risen due to the increasing prevalence of long-term diseases such as dementia. In Europe, the forecast under the "healthy ageing scenario" suggests an increase in LTC spending from 1.6 % gross domestic product (GDP) in 2016 to 2.7% of GDP in 2070. These estimates however vary considerably between welfare states, with estimates for 2016 ranging from more than 5% of GDP in the Netherlands to less than 1% of GDP in Spain (Fig. 5).

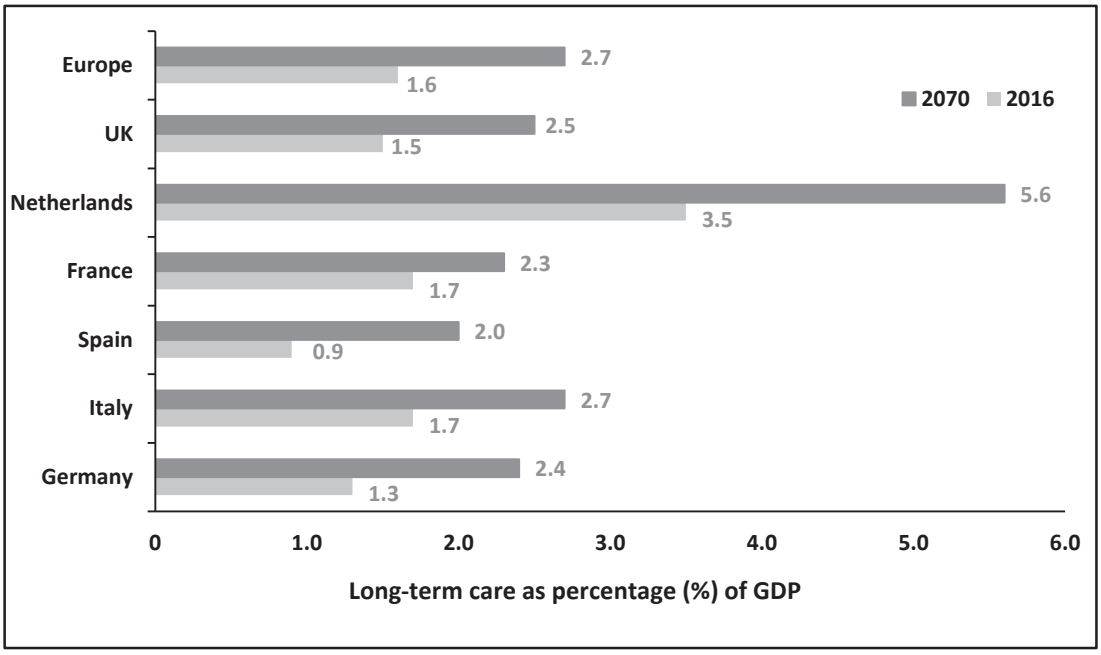

Fig 5 Projected long-term care expenditure as a percentage (%) of GDP under the healthy ageing scenario
Data Source: European Commission: The 2018 Ageing report

Long-term care for older adults is a complex service that not only includes home and nursing care, but also social and residential (housing) dimensions [129]. Thus, social and economic policies interventions by the state may help level out health inequalities between socioeconomic groups at old age.

2.7 Time use activities

Time spent by older adults, especially in retirement, has increased considerably as a result of the increasing life expectancy [130]. This major life transition affects the amount of time devoted to the various life tasks. A direct corollary is that time use patterns are restructured, and may have flow-on effects on diverse tasks, which can subsequently affect older adults' health in complex ways. For example, more time devoted to passive leisure activities may reduce the time allocated to physical activities such as walking or cycling, which can lead to a net loss in health. On the contrary, a reduction in time allocated to sedentary activities could have a beneficial effect on health [131], because being physically active has been shown to be associated with reduced risk of chronic illness and mental health conditions among older adults [25, 29, 30]. Sedentary behaviours on the other hand may increase the risk of cardiovascular diseases [132]. Time is a social resource, thus, many factors including gender, cultural beliefs, behaviours and institutional policies can influence its daily use [73, 83], which in turn can contribute to health inequalities between men and women [72, 73].

The goal in this chapter is to critically discuss the impact of time use activities (i.e., housework, paid work, leisure and personal activities) on health, particularly, emphasising how these activities affect the health conditions of older men and women.

2.7.1 Housework activities

Life transitions such as retirement affect gendered time use, especially housework activities (e.g., cleaning, cooking, gardening, and maintenance). These time use activities can be regarded as the main "productive work" among older adults in retirement, filling in the hours that hitherto have been devoted to paid work. Although household work constitutes part of the daily lives of older adults [118], gender profiling in the type of activities performed has been noted [72, 73]. While women tend to perform routine, repetitive household tasks such as washing clothes, cooking and cleaning, men are usually responsible for occasional tasks such as repair works and maintenance [118, 133]. Moreover, gender differences in the time allocated to these

housework activities exist, even in high-income countries [83, 118]. In the US, Sayer et al. [133] observed a gender gap of 1.0 hour in time devoted to housework activities among older people aged 75 years and over. The authors found that while women allocated 3.9 hours to household work including childcare and housework, men devoted 2.9 hours to such activities. Similar trends have also been observed in Europe. In a comparative study, Gauthier and Smeeding [118] found gender differences in the division of household activities among elderly people aged 75 years and above in some European countries, where time devoted to housework ranged from 1.5 hours in Germany to 5.0 hours in Italy. Even though older men devote the least of time to housework activities, a trend analysis of time use among the elderly revealed that time allocated to housework activities among older men has increased over the years [134].

The unequal distribution of housework activities between men and women has been noted to be a contributing factor for the gender-specific inequalities in health, even at old age [72, 73, 135]. In a time use study, Bird and Fremont [73] observed that women have poorer health than men due to unequal division of housework. The authors concluded that if role-related activities such as household tasks were to be divided equally between genders, women would have better health than men. Undoubtedly, gender inequalities influence health through unfair divisions of housework activities, as further demonstrated in other studies [72, 73]. More often the adverse health consequences related to this phenomenon are psychological, including distress conditions [72] and depressive symptoms [135], rather than adverse physical health conditions [71]. The kind of housework activities that men and women engage in may play a non-negligible role in the occurrence of the adverse health differences detailed. The gender distribution profile of housework suggests that men are more likely to use their strength in the performance of heavy housework activities such as yard work and repair works; thus they may suffer more physical health consequences than mental health problems. On the other hand, routine housework activities such as cooking and cleaning demand higher psychological involvement which may negatively affect the mental health of women.

2.7.2 Paid work activities

In some high-income countries, an increasingly significant share of older adults return to work after the statutory retirement age [108]. This phenomenon is called bridge employment [136], where usually a sizable proportion of older men and women seek part-time, full-time or self-employment wage or salary jobs when they retire. It is called "bridge" employment because it is a transition job after retiring from a career job before completely withdrawing from the labour market. Evidence suggests that older adults are more likely to be in part-time employment than in full-time [108], and there are also significant gender and cross-country variations in the employment rates (Fig. 6a & b). Over the past decade, the employment rate among older men and women aged 65 years and over has increased steadily. Overall, women have participated in a much lower extent than men. For example, in 2017 the gender gap in the participation rate ranged from 8.3 percent in the US to 1.3 in Spain. The trend further revealed that while the US has the highest participation rate for both men and women, Southern European countries such as Spain, Italy and France lagged behind, with low labour force participation rates for both genders (Fig. 6a & b).

Regarding hours spent on paid work after retirement, cross-country and gender variations have been observed in prior studies [118, 133]. Gauthier and Smeeding [118] found that older men aged 75 years and over in the US devoted on average 0.6 hours a day on paid work activities, while women allocated 0.4 hours per day on such activities. The study further showed that while older men (75 years and above) in Italy devoted 0.4 hours to paid work, their female counterparts allocated on average 0.1 hours per day to paid work activities. Similar patterns were observed in a US study, where older men in their early retirement ages (65-69 years) devoted on average 1.8 hours per day to paid work compared to 1.0 hours per day among women [133].

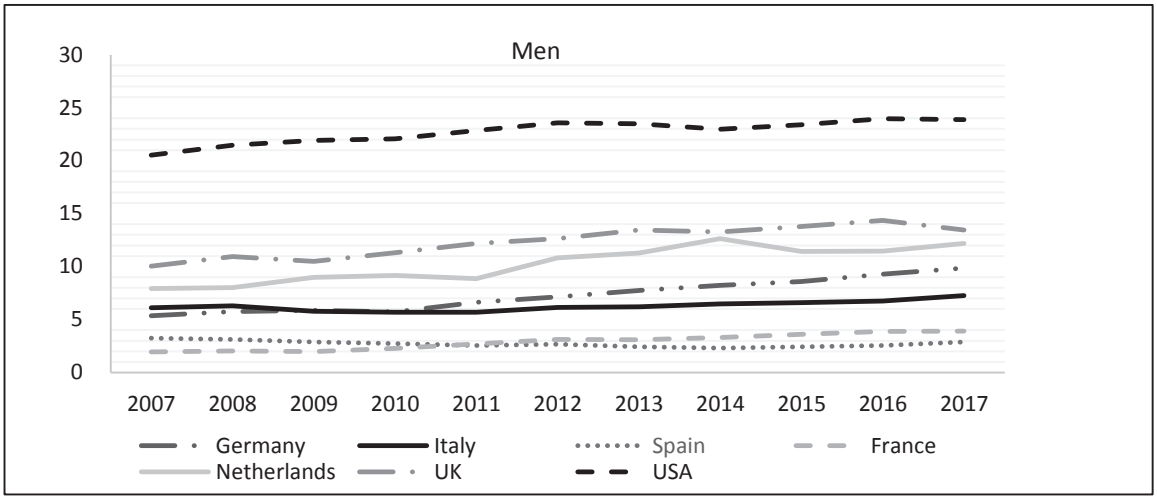

Fig 6a Employment rates among older men aged 65+ in Germany, Italy, Spain, France, the Netherlands, UK and the US from 2007-2017, by gender
Data Source: OECD (Labour force surveys), https://data.oecd.org/emp/employment-rate-by-age-group.htm

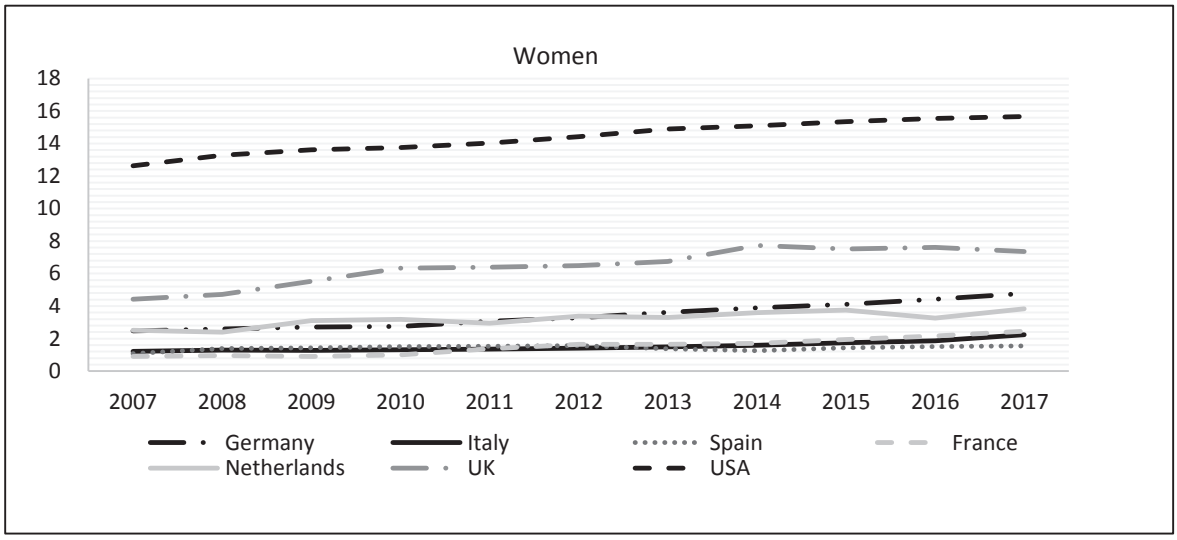

Fig 6b Employment rates among older women aged 65+ in Germany, Italy, Spain, France, the Netherlands, UK and the US from 2007-2017, by gender
Data Source: OECD (Labour force surveys), https://data.oecd.org/emp/employment-rate-by-age-group.htm

Due to the rising popularity of paid work after retirement, post-retirement health among older adults in employment has become a critical issue at both individual and societal level [26], probably because of the possible health consequences during this major life transition. Studies examining the implications of paid work after retirement largely focused on psychological outcomes such as life satisfaction [137, 138]. However, of late, there has been some research on the potential physical and mental health benefits of time allocation to paid work after retirement [139, 140]. For instance, in a recent study Zhan et al. [139] used longitudinal data to examine the effect of bridge employment on retirees' health status, including physical functioning and depression. They found that paid work after retirement was associated with fewer major diseases and better mental health outcomes. Similarly, Ling and Chi [141] found paid work at old age to be associated with better self-reported health among older adults in China. Meanwhile, among older adults in Korea, Jang et al. [140] found that employment after retirement increased depressive symptoms among older men. The same effect was observed among older women, but not statistically significant. In spite of these inconsistent findings, paid work after retirement has been shown to be beneficial to overall life satisfaction among older men and women [137, 142].

2.7.3 Leisure-time activities

In retirement, older adults may invest significant time and effort in leisure activities in the absence of substantial paid work. The commitment and frequency of participation in such activities are essential for successful ageing [27]. As the prerequisite for successful or healthy ageing is multidimensional, time allocated to leisure may be an important component [27, 28], which can help older people maintain physical and cognitive functions [27, 143]. In a 6-year follow-up study among older adults aged 67-95 years, Menec [143] highlighted the importance of leisure activities in successful aging. He classified time devoted to leisure activities as social (i.e., visiting family and friends, participation in religious and club activities, civic duties and sports) and solitary (i.e., handwork hobbies such as knitting and sewing, going to the cinema, theatre, art, writing and reading books), and concluded that these activities were

significant factors and contributors to various aspects of successful ageing such as happiness, functional abilities and reduced mortality. These findings were confirmed in another longitudinal study of 2,761 elderly men and women aged 65 and above in the US [29]. In the said study, Glass and colleagues [29] found that participation in leisure activities such as attending church, going to the movies and passive sports activities was associated with reduced risk of mortality among older adults.

Indeed, an increase in the time allocated to leisure activities may reduce the amount of time devoted to other daily activities. Regarding the time allocated to active leisure among older adults, previous research indicated that it varies by gender and across countries [118, 133]. Gauthier and Smeeding [118] found that older men aged 75 years and over in the US allocated on average 4.0 hours a day on active leisure activities (including volunteer work, hobbies, sports and fitness, and other social activities) while women devoted 3.6 hours per day to such activities. The study also noted a significant gender gap of 1.4 hours per day in Italy, where older men (75 years and above) devoted 4.2 hours to active leisure while their female counterparts allocated on average 2.8 hours per day. In a further study from the US, Sayer et al. [133] also found a gender gap in time use, with older men aged 70 years and older allocating on average 7.7 hours per day to leisure and sports activities compared to 7.0 hours per day among women.

In a broader perspective, regarding health outcomes, time spent on leisure has been advocated as a pathway through which older adults' physical and mental health can improve [27, 28]. Previous studies have provided evidence that time allocation to leisure activities among older adults is positively associated with diverse positive health outcomes, including physical and mental health [30, 144-146]. For example, in a community-based longitudinal study of 1,772 American men and women aged 65 years and older, Scarmeas et al. [144] found that more time devoted to active leisure activities was associated with a reduced risk of dementia among the elderly. Similarly, Eriksson and colleagues [146] investigated the relationship between leisure activities and the risk of dementia among older adults aged 65 years and older in Sweden. This 15-year prospective study concluded that active leisure activities such as spending time with family and friends, leisure trips and religious activities were associated with decreased

risk of dementia. Further analysis by the authors, however, indicated that mental activities such as reading books, magazines and playing music were only associated with a reduced risk of dementia in the first 1-5 years after baseline. It appears the type of leisure that older adults engage in may have distinct health implications as indicated by the findings reported by Eriksson et al. [146] and other previous research [147]. While participation in active leisure activities may be beneficial to older men and women's health, more time devoted to passive leisure activities such as watching television, listening to radio and relaxing could also have a negative impact on their health including cardiovascular diseases and obesity [132, 148]. In a recent longitudinal study of ageing, Hamer and Stamatakis [147] found a positive association between prolonged time devoted to viewing television and poorer cognitive function among older adults. Parallel findings among 6,090 men and women from the English Longitudinal Study of Ageing (ELSA) study also revealed that more time allocated to TV viewing was associated with higher depressive symptoms and higher BMI among older men and women [149].

2.7.4 Personal-time activities

A substantial component of daily time use activities among older adults is devoted to personal activities such as eating, bathing, and sleeping. The latter constitutes the lengthiest daily time use activity [118, 133, 150, 151] and is also functional for older adults well-being [152]. Due to time constraints within a day, any additional time devoted to sleep means spending less time on other daily activities such as leisure. Sleeping time however increases with age, probably because of the increasing incidence of ill-health at older age [118]. In the US, older adults aged 70 years and older were reported to devote an average of 9.0 hours per day to sleep [133]. This is similar to findings of a cross-country analysis on sleep patterns in Europe, which revealed that, at (95th percentile), older adults aged 74-84 years old in France, Italy, Spain and the UK devoted 9.0 hours to sleep. The 95th percentile was at 10.0 hours for Portugal and Germany [150]. It remains unclear whether older men sleep longer than older women or vice versa [118, 133, 150]. Sayer et al. [133] found no gender gap in sleep duration

for American men and women aged 70 years and older. This was confirmed in a cross-sectional time use study also conducted in the US by Krantz-kent and Stewart [151], in which both men and women aged 70 years and older were found to have the same sleep duration of 9.0 hours per day. Meanwhile, in a study of 8,091 older adults aged 55 and 101 years in seven European countries, Ohayon [150] found gender differences in time devoted to sleep and concluded that sleep duration was longer in older men than older women.

The quantity of sleep has been shown to be an important determinant of health [153-155]. Thus, the amount of time allocated to sleep may have significant health consequences for individuals across the life course. Among the older adults, accumulating evidence from both longitudinal studies and cross-sectional findings [152-154, 156] concluded that deviations of sleep hours from 7-8 hours are detrimental to older adult's health. In a prospective study by Cai et al. [154], short sleep duration (<7 hours) per day and long sleep duration (>8 hours) were found to be associated with increased risks of stroke, cardiovascular disease, diabetes, cancer and mortality among elderly Chinese men and women. Similarly, López-García and colleagues [153] investigated the effect of sleep duration on obesity among older adults aged 60 years and older in Spain. They found that those who slept 9.0 hours per day were at a higher risk of severe obesity (OR: 1.57, 95% CI: 1.00-2.47) compared to a those who slept 7.0 hours a day. Furthermore, a recent meta-analysis of nighttime sleep duration and all-cause mortality among older adults showed that, compared with 7.0 hours of sleep time, the relative risk ratio associated with short sleep duration (e.g., <5 hours a day) was (OR: 1.04, 95% CI: 1.01-1.07), whereas that associated with long sleep duration (e.g., >9 hours a day) was (OR: 1.21, 95% CI: 1.18-1.24) [155].

In summary, the review of the extensive literature on time use suggests that the choice of activity and the amount of time dedicated to those activities may have diverse health implications among older men and women. Thus, the "productive" use of both objective and subjective aspect of time may be essential for successful ageing. As suggested by Rowe and Khan [27], the concept of successful ageing is more than the absence of diseases. The authors hence noted that the productive use of time, as well

as active engagement in life activities are crucial for high cognitive and physical functions among older people, which in turn, may lead to better health outcomes.

2.7.5 Theoretical model for social determinants of health at old age

There have been concerns that existing theoretical models on the social determinants of health may not be applicable among older adults, especially after retirement [94]. For instance, as discussed in section 2.3, the inclusion of some of the traditional measures of SES (e.g., income and occupation) to assess gender and socioeconomic inequalities in health among the elderly may be problematic [43, 93-95]. In view of this, there have been discussions in the literature on the suitability and reliability in the application of these measures [94, 95], and the extent to which they can be included in health inequality models at old age. On one hand, gender and social roles including daily activities have been suggested as complementary social indicators to socioeconomic status. However, according to Bird and Freemont [73] using gender roles (i.e. marital status and parental status) as measures to examine gender inequality is crude and indirect and may not provide all the detailed information one may need to understand the time and effort an individual may spend performing such gender or social roles. They further recommended that time spent on social roles and activities be investigated.

In line with this thought, a theoretical model that is most germane to health inequalities among older adults has been proposed in this thesis (Fig. 7). The model is an overview of a hypothetical model for the social determinants of health at old age. Building on the conceptual model of the commission on the social determinants of health (Fig. 4), this thesis included time use activities as intermediary determinants and classified them as behavioural factors because they may have proximal effects on the health of older adults. On the basis of this model, it was expected that older men and women would display different time use patterns, due to the likely impact of gender roles and social policies on the distribution of time resources. In the illustrative model, while social and public policies may not alter older adults' time constraints directly, they may influence socioeconomic status such as wealth. Additionally, structural

determinants including educational attainment may determine the availability of material and psychosocial resources, which in turn may directly or indirectly influence the health status of older men and women.

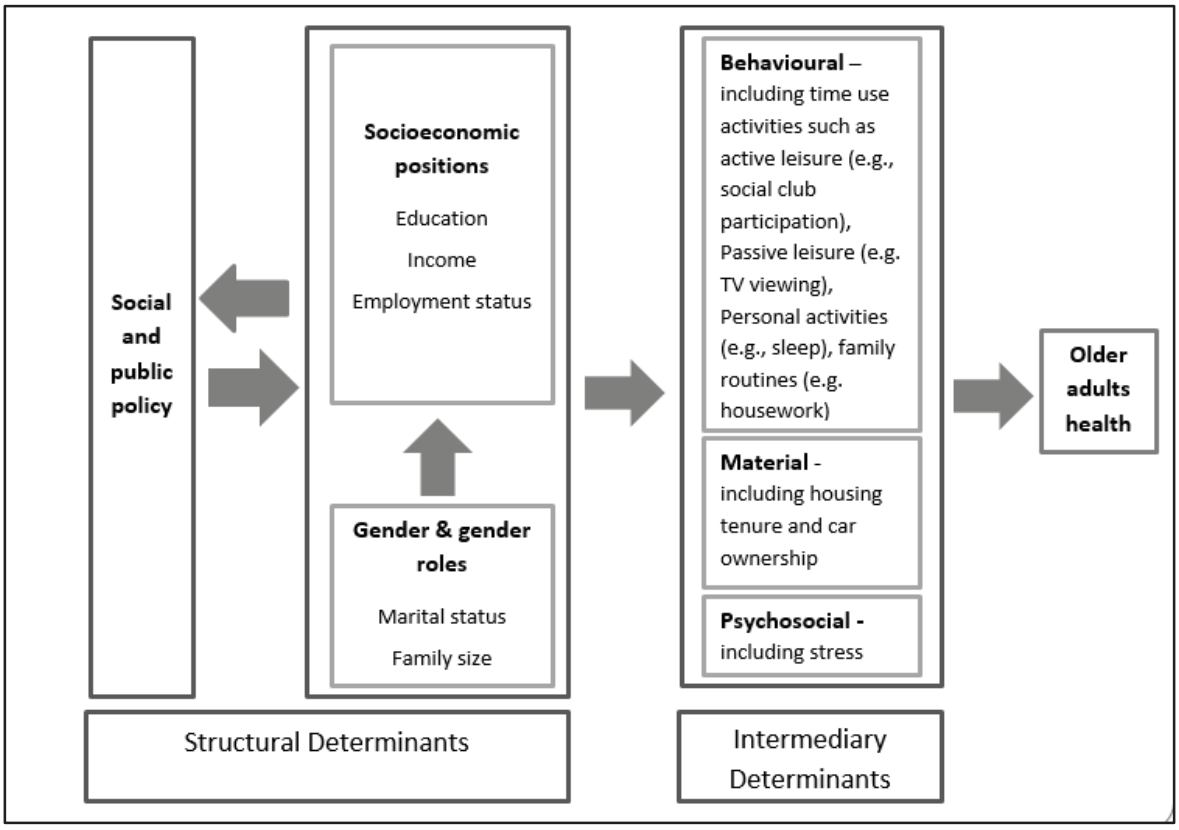

Fig 7 Hypothesized model for social determinants of health at old age (inspired by WHO 2010), Commission on the social determinants of health (CSDH) conceptual model

Indeed, the conceptual model of the commission on the social determinants of health has emphasised the importance of behavioural risk factors such as smoking, and alcohol consumption as determinants of health inequalities in the general population [45]. However, what becomes apparent is that daily time use behaviours as social determinants of health is not part of the broader systematic approach and framework. Due to time availability at old age, and especially after retirement, a complete picture and analysis of time use activities is needed to provide a better and holistic explanations for health inequalities among older adults. To the best of my knowledge, this thesis is the first to examine time allocation to diverse social roles and activities as possible

explanations for the observed inequalities in health among elderly men and women in Western industrialised countries.

3 Research objectives

The overall aim of this thesis is to explore social and economic determinants of health among elderly men and women simultaneously, using a combined framework of time use activities, socioeconomic status (SES) and family characteristics. The thesis also aims to explain the gender and cross-national differences in health in Western industrialised countries. Specifically, this thesis addresses the following research questions:

1) How do older adults spend their time? To what extent do patterns of time use vary by gender and across countries among the elderly? (Study I).

2a) How do time use activities, SES and family characteristics impact the health of the elderly? (Study I).

b) To what extent do these effects vary by gender and across countries (Study I).

c) To what extent do these social factors explain gender differences in health among the elderly? (Study I).

3) To what extent is the association between housework activities and health moderated by sleep hours among elderly men and women? (Study II).

4) Does stress play a mediating role in the relationship between work-related activities (paid work and unpaid work) and health among elderly men and women? (Study III).

4 Data material and measurements

4.1 Data

The analysis is based on data from the Multinational Time Use Study (MTUS, version W53), a large cross-national, harmonized and comparative time use database from 25 countries, which is collated and organized by the centre for Time use Research at the University of Oxford [157]. For this thesis, I examined data from 7 countries: Germany, France, Italy, Spain, UK, US, and the Netherlands. These countries were selected based on the availability of the health outcome variable (self-reported health) in the respective diary collection. Nonetheless, the set of countries represent different welfare states regimes [123] as well as social norms and public policies [83]. The heterogeneities in the sample capture a more contemporary societal trend, and further served as a very useful basis for a gender and cross-country comparative analysis.

The various surveys constituting the MTUS data used a 24-hour diary method, where diarist or respondent provide a 24-hour (1,444 minutes) sequential record of all activities prior to the interview. Although this retrospective mode of time use data collection can be cognitively demanding, especially among older adults [133], it has been shown to be more accurate and reliable than estimates from stylized survey questions[158, 159]. Stylized techniques, for example, ask individuals to "quickly" sum up the amount of time spent on various activities over a reference period, typically a week or a month [133]. This approach may not provide a full picture of all activities carried out within a day as compared to the 24-hour time diary method [159].

In addition to the full-day period diaries, the data contains a rich set of information on the socioeconomic situation (i.e., education and employment status) and demographic characteristics on the respective diarist. In the interview, the diarist also provided information on their current health status and the total time spent on activities during the day in 10 or 15min intervals. A technical summary of the survey is presented in Table 2.

Table 2 Technical information on the surveys

Country	Year	Original sample size[1]	Analysis sample size	Response rate (%)	Diary (# days)	Time interval
Germany	2001	11,919	3,326	96	3	10 min
Italy	2002	55,773	8,709	92	1	10 min
Spain	2002	46,774	9,889	64	1	10 min
Netherlands	2000	11,813	1,764	25	7	15 min
France	1998	15,441	2,231	88	1	10 min
UK	2000	11,667	2,870	45	2	10 min
USA	2003	136,000	6,478	57	1	Free

Note: 1- The original sample size refers to the number of individuals (all ages)

In most of the countries, the dairy data was based on a grid of 10 minute-intervals of time, but the number of diary days differed across countries (Table 2). For example, in the Netherlands, diarist reported their time use activities for seven consecutive days. In France, Italy, Spain and the US, respondents reported time use on a randomly assigned day of the week, and in the UK this was done on two days, one weekday and one weekend day. In the European countries, the diaries were self-administered and completion was followed by a personal visit by study staff. In the US, diaries were collected through a variety of procedures including return mail, telephone interviews and personal visits. For the purpose of this thesis, the sampling frame was restricted to older adults who were 65 years and above at the time of the survey. This minimum age was chosen based on the retirement age in most EU countries [108]. The sample sizes for the final analysis varied considerably across countries, ranging from 1,764 in the Netherlands to 9,889 in Spain (Table 2).

In the MTUS database, time use activities have been harmonized across all surveys and coded into 41 activities. The details and codes of the 41 activities are presented in Appendix B. For the purpose of this thesis, the 41 daily activities were further group into five broad and distinct clusters (see, Table 3), as was done in previous studies [73, 118].

Table 3 Activities included in the Time-use variables

Broad category	Description
Paid work	Including paid work at home and second job
Housework	Including cooking, washing up, laundry, repair and maintenance, gardening and shopping
Active leisure	Including active sports, walks, leisure travel, excursions, cinema, parties, social club, pub, restaurant, visiting family and friends, reading books, magazines and knitting sewing
Passive leisure	Including listening to radio, viewing television and listening to radio
Personal activities	Including sleep and personal care (e.g., eating, bathing and dressing)

4.2 Measurements

4.2.1 Indicators of health

Two types of health indicators were used in this thesis: self-reported health (SRH) and stress. SRH was used in all three studies, while stress was used as both an outcome variable and an independent variable in study III.

In all three studies, gender and socioeconomic inequalities in health among older adults aged 65 years and above were analysed using SRH. SRH gives an account of an individual's general health condition by asking respondents to report their general health status. It has been shown that this subjective measure of a person's overall health is more inclusive and accurate measure of health status [160], and a better predictor of mortality among the elderly [161]. In the survey, the question posed to the diarist was "How is your health in general: would you say that it is…?" response options: zero (poor) to three (very good).

In study III, stress in terms of time pressure was used as an outcome variable and an independent variable to examine the direct and indirect relationships between psychosocial factors and SRH. Intense time pressure was used as an indicator of stress [110]. In the data, time pressure was defined as a self-reported account of the diarist's

feeling of being rushed. In order to construct a scale to measure the subjective feeling of being rushed, I followed the Dapkus [162] approach of measuring stress. This allows the capturing of an individual's subjective stressful dimensions of the phenomenology of time (i.e., rushed tempo of doing certain activities). Stress defined in terms of time pressure was measured using the following questions: "Would you say you always feel rushed even to do the things you have to do, only sometimes feel rushed, or almost never feel rushed?" response options: (1) never (2) sometimes and (3) always.

4.2.2 Socioeconomic status

As indicated in the previous sections, the three most common indicators of socioeconomic status are education, occupation and income. While all three indicators were used in this thesis, wealth was used instead of income as it is a better indicator of permanent economic position [163], especially among the elderly [94]. Further, income might not give a true picture of the material well-being of the elderly after retirement. In line with previous studies [40, 94, 98], housing tenure (owner occupier vs renting) and car ownership (no car, one car, two or more cars) were the two proxy indicators used to measure wealth. Furthermore, employment status (i.e. employed and unemployed) was used instead of occupational status because using occupation-based classifications (e.g., ISCO-International Standard Classification of Occupations)[164] may exclude a large proportion of older adults who were not in any form of occupation after retirement. Educational attainment was categorised into three groups: less than secondary education, completed secondary education and above secondary education.

4.2.3 Time use activities

In study I, time use activities were categorised into five broad categories (see section 4.1, table 3). Time devoted to these activities was directly estimated from the data and each category was measured in hours per day. In study II, which examined the relationship between time spent on housework activities and sleep hours on SRH, time devoted to the sub-category of housework such as cleaning, cooking, gardening, maintenance and childcare was measured in minutes per day. Time allocated to sleep

was also used as a sub-category of personal activities. Sleep duration was defined as the total amount of time devoted to sleep and encompassed all forms of sleep, including naps. Based on existing cut-offs in epidemiologic studies [165], time devoted to sleep was classified into three categories: short sleep duration (<7 hours), optimal sleep duration (7-8 hours), and long sleep duration (>8 hours).The third study, study III, examined the pathways through which work-related time use activities, socioeconomic status and stress impact on SRH. In order to investigate potential "stress buffers", time devoted to social activities (e.g., visiting friends and family and social club participation) were further considered as a sub-category of active leisure.

Other covariates included in the analyses were age, household size (0, 1, 2, 3+) and marital status (single, married, divorce, cohabiting).

4.3 Analytical strategy

Various statistical analyses were performed in all three studies. In study I, all the analyses were stratified by gender and country. In study II and III, the analysis was conducted separately for men and women but based on pooled data from all the countries. In all the three studies, information on the distributional characteristics of all the variables and the mean time devoted to different time use activities was further provided.

In studies I and II, multiple binary logistic regressions were applied in order to examine the relationship between SES, time use activities and SRH. The binary logit model estimates the probability of the dependent variable (SRH) to be 1 ($Y = 1$). Thus, if 1 is the success outcome with probability π, and 0 is the failure outcome with probability $1 - \pi$, then Y can be defined as Bernoulli random variable with an expectation $\mathrm{E}[Y] = \pi$. This can be expressed mathematically as follows:

$$pr(Y = 1 \mid x) = \frac{\exp(x\beta)}{1 + \exp(x\beta)} \quad (1)$$

In study I, a counterfactual decomposition method was further applied to identify the relative contribution of SES and time use activities to total gender inequality in health among the elderly. An extension of the Blinder-Oaxaca decomposition method for non-linear models proposed by Yun [166] was used. The decomposition for the non-linear equation such that $pr(Y = 1) = \Phi(X\beta)$ can be expressed as:

$$\bar{Y}_m - \bar{Y}_w = \sum_{i=1}^{i=K} W^i_{\Delta X}\left[\Phi(X_m\beta_m) - \Phi(X_w\beta_m)\right] + \sum_{i=1}^{i=K} W^i_{\Delta\beta}\left[\Phi(X_w\beta_m) - \Phi(X_w\beta_w)\right] \quad (2)$$

where Φ is a standard normal cumulative distribution function, Y = health status; β = regression coefficient; X= covariates; m = men; w = women; W= weight assigned to each covariate that is equal to its proportional contribution to the total endowment or coefficient effect.

Decomposition methods such as the concentration index (CI) can also be used to measure inequalities in health [167]. However, the advantage of applying the Blinder-Oaxaca decomposition method over the CI was that it allowed the partitioning of health inequality between men and women into two components (see, equation 2). The first component of the equation is the "endowment effect". This part represents the gender gap in health due to inequalities or differences in group characteristics (e.g., SES and time use activities). The second component is the "coefficient effect", which represents the part of inequality due to differences in coefficients. In this thesis, the focus was on the endowment effect, with decomposition estimates showing how characteristics individually contribute towards the health gap between elderly men and women.

In study III, a Structural Equation Model (SEM) was fitted to estimate the direct and indirect relationship between SRH, stress, time use activities and other social factors. This can be expressed mathematically as follows:

$$\mathrm{Y} = \mathrm{BY} + \Gamma X + \alpha + \varsigma \quad (1)$$

where, Y = vector of the endogenous variables (self-reported health and stress); X = vector of the exogenous variables, both latent (SES) and observed (age, marital status, paid work, housework and social activities); B and Γ = matrices of the coefficients; α = vector of the intercepts; ς = vector of the error terms.

Finally, in order to test whether stress in terms of time pressure mediates the relationship between work-related activities (paid work and unpaid work) and health, indirect and total effects models were constructed. This can be express as:

$$\mathrm{c} = \mathrm{c}' + \mathrm{ab} \quad (2)$$

Where, c = Total effect, c' = Direct effect, ab = Indirect effect.

The goodness of fit for the SEM models was assessed using the Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) as suggested by Hooper et al. [168].

5 Summary of Results

In this section of the thesis, the main results from Studies I to III are presented.

5.1 Time use at older age: Gender and cross-national differences (Study I[1])

Daily time use varied considerably among older men and women and across countries. Figures 8 & 9 present some answers to the question of how men and women in high-income countries spend their time at older ages, especially after retirement. The results showed that gender differences in time use activities persist at old age. In general, older women devoted more time to housework activities than older men, whereas older men tended to spend more time on active leisure, passive leisure and paid work. Looking at country level, older women in Italy devoted the most time to housework activities, more than 5 hours per day, while older women in the US reported the lowest (3.8 hours per day) (Fig. 8). Time allocated to active leisure activities was similar across countries among older men, but not among older women. Among the latter, the most time allocated to active leisure activities was found in Germany (4.1 hours per day), and the least in Spain (2.9 hours per day) and Italy (3. 0 hours per day). In all countries, older women spent less time on passive leisure activities than older men. The highest time devoted to these activities among older men was found in the US, where they devoted on average 5.7 hours per day (Fig. 9). The lowest value was observed in Germany (3.5 hours per day). As to be expected, older men allocated more time to paid work than older women. Nonetheless, older men and women in the US generally devoted more time to these activities compared to their peers in the other countries. Regarding personal activities (including sleep hours), older men and women in Spain devoted the most time to these activities, while the least time was observed in the UK and the US. However, across all countries, the results showed that both

[1] **Adjei, N. K.,** Brand, T., & Zeeb, H. (2017). Gender inequality in self-reported health among the elderly in contemporary welfare countries: A cross-country analysis of time use activities, socioeconomic positions and family characteristics. *PloS one*, *12*(9), e0184676

genders spent more time on personal activities than on the other activities (Fig. 8 & 9).

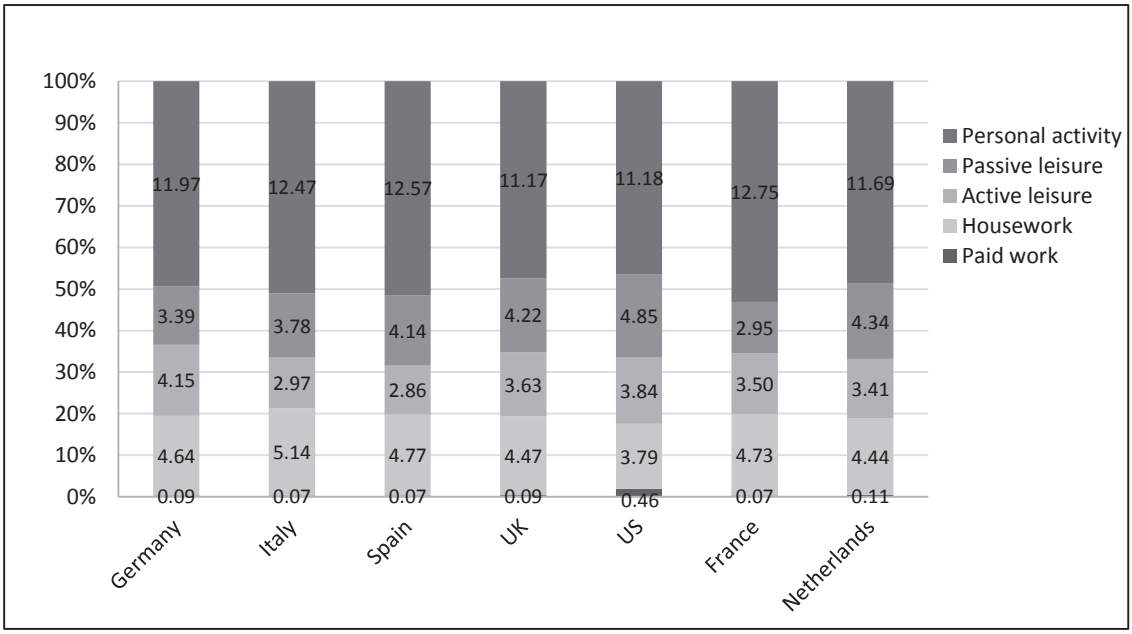

Fig 8 Older women's daily time use across countries

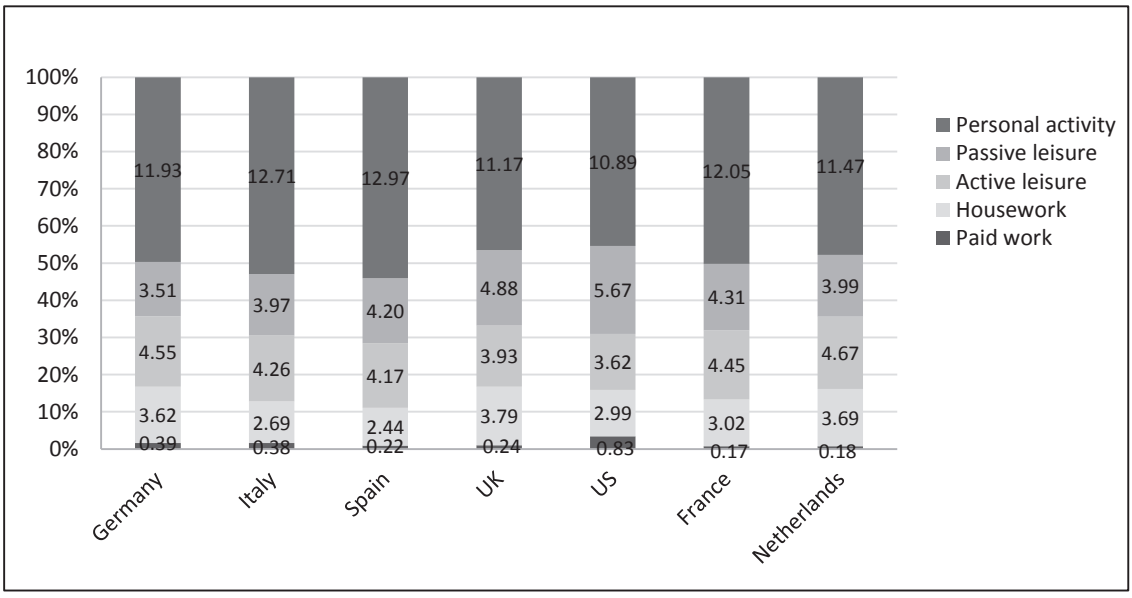

Fig 9 Older men's daily time use across countries

5.2 Time use at older age and self-reported health (Study I, II[2] & III[3])

Results based on the pooled data from all the countries (study I & III) showed that, in general, older men and women who allocated a significant amount of time to paid work, housework and active leisure activities had higher odds of reporting good health. Further analysis in study II revealed that both short (<7 hours) and long (>8 hours) sleep duration were negatively associated with health for both genders. However, the results of an interactive association between housework activities, sleep duration and health status varied considerably between men and women. Among older women, long hours of housework combined with either short or long sleep was negatively associated with health. For older men, devoting long hours of time to housework was positively associated with health, regardless of sleep duration (Fig. 10).

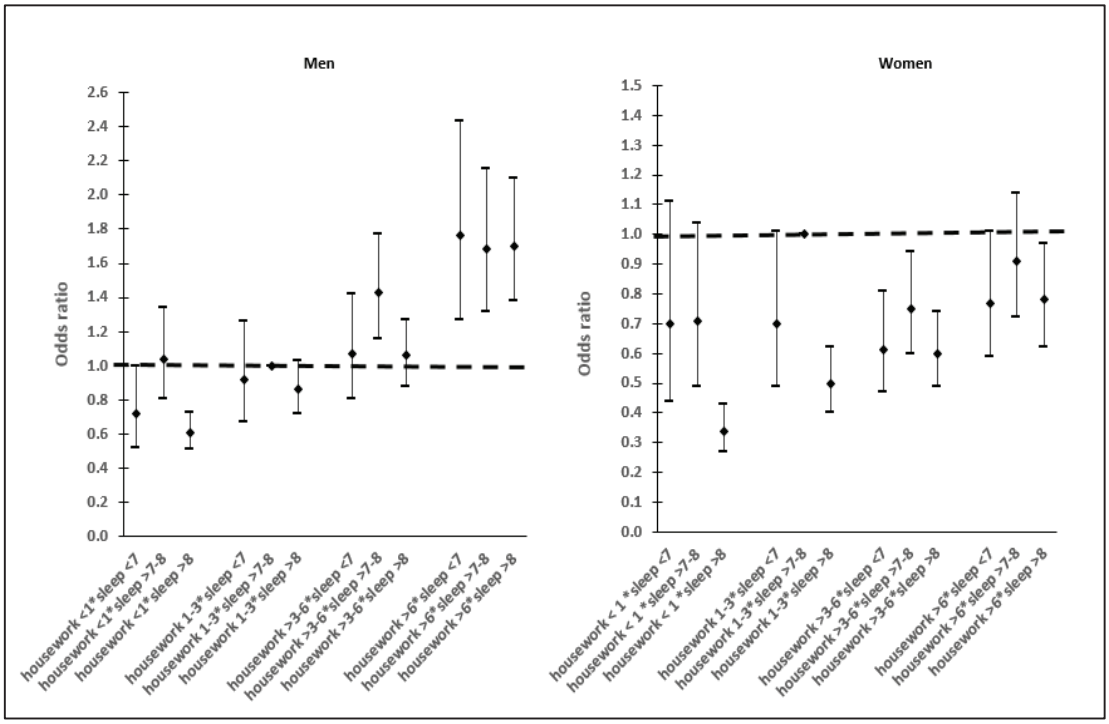

Fig 10 Combined associations between good self-reported health status, total housework hours and sleep hours, pooled data of 7 countries. Men and women, 65+ years old.

[2] **Adjei, N. K.**, & Brand, T. (2018). Investigating the associations between productive housework activities, sleep hours and self-reported health among elderly men and women in western industrialised countries. *BMC public health*, *18*(1), 110.

[3] **Adjei, N. K.**, Jonsson, K. R., & Brand, T. (2018). Time spent on work-related activities, social activities and time pressure as intermediary determinants of health disparities among elderly women and men in 5 European countries: a structural equation model. *International journal for equity in health*, *17*(1), 121.

A cross-country analysis (study I) revealed that the association between time use activities and self-reported health was statistically significant only in some countries. For example, the positive association between paid work and self-reported health was significant in Spain and the US, but not in Germany, Italy and the UK. Housework and active leisure were positively associated with self-reported health among older men across all countries, with some inconsistencies in Italy and Germany. Among women, participation in active leisure was positively associated with health in all countries except the UK. In contrast, passive leisure activities, such as listening to radio and watching television, were negatively associated with health. The effects were however not significant in some countries for both genders. Similarly, more time allocated to personal activities was negatively associated with self-reported health among older men and women.

5.3 Gender and socioeconomic inequalities in health (Study I and Study III)

The main findings were that gender and socioeconomic inequalities in self-reported health persist in old age. While results based on the pooled data showed that women generally reported poorer health status than men, a cross-country analysis revealed that gender differences in self-reported health were found only in Germany, Italy and Spain, but not in the UK and the US. Further decomposition analysis showed that the two largest contributing factors to the health inequality, in terms of differences in group characteristics, are education and active leisure (Fig. 11). In the figure, the positive numbers indicate a reduction in health inequality that would have occurred if older women had older men's characteristics, while the negative estimates indicate that the variable in question contributes to the health gap in the direction that runs counter to the overall health gap.

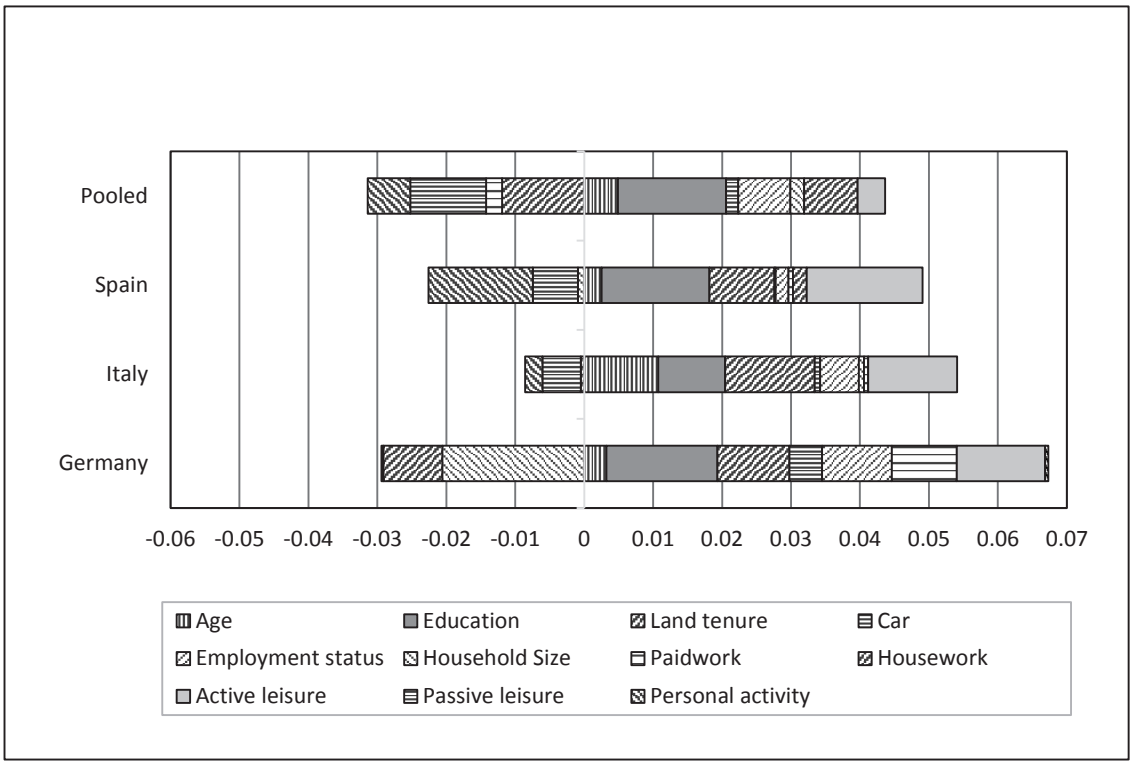

Fig 11 Inequality contributions in terms of differences in group characteristics

Furthermore, all the three indicators of SES, education, wealth and employment status, showed consistent patterns of health inequalities between groups of high and low SES among both genders. The results were however inconsistent for role occupancy (e.g., marital status).

5.4 Stress and health (Study III)

The findings indicated that stress, defined in terms of time pressure, was positively associated with self-reported health among older men and women. In addition, the results showed that work-related time use activities (paid work and housework) had a significant direct effect on stress. Whereas housework activities was positively associated with health among both genders, paid work was found to be negatively associated with self-reported health among men. The result was however not statistically significant among women. The findings further revealed that although stress had a strong direct negative effect on the health of both genders, it does not indirectly influence the positive effects of work-related time use activities on health

(Fig. 12). Finally, participation in social activities was positively associated with self-reported health but had no significant impact on stress for both genders.

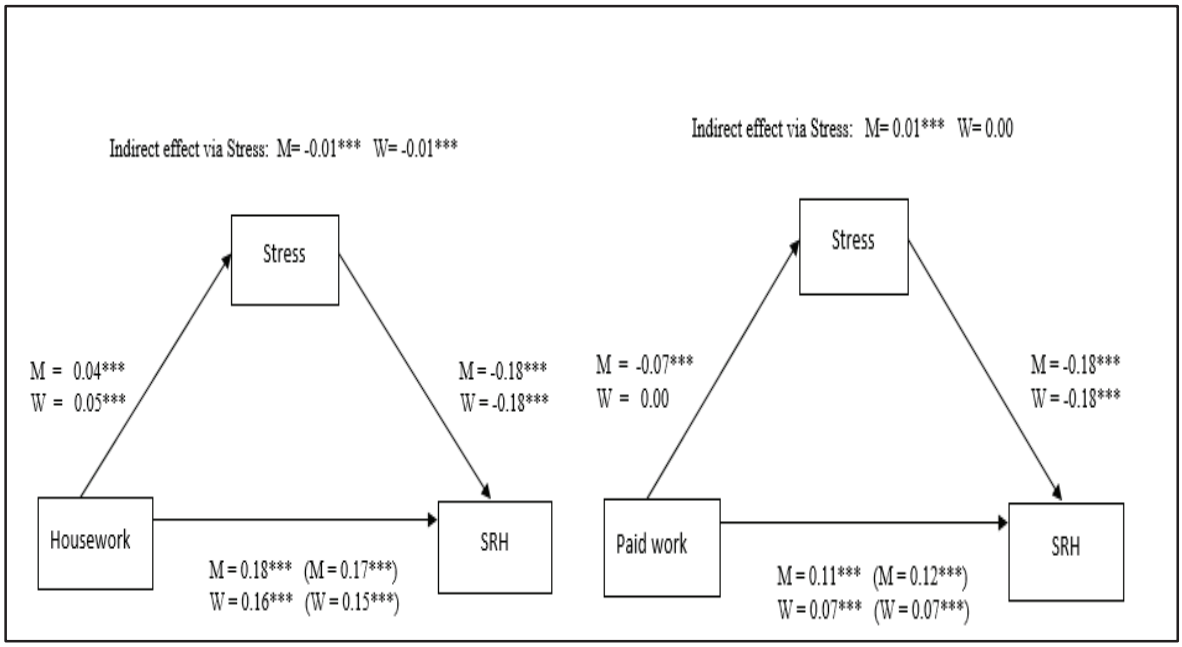

Fig 12 Indirect effects of housework and paid work on self-reported health (SRH) via stress. Standardized coefficients, adjusted for socioeconomic status (SES), age, marital status, social activities and work-related time use activities. Coefficients for the total effects in parentheses. M = men, W = women. *** p<0.001; ** p<0.01; * p<0.05.

6 Discussion and reflections

In the light of the global population ageing, investigating the determinants of health inequalities among the elderly is crucial for an effective health policy planning and implementation. The primary aim of this thesis was to explore social and economic determinants of health inequalities among elderly men and women simultaneously, using a combined framework of time use activities, socioeconomic status and family characteristics. A second aim was to explain the gender and cross-national inequalities in health in Western industrialised countries. The overarching approach in this thesis has been exploratory, because of the concerns regarding the suitability and reliability of measures used in assessing gender and socioeconomic inequalities in health at older age [43, 93-95]. Thus, the proposed framework presented here serves as a starting point for a discussion on complementary theoretical models of determinants of health inequalities among the elderly population. The three empirical studies that form the basis of this thesis did not claim the existence of any causal relationships between social factors and health outcomes. They instead demonstrated that parallel to socioeconomic factors, time use activities after retirement may have a non-trivial differential impact on the health status of elderly men and women. These findings are discussed and reflected on in-depth in the following paragraphs.

6.1 Gender inequalities in health: A male-female health-survival paradox at old age?

The gender health-survival paradox is a well-known phenomenon in epidemiological and biomedical research. Women, on average, live longer, yet they report poorer health and more psychiatric symptoms than men. Although the cause of this paradox is obscure, prior evidence has shown that a combination of social and biological factors largely explain the gender inequalities in health [61, 62, 169]. In this thesis, the focus is on the gap in self-reported health among elderly men and women, where multiple factors including environmental, social and behavioral risk factors have also been attributed to reporting differences [40, 47, 99]. But the question is,

should/can the gender differences in health outcomes be generalised across countries and population sub-groups? The studies comprising this thesis indicate a more complex phenomenon than is often proposed. In study I, results from the pooled model based on all five countries showed a marked gender gap in self-reported health among older adults in industrialised countries, but this was not the case when the data was examined by country. Gender differences in self-reported were found in Germany, Italy and Spain but not in the US and the UK. The non-existence of gender gap in self-reported health observed in the last two countries has also been reported in other studies from developed countries [170-172]. In a five years longitudinal study conducted in Finland, Leinonen and Heikkinen [172] did not find any gender differences in self-reported health among older adults aged 75 to 80 years. Neither were gender differences found among older adults in the UK [170]. In a study by Marks [171] conducted in the US, older men evaluated their health as being worse compared to older women. In light of these outcomes, it is clear that some findings on gender differences in health do not fit in the dominant paradigm, which concurs with findings in our data. The conventional view of the health paradox may hence have been "over-generalised" [170]. In general, the empirical evidence suggests that gender differences in health may vary according to the health conditions and the phase of the life cycle [170].

On the other hand, the existence of a gap in health between men and women allows for an assessment of the factors that contribute to the differences in health outcomes. Hence, this thesis moved the level of discourse from a mere description of gender differences to examining factors that might explain those health inequalities. The results revealed that the size of the gender gap in self-reported health in Germany, Italy and Spain was influenced by both socioeconomic factors and time use activities. Gender gaps in education and active leisure activities were the main contributing factors for the observed health inequalities among older men and women. Regarding educational attainment, a similar explanation was offered by Boerma et al. [173] in a recent study on the assessment of a gender gap in self-reported health in 59 countries. Similarly, Macintyre et al. [170] noted that the existence or non-existence of gender

inequalities in health among older adults could be attributed to differences in social factors such as employment, education and domestic activities.

The consistency in the results suggest that social factors and gender roles are key contributing factors to the gender inequalities in self-reported health among the elderly. In the last few decades, a body of research supporting the view that gender inequalities in health outcomes are deeply rooted in social or gender roles has emerged [72, 73, 169]. As a result, the role approach has been recommended as a complementary framework to the traditional social class approach [45]. Marital status was introduced in the analyses in order to assess the association between role occupancy and health. The results showed that the protective effect of marriage on self-reported health is unequal among older men and women. Marriage seems to be more beneficial to the health of men than women, which is consistent with prior evidence [174, 175]. A possible explanation for these gender differentials may be that married women have the primary responsibility for unpaid household work and other family duties such as caregiving, which may cause higher psychological and physical stress [72, 73]. In study II, the findings from the interactive association between housework activities and sleep duration further showed that long hours of housework combined with poor sleep was associated with poor health among older women but not older men. This higher prevalence of poor health among women may be due to "role overload" [72], as this phenomenon can lead to greater stress and may subsequently impact health negatively. Stress, as measured in the Multinational time use surveys, was found to be more common among women. In study III, the results indicated that women were more likely to report higher levels of stress than men, in agreement with prior findings [117, 176]. Indeed, stressful conditions have been found to predict a variety of somatic diseases [177, 178], and poor self-reported health [179], as found in study III.

The evidence from this thesis and that of earlier findings suggest that gender and social roles are important determinants of health outcomes. However, the magnitude and direction of the effect may vary across countries due to differences in social norms and cultural attitudes towards gender roles [83, 170].

6.2 Socioeconomic inequalities in health among the elderly

Over the past decades, a large number of empirical work has shown that social class inequalities in health persist in advanced welfare countries [43, 47, 95], also among the elderly [92, 180]. There are however various ways in which "social class" can be measured [99]. Among older adults, an important or controversial issue is how social class inequalities in health should be measured. Material deprivation, employment status and an individual's income are some of the indicators used in previous studies [93, 94, 98], often chosen without theoretical basis. As discussed in the previous sections, strong arguments have been made against the use of some of the traditional measures (i.e., income and occupation), especially after retirement. Although there is still no consensus about the best indicators [181, 182], some previous research recommended the use of multiple social class indicators in order to explore the multidimensional nature of these social measures at old age [98, 183]. For example, Grundy & Holt [98] pointed out that the use of education combined with a deprivation indicator is the best measure of social position for older adults. In order to maintain a clear and concise focus in this thesis, social class or position has been limited to the "best" indicators (i.e. education and wealth). Employment status was also considered since it has been shown that a small proportion of older adults are involved in some form of employment after they retire [183].

In the three studies constituting this thesis, an inverse relationship between socioeconomic status and self-reported health was found. All three indicators of socioeconomic status, i.e. education, wealth and employment status showed that older adults with low socioeconomic status were more likely to report poorer health compared to those with higher socioeconomic status, when other factors were controlled for. In study III, these indicators were also found to be independent predictors of health outcomes among elderly men and women. Meanwhile, educational attainment showed the strongest relationship among both men ($r = 0.20$) and women ($r = 0.21$). This means that older adults with higher educational attainment had a higher probability of reporting good health than older adults without formal education.

Similarly, a positive association was found between wealth and self-reported health. As was done in previous studies [40, 94, 98], housing tenure and car ownership were used as proxy indicators to measure wealth. In study I, these two indicators were found to be positively associated with self-reported health among elderly men and women, but the association was not observed in all high-income countries, as in a previous study [94]. Furthermore, due to the rising part-time employment after retirement [108, 136], the association between employment status and health outcomes was further analysed in study I and II. The findings revealed that being employed after retirement was associated with good health. The positive associations between socioeconomic positions and health outcomes have been found among the elderly in previous studies [94, 98, 183, 184]. These outcomes are consistent with findings from studies on the working-population [101, 185], and fit in with the conclusions of earlier reports such as the Black report [37] and the Whitehall cohort study [38], that have established graded patterns of social inequalities in health.

Several reasons why social inequalities in health exist have been given, including artefact (i.e., social inequalities in health outcomes may be as a result of measurement errors), social selection, behavioural risk factors and material circumstances [38, 44, 99]. Among the elderly, a common explanation given is that they are exposed to a wide range of psychosocial risk factors such as stress, when in lower socioeconomic position [105]. House et al. [105] noted that the impact of psychosocial risk factors on health outcomes increases with age, and may also differ by gender [186]. Contrary to the general hypothesis that lower social status leads to greater exposure to stress [104, 187], the findings in study III showed that stress in terms of pressure was significantly higher among elderly men with higher socioeconomic status but not among elderly women. The contradictions in the pattern of findings may, perhaps, be due to the measurement of stress [110]. Indeed, stress can be induced by stressful life events or environmental demands such as role strain, financial strain, work overload, threat and time pressure. It can also be as a result of demands from an individual's physiological and psychological system [110, 188]. The studies in this thesis only considered intense time pressure [112, 113] and not stressful life events [104]. Stressful life and daily hassles on

the other hand have been shown to be experienced among men and women in low social status in previous studies [104, 189]. In addition to these explanations, some previous research also offered evidence that old age social inequalities in health may also emanate from an individual's past life experiences or exposures to risk factors over time [99, 100].

6.3 Time use and health at older age

The increasing life expectancy among older adults naturally means an increase in time spent in retirement. In fact, time devoted to housework, leisure activities and sleep have increased over time due to the decrease in time allocation to paid work after retirement [190, 191]. In the US, Robinson et al. [191] found that between 1975 and 1995, time devoted to all forms of leisure among the elderly aged 65 years and older increased by approximately 10 hours per week. Data from some European countries also indicated an increase in housework and leisure time among older adults over the years [190]. Gauthier and Smeeding found that between 1980 and 1995, time devoted to social leisure among older adults aged 75 and over increased by about 2 hours per week in the Netherlands [190]. A similar trend was observed for housework, but there were large gender and cross-country differences [118, 133, 190]. In line with these earlier studies, time use at old age was found to vary considerably between men and women and across countries. While elderly women allocated more time to housework activities, elderly men devoted more time to active leisure and paid work activities. Nonetheless, Bianchi and colleagues [192] noted that men's housework hours has increased over the years. On the other hand, the upsurge of women in the labor market has altered employment rates at old age, whereby labor force participation among elderly woman has seen a steady increase over time (Fig. 6).

A factor that may be expected to influence the ability of the elderly to perform certain time use activities at old age is disability or ill-health. One significant measure of age-related disability or functioning is the ability to perform daily time use routines. The oldest old may need help in performing basic or Instrumental Activities of Daily Living (IADL) such as housekeeping, bathing, eating and shopping [193-195],

particularly among hospitalized and institutionalized elderly people [196]. However, findings from the latest available studies have indicated a decline in the prevalence of old age disability [19, 20, 197]. In the US, a trend analysis in functional limitations among older adults based on data from 1984 to 1993 showed a substantial decline in disability, even among those aged 80 and above [197]. The study further reported that the percentage of having difficulty in lifting, climbing stairs and walking had also declined over time. Moreover, in Europe, Lafortune and Balestat [20] observed a decline in disability among elderly people in Italy, Denmark, Finland and the Netherlands. These findings thus seem to support the compression of morbidity hypothesis [15], indicating that the elderly are living healthier for a long time.

In view of the aforementioned hypothesis and assertions, the influence of time use activities and health were analysed. Results presented in this thesis suggest that not all time use activities are beneficial to the health of older people, unfortunately. While active pursuit activities were found to be positively associated with health, sedentary activities were seen to be negatively associated with health. In study I and III, for instance, the results showed that active pursuits including walking, sports, civic duties and participation in social activities had a positive impact on the health of both older men and women. Previous studies have also echoed the importance of active pursuits for psychological and physical wellbeing [198, 199], as well as lower mortality risk among older people [29]. As Rowe and Khan reiterated, engagement in active life activities are essential for successful or active ageing [27], and successful "agers" may have a low likelihood of disease-related disability and high cognitive functioning. In a recent study, Kim et al. [30] concluded that active leisure increases the psychological feelings and physical functioning of older adults.

In contrast, passive leisure or sedentary time (e.g., watching television, listening to radio and tapes and relaxing) was found to be negatively associated with self-reported health among both men and women. The majority of previous studies that analysed the association between sedentary activities and health outcomes found similar adverse health effects [200-203]. It has been suggested that the "non-exercise" nature of these activities may be responsible for the negative association. Because cognitive,

psychosocial and physical status are important factors of healthy or successful ageing, an increase in time spent on sedentary activities may imply an increased risk of cardiometabolic diseases and mortality [203] as well as less successful ageing [204]. On the other hand, more time devoted to physical activity may decrease functional decline [205], reduce the risk of obesity [206] and improve the overall wellbeing of older adults [207]. The results of study I and II thus support the need for interventions to reduce the time that older adults spend on sedentary activities. In study I, gender and cross-national differences in sedentary behavior were observed. Older men spent more time on sedentary activities compared to older woman, as also reported by Leung et al. [202]. The highest time devoted to these activities was found in the US (5.8 hours per day among men and 4.8 hours per day among women). Clearly, this result shows that some amount of sedentary time should be reinvested into movement behavior. A study by Buman et al. [207] suggested that replacing 30 minutes per day of sedentary time with an equal amount of light physical activity can be beneficial to older adults' health.

The World Health Organization (WHO) in its physical activity guidelines published in 2010, recommends that older adults aged 65 years and above should engage in at least 150 minutes of moderate intensity physical activity or 75 minutes of vigorous intensity per week or both. It further recommended that older adults should engage in muscle- strengthening activities at least two days in a week [208]. Although it has been argued that older adults may not be able to meet these recommendations due to diminished functioning ability [209], it was observed in this thesis that older adults devoted, on average, 300 minutes per day to all forms of active pursuits including walking, cycling, dancing, sports, volunteering and participation in social activities. There were however gender and cross-national differences, as has been observed in some high-income countries [118, 133]. It is also worth noting, nonetheless, that even when people are physically active, prolonged time devoted to sedentary time can still have deleterious health impacts [210].

The levels of physical activities for older adults recommended by the WHO strongly encourage engagement in housework activities to achieve health benefits [208]. In general, it is expected that time allocation to light, moderate and vigorous

household activities such as cleaning, washing and gardening should result in a greater health benefit, especially among the elderly, because these activities require some form of physical exertion [211]. However, the level of evidence supporting the health benefits of housework among elderly men and women is still unclear [29, 212, 213]. While some studies suggested that both light and heavy domestic activities, particularly among elderly women, may not be associated with health benefits [212, 213], others indicated that moderate-intensity domestic activity such as gardening has a positive effect on older adults health [29]. In this thesis, domestic physical activities such as gardening, home maintenance, cooking, and cleaning was found to be positively associated with self-reported health. How much domestic work is good for the health of older men and women though? In study II, the interactive association between domestic activities and sleep duration indicated that long hours of housework could be positively associated with self-reported health among elderly men, irrespective of sleep duration. For older women, only one to three hours of housework activities combined with optimal sleep duration (7-8 hours) is beneficial to self-reported health (Fig. 10).

Sleep duration has been shown to have significant health consequences for younger and older adults [214, 215]. This thesis replicates similar findings from earlier epidemiologic studies [216, 217], in which a U-shaped relationship between sleep hours and health outcomes was established. Short sleep duration (<7 hours) and long sleep duration (>8 hours) were not only significantly associated with poor self-reported [217, 218], but also other adverse health outcomes including obesity, coronary heart disease, cardiovascular disease [219, 220] and mortality [221]. A number of causal pathways linking poor sleep and health have been posited [222, 223]. Grandner and Drummond discussed some of the potential mechanism that may account for the negative relationship between long sleep duration and mortality [223]. They further indicated that confounders such as depression, fatigue, poor sleep quality and sleep apnea are risk factors associated with excessive sleep. Conversely, insufficient sleep has also been found to be linked with fatigue [224], which may lead to reductions in physical activities [225, 226]. In a longitudinal study involving 16,183 women in the US, Patel et al.

observed that short sleep duration was associated with reduced reported physical activity [225]. Other studies also suggest that sleep loss may impact energy expenditure through thermoregulation [227, 228].

An important theme that has emerged from this thesis is that high-activity energy expenditure among older men and women can help improve their health status and general wellbeing [229, 230]. Although the total energy expenditure on time use activities could not be ascertained within the context of this thesis, some previous studies calculated the physical activity energy expenditure (PAEE) of time use, using a metabolic equivalent of task (MET) [229, 231, 232]. A MET value of 1 is equivalent to the energy expended while sitting down quietly [231]. In a recent study among older adults aged 70-82 years, Manini et al. [229] found that time use activities such as housework (washing, mopping, cleaning, etc.), child care, gardening, volunteering and walking at a pace of 2.5 mph were equivalent to a MET value of 3.0. In line with this calculation, this thesis concludes that less active older adults are likely to have poorer health and they may also be at high risk of mortality [29, 233].

7 Methodological considerations

This thesis has tried to overcome some of the limitations existing in previous studies on social and gender inequalities in health among older adults by applying advanced statistical methods to examine the complex direct and indirect pathways through which social factors impact the health of the elderly population in Western industrialised countries. What appears to be missing in previous health inequalities analysis is the use of "appropriate" social and economic indicators that are most germane to older adults in later years. Thus, the three studies comprising this thesis constitute the first research analysing health inequalities among older adults through a combined framework of socioeconomic position, family characteristics and time use activities using a large-scale and homogeneous data set from Europe and the US. Nonetheless, this present work, like all other research, raises methodological issues that are likely to occur in health inequality research, whose possible implications are discussed hereafter.

7.1 Misclassification

This thesis used subjective rather than objective reports for the main dependent variables (self-reported health and stress) and independent variables (time use activities), potentially leading to misclassification [234]. Misclassification, also known as information or reporting bias, is one of the systematic errors that affect the validity of health inequality research. This bias occurs if participants report inaccurate information due to questionnaire design, recall time frame, cognitive abilities [234, 235] and social desirability [235]. With regard to social desirability, it has been speculated that participants with higher socioeconomic status may expect good health and thus rate health problems at lower thresholds than those in lower socioeconomic status [236]. Furthermore, other reports suggested that women are more susceptible than men to misclassification of self-reported health, as they tend to over-report minor health problems than men [237]. Such misclassifications can attenuate research findings which might lead to the observed lower social gradient in health among

women. Meanwhile, in a study assessing whether women "over-report" ill-health, Macintyre et al. [238] concluded that reporting behaviours do not differ by gender, as was also found in other studies [170-172]. The validity and reliability of self-reported health (perceived general health, health complaints, chronic conditions and disabilities) as a measure of assessing overall health status has thus been established in several epidemiological studies [160, 161, 239], and has been shown to predict mortality among the elderly [161].

Self-report of time use activities on the other hand may suffer from recall bias, because completing retrospective or "yesterday" diaries can be cognitively demanding. The 24-hour diary data requires participants to recall all activities and reconstruct time use events that they engaged in on a prior day [133], which may affect the accuracy of reported information. Nonetheless, a few studies that explored the validity of the 24-hour time diary among the elderly indicated a high level of accuracy of data [240, 241]. For instance, in an attempt to assess the reliability of retrospective time use diaries in old age, Klumb and Baltes [240] found a considerable agreement between Yesterday Interviews (YI) and Experienced-Sampling Measures (ESM) among older adults aged 72 or older in Germany. Where there were discrepancies between YI and ESM, the researchers concluded that cognitive abilities did not appear to explain the differences. Thus, retrieving "yesterday" time use information from memory can be one of the more reliable and accurate ways of measuring time use activities as compared to other data collection procedures such as estimates from stylized survey questions [158, 159].

7.2 Confounding and mediation

Analyzing determinants and inequalities in health is a challenging area of research because health inequalities may be affected in complex ways by biological, environmental and psychosocial factors. Hence, the issue of confounding (i.e. whether some variables are associated with both the dependent and independent variables) and mediation (i.e. whether some variables interplay between the dependent and the independent variables) should be taken into account by health inequality researchers. Failure to adjust for potential confounders (and possibly mediators) can be lead to

underestimation or overestimation. It can also contort the direction and magnitude of the association between the exposure and outcome variables [242].

In this thesis, it was possible to take a variety of factors (age, gender, socioeconomic status, psychosocial factors and behavioural risk factors including physical activities), that have been shown to predict ill-health at older ages [44, 99, 181, 183] into account simultaneously. Measures at the individual level such as family characteristics and social support were additionally accounted for. In order to analyse the potential impact of possible confounders, a hierarchical modeling strategy was followed in study I [243], as this approach helps to identify the complex inter-relationship between different risk factors. When potential confounding bias exist, stepwise methods yield better power to assess the independent effect of each predictor. In general, after controlling for relevant factors in a step-by-step manner, the addition of possible confounders has been observed to have minimal impact on the main findings, although the inclusion of some variables attenuated some of the results [183]. In other words, adjusting for a confounder does not remove the effect of socioeconomic inequalities on self-reported health among elderly men and women.

In the SEM Models (study III), it was possible that some aspects of behavioural pathways (smoking and alcohol consumption) could mediate the relationships between social factors and the health outcomes (self-reported health and stress). Unfortunately, such risk factors were not included in the theoretical model, due to data constraints. Nonetheless, as discussed in section 2.3, it is unlikely that the association between gender, socioeconomic status and health could be fully (directly) or indirectly explained by differences in behavioural risk factors.

7.3 Health selection

A very important issue when studying and analysing social inequalities in health is health selection [244-247], which suggests that a person's health status influences his or her ability to maintain or achieve a desirable social status. In other words, health status determines socioeconomic position rather than socioeconomic position determining health. Correspondingly, this hypothesis seems to suggest that the

association between time use activities and health could also be driven by the health status of older adults (reverse causation). This notion is particularly applicable to cross-sectional studies of time use activities and health: do older people devote more time to certain time use activities due to good health? Or is it that they are healthy as a result of performing certain time use activities? The present thesis focuses on the influences of social status and time use activities on health rather than vice versa.

Although further longitudinal research is needed to confirm the direction of findings, several results on social status and health have concluded that health selection does not seem to play a major role in explaining the social gradient in health outcomes [244, 248, 249]. While there may also be some evidence of a selection effect [250], it has been shown that the effect does not necessarily contribute to socioeconomic inequalities in health [244, 250].

7.4 Generalisability

This thesis, like other research, raises a question of relevance as well as whether the results are generalisable. The research presented here consists of older adults (65 years and older) who were community-dwelling, but not institutionalised [183, 184]. Although excluding institutionalised older persons may lead to underrepresentation of elderly women in the sample [251], many of whom have poor health [252, 253], the response rates were found to be higher among women. Moreover, the sample sizes used for the analyses were extremely large, thereby providing a fair picture of the studied population.

Findings in this thesis can be generalised to older adults in other Western and industrialised societies because the selection of the countries was strategic. All the seven countries (Germany, Italy, Spain, France, the Netherlands, UK and the US) chosen for this study represent different typologies of welfare states regimes [123], which subsequently allowed for the cross-national comparative analysis in study I. The cross-national comparison was essential because it showed whether one can generalise the conventional "gender-and-health-paradox" view at the societal level. The findings were as expected, which favors the notion of generalisability of the results.

8 Conclusions

- Social patterning of health inequalities persist at older ages in Western industrialised countries. However, the magnitude of these inequalities differ across countries and are shaped by unequal distribution of social and time use resources.
- The indicators of SES including education, wealth and employment status showed consistent patterns of health inequalities between groups of high and low SES. These measures of SES and other social factors such as marriage were also found to be independent predictors of health outcomes (self-reported health and stress) among older adults. The pattern was similar between elderly men and women.
- The conventional view on the male-female health-survival paradox that women live longer yet they report poorer health could only be partially confirmed in this present study. Indeed, the cross-national analysis of health status between countries revealed non-existence of gender inequalities in self-reported health in the US and the UK, but significant gender disparities were detected in Germany, Italy and Spain. The main explanatory factors for the observed health inequalities were gender differences in educational attainment and time devoted to active leisure activities.
- Time use activities remain strongly gendered, even after retirement. This thesis provides evidence that time use at older age is strongly associated with self-reported health and stress. Older adults engagement in active and social activities are relevant for maintaining good health whereas more time allocation to sedentary activities can be detrimental to older adults health.
- Stress, in terms of time pressure, has a strong direct negative impact on self-reported health among older men and women. However, it does not indirectly influence (mediate) the positive relationship between work-related time use activities (paid work and housework) and self-reported health. The time

availability hypothesis, which posits that older adults may not have the same time pressure as younger adults after retirement was tested and confirmed for the first time in this thesis.

9 Policy relevance and implications

Discovering social factors that determine health inequalities among older adults is a difficult task, but this thesis has provided some insights on the proximate and distal social factors associated with health inequalities in later life. The studies offered the possibility to assess and analyse the direct and indirect pathways or mechanisms through which social, psychosocial and some behavioural risk factors contribute to health inequalities among older adults. The results of this thesis suggest that inequalities in health at older age are a result of various complex socially patterned exposures and behaviours. Further, reducing or eliminating these social inequalities in health requires a wider range of targeted intervention strategies. The findings demonstrate the importance of taking a broader range of social factors, particularly, time use activities into account when analysing health inequalities among older adults. Considering how elderly people spend their time after retirement should be seen as a critical tool for intervention planning because the studies comprising this thesis and others [72, 73] suggest that unequal distribution of time use resources among men and women explain, in part, the gender inequalities in health in Western industrialised countries.

It is therefore important to implement stronger gender equity policies. As discussed in section 7.4, the countries selected for this study represent different institutional settings and differ on national policies and social norms [83, 254]. In the comparative analysis, it was observed that cross-national variations in welfare provisions of care such as service and cash benefits for older adults [255], may contribute to the explanations of the time differentials in patterns of time use activities between countries. Beyond that, the complex relationship between the welfare state and family structures may increase or decrease the cost and time associated with certain time use activities (e.g., social support services and leisure participation). A direct corollary is that men and women may display different time allocation patterns in response to the existing welfare state policies. Also, cultural norms may shape the relationship between time allocation decisions and health status as seen in Italy and

Spain (to a lesser extent Germany) [83], where gender roles are still shaped in a more traditional way. This entrenched system urges women to devote a lot of time to housework activities [254], which may limit opportunities for active and social pursuits [256]. It has also not escaped notice that the imbalances between daily time use activities have been shown to have negative implications on health outcomes in previous studies [73, 254, 257]. Thus, public policies targeted at reducing health inequalities at older ages should incorporate the simultaneous consideration of gender, time use activities and an individual's socioeconomic status in their action. This may prove to be an efficient and effective way to tackle social inequalities in health among the elderly population.

10 Future directions

Population ageing is poised to become a public health challenge, globally. Thus, researching into health inequalities and determinants of health at older ages will never be an off-topic, not only in Western industrialised countries but also around the world. Although this thesis examined countries with diverse institutional settings, it might be worthwhile for future studies to include countries from the Nordic regions such as Sweden and Finland. This would contribute greatly to the development of the literature, because of the commitment of the Nordic countries to public policies that enhance gender equality in family life [258]. At this point, it can only be speculated that as the institutional arrangements in the Nordic countries allow for a better societal balance [259, 260], there might be (more) equitable distribution of socioeconomic and time use resources in subpopulation groups, leading to health equity.

Prior studies have signaled that time use activities among men and woman have changed over the years [134, 261, 262], largely due to changes in national policies and social norms [258]. A trend analysis of time use activities in the US [134] and Europe [262] suggested that men's inclination to do housework has increased over the years. On the other hand, women's time allocation to paid market work has increased significantly. These two perspectives suggest possible trade-offs in the amount of time allocation to other activities such as leisure and social activities (even sleep hours). Do the shifts over time imply better or worse health? Further research is needed to explore how the changes in patterns of time use impact the health status of older men and women. Could it be that the gender gap in health due to unequal distribution of time resources is widening or reducing? More importantly, longitudinal research is needed to get more profound insights into the associations between time use activities, SES and the dependent variables, to determine the direction of relationships or causality.

Finally, due to the debate in relation to possible recall bias and social desirability effects of self-report measures [235, 263], future research should explore the use of more objective and sophisticated time use data collection technologies such as accelerometers and pedometers. Accelerometers can detect activities of different

intensities, whereas pedometers record the number of steps [264-266]. Subsequent comparison of these objective measures to the 24-hour dairy will allow researchers to be more certain about the technical reliability and validity of time budget diaries.

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13 Appendix

I. Appendix A Publications

Appendix A. 1 **Study 1**: Adjei, N. K., Brand, T., & Zeeb, H. (2017). Gender inequality in self-reported health among the elderly in contemporary welfare countries: A cross-country analysis of time use activities, socioeconomic positions and family characteristics. PloS one, 12(9), e0184676.

Appendix A. 2 **Study 2**: Adjei, N. K., & Brand, T. (2018). Investigating the associations between productive housework activities, sleep hours and self-reported health among elderly men and women in western industrialised countries. BMC public health, 18(1), 110.

Appendix A. 3 **Study 3**: Adjei, N. K., Jonsson, K. R., & Brand, T. (2018). Time spent on work-related activities, social activities and time pressure as intermediary determinants of health disparities among elderly women and men in 5 European countries: a structural equation model. International journal for equity in health, 17(1), 121.

II. Appendix B Supporting information (supplementary tables)

III. Appendix C Author contributions

IV. Appendix D Further publications and oral presentations

Study I

PLOS ONE

RESEARCH ARTICLE

Gender inequality in self-reported health among the elderly in contemporary welfare countries: A cross-country analysis of time use activities, socioeconomic positions and family characteristics

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Data Availability Statement: The data used for this study were obtained from the Multinational Time Use Study (MTUS), https://www.timeuse.org/mtus/access. Access to this data is free of charge; however, any researcher wishing to use the data must register to have access.

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Abstract

Background

Paradoxically, despite their longer life expectancy, women report poorer health than men. Time devoted to differing social roles could be an explanation for the observed gender differences in health among the elderly. The objective of this study was to explain gender differences in self-reported health among the elderly by taking time use activities, socioeconomic positions, family characteristics and cross-national differences into account.

Methods

Data from the Multinational Time Use Study (MTUS) on 13,223 men and 18,192 women from Germany, Italy, Spain, UK and the US were analyzed. Multiple binary logistic regression models were used to examine the association between social factors and health for men and women separately. We further identified the relative contribution of different factors to total gender inequality in health using the Blinder-Oaxaca decomposition method.

Results

Whereas time allocated to paid work, housework and active leisure activities were positively associated with health, time devoted to passive leisure and personal activities were negatively associated with health among both men and women, but the magnitude of the association varied by gender and country. We found significant gender differences in health in Germany, Italy and Spain, but not in the other countries. The decomposition showed that differences in the time allocated to active leisure and level of educational attainment accounted for the largest health gap.

Conclusions

Our study represents a first step in understanding cross-national differences in the association between health status and time devoted to role-related activities among elderly men and women. The results, therefore, demonstrate the need of using an integrated framework of social factors in analyzing and explaining the gender and cross-national differences in the health of the elderly population.

Introduction

Over the past decades, population ageing has been one of the major global demographic processes [1–3]. The percentage of those aged 60 years and above increased from 8% in 1950 to 12% in 2013 and it is projected to increase to 21% by 2050 [4]. Empirical research shows that women have a longer life expectancy than men [5–7]. In 2013, UN data indicated that 85 men per 100 women were 60 years or over and 61 men per 100 women were 80 years or over [4]. Although women live longer than men, they report poorer health [8], as well as more physical limitation [9] and chronic conditions [10]. This health-survival paradox can partly be explained by gender differences in biological factors such as genetics and hormonal exposure [11–13]. Several earlier studies have also shown that gender differences in socio-economic position (SEP) contribute to health disparities among the younger population [14–16] and the elderly [17–19]. A possible explanation of this outcome is that SEP is often lower among women and thus they are exposed to more health adversities [20]. However, there is still no consensus about the best indicators of SEP to be used among the elderly [19,21–23]. Thus, there is a need to further explore the suitability of reliable social factors among older men and women.

Apart from biological factors and SEP, social roles and activities may explain gender differences in health [24]. Since gender is perceived to be a distinct feature with respect to social roles, some studies have examined the differences in time spent on role-related activities among men and women [25,26]. Although men have increased the amount of time allocated to some role-related activities such as housework, their contribution to these activities remains lower than that of women [25]. Coltrane [26] showed that women spend two or three times more time doing routine, repetitive housework than men. Even after retirement, gender roles are still shaped in a traditional way in some welfare countries, especially in the Southern European countries, where women continue to assume the role of a housewife [27]. This unequal distribution of household activities limits women's participation in active leisure and other social activities [28], which may have a negative effect on their health.

However, the extent of gender and cross-national differences in the distribution of time regarding role-related activities varies by social norms and national policies [27,29]. These mediating factors have also been identified as potential contributing factors to health inequality. For example, Eikemo and colleagues [30] found that 10 percent of differences in self-reported health could be linked with welfare states characteristics. Thus, policies and social norms may affect the allocation of time by influencing the patterns of daily activities.

Several studies have explored the relationship between social roles and health [31–33], but only some have focused on this topic among the elderly [34,35]. Moreover, the conceptual framework used by these studies on the elderly was related to "role occupancy", such as parental status (i.e., the presence of children in the household) and marital status (i.e., being married, divorced, separated or widowed), and their associations with health. These measures of social

roles are crude and indirect and might give little information on how much time and effort are spent on role-related activities such as housework, childcare, and other household activities [24].

In this study, we operationalized social roles as time allocation to the various role-related activities among older men and women based on Bird and Fremont [24]. Time use data was used to examine the extent to which the "role occupant" fulfils the role. The amount of time spent on role-related activities such as household work, childcare, maintenance, voluntary work and other activities were estimated using diary-based time allocation data. Time diary has been shown to be more reliable, accurate and providing a better picture of how social roles influence health as compared to survey estimates [24].

So far, only four studies have examined the relationship between time allocation and health [24,36–38]. Time allocated to differing social roles has yet to be examined as an explanation for the observed gender differences in health among the elderly. The objective of this study is to explore social and economic determinants of health among elderly men and women simultaneously, using a combined framework of time use activities, socio-economic positions and family characteristics. The study aims to explain the gender and cross-national differences in health based on data from five welfare countries (Germany, Italy, Spain, United Kingdom and the United States).

The following research questions will be addressed:

1a) How do time use activities, SEP and family characteristics impact the health among the elderly?

b) To what extent do these effects vary by gender and across countries.

c) To what extent do these social factors explain gender differences in health among the elderly.

Methods

Data

We used data from the Multinational Time Use Study (MTUS, version W53). The MTUS data is a large cross-national, harmonized and comparative time-use database from 25 countries across six waves. This data collection has been organized by the Centre for Time Use Research, located in the Department of Sociology at the University of Oxford. The data set contains information on the socio-economic and demographic background of the respective diarist and the total time spent on 41 activities over a 24-hour period [39]. The full-day period diaries were self-administered, followed by a personal visit of study staff in most European countries. The authors were granted approval from the Multinational Time Use Study Review Board to obtain and use the collected data for analysis. All data were anonymized prior to the authors receiving the data.

For the purpose of this study, we limited our sample set to respondents who were 65 years and above at the time of study. The minimum age was chosen based on the retirement age in most EU countries [40]. We also included information from retired persons who had paid work. The countries included in this analysis are the United Kingdom (survey year, 2000); the United States (survey year, 2003); Spain (survey year, 2002); Italy (survey year, 2002); and Germany (survey year, 2001). Data from these countries were of special interest because they include the outcome variable "self-reported health" and numerous independent variables

relevant for this study. The use of data from multiple countries furthermore allows for direct comparison of findings.

Health outcome

The study used self-reported health as a measure of health status ("How is your health in general; would you say that it is . . ..?" response options: zero (poor) to three (very good)). We created a dichotomous outcome as in [41], where good health took a value of "0" if the respondent reported "very good" or "good" health and a value of "1" if they reported "poor" or "fair" health.

Time use

All time use variables were measured in hours per day. We limited our study to respondents who reported all 1440 minutes (24 hours) of activities during the day in the diary, and hence adopted the broad categories suggested earlier by Gauthier and Smeeding [1]. S1 Table (appendix) lists the detailed activities included in the following 5 broad categories.

- Paid work (e.g. paid work, travel to and from work)
- Housework (e.g. cooking, washing, gardening, shopping)
- Active leisure Activities (e.g. walking, volunteer, sports, travel for pleasure)
- Personal activities (e.g. sleep, eating, bathing, dressing, medical care)
- Passive leisure activities (e.g. watching television, relaxing)

Socio-economic position and family characteristics

Socio-economic positions were measured by three indicators: Education, wealth and employment status. Education was categorized into three groups: less than secondary education, completed secondary education and above secondary education. Housing tenure (owner occupier vs. renting) and car ownership (no car, one car and two or more cars) were the two indicators used to measure wealth. Employment status in two categories was included in the model to examine the impact of paid employment at older ages. Family characteristics were measured by household size categorized into three groups: single person household, two person household, and three or more person household.

Analytical strategy

The analytic strategy included three separate steps. In the first step, the descriptive analysis provided information on distributional characteristics of all variables including the mean time allocated to the various activities across all countries. In the second step, we applied binary logistic regressions to examine the association between time use, SEP, family characteristics and self-reported health simultaneously. The analyses were done separately for men and women as well as pooled models. Estimates in the pooled models were derived from hierarchical modeling of self-reported health in which the variables were added sequentially.

The binary logit model estimated the probability of the dependent variable (self-reported health) to be 1 (Y = 1), which is expressed mathematically as follows:

$$pr(Y = 1|x) = \frac{\exp(x\beta)}{1 + \exp(x\beta)} \quad (1)$$

In the third step, a decomposition method was applied to identify the relative contribution of the different factors to total gender inequality in health. We used an extension of the Blinder-Oaxaca decomposition method proposed by Yun [42] for non-linear models to examine the contribution of social factors to female excess in the probability of reporting poor health. The decomposition for a non-linear equation such as $pr(Y = 1) = \Phi(X\beta)$ can be expressed as:

$$\bar{Y}_m - \bar{Y}_w = \sum_{i=1}^{i=K} W^i_{\Delta X}[\Phi(X_m\beta_m) - \Phi(X_w\beta_m)] + \sum_{i=1}^{i=K} W^i_{\Delta\beta}[\Phi(X_w\beta_m) - \Phi(X_w\beta_w)] \quad (2)$$

where Φ is a standard normal cumulative distribution function, Y = health status; β = regression coefficient; X = covariates; m = men; w = women; W = weight assigned to each covariate that is equal to its proportional contribution to the total endowment or coefficient effect.

This decomposition method allows partitioning the health differences between men and women into two components, with men as the reference group [43]. The first component is the *"the endowment effect"* which represents the part of the gender gap in health that is due to differences in group characteristics. The second component is the *"coefficient effect"* which represents the part due to differences in the group processes. In line with Williams [44], we focused on the part of the gap that is due to differences in group characteristics (such as education and time use), with decomposition estimates showing how characteristics contribute individually to the health gap. The contributions of the included factors to the health gap can be positive or negative [45]. Using a counterfactual decomposition framework [42], a positive number indicates a reduction in female excess that would have occurred if women had men's characteristics. Negative estimates indicate that the variable in question contributes to the gap in the direction that runs counter to the overall health gap [44]. All statistical analyses were performed in STATA version 14 [46].

Results

Descriptive statistics

The descriptive statistics for men and women for each country are shown in Tables 1 and 2. Gender differences were found in age, education, wealth, employment status and household size, but there was marked cross-national variation. No gender difference was found in self-reported health in the US and the UK, but in the other countries. Women were slightly older than men. They also had lower educational attainment as compared to men. The largest percentage of elderly men and women who reported having a tertiary education was found in the US (46.9% for men and 40.3% for women), Germany (47.5% for men and 17.5% for women), UK (18.3% for men and 10.0% for women). A larger proportion of women than men reported living in a one-person household.

Time use varied considerably between men and women and across countries. Overall, women allocated more time to housework activities compared to men. On the other hand, elderly men tended to devote more time to active leisure, passive leisure and paid work. The cross-country comparison revealed that women in Italy spent on average more time on housework activities (5.1 hours per day). US women spent remarkably fewer hours on housework

Table 1. General description of the study sample (in percentages, means and SD), men.

	Germany		Italy		Spain		UK		USA	
	(*n* = 1478)		(*n* = 3770)		(*n* = 4234)		(*n* = 1315)		(*n* = 2426)	
	Mean / %	SD	Mean/ %	SD	Mean/ %	SD	Mean/ %	SD	Mean/ %	SD
Self-reported health										
Good	39.2%		26.6%		41.5%		52.9%		67.4%	
Poor	60.8%		73.4%		48.5%		47.1%		32.6%	
Time use Activity										
Paid work hours/day	0.39	1.66	0.38	1.68	0.22	1.22	0.24	1.30	0.83	2.43
Less than 1	92.8%		94.4%		96.0%		95.5%		87.4%	
1or more	7.2%		5.6%		4.0%		4.5%		12.7%	
House work hours/day	3.62	2.40	2.69	2.48	2.44	2.51	3.79	2.40	2.99	2.77
Less than 4	57.3%		72.3%		74.4%		55.1%		69.9%	
4 to 6	25.8%		17.2%		15.6%		26.1%		14.5%	
>6	16.9%		10.5%		9.9%		18.9%		15.6%	
Active leisure hours/day	4.55	2.68	4.26	2.69	4.17	2.72	3.93	2.90	3.62	3.22
Less than 2	16.3%		20.6%		22.8%		27.5%		37.5%	
2 to 4	31.1%		29.6%		27.2%		31.6%		24.6%	
>4	52.6%		49.9%		50.0%		40.8%		37.9%	
Passive leisure hours/day	3.66	2.03	4.33	2.17	4.51	2.25	4.57	2.50	5.81	3.77
Less than 3	37.9%		26.9%		25.1%		26.9%		23.9%	
3 to 5	40.1%		39.7%		38.8%		35.4%		25.6%	
>5	22.0%		33.5%		36.2%		37.6%		50.6%	
Personal activity hours/day	11.93	1.95	12.71	2.14	12.97	2.35	11.17	1.90	10.89	2.52
Less than 10	12.3%		7.1%		5.4%		23.7%		34.4%	
10 to 12	44.9%		34.0%		30.9%		49.1%		39.9%	
>12	42.8%		59.0%		63.7%		27.2%		25.7%	
Age	71.21	4.81	72.50	5.01	72.59	5.09	72.40	5.10	72.89	5.26
65–69	44.1%		35.0%		34.7%		35.4%		33.8%	
70–74	29.6%		29.2%		27.8%		28.1%		24.9%	
75–79	17.1%		19.6%		19.6%		21.3%		20.7%	
80+	9.3%		16.1%		18.0%		15.2%		20.7%	
Education										
Incomplete Sec. or less	10.7%		67.5%		68.3%		63.3%		21.5%	
Secondary completed	41.8%		27.7%		23.2%		18.5%		31.7%	
Tertiary Completed or above	47.5%		4.8%		8.5%		18.3%		46.9%	
Wealth										
Land tenure										
Renting	41.1%		16.9%		9.4%		27.5%		15.8%	
Owner occupier	58.9%		83.1%		90.7%		72.6%		84.3%	
Car Ownership										
No car	11.8%		16.0%		40.9%		27.9%		-	-
1 Car	72.3%		48.4%		42.0%		57.2%		-	-
2+ Car	16.0%		35.6%		17.1%		14.9%		-	-
Employment Status										
Not working for pay	83.7%		92.4%		96.3%		91.8%		77.2%	
Currently in paid employment	16.3%		7.6%		3.7%		8.2%		22.8%	
Household size	2.10	0.81	2.36	1.02	2.55	1.20	1.91	0.70	1.77	0.93
1 Member	14.0%		12.9%		10.5%		21.9%		40.6%	

(*Continued*)

Table 1. (*Continued*)

	Germany		Italy		Spain		UK		USA	
	(*n* = 1478)		(*n* = 3770)		(*n* = 4234)		(*n* = 1315)		(*n* = 2426)	
	Mean / %	SD	Mean/ %	SD	Mean/ %	SD	Mean/ %	SD	Mean/ %	SD
2 Members	70.1%		75.6%		52.3%		69.1%		49.9%	
3+ Members	15.9%		11.5%		37.2%		9.1%		9.6%	

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activities (3.8 hours per day). Time devoted to active leisure did not vary much across countries among men but women. The most time devoted to active leisure was found in Germany (4.1 hours per day), the least active leisure time in Italy (3.0 hours per day) and Spain (2.9 hours per day). Allocation of time for paid work was highest in the US for men and women. Regarding the time allocated to passive leisure, men in the US devoted most hours to these activities (5.8 hours per day), while the lowest value was observed in Germany (3.7 hours per day). Women in all countries spent less time on passive leisure. Finally, the analysis of personal activities showed that men and women in Spain devoted the most time to personal activity (13 and 12.6 hours per day) while the least time spent on these activities was found in the UK and the US (approximately 11.2 hours per day).

Logistic regression

The results of the multivariate logistic regression models are shown in Tables 3 (pooled model), 4 and 5 (separated by gender and country).

The pooled model shows that all time use activities were related to health in the crude and the fully adjusted model (Table 3). In the full model, we observed that elderly people who spent more than 1 hour on paid work activities had lower odds of reporting poor health (OR = 0.75; 95% CI = 0.63–0.90) as compared to those who spent less than 1 hour to these activities. Individuals who spent more than 6 hours per day on housework activities had lower odds (OR = 0.65; 95% CI = 0.60–0.71) of reporting poor health compared to those who spent less than 4 hours to these activities. We also observed a strong association between poor health and time devoted to active leisure activities. Individuals who devoted more than 4 hours per day to active leisure activities were less likely to report poor health (OR = 0.53; 95% CI = 0.49–0.58) as compared to those who devoted less than 2 hours per day to these activities. Passive leisure and personal activity (including sleep hours) were associated with higher odds for poor health. Individuals who spent more than 5 hours on passive leisure activities were more likely to report poor health (OR = 1.31; 95% CI = 1.21–1.42) compared to those who devoted less than 3 hours to these activities. The odds of reporting poor health was significantly higher (OR = 1.43; 95% CI = 1.31–1.56) for individuals who spent more than 12 hours per day on personal activities compared to those who spent less than 10 hours.

Regarding the other factors, many patterns were similar to results from other reports. Women were more likely to report poor health than men (OR = 1.32; 95% CI = 1.25–1.40). Educational attainment was significantly associated with health status. We found a negative gradient with the prevalence of poor health increasing with decreasing educational level. Odds of reporting poor health increased with age. Furthermore, the odds of reporting poor health status was lower among homeowners than renters (OR = 0.80; 95% CI = 0.75–0.86). Respondents who were currently in paid employment were less likely to report poor health as compared to those not working for pay (OR = 0.52; 95% CI = 0.45–0.59). Surprisingly, larger household size was positively associated with poor health status in model 2, but this association disappeared in model 3. Compared to Germany, elderly people in Italy and Spain had higher

Table 2. General description of the study sample (in percentages, means and SD), women.

	Germany		Italy		Spain		UK		USA	
	(*n* = 1848)		(*n* = 4939)		(*n* = 5659)		(*n* = 1694)		(*n* = 4052)	
	Mean / %	SD	Mean / %	SD	Mean / %	SD	Mean / %	SD	Mean / %	SD
Self-reported health										
Good	46.8%		16.9%		32.6%		52.9%		68.2%	
Poor	53.2%		83.1%		67.4%		47.1%		31.8%	
Time use Activity										
Paid work hours/day	0.09	0.60	0.07	0.71	0.07	0.67	0.09	0.78	0.46	1.80
Less than 1	97.7%		98.9%		98.6%		98.2%		92.6%	
1or more	2.3%		1.2%		1.4%		1.8%		7.4%	
House work hours/day	4.64	2.34	5.14	2.74	4.77	2.71	4.47	2.29	3.79	2.88
Less than 4	38.7%		31.7%		35.8%		40.9%		58.4%	
4 to 6	35.4%		30.3%		32.6%		35.1%		20.4%	
>6	25.8%		38.0%		31.7%		24.1%		21.2%	
Active leisure hours/day	4.15	2.59	2.97	2.21	2.86	2.28	3.63	2.54	3.84	3.09
Less than 2	22.1%		34.3%		37.5%		27.7%		33.1%	
2 to 4	31.6%		38.6%		36.2%		35.8%		25.7%	
>4	46.3%		27.2%		26.3%		36.4%		41.2%	
Passive leisure hours/day	3.39	1.88	3.78	2.10	4.14	2.22	4.22	2.31	4.85	3.35
Less than 3	41.9%		37.5%		31.1%		30.3%		32.9%	
3 to 5	42.4%		38.9%		39.3%		38.9%		26.8%	
>5	15.7%		23.6%		29.6%		30.8%		40.3%	
Personal activity hours/day	11.97	2.03	12.47	2.19	12.57	2.32	11.17	1.96	11.18	2.57
Less than 10	10.2%		8.0%		7.0%		23.0%		29.9%	
10 to 12	47.1%		39.1%		39.6%		48.9%		39.8%	
>12	42.7%		53.0%		53.4%		28.0%		30.3%	
Age	71.74	5.13	73.3	5.21	73.24	5.18	73.1	5.00	73.89	5.34
65–69	41.7%		29.5%		30.4%		30.6%		28.0%	
70–74	25.6%		26.9%		27.1%		27.7%		22.5%	
75–79	18.8%		20.7%		19.8%		23.0%		20.8%	
80+	13.9%		22.9%		22.6%		18.7%		28.7%	
Education										
Incomplete Sec. or less	28.9%		80.1%		77.7%		76.5%		21.3%	
Secondary completed	53.6%		17.9%		18.5%		13.5%		38.4%	
Tertiary Completed or above	17.5%		2.1%		3.9%		10.0%		40.3%	
Wealth										
Land tenure										
Renting	51.7%		23.3%		12.0%		30.8%		21.0%	
Owner occupier	48.3%		76.7%		88.0%		69.2%		79.0%	
Car ownership										
No car	32.4%		38.3%		55.4%		48.6%		-	-
1 Car	59.2%		34.1%		32.1%		43.5%		-	-
2+ Car	8.4%		27.6%		12.5%		7.9%		-	-
Employment Status										
Not working for pay	92.4%		98.4%		98.4%		95.7%		86.4%	
Currently in paid employment	7.6%		1.6%		1.6%		4.3%		13.6%	
Household size	1.78	1.00	2.00	1.10	2.31	1.30	1.62	0.72	1.52	0.87
1 Member	45.0%		36.6%		26.0%		47.3%		62.3%	

(*Continued*)

Table 2. (*Continued*)

	Germany		Italy		Spain		UK		USA	
	(*n* = 1848)		(*n* = 4939)		(*n* = 5659)		(*n* = 1694)		(*n* = 4052)	
	Mean / %	SD	Mean / %	SD	Mean / %	SD	Mean / %	SD	Mean / %	SD
2 Members	42.2%		42.2%		43.2%		46.8%		30.2%	
3+ Members	12.8%		21.3%		30.8%		5.9%		7.5%	

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odds of reporting poor health (OR = 2.85; 95% CI = 2.59–3.14 and OR = 1.19; 95% CI = 1.09–1.31), and elderly people in the UK and the US had lower odds of reporting poor health (OR = 0.68; 95% CI = 0.61–0.76 and OR = 0.47; 95% CI = 0.43–0.52).

Tables 4 and 5 show the results of multivariate logistic regression models separately per gender and country.

Among men, time devoted to paid work activities was significantly associated with health in Spain and the US, but not in Germany, Italy and the UK (Table 4). Housework activities and active leisure activities were positively associated with health across the countries, with some inconsistencies in Germany and Italy. With regards to passive leisure and personal activities, we found a negative association with health in some, but not all countries. Here, more time devoted to these activities was associated with poor health.

Among women, only in Germany, paid work was positively associated with health. In contrast, in all countries but Germany, time spent on housework activities was positively associated with health. Time allocated to active leisure was positively associated with health in all countries except the UK. More time spent on passive leisure activities increases the likelihood of reporting poor health among women in Italy, UK and the US, but the effects were not statistically significant in Germany and Spain.

Non-linear decomposition

Table 6 gives the results of the country specific non-linear decomposition of female excess in the probability of reporting poor health. The female excess in the probability of reporting poor health was statistically decomposed into two parts, namely the part of inequality due to differences in group characteristics (endowment effect), and the part of inequality due to differences in group processes (coefficient effects). As discussed in the method section, we focused on the part of inequality due to differences in group characteristics (by variables) and the overall inequality due to differences in group processes.

In absolute terms, Germany reported the lowest and Italy the highest predicted probability in poor health. In contrast, Germany reported the highest female excess (0.140; 95% CI = 0.106–0.174) in the probability of reporting poor health followed by Italy (0.096; 95% CI = 0.079–0.114) and Spain (0.089; 95% CI = 0.070–0.108) while no female excess was found in the UK and the US.

Italy reported the highest total gender gap (approximately 47%) attributed to differences in group characteristics, followed by Spain (approximately 30%) and Germany (approximately 27%). The two largest contributing factors to this component of gender inequality in health among elderly people across all countries are education and active leisure. If women were to allocate the same time to active leisure activities as men, the female excess in the probability of reporting poor health would be reduced by approximately 18% in Spain and approximately 13% in Italy. In Germany, education is the largest contributor to the part of the inequality deriving from differences in group characteristics. The gender gap would be reduced by

Table 3. Multivariate associations between poor self-reported health status, time use, socio-economic position and family characteristics, pooled data of 5 countries. Men and women 65+ years old.

Variables	Model 1[1]	Model 2[2]	Model 3[3]
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Time use Activity			
Paid work hours/day			
Less than 1 (ref)			
1or more	0.38 (0.34–0.44)**	1.00 (0.84–1.19)	0.75 (0.63–0.90)**
House work hours/day			
Less than 4 (ref)			
4 to 6	0.93 (0.87–0.99)*	0.86 (0.81–0.92)**	0.76 (0.71–0.81)**
>6	0.92 (0.86–1.00)*	0.83 (0.76–0.90)**	0.65 (0.60–0.71)**
Active leisure hours/day			
Less than 2 (ref)			
2 to 4	0.82 (0.77–0.87)**	0.86 (0.81–0.92)**	0.75 (0.70–0.81)**
>4	0.57 (0.53–0.61)**	0.66 (0.61–0.71)**	0.53 (0.49–0.58)**
Passive leisure hours/day			
Less than 3 (ref)			
3 to 5	1.24 (1.17–1.32)**	1.16 (1.09–1.23)**	1.14 (1.07–1.21)**
>5	1.38 (1.28–1.48)**	1.24 (1.15–1.34)**	1.31 (1.21–1.42)**
Personal activity hours/day			
Less than 10 (ref)			
10 to 12	1.54 (1.43–1.66)**	1.29 (1.19–1.39)**	1.01 (0.94–1.10)
>12	2.84 (2.62–3.07)**	2.05 (1.89–2.23)**	1.43 (1.31–1.56)**
Sex			
Men (ref)			
Women		1.20 (1.14–1.27)**	1.32 (1.25–1.40)**
Age			
65–69 (ref)			
70–74		1.14 (1.07–1.22)**	1.15 (1.08–1.23)**
75–79		1.35 (1.26–1.45)**	1.41 (1.31–1.52)**
80+		1.32 (1.23–1.42)**	1.44 (1.33–1.55)**
Education			
Incomplete Sec. or less (ref)			
Secondary completed		0.47 (0.45–0.50)**	0.58 (0.54–0.61)**
Tertiary completed or above		0.27 (0.25–0.29)**	0.47 (0.43–0.51)**
Wealth			
Land tenure			
Renting (ref)			
Owner occupier		0.81 (0.76–0.86)**	0.80 (0.75–0.86)**
Employment Status			
Not working for pay (ref)			
Currently in paid employment		0.42 (0.37–0.48)**	0.52 (0.45–0.59)**
Household size			
1 member (ref)			
2 members		1.18 (1.11–1.26)**	1.03 (0.97–1.10)
3+ members		1.34 (1.24–1.44)**	1.03 (0.95–1.11)
Welfare States (countries)			
Germany (ref)			

(*Continued*)

Table 3. (*Continued*)

Variables	Model 1[1]	Model 2[2]	Model 3[3]
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Italy			2.85 (2.59–3.14)**
Spain			1.19 (1.09–1.31)**
United Kingdom			0.68 (0.61–0.76)**
United States			0.47 (0.43–0.52)**
Observations	31,425	31,425	31,425
Pseudo R2	0.052	0.107	0.152
Log Likelihood	-20263.22	-19090.029	-18128.073

aOR- adjusted Odd Ratio,

** p<0.01,

* p<0.05. Regression include day-of-week dummies.

[1] Includes only time use activities

[2] Includes time use activities, socio-economic position and family characteristics

[3] Includes time use activities, socio-economic position, family characteristics and countries

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approximately 12% if women had the same educational attainment as men. Passive leisure contributed negatively to this part of inequality in all countries, and personal activities showed mixed contributions in different countries.

Discussion

As far as we know, this is the first study to analyze simultaneously the relationship between time use activities, SEP, household characteristics and health among elderly men and women in four European countries and the US. Our study also examined gender and cross-country differences in patterns of time use among the elderly. On the descriptive level, our study showed that elderly women allocate more time to housework activities as compared to men. Elderly men tended to devote more time to active leisure, passive leisure and paid work with some cross-country variations. All time use activities were related to health with paid work, housework and active leisure activities positively and passive leisure and personal activities negatively associated with health. However, the magnitude of the association varied by gender and across countries. We found gender differences in health, but these differences vary visibly across countries with no gender gap in health observable in the UK and the US. Decomposing the gap in health, the study showed that differences in the time allocated to active leisure and level of educational attainment accounted for the largest share of the health gap.

Gender differences in health status

Our findings could only partially confirm the conventional view on the health paradox in contemporary welfare countries [47], that women live longer yet they report poorer health [48,49]. The results indicated that gender differences in health among the elderly do not exist in the UK and the US. Other studies have also found no gender differences in self-reported health and a number of health conditions in countries such as Finland [50], the UK and the US. In the UK, Macintyre et al. [47] revealed that female excess varied according to health conditions and phase of the life cycle. They concluded that female excess in reporting poor health was consistently found across the life span for psychological distress conditions, but was far less apparent or reversed for a number of physical symptoms and conditions. Likewise, a

Table 4. Multivariate associations between poor self-reported health status, time use, socio-economic position and family characteristics. Men, 65+ years old.

Variables	Germany	Italy	Spain	UK	USA
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Time use Activity					
Paid work hours/day					
Less than 1 (ref)					
1or more	0.77 (0.42–1.41)	0.72 (0.45–1.17)	0.66 (0.42–1.03)*	0.70 (0.33–1.48)	0.63 (0.40–1.00)*
House work hours/day					
Less than 4 (ref)					
4 to 6	0.92 (0.70–1.22)	0.72 (0.58–0.90)**	0.72 (0.60–0.88)**	0.62 (0.46–0.83)**	0.65 (0.49–0.85)**
>6	0.73 (0.50–1.07)	0.98 (0.71–1.34)	0.58 (0.44–0.76)**	0.46 (0.31–0.68)**	0.50 (0.36–0.69)**
Active leisure hours/day					
Less than 2 (ref)					
2 to 4	1.07 (0.76–1.50)	1.07 (0.84–1.36)	0.74 (0.61–0.89)**	0.59 (0.43–0.81)**	0.78 (0.62–0.99)*
>4	0.64 (0.43–0.94)*	0.77 (0.59–1.01)*	0.61(0.50–0.76)**	0.45 (0.31–0.65)**	0.47 (0.36–0.61)**
Passive leisure hours/day					
Less than 3 (ref)					
3 to 5	1.27 (0.98–1.65)	1.12 (0.93–1.35)	1.09 (0.92–1.28)	1.26 (0.93–1.71)	1.13 (0.85–1.50)
>5	1.35 (0.96–1.90)	1.35 (1.07–1.70)*	1.13 (0.93–1.37)	1.16 (0.82–1.64)	1.24 (0.92–1.68)
Personal activity hours/day					
Less than 10 (ref)					
10 to 12	1.22 (0.84–1.78)	0.94 (0.70–1.27)	1.23 (0.91–1.65)	0.80 (0.60–1.09)	1.04 (0.83–1.31)
>12	1.51 (1.01–2.25)**	1.19 (0.87–1.62)	1.91 (1.42–2.58)**	0.99 (0.69–1.41)	1.68 (1.30–2.16)**
Age					
65–69 (ref)					
70–74	1.09 (0.84–1.42)	1.77 (1.47–2.13)**	1.14 (0.97–1.34)	0.89 (0.66–1.20)	1.00 (0.78–1.28)
75–79	1.43 (1.04–1.96)*	1.63 (1.32–2.02)**	1.33 (1.11–1.61)**	1.59 (1.15–2.21)**	1.09 (0.84–1.42)
80+	1.23 (0.82–1.85)	2.52 (1.92–3.31)**	1.39 (1.14–1.70)**	1.10 (0.76–1.60)	1.03 (0.79–1.33)
Education					
Incomplete Sec. or less (ref)					
Secondary completed	0.78 (0.54–1.14)	0.64 (0.54–0.75)**	0.65 (0.55–0.75)**	0.96 (0.70–1.30)	0.54 (0.43–0.69)**
Tertiary completed or above	0.90 (0.62–1.30)	0.60 (0.43–0.84)**	0.48 (0.38–0.61)**	0.72 (0.51–1.01)*	0.40 (0.32–0.51)**
Wealth					
Land tenure					
Renting (ref)					
Owner occupier	0.91 (0.72–1.15)	0.92 (0.75–1.14)	0.94 (0.75–1.18)	0.69 (0.52–0.92)*	0.85 (0.66–1.10)
Car ownership					
No car (ref)					
1 car	0.75 (0.53–1.07)	0.67 (0.51–0.88)**	0.72 (0.62–0.83)**	0.71 (0.53–0.95)**	-
2+ cars	1.10 (0.68–1.77)	0.54 (0.40–0.71)**	0.68 (0.55–0.84)**	0.74 (0.47–1.16)	-
Employment Status					
Not working for pay (ref)					
Currently in paid employment	0.50 (0.34–0.74)**	0.70 (0.48–1.04)	0.70 (0.44–1.11)	0.38 (0.21–0.68)**	0.54 (0.39–0.75)**
Household size					
1 member (ref)					
2 members	1.09 (0.78–1.51)	0.88 (0.68–1.13)	1.00 (0.80–1.25)	0.94 (0.70–1.27)	0.73 (0.60–0.89)**
3 members	1.49 (0.96–2.30)*	0.94 (0.71–1.24)	1.07 (0.84–1.36)	1.95 (1.18–3.24)**	1.02 (0.74–1.41)
Observations	1,478	3,770	4,234	1,315	2,426

(*Continued*)

Table 4. (*Continued*)

Variables	Germany	Italy	Spain	UK	USA
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Pseudo R2	0.050	0.071	0.063	0.087	0.109
Log Likelihood	-940.8543	-2026.5036	-2693.9923	-830.0513	-1364.4081

aOR- adjusted Odd Ratio; Regression include day-of-week dummies

** p<0.01,

* p<0.05.

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longitudinal study in the US among men and women in their late adult life found that women had better self-reported health than men, but they report higher rates of symptoms related to discomfort and functional impairment than men [51].

Explanations for the existence or the non-existence of the gender gap in health refer to differences in labor force participation, education, recreational activities, and domestic activities among men and women [47]. The results of this present study are consistent with these explanations and confirm that differences in the levels of educational attainment as well as active leisure activities largely explain the gender differences in health among elderly. In the UK and the US, we found relatively little differences in the highest educational level among men and women, as shown Tables 1 and 2.

Gender differences in socio-demographic, economic position and family characteristics related to health status

Prior evidence demonstrated that health inequality based on social class exists among the elderly [52,53]. Gender disparities in socio-demographic and economic positions have been suggested as a possible explanation for these observed differences in health [17–19], but there may be variations in gender differences in vulnerability to socio-economic status indicators on health conditions across countries [54,55]. All the three indicators of SEP including education, wealth and employment status showed consistent patterns of health disparities between groups of high and low SEP in our study. However, our results showed also significant gender and cross-country differences in the magnitude of the associations, similar to those reported in previous studies among the elderly [54,55]. Age was significantly associated with poor health among men and women in all countries but not in the US. Nonetheless, previous research also showed a strong negative association between age and health among the elderly [56]. In line with previous studies [19,21], educational attainment was significantly associated with health status in both elderly men and women in all countries; the prevalence of poor health increased with decreasing educational level.

In all the countries, the labour force participation among the elderly was lower for women than for men (Tables 1 and 2). The US recorded the highest proportion (approximately 23% for men and approximately 14% for women) of labour force participation compared to the European countries in our study. Evidence from the US suggests that changes in pension systems and a high cost of health care in recent years are potential explanations for the high employment rate among the elderly [57], whereas most EU countries have universal health care systems [40].

Housing tenure and car ownership were used as proxy indicators for measuring wealth. These two indicators were significantly associated with health among men and women, but

Table 5. Multivariate associations between poor self-reported health status, socio-economic position, family characteristics and time use. Women, 65+ years old.

Variables	Germany	Italy	Spain	UK	USA
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Time use Activity					
Paid work hours/day					
Less than 1 (ref)					
1or more	0.49 (0.22–1.05)*	1.48 (0.63–3.48)	0.95(0.48–1.87)	0.86 (0.33–2.20)	1.20 (0.76–1.89)
House work hours/day					
Less than 4 (ref)					
4 to 6	0.85 (0.66–1.08)	1.02 (0.81–1.28)	0.69(0.59–0.81)**	0.85 (0.67–1.10)	0.69 (0.57–0.84)**
>6	0.93 (0.67–1.28)	0.75 (0.57–0.98)*	0.57(0.46–0.69)**	0.70 (0.51–0.96)*	0.62 (0.49–0.79)**
Active leisure hours/day					
Less than 2 (ref)					
2 to 4	0.83 (0.62–1.11)	0.95 (0.78–1.16)	0.63(0.54–0.73)**	0.97 (0.74–1.26)	0.64 (0.53–0.77)**
>4	0.42 (0.30–0.60)**	0.74 (0.57–0.96)*	0.40(0.33–0.49)**	0.86 (0.62–1.19)	0.59 (0.48–0.73)**
Passive leisure hours/day					
Less than 3 (ref)					
3 to 5	1.13 (0.90–1.42)	1.22 (1.02–1.46)*	0.99(0.86–1.14)	1.31 (1.02–1.70)*	1.22 (1.00–1.49)*
>5	1.07 (0.76–1.52)	1.39 (1.06–1.82)*	1.06(0.87–1.28)	2.26 (1.65–3.08)**	1.45 (1.17–1.80)**
Personal activity hours/day					
Less than 10 (ref)					
10 to 12	0.64 (0.46–0.90)*	1.00 (0.76–1.32)	1.07(0.85–1.35)	0.91 (0.69–1.19)	1.17 (0.97–1.41)
>12	0.85 (0.58–1.24)	1.33 (0.98–1.81)*	1.37(1.06–1.76)*	1.44 (1.04–1.99)*	2.05 (1.66–2.53)**
Age					
65–69 (ref)					
70–74	0.82 (0.64–1.05)	1.34 (1.11–1.62)**	1.03(0.89–1.20)	1.21 (0.92–1.59)	1.06 (0.85–1.31)
75–79	1.23 (0.93–1.62)	2.33 (1.84–2.96)**	1.23(1.04–1.47)*	1.34 (1.00–1.79)*	1.16 (0.93–1.44)
80+	2.04 (1.46–2.84)**	2.64 (2.02–3.46)**	1.14(0.95–1.37)	1.36 (0.99–1.88)*	1.03 (0.84–1.27)
Education					
Incomplete Sec. or less (ref)					
Secondary completed	0.89 (0.70–1.11)	0.66 (0.55–0.79)**	0.47(0.41–0.54)**	1.00 (0.73–1.37)	0.39 (0.32–0.47)**
Tertiary completed or above	0.86 (0.63–1.17)	0.44 (0.28–0.69)**	0.41(0.31–0.55)**	1.35 (0.93–1.95)	0.27 (0.22–0.32)**
Wealth					
Land tenure					
Renting (ref)					
Owner occupier	0.79 (0.63–0.97)*	0.98 (0.80–1.18)	1.06(0.88–1.27)	0.68 (0.53–0.87)**	0.62 (0.52–0.74)**
Car ownership					
No car (ref)					
1 car	0.68 (0.53–0.87)**	0.65 (0.52–0.81)**	0.76(0.66–0.88)**	0.53 (0.41–0.69)**	-
2+ cars	0.69 (0.42–1.13)	0.61 (0.49–0.78)**	0.68(0.55–0.85)**	0.23 (0.14–0.39)**	-
Employment Status					
Not working for pay (ref)					
Currently in paid employment	0.75 (0.50–1.13)	0.34 (0.17–0.67)**	0.43(0.23–0.81)**	0.64 (0.35–1.18)	0.32 (0.23–0.46)**
Household size					
1 member (ref)					
2 members	2.34 (1.83–3.00)**	1.13 (0.92–1.40)	1.05(0.89–1.23)	1.63 (1.27–2.10)**	1.27 (1.07–1.50)**
3 members	1.97 (1.31–2.96)**	1.25 (0.97–1.61)*	1.15(0.94–1.39)	3.83 (2.20–6.69)**	1.04 (0.78–1.39)
Observations	1,848	4,939	5,659	1,694	4,052

(*Continued*)

Table 5. (*Continued*)

Variables	Germany	Italy	Spain	UK	USA
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Pseudo R2	0.079	0.075	0.071	0.089	0.131
Log Likelihood	-1176.0733	-2077.1254	-3318.7431	-1067.6131	-2201.9978

aOR- adjusted Odd Ratio; Regression include day-of-week dummies

** p<0.01,

* p<0.05.

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not in all countries observed. For example, we found a strong positive association with health among male owner occupiers in the UK, which could not be observed in the other countries. Meanwhile, among women, this strong association persisted not only in the UK but also Germany and the US. This results concurred with the findings of Dalstra et al. [21], who found that health differences for housing tenure were generally smaller in all countries observed except the UK and the Netherlands. Our findings suggest that the relationship between housing tenure and health among the elderly largely depends on the country and the findings may be due to the differences in the national housing policies and local housing market. We further showed a strong positive association of car ownership with health for both elderly men and women. This result is in line with a study conducted by Arber and Ginn [58], which have shown that elderly people who do not own a car have higher odds of reporting poor health. However, we found a weaker association for men in Germany, but not elsewhere, while the association was stronger for women in Germany and the other countries. These findings suggest that wealth plays a critical role in the health of elderly men and women and could be linked to the fact that material resources such as car ownership enable the elderly to carry out daily activities such as shopping with ease. Also, material resources enable older adults to participate in leisure and social activities [58], as these activities were found in this study and previous studies [59,60] to be associated with good health among elderly men and women.

Surprisingly, our findings regarding household size suggest that living in a larger household is associated with poor health among elderly men and men. However, the association was stronger among women than men, except in Italy. Among men, the association was not significant in the southern European countries. A common explanation for this phenomenon is that people living in larger households, especially women, suffer more stress [61].

Gender differences in time use activities related to health status

Regarding time spent on housework activities, the results showed that there were gender and cross-country differences. Women spent more time than men in housework activities, consistent with prior evidence [62,63]. Nonetheless, time allocated to housework activities among men has increased over the years [62], and has become more equal with women over time [63]. Despite the apparent gender inequality in time allocation to housework activities, we found that time devoted to housework activities was positively associated with health among both women and men across all countries. Among the working population, unequal division of household labor has been linked with adverse health outcomes among women [24,64]. This could to some extent be explained by the "double burden" of work hypothesis, where the combination of paid market work and domestic work has been proposed be more stressful for women than men [65]. However, given a changed time availability after retirement, this hypothesis might lose its premise in explaining the effect of housework activities on health

Table 6. Non-linear decomposition of female excess in the probability of reporting poor health, by country.

Inequality contributions in terms of differences in group characteristics (by variables) & group processes	Germany		Italy		Spain		UK*	USA*
	Absolute (95% CI)	**Percent**	**Absolute (95% CI)**	**Percent**	**Absolute (95% CI)**	**Percent**	**Absolute (95% CI)**	**Absolute (95% CI)**
Predicted mean in women	0.532 (0.510–0.555)		0.831 (0.820–0.841)		0.674 (0.662–0.686)		0.470 (0.447–0.494)	0.318 (0.304–0.332)
Predicted mean in men	0.392 (0.368–0.417)		0.734 (0.720–0.749)		0.585 (0.570–0.599)		0.471 (0.444–0.498)	0.326 (0.307–0.344)
Female excess	**0.140 (0.106–0.174)**		**0.096 (0.079–0.114)**		**0.089 (0.070–0.108)**		**-0.000 (-0.036–0.036)**	**-0.008 (-0.031–0.016)**
Age	0.003 (0.001–0.006)	2.30%	0.011 (0.008–0.014)	11.10%	0.003 (0.001–0.004)	2.80%	0.003 (-0.001–0.007)	0.000 (-0.001–0.001)
Education	0.016 (0.005–0.028)	11.50%	0.010 (0.007–0.013)	10.10%	0.016 (0.012–0.019)	17.50%	0.002 (-0.004–0.009)	0.003 (-0.004–0.010)
Land tenure	0.010 (0.000–0.021)	7.50%	0.013 (0.009–0.017)	13.40%	0.009 (0.006–0.013)	10.50%	0.026 (0.003–0.049)	0.002 (-0.002–0.005)
Car	0.005 (0.001–0.009)	3.40%	0.001 (-0.001–0.002)	0.80%	0.000 (-0.001–0.001)	0.20%	0.003 (-0.001–0.008)	-
Employment status	0.010 (0.004–0.016)	7.20%	0.006 (0.002–0.009)	5.80%	0.002 (-0.000–0.004)	2.10%	0.006 (-0.002–0.013)	0.007 (-0.006–0.020)
Household Size	-0.021 (-0.031–-0.010)	-14.70%	0.001 (-0.004–0.005)	0.80%	-0.001 (-0.005–0.003)	-1.00%	-0.024 (-0.042–-0.007)	-0.001 (-0.003–0.001)
Paidwork	0.009 (0.001–0.017)	6.70%	0.001 (-0.006–0.007)	0.60%	0.001 (-0.003–0.004)	0.80%	0.003 (-0.002–0.008)	0.001 (-0.002–0.004)
Housework	-0.009 (-0.026–0.009)	-6.10%	-0.000 (-0.045–0.044)	-0.50%	0.002 (-0.040–0.044)	2.20%	-0.022 (-0.038–-0.006)	-0.007 (-0.020–0.005)
Active leisure	0.013 (0.004–0.022)	9.10%	0.013 (-0.011–0.037)	13.40%	0.017 (-0.007–0.041)	18.80%	0.007 (-0.001–0.015)	-0.002 (-0.005–0.001)
Passive leisure	-0.000 (-0.005–0.004)	-0.20%	-0.006 (-0.016–0.005)	-5.80%	-0.007 (-0.014–0.001)	-7.30%	-0.007 (-0.013–-0.001)	-0.002 (-0.007–0.003)
Personal activity	0.000 (-0.001–0.002)	0.30%	-0.003 (-0.007–0.002)	-2.60%	-0.015 (-0.023–-0.007)	-17.00%	0.000 (-0.001–0.001)	0.002 (-0.002–0.006)
Contribution to that part of inequality due differences in group characteristics **(Endowment effects)**	0.038 (0.020–0.056)	**27.00%**	0.045 (0.035–0.056)	**47.20%**	0.026 (0.016–0.037)	**29.70%**	-0.003 (-0.019–0.013)	0.003 (-0.007–0.014)
Contribution to that part of inequality due differences in group processes **(Coefficient effects)**	0.102 (0.073–0.131)	73.00%	0.051 (0.037–0.065)	52.80%	0.063 (0.047–0.079)	70.30%	0.003 (-0.029–0.035)	-0.011 (-0.032–0.010)

* No female excess in the probability of reporting poor health

CI: 95 percent confidence interval.

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among elderly men and women because the elderly may not have the same time constraints of combining both paid work and household activities like the working-age adults.

The few studies that examined the effects of housework on the health among elderly men have given inconsistent results [66–68]. The study by Lawlor et al. [67] examined the impact of domestic activities on health among British women aged 60 to 79 years. Heavy housework activities were not associated with reduced likelihoods of being overweight. Although Wen et al. [68] found the association of housework and health of older adults to be not significant overall, washing clothes and house cleaning were negatively associated with health among women. They speculated that these activities involve almost no interpersonal communication and less extensive physical exertion, hence the negative association with health. On the other hand, housework that involves physical activity may be beneficial to health among older adults [68]. Our measures of housework includes, beside washing clothes and cleaning house, activities that require some form of physical exertion such as gardening, grocery shopping, odd jobs and domestic travels (S1 Table). Accordingly, our finding of the effects of housework on health among elderly men and women may be influenced by the extent of physical exertion of these activities.

Paid work at older ages was associated with good health among men, as found in previous studies [69–71], but the patterns were not consistent among women. While we found a negative gradient for paid work and poor health, a longitudinal evidence by Luoh and Herzog [71] suggest that a moderate amount of time devoted to paid work activities is sufficient for a good health and additional time spent on paid work activities will not necessarily increase the health benefit among the elderly.

Active leisure was positively associated with health status for both elderly men and women in all countries, consistent with prior evidence [59,60,72]. Nonetheless, allocation of time to active leisure activities differed between men and women and across countries. As shown in other studies, men devoted more time to active leisure than women [73–75]. Again, consistent with previous studies [36,76] we found that women in Italy and Spain devoted less time to active leisure activities as compared to their female counterparts in other countries. Burda et al. [77] suggested that cross-country differences in social norms with regards to total work distribution and time use patterns are possible explanations for the patterns of gender inequality observed in the Southern European countries. In these countries, gender roles often are shaped in a traditional way where housework activities are traditionally reserved for women [27,78]. Thus, it is evident from our results that part of the time that would be devoted to active leisure was reallocated to housework activities. As a consequence, women in these countries spent a relatively shorter amount of time on active leisure activities while the amount of time devoted to housework activities increases.

Nevertheless, it seems that regardless of cultural or social norms time devoted to active leisure activities is positively related to health of the elderly. Previous studies have also stressed the importance of older adult's participation in active leisure activities for social, psychological and physical health benefit. For example, a study by Kim et al. [60] found that active leisure activities increase the psychological feelings and physical functioning among the elderly. Also, more time spent on fitness activities has been found to be associated with lower risk of mortality among the elderly [79].

In contrast to active leisure activities, passive leisure activities such as listening to radio and tapes, watching television and relaxing were negatively associated with health among both men and women. Similar to our study, television viewing has been linked to poor health, cognitive decline, depressive symptoms and anxiety in older men and women [80,81]. Furthermore, an increase in time spent on television has also be found to be associated with a varied series of health outcomes among older men and women including obesity [82] and

cardiovascular disease [83]. However, Nguyen et al. [84] found that television viewing among older adults was a strategy to cope with depressive symptoms. Likewise, Potts and Sanchez [85] found that television viewing is a way of escaping from depression. The negative association of passive leisure activities on health in most previous studies and this study can be explained by the sedentary nature of these activities as they require little or no physical or mental energy.

Similar to passive leisure activities, more time devoted to personal activities such as sleep, meals and personal services was negatively associated with health among elderly in all countries. No difference in time devoted to personal activities was found between men and women within-countries, but there were cross-national variations. Our results also showed that elderly men and women spent more time on personal activities than those observed for the other activities but more of this time was devoted to sleep. This is not surprising because the increasing incidence of health conditions at older age restrict daily activities among the elderly [1]. As a result, time devoted to personal activities, especially sleep increases among older men and women. Sleep duration has been found to be associated with adverse health outcomes among the elderly including obesity and sarcopenia [86], and cardiovascular disease [87]. Ikehara et al. [87] showed a U-shaped association between sleep duration and mortality from cardiovascular diseases and non-cardiovascular diseases among older adults. In our study, we are unable to separate out the effect of only sleep duration on health. However, our measure of personal activities which includes not only time devoted to sleep, but also time spent on meals and personal services such as bathing concurred with these findings, suggesting that longer durations of these activities are associated with poor health among elderly men and women.

Policy and research implications

Our findings provide evidence of the relationship between social roles (time allocated to role-related activities) and health among the elderly in a gender-specific and country-comparative context. We compared data from Germany, Spain, Italy, UK and the US. These countries represent different institutional settings and differ on national policies and social norms [27]. National policies, in particular welfare provisions, have been shown to have a significant effect on health [88]. Therefore, gender and cross-national variations in health may be explained to some extent by national context and social norms. This complex relationship between the state and family may increase or decrease cost and time in terms of social support, provision of care services and leisure opportunities. As a consequence, men and women may display different time allocation patterns in response to the existing welfare system. In the specific case of our comparative analysis, we found that cross-national variations in welfare provisions of care such as service and cash benefit for the elderly [89] may explain to some extent the differences in the patterns of time use. Furthermore, cultural norms may also shape the relationship between time use allocation decision and health as found in the southern European countries [27], where gender roles are still shaped in a more traditional way. As a result, women devote more time to housework. This time inflexible routine housework activities limit opportunities for engaging in other social and leisure activities for women [28], which affects their health negatively. In our decomposition analysis, we found that the share of health inequality that is explained by active leisure is more than the share due to SEP in Italy and Spain. Therefore, the results of this study demonstrate the importance of taking into account time spent in social roles in the analysis of gender differences in health among the elderly.

Limitations

The cross-sectional design of this study prevents us to conclude any causal association. Because the association between time use activities and health may be reciprocal, conclusions such as "older people allocate less time to certain time use activities due to poor health" (and vice versa) cannot be drawn. Again, this study relied on self-reports of time use activities and general health status. Nonetheless estimates from time use surveys have been found to be more accurate and reliable than survey estimates [90,91]. Although self-reported health has been shown to be an inclusive and accurate measure of health status [92], and a good predictor of mortality among the elderly [93], it should also be acknowledged that there may be gender and cross-country differences in reporting [94,95].

Another possible limitation is that only primary activities were considered in the analysis due to data limitations, although it has been shown that performing secondary activities like care activities and watching television simultaneously with primary activities may provide some detailed information about time use. Thus, eliminating parallel activities may distort the picture of the time devoted to the various task of life. However, in practice, secondary activities are usually ignored in time-use analysis [96]. Due to data constraints, this study could not include income which is a traditional measure of SEP. Albeit, in research among the elderly, wealth has been suggested as a better measure of economic well-being as compared to income [97], as it better reflects the permanent economic position [98]. Therefore, the present study utilizes car ownership and land tenure as proxy indicators for measuring wealth [21,58]. Although we have controlled for a variety of confounding factors, biological traits and behavioral risk factors which may play a role in the explanation of gender inequalities in health were not included in the present findings.

Despite these limitations, this study provides the first overview of time use activities and their relationship with health using a large-scale and comparative set of time use data across Europe and the US of the elderly population.

Conclusions

The overall goal of this study was to explain the gender differences in health among the elderly by taking time use activities and other social factors into account. We conclude that education and time spent on active leisure are the largest contributors to gender differences in health among the elderly. The evidence provided in this study demonstrates the need for and usefulness of an integrated framework of social factors in analyzing and explaining the gender and cross-national differences in health among the elderly.

Supporting information

S1 Table. Typology of activities.
(DOCX)

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S1 Table. Typology of activities

Broad categories of activity	Name of variable (harmonised)	Description
1. Paid work	AV01	Paid work
	Av02	Paid work at home
	AV03	Second job
	AV05	Travel to/ from work
2.Housework	AV06	Cooking/Washing up
	AV07	Housework
	AV08	Odd jobs
	AV09	Gardening, pets
	AV10	Shopping
	AV12	Domestic travel
3.Active leisure	AV11	Child care
	AV23	Civic duties
	AV19	Active sport
	AV21	Walks
	AV17	Leisure travel
	AV18	Excursions
	AV22	Religious activities
	AV24	Cinema, theatre
	AV26	Social club
	AV27	Pub
	AV28	Restaurant
	AV29	Visiting friends
	AV04	School/classes
	AV20	Passive/observer sports
	AV33	Study
	AV34	Reading books
	AV35	Reading papers and magazines
	AV37	Conversation
	AV38	Entertaining friends
	AV39	Knitting sewing etc.
	AV40	Other hobbies
4.Passive leisure	AV30	Listening to radio
	AV31	Television, video
	AV32	Listening to tapes etc.
	AV36	Relaxing
5.Personal activity	AV13	Dressing/toilet
	AV14	Personal Services
	AV15	Meals, snacks
	AV16	Sleep

Study II

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Investigating the associations between productive housework activities, sleep hours and self-reported health among elderly men and women in western industrialised countries

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Abstract

Background: After retirement, elderly men and women allocate more time to housework activities, compared to working-age adults. Nonetheless, sleep constitutes the lengthiest time use activity among the elderly, but there has not been any study on the associations between time spent on housework activities, sleep duration and self-reported health among the older population. This study not only examined individual associations between self-reported health and both housework activities and sleep duration, but it also explored self-reported health by the interaction effect between housework activities and sleep duration separately for men and women.

Methods: Pooled data from the Multinational Time Use Study (MTUS) on 15,333 men and 20,907 women from Germany, Italy, Spain, UK, France, the Netherlands and the US were analysed. Multiple binary logistic regression models were used to examine the associations between three broad categories of housework activities ((1) cooking, cleaning and shopping, (2) gardening and maintenance; (3) childcare) and health. We further investigated the extent to which total housework hours and sleep duration were associated with self-reported health for men and women separately.

Results: We found a positive association between time devoted to housework activities, total housework and health status among elderly men and women. Compared to those who spent 1 to 3 h on total productive housework, elderly people who spent >3 to 6 h/day had higher odds of reporting good health (OR = 1.25; 95% CI = 1.14–1.37 among men and OR = 1.10; 95% CI = 1.01–1.20 among women). Both short (<7 h) and long (>8 h) sleep duration were negatively associated with health for both genders. However, the interactive associations between total productive housework, sleep duration, and self-reported health varied among men and women. Among women, long hours of housework combined with either short or long sleep was negatively associated with health.

Conclusions: Although time allocation to housework activities may be beneficial to the health among both genders, elderly women have higher odds of reporting poor health when more time is devoted total housework combined with either short or long sleep duration.

Keywords: Self-reported health, Gender, Elderly, Sleep duration, Housework activities

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Background

Due to the increase in life expectancy among older adults, time spent in retirement has increased remarkably [1]. In fact, the retirement of an individual affects the distribution of allocated time to the various task of life. A plethora of literature has examined how elderly men and women spend their time after retirement. Most of the related literature that examined post-retirement time use showed that elderly men and women are more involved in social roles and activities such as voluntary work [2–4], leisure activities [5, 6], grandparenting [7, 8] and household activities [6, 9], than their younger counterparts [9–11].

Household activities are part of the daily lives of older people. These activities have become their main "productive work" after retirement [12]. Using longitudinal data, Szinovacz [13] found that retirees devoted more time to housework activities than their working spouses. However, evidence suggests that gender inequality in the division of household labor largely persists in high-income societies even after retirement [13, 14]. Most studies confirm that elderly women spend more time on housework activities than men [14–16], although time allocated to housework activities among men has increased over recent years [15]. Again, women typically perform routine, repetitive tasks such washing clothes, cooking and cleaning house [17, 18], while men are responsible for occasional tasks such as household repair works, vehicle maintenance and yard work [17, 18]. It has been suggested that this inequitable division of housework is one of the factors that contribute to the observed adverse health differences among men and women including psychological distress [19] and depressive symptoms [20]. These adverse health outcomes are stronger for women than men in their prime working age [21]. Thus, gendered work-life imbalance could be a contributing factor for health inequalities, where women are more likely than men to report poorer health [19]. Although the gendered distribution of housework seems to be correlated with low psychological well-being and poor health among women, there is some evidence that suggests housework may have a positive impact on physical health among elderly men and women [14, 22].

Nonetheless, an important aspect of daily time use activities among older men and women is sleep. Sleep is one of the most important determinants of health [23]. Thus, the duration and quality of sleep have significant health consequences for children, adults and the elderly. Among the elderly, sleep constitutes the lengthiest daily activity [24]. This is expected because the increasing prevalence of health conditions at older age restricts time allocation for other daily activities [6]. Time devoted to sleep is therefore crucial because it has been shown to be correlated with health among older adults. Among adults, short sleep has been found to be associated with some adverse health outcomes including cardiovascular disease and obesity [25]. Conversely, long sleep duration has been linked with increased risk of mortality and morbidity [23].

Time resources are limited within 24 h or 1440 min in a day. Therefore, within this period, time devoted to a particular activity influences time allocation to other daily activities. For example, more time allocation to housework may decrease the amount of time devoted to sleep or other time use activities such as leisure.

To our knowledge, only one study has examined the effect of various housework activities on health among older adults [26]. Moreover, the gender-specific interactive effects of time spent on housework and sleep duration on self-reported health have yet to be investigated among the elderly. Accordingly, this study seeks to explore the relationship between housework activities, total housework and sleep on self-reported health among the elderly in high-income countries. The following two questions will be addressed:

1) How does time spent on housework activities impact the health among the elderly? To what extent do these effects vary by gender?
2) To what extent is the association between housework activities and health moderated by sleep hours among men and women?

Methods

Data

Data came from the Multinational Time Use Study (MTUS, version W53), a cross-national harmonized and comparative time-use database. The Centre for Time Use Research at the University of Oxford organized and collated this data, which was a collection of national randomly-sampled time-use surveys conducted by institutions in 25 countries [27]. This data set contains information on time allocation to various daily tasks, as well as socio-economic and demographic background information of the respective diarist. Diaries were self-administered, followed by a personal visit in most countries. In the interviews, individual participants reported the total time spent per day on 41 activities in 5, 10 or 15-min intervals [27], during a randomly assigned day in a week in Spain, Italy, Germany France and the US or two days (weekday and weekend) in the UK. In the Netherlands, individuals report their activities throughout the 24 h of the day for seven consecutive days. We excluded individuals whose diaries did not sum up to 1440 min (24 h) of activities during the day. Only primary or "main" activities were included in this analysis. Information on secondary activities (activities done while multitasking) were not captured. After considering the minimum retirement age in most EU countries.,

we limited our sample to individuals who were 65 years and above. For the selection of countries, we selected countries that incorporate health and wellbeing measures into their diary collections. The countries used for the final analysis after these exclusions were the United Kingdom (survey year: 2000; response rate: 45%), the United States (survey year: 2003, response rate: 57%), Spain (survey year: 2002; response rate: 64%), Italy (survey year: 2002; response rate: 92%), Germany (survey year: 2001; response rate: 96%), France (survey year: 1998, response rate: 88%) and the Netherlands (survey year: 2000; response rate: 25%).

Independent variables

Time spent on housework activities and sleep were the two independent variables used for this study. Sleep time and time allocated to housework activities were directly estimated from the data. Because it is not easy to identify productive household activities in time use research, we used the "third party" criterion to identify and select these activities. This approach is widely used in the literature in defining productive household activities [28]. By this criterion, "if an activity is of such a character that might be delegated to a paid worker, then that activity shall be deemed productive" [29]. In other words, this comprises housework that people can pay others to perform for them. Hence, activities such as cooking, gardening, washing, maintenance, laundry, grocery shopping and childcare were considered as productive housework activities. In this current study, we focused on three broad categories of housework activities, in line with Wen et al. [26]:

- cooking, cleaning and shopping
- gardening and maintenance
- childcare

Each category of time use activity was measured in minutes per day. Total housework hours were measured in hours per day. Sleep hours or duration was defined as the total amount of time devoted to sleep. This encompasses all forms of sleep (including daytime sleep and naps). Sleep hours were classified into three categories, i.e., <7 h (short sleep duration), 7–8 h (optimal sleep duration), and >8 h (long sleep duration), based on existing cut-offs in epidemiologic studies [30].

Dependent variable

The dependent variable was self-reported health. In the time-use survey, the question posed to the diarist was "How is your health in general; would you say that it is …?" response options: zero (poor) to three (very good). We categorized the responses into poor (poor or fair) and good (good or very good) [14]. Self-reported health has been shown to be a reliable and accurate measure of current health status [31, 32].

Covariates

Covariates included in the analyses were age, education (less than secondary education, completed secondary education and above secondary education), housing tenure (owner-occupier, renting), employment status (not working for pay, currently in paid employment), household size (1, 2, 3+) and car ownership (no car, one car and two or more cars).

Statistical analysis

The first part of the analysis was primarily descriptive, where information on distributional characteristics of all variables including the mean time allocated to the various productive housework activities was provided. In the second part of the analysis, we applied binary logistic regression to model the association between self-reported health and each of the three broad housework categories, total housework and sleep hours. The multivariate regression models included other time use activities (paid work, active leisure, passive leisure and personal activities, see Additional file 1: Table S2). In the third part, we examined the combined association of total productive housework hours and sleep duration (short sleep duration, optimal sleep duration and long sleep duration) on self-reported health. Here, we investigated twelve combinations as follows: four groups of total productive housework hours (housework <1 h/day, housework 1 to 3 h/day, housework >3 to 6 h/day, housework >6 h/day) × three groups of sleep hours (sleep <7 h/day, sleep >7 to 8 h/day, sleep >8 h/day). The >7 to 8 h/day sleep duration and 1 to 3 h/day time spent on productive housework categories were chosen as the reference. The analyses were done separately for men and women. All statistical analyses were performed in STATA version 14 [33].

Results

Descriptive statistics

The descriptive statistics for respondents stratified by gender are shown in Table 1.

Women in the study were slightly older than men. The mean age of women was 73.2 years and for men 72.4 years. Men had higher educational attainment than women. About 20.3% of elderly men and 13.3% of women reported having a tertiary education. Elderly men were more likely to own a house than women (77.5% vs 73.2%). Regarding employment status, about 9.0% of older men were in paid employment, compared to 4.7% of women. The average number of people in the household was similar for both men and women (approximately 2 members).

Gender differences were also found in time allocation to productive housework activities. Older men and women both allocated more time to cleaning and cooking than to occasional task such as gardening and maintenance.

Table 1 General description of the study sample (in percentages, means and SD), men and women

	Men (15,333)		Women (20,907)	
	Mean / %	SD	Mean / %	SD
Sociodemographic and economic factors				
Age	72.39	5.06	73.19	5.21
65–69	35.7%		31.0%	
70–74	28.3%		26.3%	
75–79	20.0%		20.7%	
80+	16.1%		22.0%	
Education				
Incomplete Sec. or less	49.6%		58.3%	
Secondary completed	30.1%		28.3%	
Tertiary Completed or above	20.3%		13.3%	
Land tenure				
Renting	22.5%		26.8%	
Owner occupier	77.5%		73.2%	
Employment Status				
Not working for pay	91.0%		95.3%	
Currently in paid employment	9.0%		4.7%	
Household size	2.20	1.02	1.89	1.08
1 member	18.2%		41.6%	
2 members	59.1%		41.3%	
3+ members	22.8%		17.1%	
Time use Activity				
Cleaning, cooking & shopping mins/day	84.74	97.02	217.88	139.45
0 min	27.4%		7.2%	
>0 to 60	27.4%		9.7%	
>60 to 120	18.2%		11.4%	
>120	26.9%		71.8%	
Gardening and maintenance mins/day	68.56	109.37	38.54	77.43
0 min	50.4%		59.2%	
>0 to 60	17.4%		21.4%	
>60 to 120	11.0%		9.3%	
>120	21.2%		10.2%	
Childcare mins/day	1.41	15.02	2.07	19.59
0 min	98.3%		97.7%	
>0 to 60	1.0%		1.2%	
>60 to 120	0.3%		0.5%	
>120	0.4%		0.5%	
Total Housework hours/day	3.09	2.65	4.72	2.71
Less than 1	26.4%		10.0%	
1 to 3	27.1%		16.4%	
>3 to 6	31.9%		42.8%	
>6	14.7%		30.8%	
Sleep hours/day	9.43	2.07	9.34	2.10
less than 7	6.7%		6.9%	
>7 to 8	17.4%		18.2%	
>8	75.9%		75.0%	

However, men spent remarkably fewer hours on cleaning, cooking and shopping than women (88.7 min/day vs 217.9 min/day). On the other hand, women devoted fewer hours on gardening and maintenance than men (38.5 min/day vs 68.6 min/day). Regarding the time allocation to total housework, women devoted most hours to these activities (4.7 h per day) compared to men (3.1 h per day). A cross-country comparison in Additional file 2: Table S1 revealed that the most time spent on total housework among elderly women was found in Italy (5.2 h per day) and Germany (5.1 h per day), while the lowest value was observed in the US (4.0 h per day). In contrast, elderly men in Italy devoted the least time to total housework activities (2.7 h per day), while the most time spent on these activities was found in Germany (4.2 h per day).

Time allocated to sleep hours was similar in both genders. Elderly men and women slept for approximately 9 h per day (including daytime sleep and naps). Again, we observed that there were no differences in time devoted to sleep hours among men and women within-countries, but there were cross-national variations (Additional file 2: Table S1). For instance, elderly men and women in Spain and France devoted the most time to sleep hours (approximately 10 h per day), while the average time spent on these activities in the other countries was 1 h less.

Logistic regression

The results of the adjusted OR and 95% CI for the association between the three broad productive housework activities, total housework, sleep hours and the outcome self-reported health are shown in Tables 2 and 3.

Among men and women, we found a positive association between housework activities and self-reported health. However, there were differences in the magnitude of the associations. Time devoted to both routine and repetitive housework activities was significantly associated with good health. We observed that elderly people who spent more than 120 min/day on cleaning, cooking and shopping activities had higher odds of reporting

Table 2 Multivariate associations between good self-reported health status and housework, pooled data of 7 countries. Men, women 65+ years old

Variables	Men	Women
	aOR (95% CI)	aOR (95% CI)
Time use Activities		
Cleaning, cooking & shopping mins/day		
0 min (ref)	1.00 (reference)	1.00 (reference)
>0 to 60	1.23 (1.12–1.35)**	1.61 (1.38–1.89)**
>60 to 120	1.13 (1.02–1.26)*	1.46 (1.25–1.70)**
>120	1.58 (1.43–1.74)**	1.48 (1.30–1.68)**
Gardening and maintenance mins/day		
0 min (ref)	1.00 (reference)	1.00 (reference)
>0 to 60	1.27 (1.16–1.40)**	1.31(1.22–1.41)**
>60 to 120	1.40(1.25–1.56)**	1.43(1.29–1.59)**
>120	1.80(1.64–1.98)**	1.56(1.41–1.73)**
Childcare mins/day		
0 min (ref)	1.00 (reference)	1.00 (reference)
>0 to 60	1.18 (0.85–1.65)	1.11 (0.85–1.46)
>60 to 120	1.60 (0.85–3.00)	1.25 (0.83–1.87)
>120	1.81 (1.03–3.20)*	2.46 (1.63–3.72)**
Pseudo R2	0.0815	0.1049
Log Likelihood	−9728.2581	−12,635.574

*Notes: aOR- adjusted Odd Ratio, ** p < 0.01, * p < 0.05.* CI: confidence interval. Adjusted by age, education, householdsize, land tenure, employment status and other time use activities (active leisure, paid work, passive leisure & personal activities)

Table 3 Multivariate associations between good self-reported health status, total housework and sleep hours, pooled data of 7 countries. Men, women 65+ years old

Variables	Men	Women
	aOR (95% CI)	aOR (95% CI)
Total housework hours/day		
less than 1	0.74 (0.67–0.81)**	0.69 (0.60–0.78)**
1 to 3	1.00 (reference)	1.00 (reference)
>3 to 6	1.25 (1.14–1.37)**	1.10(1.01–1.20)**
>6	1.86 (1.65–2.11)**	1.38(1.24–1.53)**
Sleep hours/day		
less than 7	0.83 (0.71–0.97)*	0.84 (0.73–0.95)*
>7 to 8	1.00 (reference)	1.00 (reference)
>8	0.78 (0.71–0.85)**	0.75 (0.69–0.81)**
Pseudo R2	0.0834	0.1053
Log Likelihood	−9707.8736	−12,629.694

*Notes: aOR- adjusted Odd Ratio, ** p < 0.01, * p < 0.05.* CI: confidence interval. Adjusted by age, education, household size, land tenure, employment status and other time use activities (active leisure, paid work, passive leisure & personal activitie

good health (OR = 1.58; 95% CI = 1.43–1.74 among men and OR = 1.48; 95% CI = 1.30–1.68 among women) compared to those who devoted no time to these activities. Gardening and maintenance activities were associated with higher odds for good health. Older people who spent more than 120 min/day on these activities were more likely to report good health (OR = 1.80; 95% CI = 1.64–1.98 among men and OR = 1.56; 95% CI = 1.41–1.73 among women) compared to those who did not allocate any time to these activities. The odds of reporting good health were significantly higher (OR = 1.81; 95% CI = 1.03–3.20 among men and OR = 2.46; 95% CI = 1.63–3.72 among women) for elderly people who spent more than 120 min/day on childcare activities compared to those who devoted no time to childcare.

Furthermore, Table 3 shows that total productive housework activities and sleep duration were also related to health in both genders. In the model, we found a statistically significant association between good health and time devoted to housework. Elderly people who spent more than 6 h on housework activities had higher odds of reporting good health (OR = 1.86; 95% CI = 1.65–2.11 among men and OR = 1.38; 95% CI = 1.24–1.53 among women) compared to those who spent 1 to 3 h on these activities. The odds of reporting good health status were lower among older people who devoted less than 7 h (OR = 0.83; 95% CI = 0.71–0.97 among men and OR = 0.84; 95% CI = 0.73–0.95 among women) and more than 8 h (OR = 0.78; 95% CI = 0.71–0.85 among men and OR = 0.75; 95% CI = 0.69–0.81 among women) compared to those who reported a sleep duration between 7 to 8 h.

Interactions

Table 4 and Fig. 1a and b shows the combined associations of total housework hours and sleep duration on self-reported health by gender.

Among both genders, any combination of sleep duration not equal to 7–8 h and less than one hour spent on total housework was significantly associated with poorer health. On the other hand, the odds of reporting good health were significantly higher among older men who devoted more than 6 h/day of housework with any sleep hours category as compared to the reference group. Conversely, the odds of reporting good health were significantly lower among elderly women with any combination of sleep hours category with more hours of housework as compared to the reference group defined as above.

Discussion

This study explored the individual association between housework activities, sleep duration and self-reported health, and additionally examined the combined associations of total housework and sleep duration on self-reported health among elderly men and women in selected

Table 4 Combined associations between good self-reported health status, total housework hours and sleep hours, pooled data of 7 countries. Men, women 65+ years old

Combinations	Sleep <7 h/day	Sleep >7 to 8 h/day	Sleep >8 h/day
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Men			
Housework <1 h/day	0.72 (0.52–1.00)*	1.04 (0.81–1.34)	0.61 (0.51–0.73)**
Housework 1 to 3 h/day	0.92 (0.67–1.26)	1.00 (reference)	0.86 (0.72–1.03)
Housework >3 to 6 h/day	1.07 (0.81–1.42)	1.43 (1.16–1.77)**	1.06 (0.88–1.27)
Housework >6 h/day	1.76 (1.27–2.43)**	1.68 (1.32–2.15)**	1.70 (1.38–2.10)*
Women			
Housework <1 h/day	0.70 (0.44–1.11)	0.71 (0.49–1.04)*	0.34 (0.27–0.43)**
Housework 1 to 3 h/day	0.70 (0.49–1.01)*	1.00 (reference)	0.50 (0.40–0.62)**
Housework >3 to 6 h/day	0.61 (0.47–0.81)**	0.75 (0.60–0.94)*	0.60 (0.49–0.74)**
Housework >6 h/day	0.77 (0.59–1.01)*	0.91 (0.72–1.14)	0.78 (0.62–0.97)*

*Notes: aOR- adjusted Odd Ratio, ** $p < 0.01$, * $p < 0.05$.* CI: confidence intervals. Adjusted by age, education, household size, land tenure, employment status and other time use activities (active leisure, paid work, passive leisure & personal activities)

high-income countries. As far as we know, this is the first study to analyze these interactive associations among elderly men and women in six European countries and the US using time use data. On the descriptive level, our study showed that elderly women allocate more time to routine and repetitive housework such as cleaning and cooking, whereas elderly men tend to devote more time to occasional tasks such as gardening and maintenance. Interestingly, both routine and occasional housework activities were positively associated with health among elderly men and women, but the magnitude of the association varied. Regarding time spent on total housework activities, there were gender and cross-country differences. Women spent more time than men in housework activities, consistent with previous literature [11, 12]. However, we observed a cross-country variation in time devoted to these activities. The result as shown in Additional file 2: Table S1 revealed that elderly women in the southern European countries and Germany allocated most time to total housework activities. In contrast, men's total housework activities were about 2 h per day less than that of women in the southern European countries. Meanwhile, the difference

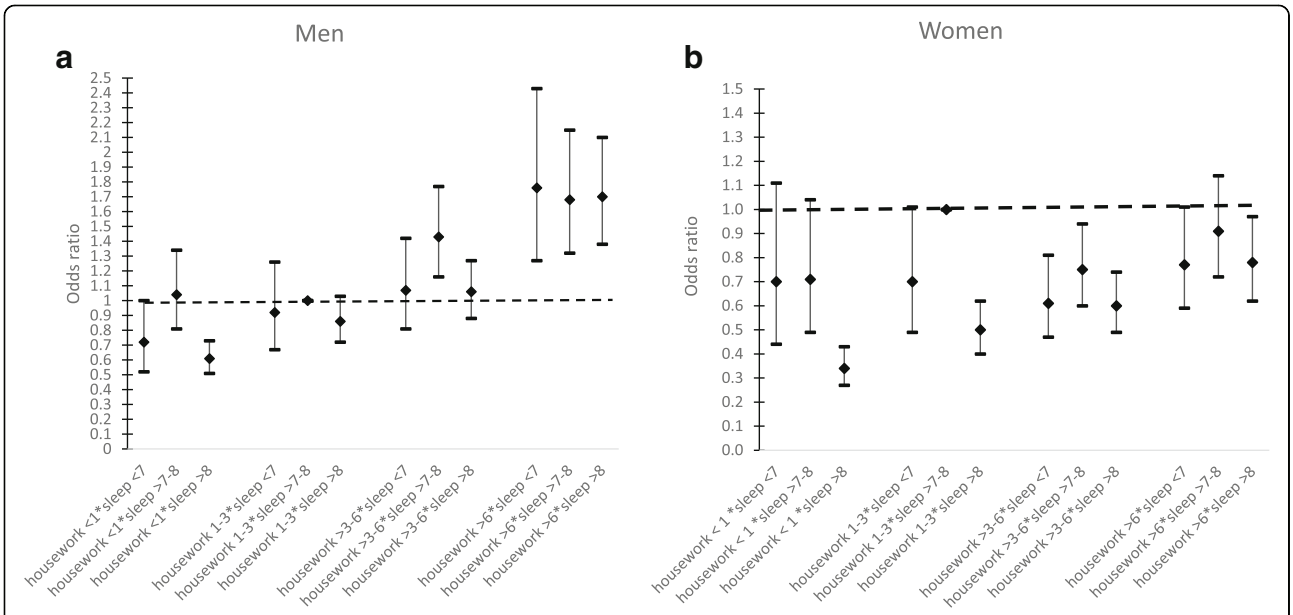

Fig. 1 a Combined associations between good self-reported health status, total housework hours and sleep hours, pooled data of 7 countries. Men, 65+ years old. **b** Combined associations between good self-reported health status, total housework hours and sleep hours, pooled data of 7 countries. Women, 65+ years old

in housework among older men and women was approximately 1 h per day in Germany. Gender differences in the allocation of time especially for housework may to some extent be explained by cultural and social norms [34]. These norms may shape total work distribution and time use patterns of the various task of life among men and women. For instance, in the southern European countries where gender roles are still shaped in a more traditional way [34], women devote a significant amount of time to housework activities while the amount of time devoted to other time use activities may be reduced.

Housework activities, sleep hours and health

Although gender inequality in time allocation to housework activities exists [15, 16], we found that time devoted to the three broad categories of housework activities were positively associated with health among elderly women and men. Our findings of the association between routine housework activities (cleaning, cooking and shopping) and health contrast with a recent study conducted in China. Wen et al. [26] found no significant association of cooking, cleaning and grocery shopping and health among older men, but washing clothes and house cleaning were negatively associated with health among women. Meanwhile, our results corroborate a longitudinal study of 2761 older Americans aged 65 years [35]. Glass et al. [35] found productive housework activities such as cooking, shopping and gardening to be associated with lower risk of mortality. To these effects, we note that the three broad categories of housework activities involve some form of physical activities which may be beneficial to health among older adults [36]. Gardening and maintenance activities may increase fitness level and muscle strength because they require some form of physical exertion such as carrying equipment for repair works, lawn mowing, shoveling, digging holes and carrying soil. Previous studies have also stressed the health benefits of gardening for older adults; such benefits include physical health, psychological health, cognitive ability, and low risk of depression [37, 38]. Park et al. [39] recently reported that gardening has a positive effect on the blood lipid profiles, blood pressure and level of inflammatory markers in blood.

We also found a positive association between childcare and health status among older people. Although the amount of time devoted to childcare activities among the elderly is very small compared to young adults [6], caregiving support, especially caring for grandchildren, has been linked with good psychosocial health [40, 41]. Ku et al. [41] found that grandparenting was positively associated with good self-reported health and lower risk of depression. However, in some instances, more time devoted to childcare among older adults may have a negative impact on their physical or mental health [42], especially among custodial grandparents [43, 44].

Regarding time devoted to total housework hours, the result showed a positive association with health status among both genders. The few studies that examined the effects of total time spent on housework and health among elderly men have given inconsistent results [26, 35, 45, 46]. Lawlor et al. [46] reported that heavy housework was not associated with reduced likelihood of being overweight among British women aged 60 to 79 years.

Among the working population, unequal division of household labor has been linked with adverse health outcomes especially among women [19, 21]. One main hypothesis that has been advanced to explain these gender-specific inequalities in health is the "double burden" of work hypothesis. It has been postulated that the combination of paid market work and domestic work may be more stressful for women than men [47], which may affect women's health negatively [19, 48]. Research findings [6, 34] indicate that the patterns and distribution of time use vary largely among the elderly and the working population. Therefore, the elderly may not have the same time constraints of combining both paid work and household activities like the working-age adults. In this case, the "double burden" of work hypothesis might lose its premise in explaining the effect of total housework on health among elderly men and women. In our view, housework activities by the older population can be perceived as domestic leisure activities [12] and forms of domestic physical activities [38] rather than "work overload", given a changed time availability after retirement. Hence, there is overall evidence for a positive association between housework activities and health status among elderly men and women.

Regarding sleep duration and self-reported health, we found a U-shaped association where both short (<7 h) and long (>8 h) sleep duration were negatively associated with self-reported health for both genders, consistent with prior findings [49–52]. The magnitude of the association was greater for long in comparison with short sleep duration. No significant difference in sleep duration was found between men and women within-countries, but there were cross-national variations (Additional file 2: Table S1). Currently, it is unclear whether older men or older women actually sleep longer on average [53–55]. Nevertheless, both elderly men and women allocate more time to sleep than any other time use activity [6, 24]. This time use pattern is expected among older individuals due to the increasing incidence of adverse health conditions [6]. Conversely, both short and long sleep duration have been found to be associated with adverse health outcomes including diabetes mellitus [55, 56] obesity [57, 58], osteoporosis [59] and hypertension [60]. Furthermore, recent studies suggest that both short and long sleep duration are associated with increased mortality rates [23, 61]. Considering gender, a cohort study by Ikehara et al. [62] showed a U-shaped

association between sleep duration and all-cause mortality for both men and women. Even though our data does not permit examining the association with mortality, previous studies have consistently shown a strong relationship between self-reported health and mortality [63, 64].

While the assessment of gender differences in housework and sleep duration with health status was informative, our study further examined the combined associations, as they provide information about a potentially important interactive gender effect. The results showed that the interactive associations between housework, sleep duration and self-reported health vary by gender. Among men, the combination of longest housework hours with either short or long sleep duration yielded a strong positive association with self-reported health. On the contrary, a combination of longest housework hours with either short or long sleep duration yielded a negative association on self-reported health among women. The result suggests that regardless of sleep duration, less housework was associated with poor health status among both genders.

There is no prior evidence of the combined association of sleep duration and time devoted to housework on health status. Nonetheless, Kiosses and Alexopoulos [65] found that older adults who report higher levels of depression devote less time to housework and other instrumental activities of daily living (IADL) such as shopping and meal preparation. This negative association can be explained by little or no physical or mental energy associated with less housework, as physical inactivity has been found to play a significant role in the development of chronic diseases [66]. As discussed above, short and long sleep durations have also been linked to poor health [55, 56], therefore our findings of the combined effects may be attributed to the negative correlations between less housework, poor sleep and health. Regarding long housework hours and sleep duration, we observed a different pattern among both genders (Fig. 1a and b). For men, long hours of housework was associated with good health status regardless of sleep duration, whereas these very long hours of housework combined with either short or long sleep was negatively associated with health among women. In fact, these patterns suggest that long housework hours is less sensitive to elderly men's health [67] since the impact of long housework and health status appeared to be least influenced by sleep duration.

Limitations and strengths

Our study has some limitations. First, the cross-sectional design of the study prevents conclusions about causality because the association between sleep duration, housework hours and self-reported health may be reciprocal. Second, this study relied on subjective measures to assess duration of sleep, housework and health. However, time use estimates of daily activities have been found to be more accurate and reliable in time use surveys than survey estimates [68, 69]. Notwithstanding, we acknowledge that sleep disturbance [70], may impinge on sleep quality and duration [71], but sleep quality cannot be assessed with time use surveys [24]. Thus, future research should explore objective and sophisticated time use data collection technologies such as smart-phone apps and actigraphy. Third, due to data availability and constrains, we used diary data of time use surveys that have been collected at different points in time with different modes of data collection in the chosen countries, but evaluation studies suggest that these differences do not affect the comparability of the data [11]. Despite these limitations, this current study provides an initial overview of housework activities, sleep duration and their correlations with self-reported health of the population aged 65+ years using a large-scale, homogeneous and comparative set of time use data in Europe as well as the US.

Conclusions

We provide the first evidence of the associations between housework activities, sleep duration and self-reported health among older individuals in selected high-income countries. Our findings suggest that housework activities remain strongly gendered even after retirement. Our findings further suggest that even though time allocation to housework activities may be beneficial to the health among elderly men and women, women have higher odds of reporting poor health when more time is devoted total housework combined with either short or long sleep duration.

Additional files

Additional file 1: Table S2. General description of total housework and sleep hours (means and SD), men and women, by country. (DOCX 15 kb)

Additional file 2: Table S1. Typology of activities. (DOCX 16 kb)

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Authors' contribution

NKA conceived the study, performed statistical analysis and drafted the manuscript. NKA and TB critically revised and reviewed the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The data used for this study comes from the Multinational Time Use Study (MTUS). Detailed information on the survey design and characteristics are provided on the MTUS homepage, https://www.timeuse.org/mtus

Ethics approval and consent to participate

The authors were granted approval from the Multinational Time Use Study Review Board to obtain and use the collected data for analysis. All data were anonymized prior to the authors receiving the data.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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S2 Table.General description of total housework and sleep hours (means and SD), men and women, by country

	Total housework hours/day		**Sleep hours/day**	
	Mean	SD	Mean	SD
Men				
Germany	4.22	2.61	8.69	1.55
Italy	2.73	2.50	9.41	1.86
Spain	2.49	2.54	10.11	2.24
UK	3.94	2.42	8.59	1.66
USA	3.17	2.89	9.04	2.18
Netherlands	4.09	2.72	9.02	1.51
France	3.20	2.32	9.94	2.22
Women				
Germany	5.12	2.43	8.69	1.68
Italy	5.16	2.74	9.40	1.93
Spain	4.80	2.72	9.82	2.19
UK	4.60	2.33	8.62	1.75
USA	4.03	3.00	8.97	2.11
Netherlands	4.69	2.42	9.12	1.93
France	4.55	2.29	10.01	2.39

Study III

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RESEARCH Open Access

Time spent on work-related activities, social activities and time pressure as intermediary determinants of health disparities among elderly women and men in 5 European countries: a structural equation model

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Abstract

Background: Psychosocial factors shape the health of older adults through complex inter-relating pathways. Besides socioeconomic factors, time use activities may explain gender inequality in self-reported health. This study investigated the role of work-related and social time use activities as determinants of health in old age. Specifically, we analysed whether the impact of stress in terms of time pressure on health mediated the relationship between work-related time use activities (i.e. housework and paid work) on self-reported health.

Methods: We applied structural equation models and a maximum-likelihood function to estimate the direct and indirect effects of psychosocial factors on health using pooled data from the Multinational Time Use Study on 11,168 men and 14,295 women aged 65+ from Italy, Spain, UK, France and the Netherlands.

Results: The fit indices for the conceptual model indicated an acceptable fit for both men and women. The results showed that socioeconomic status (SES), demographic factors, stress and work-related time use activities after retirement had a significant direct influence on self-reported health among the elderly, but the magnitude of the effects varied by gender. Social activities had a positive impact on self-reported health but had no significant impact on stress among older men and women. The indirect standardized effects of work-related activities on self-reported health was statistically significant for housework ($\beta = -0.006$; $P < 0.001$ among men and $\beta = -0.008$; $P < 0.001$ among women) and paid work ($\beta = 0.012$; $P < 0.01$ among men and $\beta = 0.000$; $P > 0.05$ among women), which implied that the paths from paid work and housework on self-reported health via stress (mediator) was very weak because their indirect effects were close to zero.

Conclusions: Our findings suggest that although stress in terms of time pressure has a direct negative effect on health, it does not indirectly influence the positive effects of work-related time use activities on self-reported health among elderly men and women. The results support the time availability hypothesis that the elderly may not have the same time pressure as younger adults after retirement.

Keywords: Psychosocial factors, Self-reported health, Gender, Elderly, Time-use activities, Stress

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Background

Gender differences in health among the elderly have been reported in several studies [1–4]. Similar findings among younger adults [5, 6], affirms the long-standing health-survival paradox that women live longer than men, yet they report poorer health [7, 8]. However, there is some evidence that suggests non-existence of gender differences in self-reported health among the elderly in some high-income countries such as the UK, the US and Finland [9, 10]. Thus, the paradox may be country-specific as previously shown for some welfare countries [11]. Furthermore, health differences may be dependent on the health outcomes and phase of the life cycle [9]. The reasons for these observed gender disparities in health are complex and interrelated, but the most cited explanations are differences in biological traits [12–14]. Nonetheless, epidemiological research suggests that biological factors are not sufficient in explaining the health gap between women and men [12, 15].

From a health inequality perspective, several explanatory factors have been suggested [3, 15–17], most of which have been linked to differences in socioeconomic positions such as education, income, and occupation as the main sources of inequality between men and women. Studies have shown that socioeconomic position is often lower among women and thus they are exposed to high levels of stress [18], and among the elderly, they are exposed to a wide range of psychosocial risk factors, when in a lower socioeconomic position [19]. Furthermore, the differential vulnerability hypothesis also suggests that there may be variations by gender in vulnerability to behavioral and psychological health conditions [2].

Notwithstanding the importance of biological and socioeconomic forces in explaining the health disparities between men and women, these factors may not be sufficient for understanding the health gap seen between elderly persons of different gender. A further explanation may be linked to results from post-retirement time use studies which revealed that older men and women often are engaged in social roles and activities such as housework activities [20, 21], leisure activities [20, 22] and voluntary work [23–25] to different degree.

In this regard, social roles and the time invested in such activities, summarized here as time use activities, may to some extent explain the gender differences in health [26]. Studies that used the concept of social roles such as marital status (i.e., being married, divorced, separated or widowed), to examine these relationships concluded that social roles that people occupy may have an impact on their health [27, 28]. However, Bird and Fremont [26] have pointed out that these indicators of social roles are crude and indirect and thus time and effort spent on social roles and activities should be investigated.

Among the elderly, time use activities may be an important determinant of health considering the time availability after retirement [20, 29]. Interestingly, evidence suggests that gender inequality in work-related time use activities (i.e., paid work and housework) persist in high-income countries even after retirement [11, 30]. While elderly men allocate more time to paid work, older women allocate more time to housework activities [29, 31, 32], even though time allocated to housework activities among older men has increased over the years [31]. Regarding these household activities, men typically perform the occasional tasks while women are responsible for routine housework [33, 34]. Despite the gender differences in the distribution of housework, performing these activities are deemed “productive activities” [35] because they are activities that older adults might have delegated to a paid worker.

The inequitable distribution of work-related time use activities may be a contributing factor for the observed gender health differences [36, 37]. Although moderate time spent on these activities can be beneficial to health among the elderly [11], Luoh and Herzog [38] suggested that longer hours devoted to paid work activities might not necessarily improve the health among the elderly. In a recent study Adjei and Brand [39] concluded that older women have higher odds of reporting poor health when more time is devoted housework combined with either short or long sleep duration. The combination of more hours of housework and paid work activities has also been shown to be more stressful among women [40]. Moreover, longer time allocated to these activities may increase time pressures [41]. It may also reduce time availability for social activities such as participation in clubs and religious involvement [42], which may have positive health effects.

From the above discussions, it is clear that the literature on socioeconomic status, work-related activities and stress have identified a direct relationship with health among older adults. However, we argue that these psychosocial factors may have an indirect differential impact on health among men and women. Furthermore, stress in terms of time pressure can mediate the associations between health status and work-related activities, but we speculated in our previous papers [11, 39] that the strength of the relationship between these activities and self-reported health via stress might be weak, due to time availability at old age. However, this assertion has not yet been supported with empirical data among elderly men and women [11]. Our study therefore seeks to disentangle the mechanisms and pathways through which work-related activities, socioeconomic status and stress impact on the health status of the elderly. More specifically, we aimed to examine whether stress defined in terms of time pressure plays a mediating role in the relationship between work-related activities and self-reported health.

Methods

Data

Data from the Multinational Time Use Study (MTUS, version W53) were used for this study. MTUS is a cross-national harmonized and comparative time-use database from 25 countries, collated and organized by the Centre for Time Use Research at the University of Oxford [43]. Diaries were self-administered followed by a personal visit in most countries. In the interview, diarist reported the total time spent on 41 activities over a 24-h period in 5, 10 or 15-min intervals during a randomly assigned day in a week in France, Italy and Spain, and two days (weekday and weekend) in the UK. In the Netherlands, diarist reported their time use activities for seven consecutive days [43]. For the purpose of this study, we limited our sample to participants who were 65 years and above and their time use activities sum up to 1440 min (24 h). The countries considered in the final analysis were the United Kingdom (survey year: 2000; n = 2870), Spain (survey year: 2002; n = 9889), Italy (survey year: 2002; n = 8709), France (survey year: 1998; n = 2231) and the Netherlands (survey year: 2000; n = 1764). These countries were selected based on the availability of the health variable in the respective diary collection.

Measures and model specification

Structural equation models were used to test the proposed relationships between the concepts described in Fig. 1. This model reflected the hypothesized pathways between self-reported health and the psychosocial measures being assessed. Socioeconomic status (SES) was a latent variable, which was represented by a circle. This variable was measured by three observed indicators: education (less than secondary education, completed secondary education and above secondary education), wealth (measured by car ownership, and coded to indicate no car, one car and two or more cars) and employment status (not working for pay, currently in paid employment). Among older adults, these measures of SES have been shown to be associated with health [4, 44].

Self-reported health and stress in terms of time pressure, represented by rectangles, were the two key observed endogenous (dependent variables) used for this study. Self-reported health was assessed using the question: "How is your health in general; would you say that it is …? " response options: zero (poor) to three (very good). We used the responses as a 4-level ordinal variable, where higher levels indicate better health. Intense time pressure, an indicator of stress [41], was measured using the following question: "Would you say you always feel rushed even to do the things you have to do, only sometimes feel rushed, or almost never feel rushed?" The responses were coded as: (1) never (2) sometimes and (3) always. It was used as an ordinal variable, with higher levels corresponding to stress.

In the model, we considered two work-related time use activities (housework and paid work), measured in hours per day, as these activities are associated with stress, depression and physical health status [26, 36, 45].

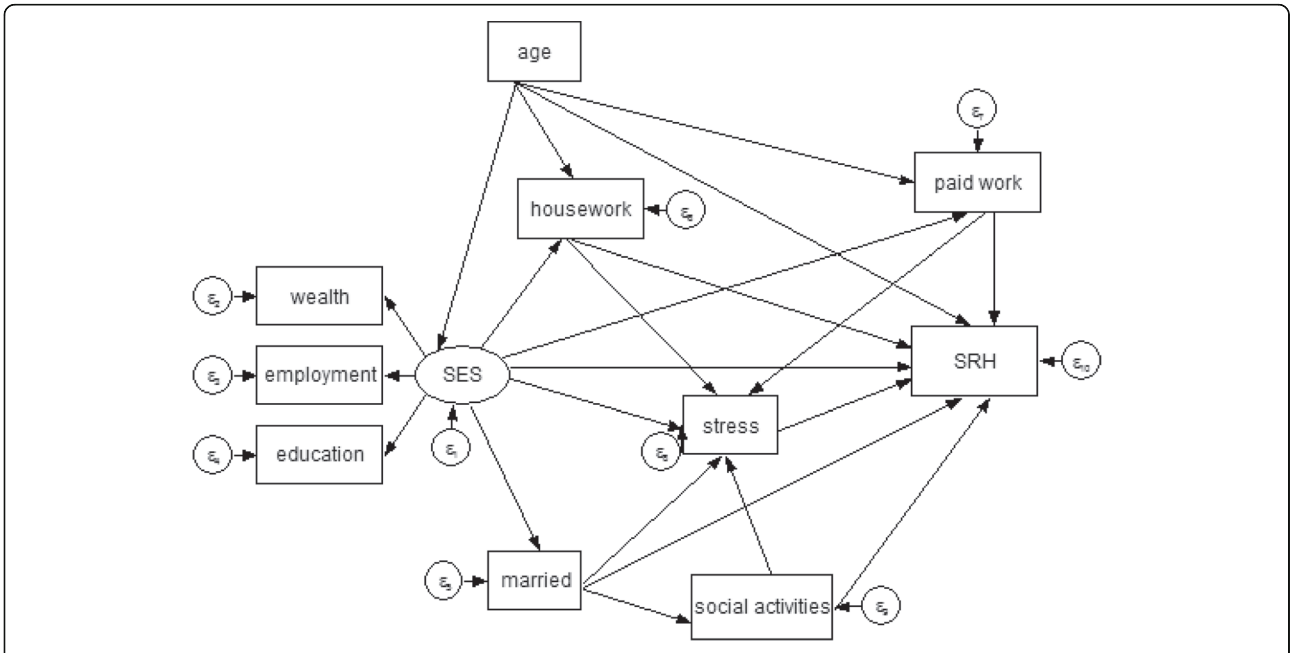

Fig. 1 Conceptual model of self-reported Health (SRH), stress measured by time pressure, socioeconomic status (SES), demographic factors, social activities and work-related time use activities (housework and paid work) among the elderly

We also included marital status (married/cohabiting vs single/widowed) and age which previous studies have found to be associated with stress and general health status [46]. To investigate work-related time use activities and potential "stress buffers", we used time devoted to social activities [41], (measured in hours per day) (Fig. 1). Additional file 1: Table S2 lists the detailed time use activities included in the 3 broad categories used for this study.

Analytic strategy

The analytic strategy included four separate steps. First, descriptive analysis summarized gender differences in self-reported health, stress and other social factors including the mean time allocated to time use activities. Second, Pearson's correlations coefficients (r) were estimated to examine the bivariate correlations of all measured variables. Third, a linear structural model was implemented and estimated using a maximum-likehood function [47]. This was aimed at estimating the direct and indirect relationship between self-reported health, stress, time use activities and other social factors. This can be expressed mathematically as follows:

$$Y = BY + \Gamma X + \alpha + \varsigma \quad (1)$$

where, = vector of the endogenous variables (self--reported health and stress); X= vector of the exogenous variables, both latent (SES) and observed (age, marital status, paidwork, housework and social activities); B and Γ = matrices of the coefficients; α = vector of the intercepts; ς = vector of the error terms.

Finally, a model for the indirect and total effects of housework and paidwork via stress was constructed. The assumption was that stress in terms of time pressure did not mediate the relationship between these work-related time use activities and self-reported health, due to time availability at old age [11]. We use the term "effect" in its technical sense and do not want to imply causation [48].

In order to test the hypothesis, we used stress as a mediating variable to estimate the indirect and total effects of these activities on self-reported health. The total effect was obtained through the summation of the direct and indirect effects using Stata's *estat teffects* command, which can be expressed mathematically as follows:

$$c = c' + ab \quad (2)$$

Where, c = Total effect, c' = Direct effect, ab = Indirect effect.

The chi-square ($\chi 2$) is the traditional measure for assessing the overall goodness of fit of an SEM model [49], however, because it is highly sensitive to large samples [49], we considered the Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA) suggested by Hooper et al. [49] to evaluate model fit. An RMSEA less than 0.06 shows a good fit. The CFI, on the other hand, ranges between 0 and 1, where values closer to 1 indicate better model fit. A good fit was defined as values greater than 0.95 and values greater than 0.90 indicates an acceptable fit to the data [49]. The *estat mindices* command was used for the modification of the initial model and the final conceptual model was subsequently determined based on the chi-square ($\chi 2$) test of additional paths from a theoretical view point. The analyses were done separately for men and women. All statistical analyses were performed in STATA version 14 [50].

Results

Descriptive statistics

Table 1 provides the distribution information of respondents, stratified by gender and Additional file 1: Tables S3 and S4 by country and gender. We observed that more elderly women than elderly men reported poorer health (20.5% vs 15.1%). Women were more likely to report stress than men. Approximately 70.7% of elderly men reported never having any intense time pressure as compared to 58.3% of women. Gender differences were also found in socioeconomic factors. Women were on average older than men (73.1 years vs 72.4 years). However, more men than women were married or cohabiting (79.9% vs 47.1%) and they also had higher educational attainment as compared to women. About 11% of elderly men and 5% of women reported having a tertiary education (Table 1).

Work-related time use activities (housework and paid work) varied considerably among elderly men and women. Women spent more time on housework activities (4.85 h/day vs 2.82 h/day), while men spent more time in paid work (0.26 h/day vs 0.08 h/day). However, a cross-country comparison in Additional file 1: Table S1 shows that the most time devoted to housework activities was found among women in Italy (5.15 h/day), while the least was observed in the Netherlands (4.44 h/day). Elderly women spent remarkably fewer hours in paid work compared to men. We observed that there were no differences in time devoted to paid work among women in Italy, Spain and France. The lowest value was observed in these countries (0.07 h/day), while most time spent in paid work was found in the Netherlands (0.11 h per day).

Regarding time allocation to social activities, men devoted on average 1.21 h/day to these activities as compared to 1.10 h/day for women. The highest value was found in the Netherlands for men and women (1.73 h/

Table 1 General description of the study sample (in percentages, means, 95% CI and SD), men and women

	Men (n = 11,168)			Women (n = 14,295)		
	Mean/ %	SD	(95% CI)	Mean/ %	SD	(95% CI)
Self-reported health						
Poor	15.1		(14.4–15.8)	20.5		(19.9–21.1)
Fair	44.5		(43.6–45.4)	47.0		(46.1–47.8)
Good	32.5		(31.7–33.4)	26.1		(25.4–26.9)
Very good	7.9		(7.4–8.4)	6.4		(5.9–6.8)
Stress						
Almost never	70.7		(69.8–71.5)	58.3		(57.5–59.1)
Sometimes	23.3		(22.5–24.1)	31.7		(30.9–32.4)
Often	6.0		(5.5–6.4)	10.0		(9.4–10.4)
Sociodemographic & economic factors						
Age	72.40	5.01		73.06	5.13	
65–69	35.3		(34.3–36.1)	31.0		(30.2–31.7)
70–74	29.0		(28.1–29.7)	27.7		(26.9–28.4)
75–79	20.2		(19.4–20.9)	20.8		(20.1–21.5)
80+	15.6		(14.9–16.3)	20.5		(19.8–21.1)
Marital Status						
Single/widowed	20.2		(19.4–20.9)	52.9		(52.1–53.7)
Married/Cohabiting	79.9		(79.0–80.5)	47.1		(46.2–47.8)
Education						
Incomplete Sec. or less	60.9		(60.0–61.8)	73.3		(72.6–74.0)
Secondary completed	28.0		(27.1–28.8)	21.4		(20.7–22.1)
Tertiary Completed or above	11.1		(10.4–11.6)	5.2		(4.8–5.6)
Wealth						
Car ownership	2.46	1.45		1.84	1.61	
No car	24.1		(23.3–24.9)	41.6		(40.7–42.4)
1 car	52.5		(51.5–53.4)	39.4		(38.6–40.2)
2+ cars	23.4		(22.5–24.1)	19.0		(18.3–19.6)
Employment Status						
Not working for pay	94.9		(94.4–95.2)	98.1		(97.8–98.2)
Currently in paid employment	5.1		(4.7–5.5)	1.9		(1.7–2.1)
Time use Activities						
Paid work hours/day	0.26	1.36		0.08	0.71	
0 h	94.9		(94.5–95.3)	98.1		(97.8–98.3)
> 0 h	5.1		(4.6–5.4)	1.9		(1.6–2.1)
House work hours/day	2.82	2.51		4.85	2.63	
Less than 1 h	29.2		(28.3–30.0)	9.0		(8.5–9.4)
1 to 3 h	27.9		(27.0–28.7)	14.4		(13.8–14.9)
3 to 6 h	31.4		(30.4–32.2)	44.5		43.7–45.3)
> 6 h	11.6		(10.9–12.1)	32.1		(31.2–32.8)
Social activities hours/day	1.21	1.83		1.10	1.68	
Less than 2 h	76.2		(75.4–77.0)	79.0		(78.2–79.6)
2 to 4 h	16.6		(15.9–17.2)	15.2		(14.6–15.8)

Table 1 General description of the study sample (in percentages, means, 95% CI and SD), men and women *(Continued)*

	Men (n = 11,168)			Women (n = 14,295)		
	Mean/ %	SD	(95% CI)	Mean/ %	SD	(95% CI)
> 4 h	7.2		(6.7–7.6)	5.8		(5.4–6.2)

day vs 1.67 h/day), the least among men in Spain (0.97 h/day) and women in France (0.88 h/day).

Bivariate analysis

The results of the bivariate analysis (Pearson correlation) between all measured variables are shown in Tables 2 (separated by gender).

Overall, the correlational pattern was very similar among women and men. The bivariate analysis showed that stress was negatively associated with self-reported health among elderly men ($r = -0.16$) and women ($r = -0.17$). All three measures of socioeconomic status including education, wealth and employment were positively associated with self-reported health among both genders. Educational attainment showed the strongest correlation among men ($r = 0.20$) and women ($r = 0.21$). Employment and wealth were positively associated with stress for both genders. Meanwhile, educational attainment was found to be negatively associated with stress among women ($r = -0.02$), but not statistically significant for men. Age was significantly and negatively associated with self-reported and stress among elderly men and women. Housework and paid work were positively associated with self-reported health and stress. However, the correlation between stress and these time use activities were low. Surprisingly, social activities were not associated with stress for both genders.

Estimates of direct, indirect and total associations

Table 3 and Figs. 2 and 3 present the estimated direct, indirect and total effects on key outcomes from the structural equation models.

Overall, SES had the greatest direct positive effect on stress among men ($\beta = 0.182$). Among women,

Table 2 Correlations between all measured variables by gender

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Men										
Self-reported health (1)										
Stress (2)	−0.162***									
Age (3)	−0.165***	− 0.019*								
Married (4)	0.035***	0.026**	−0.153***							
Education (5)	0.201***	0.007	−0.081***	0.043***						
Employment status (6)	0.096***	0.095***	−0.120***	0.031***	0.087***					
Wealth (7)	0.135***	0.069***	−0.228***	0.120***	0.154***	0.138***				
Housework (8)	0.163***	0.022*	−0.129***	−0.052***	0.024**	−0.089***	0.062***			
Paid work (9)	0.082***	0.067***	−0.094***	0.017	0.081***	0.595***	0.114***	−0.125***		
Social support (10)	0.084***	−0.004	−0.099***	− 0.043***	0.062***	0.018	0.080***	−0.142***	− 0.042***	
Women										
Self-reported health (1)										
Stress (2)	−0.159***									
Age (3)	−0.169***	−0.086***								
Married (4)	0.054***	0.057***	−0.347***							
Education (5)	0.211***	−0.018*	−0.128***	0.058***						
Employment status (6)	0.091***	0.024***	−0.089***	0.024**	0.085***					
Wealth (7)	0.119***	0.054***	−0.187***	0.213***	0.125***	0.052***				
Housework (8)	0.165***	0.072***	−0.317***	0.240***	0.007	−0.036***	0.050***			
Paid work (9)	0.061***	0.021**	−0.075***	0.027*	0.089***	0.553***	0.053***	−0.037***		
Social support (10)	0.101***	−0.006	−0.057***	− 0.081***	0.045***	−0.011	0.014	−0.159***	− 0.029***	

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

housework had the greatest positive effect on stress (β = 0.049), followed by SES (β = 0.028). Meanwhile, paid work had a negative effect on stress among men (β = −0.069), but it was not statistically significant among women. Nonetheless, both paid work and housework had a positive effect on self-reported health among older men and women. Although stress had a negative direct influence on self-reported health among men and women, we found that the paths from paid work and housework on self-reported health via stress (mediator) were very weak because the indirect effects were close to zero among both genders (Figs. 2 and 3). Hence, there was almost no difference between the direct and total effects of these work-related time use activities on self-reported health among elderly men and women.

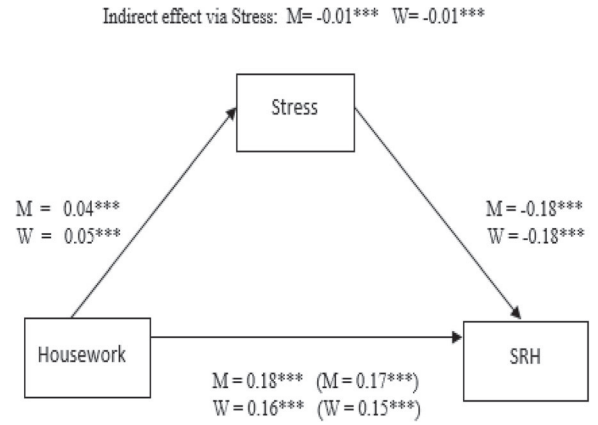

Fig. 2 Indirect effect of housework on self-reported health (SRH) via stress. Standardized coefficients, adjusted for socioeconomic status (SES), age, marital status, social activities and work-related time use activities. Coefficients for the total effects in parentheses. M = men, W = women. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

Discussion

The primary objective of the current study was to investigate the complexity of the relationships between work-related time use activities (housework and paid work), socioeconomic status, stress in terms of time pressure and self-reported health among older people in high-income countries with particular attention to gender differences in the effects. Our study not only analyzed the direct effects but also indirect and total effects, in order to disentangle the mechanisms and pathways through which these variables impact the health status of elderly men and women. The underlying premise of the study was that psychosocial factors influence the health status of older adults, however, these factors may also have an indirect differential impact among elderly men and women. Stress defined in terms of time pressure was thus viewed as a potential mediator in the relationships between social factors and health status (Fig. 1). Our study showed significant direct and indirect relationships between psychosocial factors and self-reported health among men and men, but there were gender differences in the magnitude of the associations. The key findings of the study can be summarized as follows. First, time devoted to housework and paid work was positively associated with self-reported health among elderly men and women. Second, whereas housework was positively associated with stress in both genders, paid work was negatively

Table 3 Standardized direct effects on key outcomes from the Structural Equation Model (SEM)

Path	Men	Women
Direct effects on Stress		
Age	0.003 (0.009)	− 0.060 (0.009)***
Married/Cohabitation	0.021 (0.010)**	0.024 (0.009)**
SES	0.182 (0.027)***	0.028 (0.021)
Housework	0.040 (0.009)***	0.049 (0.009)***
Paid work	−0.069 (0.025)**	− 0.003 (0.017)
Social activities	−0.001 (0.009)	0.001 (0.009)
Direct effects on Self-reported health		
Age	−0.118 (0.009)***	−0.125 (0.008)***
Married/Cohabitation	0.033 (0.009)***	−0.009 (0.008)
SES	0.237 (0.036)***	0.328 (0.054)***
Stress	−0.176 (0.009)***	−0.181 (0.007)***
Housework	0.182 (0.009)***	0.162 (0.008)***
Paid work	0.108 (0.009)***	0.065 (0.008)***
Social activities	0.103 (0.009)***	0.119 (0.008)***

Notes: Significance level: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Observed Information Matrix (OIM) standard errors in parentheses. Model fit: (CFI = 0.92; RMSEA = 0.056, with 90% C.I. = 0.054–0.059), and women (CFI = 0.89; RMSEA = 0.064, with 90% C.I. = 0.062–0.068)

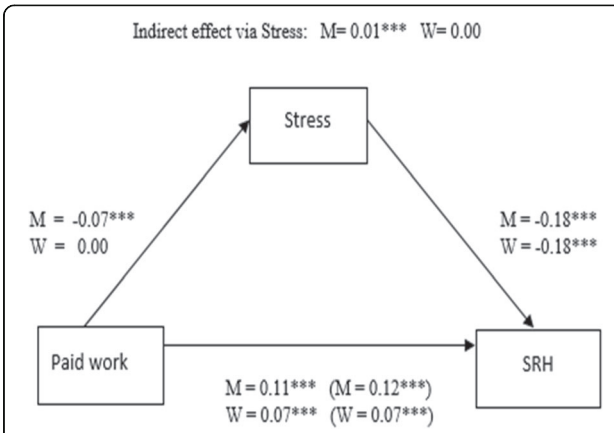

Fig. 3 Indirect effect of paid work on self-reported health (SRH) via stress. Standardized coefficients, adjusted for socioeconomic status (SES), age, marital status, social activities and work-related time use activities. Coefficients for the total effects in parentheses. M = men, W = women. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

associated with stress only among men. Third, high levels of stress had a direct negative impact on self-reported health among elderly men and women, however, we confirmed that stress in terms of time pressure does not play a mediating role in the relationship between housework, paid work and self-reported health. Finally, social activities had a positive impact on self-reported health but had no significant impact on stress among older men and women.

Relationship of the socioeconomic status, time use activities with the health outcomes by gender

Prior evidence suggests that people with low SES are more likely to report poorer health compared to those with higher SES [18, 51, 52]. However, there may be variations in gender differences in vulnerability to socioeconomic status on health outcomes [53, 54], where women are more likely than men to report poorer physical health [11] and psychological distress [36]. In our study, we found that SES measured by education, wealth and employment was an independent predictor of health outcomes among elderly men and women. In line with previous studies [55, 56], we found a positive relationship between higher SES and good health status among the older population. A possible explanation for this outcome is that individuals with low SES may lack access to physical, psychological and environmental resources [52]. Also, it has been hypothesized that low SES leads to greater exposure to stress [18]. In contrast to this hypothesis, our direct effect models showed that stress in terms of time pressure is higher as SES increases among older men, but not statistically significant for women. The explanation to the diverging findings may be due to the measurement concept of stress [41], as this study only considered intense time pressure and not stressful life events such as financial strain [18]. Meanwhile, a recent study by Talala et al. [57] on SES and the distribution of stress found a reverse and curvilinear relationships.

The growing literature documenting partnership status and health among the elderly suggest that married [58, 59] and cohabiting older adults have better health than their unpartnered counterparts [60]. Although a variety of explanations have been given for these differences [61], social isolation and depression among single individuals are some of the psychological factors attributed to this physical health outcome [62]. However, data from several studies suggest that the protective effects of marriage on health are unequal among older men and women [63, 64] and that marriage appears to be more beneficial to men's health compared to women [64–66]. Results from the current study showed a positive relationship between marriage and self-reported health only among men. As previously noted [37], a possible explanation for this phenomenon may be gender differentials in stress exposure from marital responsibilities. Nevertheless, the direct effects of relationship status in the present study indicated that both marriage/cohabitation was positively associated with stress as measured by time pressure among both men and women. This evidence and that of earlier studies [67] suggest that although marriage has an overall health benefit, it may not be a 'buffer' of stress even among the elderly. This is because the key sources of stress associated with marital roles [68] and poor marital quality among young and middle-aged adults [69] may be present among the older population.

Age was also significantly correlated with health in both elderly men and women, in line with the claim that the prevalence of good physical health decreases as age increases [11, 70]. However, age was negatively associated with stress among women but not statistically significant for men, a finding consistent with previous research that showed that older people experience less daily stress compared to midlife and younger adults [71, 72]. This is mainly due to the differential roles of the elderly compared to younger adults. For instance, children are key sources of daily stress for working-age adults and older adults usually do not have the same parental roles and responsibilities with respect to child-rearing [71].

Time devoted to social activities was positively associated with health status for both older men and women, consistent with prior studies [73–75]. Nevertheless, time allocation to social activities varied among elderly men and women across countries. In general, men allocated more time to social activities than women in all countries, except for Spain (Additional file 1: Table S1). Previous studies have also stressed the importance of older adult's participation in social support and network activities such as religious activities [74], social or other clubs [76] for psychological well-being [77] and increase in survival among older people [78]. For example, a study by Engelhardt et al. [79] found that social involvement enhances cognitive functioning among the elderly. Also, social participation has been found to be related to low level of stress and depression among the elderly [77, 80]. We therefore expected social activities to ameliorate stress among older adults, however, we found no significant direct relationship between social support activities and stress among elderly men and women. One possible reason for the lack of association may be related to measurement issues. Social activities was measured by the amount of time spent on activities such as religious activities, visiting friends, excursions and observer sports (Additional file 1: Table S2), and not measuring the quality of social support and network size [81]. These aspects of social network have been found as protective factors against stress in prior research [82].

Work-related time use activities (i.e. housework and paid work) were directly associated with both self-reported health and stress. Paid work was negatively associated with stress among men, but this association

was not found among women. Although the amount of time allocated to paid work activities among the elderly was very small compared to young adults [11], we found paid work at older ages to be directly linked with reduced stress among men. This is consistent with previous findings that support the reduced role-strain hypothesis [83], that suggests that older adults may engage in less demanding and part-time jobs after retirement, which might be less stressful for them, especially for retired men [83]. Even though we were unable to account separately for older adults' engagement in part-time work in our sample, we found that only about 5% and 2% of elderly men and women respectively in Western Europe were in paid employment (Table 1). Recent figures also shows that less than 5% of elderly people in Europe aged 65 years and above were still employed. Nevertheless, the employment rate for the subgroup 65–69 years has increased from 8.8% in 2005 to 10.5% in 2011 [84]. In the US, a higher participation rate in paid employment after retirement than in Europe has been noted [11, 84]. The explanation is that most Western European countries have universal social and healthcare systems [84]. In contrast, the high cost of health care in the US may account for the high employment rate among the older population [85]. Currently, it is still unclear whether working at old age is beneficial to older adult's physical health [11, 38, 86]. Nonetheless, this current study found paid work at old age to be positively related with self-reported health for both genders, as found in some previous studies [11, 86], but the magnitude of the effect varied among men and women [86]. Perhaps, the social network that older adults gain or maintain at their workplace [86] combined with low levels of depressions at old age, due to the reduction in the amount of time devoted to paid work activities [83] may explain these favorable direct correlations between paid work and self-reported health among the elderly.

Regarding time devoted to housework, the result showed gender and cross-national variations (Additional file 1: Table S1). Furthermore, consistent with previous evidence [11, 26, 29, 31, 32, 39], we found that women devote more to housework activities than men. In spite of these gender differences, time devoted to housework was directly and positively related with self-reported health among both genders, consistent with prior evidence [11, 39], although the investigations of the association between time devoted to housework and health in prior research were inconsistent [11, 39, 87, 88]. For example, Lawlor et al. [88] found no association between heavy housework activities and reduced levels of being overweight among older British women. Similarly, a study conducted in China by Wen et al. [87] found negative associations between health status and various types of housework activities among women. On the other hand, Adjei and Brand [39] suggested that some hours devoted to housework activities might improve the health of the elderly. This inconsistency may be due to the different contexts and health outcomes [11, 87].

While we did not find any direct negative impact of housework on self-reported health in this current study, we did find this when examining stress in terms of time pressure among both genders. When potential indirect pathways were examined, mediation analysis did not show an indirect effect of housework on self-reported health via stress. Among the working population, prior studies showed that working-age adults who devote more time to housework activities experience high levels of stress and increased depression [36, 37]. It has been suggested that multiple role demands and work overload may be possible explanations for this psychological health outcome [41, 89]. However, since it was suggested in previous studies [11, 39] that the positive relationship between work-related time use activities and physical health is attributable to less stress at old age, we therefore expected to find support for the time availability theory suggesting that older adults after retirement may not have the same time pressure as younger adults. Indeed, in line with these expectations, we found that stress in terms of time pressure does not mediate or indirectly influence the positive associations between housework, paid work and self-reported health among elderly men and women.

Our analysis is not without limitations. First, the cross-sectional design of the research prevents conclusions about causality, and it is not possible to determine directionality in the relationship between the investigated factors and self-reported health. Second, although we have controlled for a variety of confounders, biological and behavioral determinants of health status among older adults [12, 15] were not included in the theoretical model, due to data constraints. Third, this study used subjective rather than objective reports of time use activities and health status. However, estimates from dedicated time use surveys are more reliable and accurate than survey estimates [90, 91]. Furthermore, self-reported health has consistently been shown to be a valid measure of current health status [92]. Nonetheless, we acknowledge that there may be gender differences in health reporting behavior [93]. Fourth, due to data limitations, this study relied on time use surveys that have been collected at different points in time with variations in the modes of data collection in the chosen countries, however, evaluation studies suggest that these differences do not affect the comparability of the data [94]. Notwithstanding these limitations, the study provided the first overview of the inter-related pathways through which psychosocial factors impact the health of older adults using a large-scale and homogeneous time use data set from Europe.

Conclusions

The results from the SEM models provided evidence of the interrelating paths between psychosocial factors and health status among elderly men and women in western European countries. Our findings suggest that although stress in terms of time pressure has a strong direct negative effect on health, it does not indirectly influence the positive effects of work-related time use activities on self-reported health among elderly men and women. The results support the time availability hypothesis that older adults may not have the same time pressure as younger adults after retirement.

Additional file

Additional file 1: Table S1. General description of time use activities (means and SD), men and women, by country. **Table S2.** Typology of activities. **Table S3.** General description of the study sample (in percentages) by country, men. **Table S4.** General description of the study sample (in percentages) by country, women. (DOCX 35 kb)

Abbreviations

CFI: Comparative Fit Index; MTUS: Multinational Time Use Study; RMSEA: Root Mean Square Error of Approximation; SEM: Structural Equation Modelling; SES: Socioeconomic Status

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Availability of data and materials

The data used for this study comes from the Multinational Time Use Study (MTUS). Detailed information on the survey design and characteristics are provided on the MTUS homepage, https://www.timeuse.org/mtus.

Authors' contributions

NKA conceived the study, performed statistical analysis and drafted the manuscript. NKA, TB and KRJ critically revised and reviewed the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The authors were granted approval from the Multinational Time Use Study Review Board to obtain and use the collected data for analysis. All data were anonymized prior to the authors receiving the data.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

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Supporting Information

S1 Table. General description of time use activities (means and SD), men and women, by country

	Housework hours/day		Paidwork hours/day		Social support hours/day	
	Mean	SD	Mean	SD	Mean	SD
Men						
Italy	**2.69**	2.48	**0.38**	1.68	**1.38**	1.77
Spain	**2.44**	2.51	**0.22**	1.22	**0.97**	1.59
France	**3.02**	2.18	**0.17**	1.14	**1.03**	1.63
Netherlands	**3.69**	2.64	**0.18**	1.03	**1.73**	2.60
UK	**3.84**	2.36	**0.20**	1.09	**1.37**	2.13
Women						
Italy	**5.14**	2.74	**0.07**	0.72	**1.20**	1.64
Spain	**4.77**	2.71	**0.07**	0.67	**1.20**	1.43
France	**4.73**	2.28	**0.07**	0.65	**0.88**	1.51
Netherlands	**4.44**	2.36	**0.11**	0.82	**1.67**	2.43
UK	**4.55**	2.24	**0.09**	0.79	**1.23**	1.96

S2 Table. Typology of activities

Broad categories of activity	Name of variable (harmonised)	Description
1. Paid work	AV01	Paid work
	Av02	Paid work at home
	AV03	Second job
	AV05	Travel to/ from work
2.Housework	AV06	Cooking/Washing up
	AV07	Housework
	AV08	Odd jobs
	AV09	Gardening, pets
	AV10	Shopping
	AV12	Domestic travel
3.Social support	AV17	Leisure travel
	AV18	Excursions
	AV22	Religious activities
	AV24	Cinema, theatre
	AV26	Social club
	AV27	Pub
	AV28	Restaurant
	AV29	Visiting friends
	AV04	School/classes
	AV20	Passive/observer sports

S3 Table. General description of the study sample (in percentages) by country, men

Variables	France (*n*=1,118)	Italy (*n*=3,770)	Netherlands (*n*=812)	Spain (*n*=4,231)	UK (*n*=1,237)
Self-reported health					
Poor	10.4	11.9	2.6	22.6	11.7
Fair	42.5	61.5	26.7	35.9	35.3
Good	39.1	23.8	56.0	34.3	31.7
Very good	8.1	2.8	14.7	7.2	21.3
Stress					
Almost never	69.4	55.5	82.8	82.9	68.5
Sometimes	24.3	35.2	13.8	13.2	27.4
Often	6.3	9.3	3.5	3.9	4.1
Sociodemographic & economic factors					
Age					
65-69	34.4	35.0	40.5	34.7	35.5
70-74	32.0	29.2	31.0	27.8	28.0
75-79	23.5	19.6	19.8	19.6	21.1
80+	10.1	16.1	8.6	18.0	15.4
Civic Status					
Not married	16.8	19.1	21.6	20.1	25.8
Married/Cohabiting	83.2	80.9	78.5	79.9	74.2
Education					
Incomplete Sec. or less	25.9	67.5	35.3	68.3	64.4
Secondary completed	52.5	27.7	36.2	23.2	17.7
Tertiary Completed or above	21.7	4.8	28.5	8.5	18.0
Wealth					
Car ownership					
No car	0.0	16.0	1.7	40.9	27.9
1 car	78.0	48.4	83.6	42.0	57.6
2+ cars	22.0	35.6	14.7	17.1	14.6
Employment Status					
Not working for pay	98.7	92.4	97.4	96.3	92.4
Currently in paid employment	1.3	7.6	2.6	3.7	7.6
Time use Activities					
Paid work hours/day					
0 hours	96.2	94.2	95.3	95.0	95.3
>0 hours	3.8	5.8	4.7	5.0	4.7
House work hours/day					
Less than 1 hours	18.7	31.0	18.0	37.7	11.8
1 to 3 hours	33.6	28.7	25.5	26.8	25.9
3 to 6 hours	38.2	29.9	40.0	25.6	43.4
>6 hours	9.5	10.5	16.5	9.9	18.9
Social support hours/day					
Less than 2 hours	80.5	71.3	68.1	81.5	74.6
2 to 4 hours	13.2	20.9	17.7	13.7	15.6
>4 hours	6.3	7.8	14.2	4.8	9.8

S4 Table. General description of the study sample (in percentages) by country, women

Variables	France (*n*=1,113)	Italy (*n*=4,939)	Netherlands (*n*=952)	Spain (*n*=5,658)	UK (*n*=1,633)
Self-reported health					
Poor	12.9	18.8	2.9	29.0	11.8
Fair	45.6	64.3	31.6	38.4	34.5
Good	36.4	15.2	49.3	27.5	34.2
Very good	5.1	1.7	16.2	5.2	19.5
Stress					
Almost never	57.1	46.5	64.7	68.2	56.9
Sometimes	36.2	39.5	30.9	22.4	37.8
Often	6.7	14.0	4.4	9.4	5.3
Sociodemographic & economic factors					
Age					
65-69	38.5	29.5	33.8	30.4	30.8
70-74	31.1	26.9	30.2	27.2	28.3
75-79	20.5	20.7	23.5	19.8	23.2
80+	10.0	22.9	12.5	22.6	17.7
Civic Status					
Not married	30.9	57.3	60.3	51.5	55.2
Married/Cohabiting	69.1	42.7	39.7	48.5	44.8
Education					
Incomplete Sec. or less	28.7	80.1	59.6	77.7	76.5
Secondary completed	55.0	17.9	31.6	18.5	13.7
Tertiary Completed or above	16.4	2.1	8.8	3.9	9.8
Wealth					
Car ownership					
No car	0.0	38.3	13.2	55.4	48.7
1 car	81.6	34.1	53.7	32.1	43.8
2+ cars	18.4	27.6	33.1	12.5	7.5
Employment Status					
Not working for pay	98.5	98.4	97.8	98.4	95.7
Currently in paid employment	1.5	1.6	2.2	1.6	4.4
Time use Activities					
Paid work hours/day					
0 hours	97.6	98.8	96.7	97.8	98.0
>0 hours	2.4	1.2	3.3	2.2	2.0
House work hours/day					
Less than 1 hours	5.4	9.4	6.3	10.8	5.7
1 to 3 hours	15.0	12.0	20.4	14.2	18.8
3 to 6 hours	53.6	40.6	49.9	43.4	51.0
>6 hours	26.0	38.0	23.4	31.7	24.5
Social support hours/day					
Less than 2 hours	83.2	74.6	68.3	84.2	77.2
2 to 4 hours	11.9	19.8	17.4	11.8	14.3
>4 hours	4.9	5.6	14.3	4.0	8.6

Annex B: Supporting information (supplementary tables)

S1 Table. Typology of activities

Broad categories of activity	Name of variable (harmonised)	Description
1. Paid work	AV01	Paid work
	Av02	Paid work at home
	AV03	Second job
	AV05	Travel to/ from work
2.Housework	AV06	Cooking/Washing up
	AV07	Housework
	AV08	Odd jobs
	AV09	Gardening, pets
	AV10	Shopping
	AV12	Domestic travel
3.Active leisure	AV11	Child care
	AV23	Civic duties
	AV19	Active sport
	AV21	Walks
	AV17	Leisure travel
	AV18	Excursions
	AV22	Religious activities
	AV24	Cinema, theatre
	AV26	Social club
	AV27	Pub
	AV28	Restaurant
	AV29	Visiting friends
	AV04	School/classes
	AV20	Passive/observer sports
	AV33	Study
	AV34	Reading books
	AV35	Reading papers and magazines
	AV37	Conversation
	AV38	Entertaining friends
	AV39	Knitting sewing etc.
	AV40	Other hobbies
4.Passive leisure	AV30	Listening to radio
	AV31	Television, video
	AV32	Listening to tapes etc.
	AV36	Relaxing
5.Personal activity	AV13	Dressing/toilet
	AV14	Personal Services
	AV15	Meals, snacks
	AV16	Sleep

Annex C: Author contributions

I. **Adjei, N. K.,** Brand, T., & Zeeb, H. (2017). Gender inequality in self-reported health among the elderly in contemporary welfare countries: A cross-country analysis of time use activities, socioeconomic positions and family characteristics. *PloS one*, *12*(9), e0184676.

Nicholas Kofi Adjei conceived the study, performed the statistical analysis and drafted the manuscript. Hajo Zeeb and Tilman Brand critically reviewed the manuscript.

II. **Adjei, N. K**., & Brand, T. (2018). Investigating the associations between productive housework activities, sleep hours and self-reported health among elderly men and women in western industrialised countries. *BMC public health*, *18*(1), 110.

Nicholas Kofi Adjei conceived the study, performed the statistical analysis and drafted the manuscript. Tilman Brand critically reviewed the manuscript.

III. **Adjei, N. K**., Jonsson, K. R., & Brand, T. (2018). Time spent on work-related activities, social activities and time pressure as intermediary determinants of health disparities among elderly women and men in 5 European countries: a structural equation model. *International journal for equity in health*, *17*(1), 121.

Nicholas Kofi Adjei conceived the study, performed the statistical analysis and drafted the manuscript. Tilman Brand and Kenisha Russell Jonsson critically reviewed the manuscript.

Annex D: Further publications and oral presentations

Publications

I. **Adjei, N. K.**, Jonsson, K. R., & Brand, T. (2018). Psychosocial determinants of health disparities among elderly women and men in Europe: *European Journal of Public Health*, *28*(suppl_4), cky213-465.

Oral presentations

I. **Adjei Kofi Nicholas**, Russell-Jonsson Kenisha, Brand Tilman. (2018). Psychosocial determinants of health disparities among elderly men and women in Europe. Presented at the 11th European Public Health Conference. 28 November - 1 December 2018, Ljubljana, Slovenia.

II. **Adjei Kofi Nicholas**, Brand Tilman, Zeeb Hajo. (2017). Investigating socio-economic explanations for gender and cross-national inequalities in self-reported health among the elderly in contemporary welfare countries. Presented at the 28th International Population Conference. 30 October - 4 November 2017, Cape Town, South Africa.

III. **Adjei Kofi Nicholas**, Brand Tilman, Zeeb Hajo. (2017). Gender inequality in health among the elderly. Presented at the Public Health Conference: "Key Issues in Current Health Research: Ageing - Health - Equity", 29 - 30 June 2017, Bremen.

Versicherung der eigenständigen Verfassung

Hiermit versichere ich, dass ich die vorlie gende Dissertation selbständig verfasst und keine weiteren als die angegebenen Quellen und Hilfsmittel verwendet habe. Alle Stellen, die ich wörtlich oder sinngemäß aus an deren Werken entnommen habe, sind unter Angabe der Quellen als solche kenntlich gemacht.

Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegen.

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Ort und Datum Unterschrift