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The value of healthy ageing: Estimating the economic value of health using time use data

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ABSTRACT

Introduction: Economic arguments in favour of investing in health and health care are important for policy making, yet demonstrating the potential economic gains associated with health at older ages can be empirically challenging due to older peoples' limited attachment to the labour market.
Methods: We develop a novel method to quantify the economic value of health through time use data. Using data on people aged 65 years-old and older from the United Kingdom Time Use Survey (UKTUS) 2014–15, we apply survey-weighted generalized linear models to predict the time spent in non-market productive activities conditional on characteristics including age and self-perceived health. We weight these estimates of predicted minutes spent in each activity using household satellite accounts to quantify the monetary value of time spent engaging in non-market productive activities according to health status and simulate the monetary impact of health gains at older ages.
Results: Both age and self-perceived health status were associated with minutes spent in many non-market productive activities. Summing the monetized predictions of minutes spent across all types of activities indicates that being in "very good" instead of "very bad" self-perceived health is associated with an additional production of 439£, 629£ and 598£ (in real 2015 GBP) per month for an average individual aged 65 to 74 years-old, 75 to 84 years-old and 85 years-old and older, respectively. Using our simulation model, if 10% of older people in "very bad" health in the United Kingdom were to transition to "very good" health it could lead to an increase of up to 278£ million through the production of non-market activities.
Conclusions: Health at older ages creates considerable economic value which is not observed using standard national accounting measures. Our method to quantify the monetary value of health can be adapted to other settings to make the economic case for investing in healthy ageing.

1. Introduction

The global demographic landscape is undergoing significant transformation due to increases in longevity and declining birth rates. According to the United Nations, the world's population aged 65 and over is projected to more than double, reaching over 1.5 billion by 2050, while global fertility rates are expected to decline to 2.4 births per woman by 2030 and continue decreasing to 2.2 births per woman by 2050 (United Nations, 2019).

These changes in population age-mix are expected to have important economic and societal effects, in large part because of how paid work and consumption patterns vary by age. (Lee and Mason, 2011; Temple et al., 2017). Overall, the literature has consistently found an 'inverse-U' relationship between population age structure and economic growth,

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where economic performance peaks at working-ages and declines at older ages (Cylus and Al Tayara, 2021). Several mechanisms might explain this observed relationship. Changes in human capital likely play a role; older individuals, though experienced, may have lower labour productivity compared to younger working-age people if they lack some of the skills needed in modern labour markets (Feyrer, 2007, 2008). Health and disability are also likely to affect a person's ability to participate actively in paid work. For example, poor health is one of the main reasons for early retirements (van Rijn et al., 2014; Leijten et al., 2015; Scharn et al., 2018; Reeuwijk et al., 2017). Recent research also finds that, despite the historical correlation between population age structure and economic growth, health at older working ages moderates that relationship (Cylus and Al Tayara, 2021; Williams et al., 2022). While a large older working-age population on its own is associated with comparatively slower economic growth, the predicted economic growth for countries with a large older working-age population that is in good health on average does not statistically differ from that of countries with a small older working-age population.

Health is therefore likely to play a critical role in determining work and consumption behaviours throughout the life course. This notion is consistent with the Grossman model of demand for health, underscoring health care's dual role as both a consumption and an investment good, and highlighting the potential economic returns of investing in health (Grossman, 1972).

While health naturally has intrinsic value and maintaining health as people age seems to make good economic sense, making the case for investing in health at older ages beyond working age can be challenging in practice. As mentioned, much economic growth is historically attributed to the working-age population, who produce more than what they consume, driving macroeconomic performance; originally, health insurance itself was aimed at maintaining the health and productivity of workers and their families (Lee, 2003; Saltman et al., 2004). Yet, maintaining good health as people age also enables older people to contribute meaningfully to the economy. Healthy ageing can lead to prolonged labour force participation, higher productivity due to sustained cognitive and physical functions, as well as reduced health care costs that are often borne by the public sector. Furthermore, individuals in good health may be more likely to engage in community activities, informal caregiving, and other non-market productive activities that, while often overlooked in national statistics, contribute significantly to societal welfare and economic stability (Spillman and Lubitz, 2000). Investing in health at older ages, therefore, can be strategic economic policy.

The challenge remains, however, that since older people outside the labour force do not typically produce much quantifiable economic output, it can be difficult to empirically demonstrate the economic gains associated with promoting health at older ages.

Some research has addressed this issue by exploring the propensity to volunteer among older people and how this varies according to health status, while others have attempted to attach monetary values to caregiving by older people (Oliva-Moreno et al., 2015, 2019; Okun, 1993; Kydland et al., 2019). However, these activities provide a narrow interpretation of the production of older people, and as such, it is not possible to estimate the total economic gains associated with health at older ages. Bloom et al. estimate the economic value of non-market productive activities in older adults in European countries and in the United States based on the Survey of Health, Ageing, and Retirement in Europe (SHARE), the English Longitudinal Study of Ageing (ELSA) for England and the Health and Retirement Study (HRS) for the US (Bloom et al., 2020). However, only a limited number of non-market productive activities are available in these surveys. Although health was also considered in the study by Bloom et al. it focuses mainly on acute health shocks and their impact on the economic value of people aged 60 years-old or older overall (Bloom et al., 2020).

In this paper we propose a new method to demonstrate the economic value of health based on time use survey data. Time use surveys use diaries to collect data on the minutes' people spend on a wide range of activities over a fixed number of days. Importantly, they include useful demographic and health data which enable us to explore associations between people's time use and their health status and age.

We apply survey-weighted generelized linear models to predict how older people spend their time, conditional on their health status, and then weight predicted values of minutes spent using National Satellite Accounts to estimate the monetary value of changes in time use attributable to variation in health status. To the best of our knowledge, this is the first paper using time use surveys to quantify the economic value of health.

2. Methods

We performed a retrospective observational study using data obtained from the United Kingdom Time Use Survey (UKTUS) 2014–15 (Morris et al., 2016; Centre for Time Use Research, 2016). The UKTUS is a large-scale household survey assessing how individuals spent their time for 24 h (4am–4am) on both a weekday and a weekend day. For each 10-min period, individuals are asked to answer the primary activity, secondary activity, location where the activity took place, who the respondent was with and the level of enjoyment (Morris et al., 2016; Centre for Time Use Research, 2016). Besides these time diaries, respondents were also asked to respond to an individual interview, including information on country of birth and citizenship, marital status, education, employment, work hours, net individual income and receipt of benefits, and a household interview, including information on household conditions and household members and relationships (Morris et al., 2016; Centre for Time Use Research, 2016).

The UKTUS 2014-15 is a nationally representative sample of 4741 households (11,421 individuals) in England, Scotland, Wales and Northern Ireland, excluding those living in institutions, communal living, those living at the address fewer than 6 months, adult children who live away for work or study only coming home for holidays (Morris et al., 2016; Centre for Time Use Research, 2016). It used a multi-stage stratified probability sampling design by selecting primary sampling units (postcode sectors or groups of postcode sectors) at the first stage and later using a random selection of postal addressees (Morris et al., 2016; Centre for Time Use Research, 2016). Postcode sectors were previously ordered into strata according to region, population density and socio-economic grouping (Morris et al., 2016; Centre for Time Use Research, 2016). All household members aged 8 or over were automatically selected to take the individual interview and the time diary. Being a complex sample, weights to address non-coverage and non-response bias, as well as differential selection probabilities, were drawn and provided (Morris et al., 2016; Centre for Time Use Research, 2016). In this study, we focus on the subsample aged 65 years-old or older.

Our main outcome variable of interest in the UKTUS is the time individuals spent in non-market-based activities. We categorize these activities based on eight domains of non-market production in the United Kingdom Household Satellite Account (HHSA) (Office for National Statistics [Internet]): (1) housing (e.g. cleaning dwelling; disposal of waste); (2) transport (e.g. travel related to shopping); (3) nutrition (e.g. food preparation, shopping mainly for food); (4) clothing (i.e. handicraft and producing textiles); (5) laundry services (e.g. ironing); (6) childcare (e.g. physical care and supervision); (7) adult care (e.g. physical care and supervision of an adult household member); and (8) voluntary work (i.e. volunteer work through an organisation). The selection of these eight domains of non-market production in the United Kingdom HHSA is pragmatic due their inclusion in the HHSA but also grounded in their intrinsic societal and economic significance. These activities, encompassing aspects like household maintenance, care, and volunteer work, are foundational to the functioning of societies and economies, yet they remain largely invisible in conventional economic assessments unless someone is compensated financially for providing them (Folbre, 2009).

The number of minutes spent on each of these eight activities is computed for each surveyed individual in the UKTUS. The UKTUS codes for each specific activity by domain are provided in the Supplementary Table 1.

We estimate survey-weighted generalized linear models to predict the time spent (in minutes) in each activity domain for an individual, as in the equation below:

$$y_{i,a} = age_i + health_i + age_i \times health_i + v_i + \varepsilon_i$$

The outcome $y_{i,a}$ denotes the monthly time spent (in minutes) by individual i in activity a. This is a function of variables including the individual's age (age_i), which is categorised in three groups (i.e. 65 to 74 years-old, 75 to 84 years-old and 85 years-old and older), by the individual self-perceived health ($health_i$), including five response options/categories (i.e. very good, good, fair, bad or very bad), their interaction ($age_i \times health_i$) and a vector of individual controls (v_i) including sex, marital status ((1) divorced or widowed; (2) married or cohabitating; and (3) single), employment status ((1) not in paid work; (2) part-time work; and (3) full-time work) and education ((1) higher education; (2) A level or equivalent education; (3) secondary education; and (4) other). Weights included a correction for clusters (clustered by strata).

The HHSA provides the hourly monetary value or "price" of the eight non-market-based activities based on surveys, market equivalents, and other sources, as detailed in the United Kingdom Household Satellite Account (HHSA) framework (Office for National Statistics, 2002). While these monetary valuations are needed to quantify the economic impact of such activities, their usefulness is limited because they do not account for variability in skill, efficiency, and quality between non-market and market tasks as well as variability between individuals (Goldschmidt-Clermont, 1993). HHSA prices are available for the year 2000 (Holloway et al., 2022); we convert these to 2015-pounds sterling using the Office for National Statistics' Consumer Price Index (Table 1).

For each individual, the actual monthly monetary value of non-market productive activities (m_i) can be calculated as:

$$m_i = \sum_{a=1}^{8} \left(y_{i,a} \times h_a\right) / 60$$

The outcome m_i denotes the monthly value of non-market productive activities in pounds sterling as the sum of the product between the monthly time spent in each activity ($y_{i,a}$) and the 2015 estimated hourly value of each of the eight activities (h_a), as presented in Table 1. We estimate predicted values of $\hat{m}_i$ based on models estimating $\hat{y}_{i,a}$.

In order to demonstrate the potential annual economic impact ($\hat{I}$) associated with health improvements, we calculated a scenario where 10% of those in "very bad" health would shift into "very good" health, as explained in the equation below. It is important to note that this was chosen as an illustrative scenario to demonstrate the potential for economic gains associated with health improvements at older ages, rather than based on an estimate of the effectiveness of any intervention. For each age group (age), we multiplied the United Kingdom population in 2015 by the proportion in "very bad" health (v_{age}), retrieved from the Survey on Income and Living Conditions – EU-SILC. We then multiplied 10% of these individuals by the difference between the monthly monetary value for individuals with "very good" health (mg_{age}) and individuals with "very bad" health (mb_{age}). This value was then multiplied by 12 in order to obtain an annual monetary value.

$$\hat{I} = \sum_{g=1}^{3} \left(N_{age} \times v_{age} \times 0.10\right) \times \left(mg_{age} - mb_{age}\right) \times 12$$

Table 1
Hourly value of non-market productive activities in pounds sterling using the 2000 United Kingdom Household Satellite Account, converted into 2015 estimates.

Activity	Hourly value (2015)
Housing	15.40 £
Transport	6.85 £
Nutrition	3.56 £
Clothing	0.91 £
Laundry	12.29 £
Childcare	4.90 £
Adult care	4.46 £
Voluntary activity	11.63 £

3. Results

The survey sample included 1,941 respondents in the UKTUS 2014–15, aged 65 years-old or older. From these, 1,675 (86.3%) completed two diaries (both a weekday and a day of the weekend). The characteristics of the unweighted sample (N = 1,675) are provided in Table 2. The majority (61.6%) of the sample is age 65–74 and among them, 66.4% reported good or very good health. Individuals at older ages are less likely to report very good or good health, although, even among those aged 85 or more, 42% of the sample reported very good or good health. Around three-quarters of those in very good or good health were in either part-time or full-time work, whereas less than 2% of those in fair or bad health were engaged in any paid work.

Fig. 1 displays the distribution of time spent in each domain of non-market productive activities. The most time spent on non-market productive activities was on nutrition (e.g food preparation, shopping for food), housing (e.g. cleaning dwelling, disposal of waste) and transport (e.g. travel related to shopping), in descending order.

Table 3 presents regression results for the association of self-perceived health, age and their interaction with the time spent in each category of non-market productive activities, as well as for the controll variables (i.e. sex, marital status, employment and education). The effect of self-perceived health was particularly relevant as a predictor for time spent in transport and nutrition, but also, although to a lesser extent, for laundry, childcare, adult care and clothing (e.g. handicraft and producing textiles). For example, based on the main effect of self-reported health, respondents in very bad health were predicted to spend 958 fewer minutes per month taking part in nutrition-related activities (e.g. washing dishes, preparing food) than those in very good health. Those in very bad health were predicted to spent fewer minutes engaging in all eight non-market productive activities compared to respondents in very good health based on the main effects, although for housing and voluntary activity the confidence intervals were wide. Control variables also showed a statistically significant association with minutes spent in some of the activities, including employment, sex and marital status. Overall, those in paid work spent less time in non-market productive activities. Education was a weak predictor of variability in time spent in the non-market productive activities.

To better understand how minutes spent in non-market productive activities vary and incorporating the effects of interaction terms between age and self-reported health, Fig. 2 depicts the predictive values from the survey-weighted generalized linear models for each activity, age groups and the extreme original SPH categories (i.e. very good and very bad). Some activities show a substantial difference in time spent between those in "very good" (green) and "very bad" (red) self-perceived health, such as for transport, though for many activities and age groups the confidence intervals overlap. For example, in housing activities among those aged 75–84, individuals with 'very good' health spend approximately 2669 monthly minutes (95%CI 2115 to 3223), or 6.1% of their month, while those in 'very bad' health spend only around 1117 monthly minutes (95%CI 540 to 1693), or 2.6% of their month. This pattern is consistent across other age groups and activities.

Overall, in the 65–74 age group, individuals with 'very good' health are engaged in non-market productive activities for about 7831 monthly minutes (17.9% of their month), compared to only 3983 minutes (9.1%)

Table 2
Demographic, socioeconomic and self-perceived health characteristics of the subsample of respondents aged 65 years-old or older, United Kingdom Time Use Survey 2014–15. Missing data: employment status – 2 observations; education – 80 observations.

	N (%), N = 1675	Very good self-perceived health N (%), N = 346	Good self-perceived health N (%), N = 667	Fair self-perceived health N (%), N = 472	Bad self-perceived health N (%), N = 154	Very bad self-perceived health N (%), N = 36
Age (years-old)						
65-74	1031 (61.6)	242 (69.9)	443 (66.4)	252 (53.4)	77 (50.0)	17 (47.2)
75-84	506 (30.2)	86 (24.9)	184 (27.6)	169 (35.8)	54 (35.1)	13 (36.1)
85+	138 (8.2)	18 (5.2)	40 (6.0)	51 (10.8)	23 (14.9)	6 (0.4)
Male sex	775 (46.3)	156 (45.1)	321 (48.1)	204 (43.2)	76 (49.4)	18 (50.0)
Marital status						
Divorced or widowed	579 (34.5)	103 (29.8)	191 (28.6)	193 (40.9)	71 (46.1)	19 (52.8)
Married or cohabitating	1025 (61.0)	225 (65.0)	446 (66.9)	263 (55.7)	75 (48.7)	14 (38.9)
Single	75 (4.5)	18 (5.2)	30 (4.5)	16 (3.4)	8 (5.2)	3 (8.3)
Employment status						
Not in paid work	1508 (89.8)	303 (87.6)	582 (87.4)	431 (91.5)	153 (99.4)	35 (97.2)
Part-time work	103 (6.1)	28 (8.1)	48 (7.2)	26 (5.5)	0 (0.0)	1 (2.8)
Full-time work	66 (3.9)	15 (4.3)	36 (5.4)	14 (3.0)	1 (0.6)	0 (0.0)
Education						
Degree or higher education	236 (14.1)	74 (22.2)	105 (16.4)	41 (9.2)	10 (7.1)	6 (17.6)
Higher education, A level or equivalent	387 (23.0)	86 (25.7)	167 (26.1)	96 (21.5)	29 (20.6)	7 (20.6)
Secondary education	486 (28.9)	104 (31.1)	211 (32.9)	122 (27.4)	45 (31.9)	4 (11.8)
Other	490 (29.2)	70 (21.0)	158 (24.6)	187 (41.9)	57 (40.4)	17 (50.0)

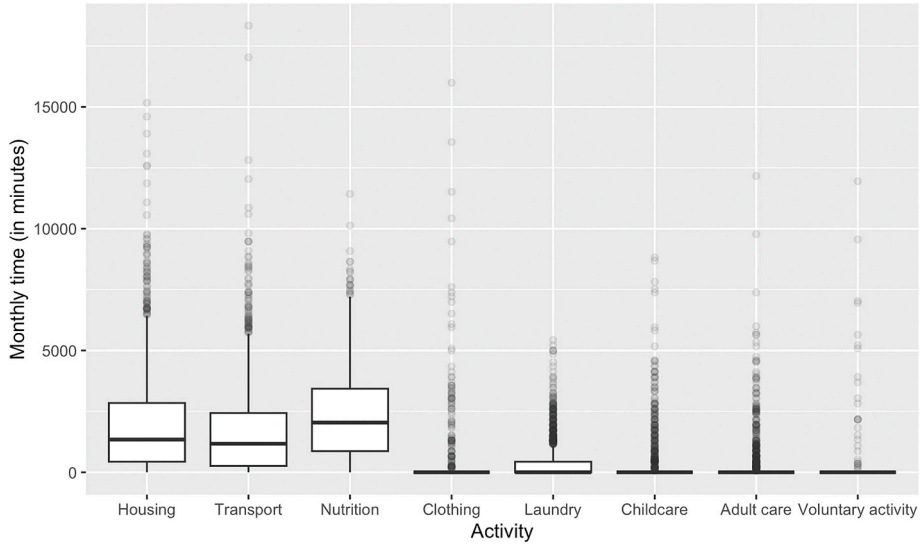

Fig. 1. Boxplots of monthly time spent (in minutes) of non-market productive activities for each type of activity among respondents aged 65 years-old or older, United Kingdom Time Use Survey 2014–15.

for those in 'very bad' health. Similarly, in the 75–84 age group, 'very good' health corresponds with approximately 7673 minutes (17.5%), while 'very bad' health individuals spend about 4038 minutes (9.2%). The difference is most striking in the 85+ category, where 'very good' health individuals spend around 5156 minutes (11.8%), in stark contrast to the 779 minutes (1.8%) by those in 'very bad' health.

To illustrate the economic value of health at older ages we use the models to predict minutes spent in each of the non-market productive activities for individuals at each of the three age-groups, assuming individuals were either in "very good" health or "very bad" health, holding constant the distribution of all the control variables (i. e. sex, marital status, employment status and education). We then apply the hourly prices from Table 1 to the predicted minutes spent for each of the non-market productive activities and compare the difference between the monetized predicted value of minutes spent in non-market productive activities for individuals in "very good" health and "very bad" health.

The models suggest that the monthly differences between being in "very good" vs. "very bad" health were 439£, 629£ and 598£ in real 2015 GBP for an average individual aged 65 to 74 years-old, 75 to 84 years-old and 85 years-old and older, respectively. Annually, these estimates represent 19.1%, 27.4% and 26.1% of the 2015 GDP per capita, (i.e. 5267£, 7544£ and 7176£, respectively). To demonstrate the potential economic gains associated with interventions aiming to deliver health improvements, if an intervention were to cause 10% of those living with "very bad" health over 65 years old in the United Kingdom in 2015 to transition to "very good" health, it could lead to an increased value of up to 278£ million (in 2015 GBP) through production of non-market activities.

4. Discussion

In this paper we estimate the economic value of health at older ages by monetising the time spent in non-market productive activities conditional on health status. Estimates of the value of being in "very good" rather than "very bad" health in the United Kingdom ranged from 19.1% of per capita GDP for 65-74-year-olds to 27.4% of per capita GDP for

Table 3
Survey-weighted generalized linear model coefficients for (monthly) time spent in non-market productive activities by age, self-perceived health and control variables, for those aged 65 years-old or older in the United Kingdom Time Use Survey 2014–15. Control variables: sex, marital status, employment status and education. *p < 0.05; **p < 0.01; ***p < 0.001.

	Housing	Transport	Nutrition	Clothing	Laundry	Childcare	Adult care	Voluntary activity
Age (years-old)								
65-74	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
75-84	673.85*	−432.64	96.37	−52.94	16.67	−285.72***	−127.48	−46.38
85+	−360.58	−1137.44***	−503.64	81.93	−251.16*	−151.79	−269.95***	−82.94
Self-perceived health (SPH)								
Very good	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Good	4.58	−230.71	98.99	−42.50	14.30	22.49	−22.93	−57.54
Fair	−121.24	−574.73**	−102.56	95.93	17.91	−66.85	−88.82	−58.14
Bad	−414.91	−753.43**	−765.74***	−81.66	−64.04	-23.39	10.40	−102.00
Very bad	−311.66	−1386.00***	−957.66*	−154.20*	−370.56***	−335.59***	−219.58***	−113.00
Age * SPH								
75–84*Good	−442.16	−27.74	−67.76	164.78	−41.58	161.81	143.68	70.11
75–84*Fair	−887.85*	−37.82	29.70	−121.68	−35.67	65.13	80.00	0.23
75–84*Bad	−766.00	−202.84	179.90	253.74	−75.50	26.25	−125.35	50.22
75–84*Very bad	−1241.14*	122.95	-7.62	400.18	211.41	500.94**	159.08	67.78
85+*Good	113.28	337.91	478.05	117.96	155.18	−168.86	26.49	52.50
85+*Fair	408.14	293.27	657.22	142.11	145.91	−122.29	178.96	46.73
85+*Bad	61.51	179.85	1108.82	−111.80	232.00	−163.01	-5.07	80.39
85+*Very bad	−1007.37	351.01	−422.65	−120.07	187.04	152.42	239.81***	91.34
Male sex	70.24	232.02*	−906.52***	−263.63***	−479.62***	−93.28*	36.15	−27.94
Marital status								
Divorced or widowed	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Married or cohabitating	156.16	113.87	−4.51	−129.73*	101.53*	−39.50	−20.09	36.40
Single	−154.75	53.87	111.50	−188.33**	41.47	−248.66***	−58.39	109.32
Employment status								
Not in paid work	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Part-time work	81.76	421.58*	−312.69	−36.61	−23.44	−175.71**	−70.00	33.24
Full-time work	−919.04***	385.98	−970.36***	40.50	−120.89	−136.69	−165.87***	117.19
Education								
Degree or higher education	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Higher education, A level or equivalent	−182.23	−110.89	88.48	−59.64	51.82	−162.70	29.85	21.44
Secondary education	−147.22	−312.75*	86.58	−97.96	19.33	−82.26	55.81	36.33
Other	−259.22	−373.36*	13.64	−145.03	29.75	−109.56	−14.65	74.64

individuals aged between 75 and 84. Perhaps counterintuitively, our estimates of the economic gains associated with health increased with age. This might be due to health mattering more as a predictor of functional capacity as people age, enabling older people to engage more in non-market activities than they would otherwise be unable to participate in if they were in poorer health. Moreover, it is possible that older people acting as rational agents optimize their healthy time by choosing activities based on the value of those activities, effectively maximizing the value of health. This line of thinking also may to some extent help to justify the higher levels of per person health spending at older ages commonly observed in developed health systems, since these higher levels expenditure may contribute to considerable economic value (Becker, 2007).

We found older people in “very bad” health spent less time engaging in many types of activities compared to people in “very good” health. The decreased time spent in these activities by older people living in “very bad” health is aligned with previous studies. For instance, Stalling et al. showed, from a sample of individuals in Bremen (Germany), that those with bad self-rated health had lower odds of active leisure, though no differences were found for active transportation or home-based activities (Stalling et al., 2020).

In two other studies, also using time use surveys, individuals were clustered by time spent in different activities. Similar variables as those in our study were found to be associated with these clusters, including gender, marital status and education (Kim, 2019; Lee, 2021). While in one of the studies health status was not clearly associated with time use activities (Kim, 2019; Lee, 2021). However, as the main outcome was belonging to activity profiles, it would be expected that the results differ from our study.

To our knowledge this is the first paper using time use surveys to quantify the economic value of healthy ageing. We believe time use surveys can be useful for such analyses in other settings, especially because they are implemented in many countries, using nationally representative samples, and include information on demographic and health. Time use surveys were previously used for other research on ageing, including to evaluate active ageing across generations or comparing time use patterns across countries (Vilhelmson et al., 2021; Victorino and Gauthier, 2005; Gauthier and Smeeding, 2003).

Our methodological approach, leveraging time-use data, marks a departure from conventional health valuation methods, and offers insights particularly relevant to policymakers considering interventions that target older populations. Traditional methods, often grounded in direct economic indicators or utility-based measures like quality-adjusted life years, might not fully capture the everyday contributions of older adults, especially outside formal economic structures (Tsuchiya, 2000). Time-use data reveals the societal contributions of older individuals beyond formal economic participation, encompassing undervalued activities like caregiving or volunteering. Unlike conventional methods that suggest diminishing returns on health investments with age, our approach highlights the economic and societal value provided by older adults, strengthening arguments in favour of spending on health care for people at older ages.

This study has several limitations and assumptions besides those mentioned in the Methods section. We have estimated predicted time spent in activities by age group and self-perceived health, although we cannot be sure that the effect of health on time spent in each activity is causal. Indeed, time use may itself have independent effects on how people perceive their health and well-being. As such, our estimates should be interpreted as an upper bound. Regarding the simulation, the 10% parameter was chosen as a representative scenario in the absence of specific data on the health improvements attributable to a potential policy or intervention. The choice of this parameter, while illustrative,

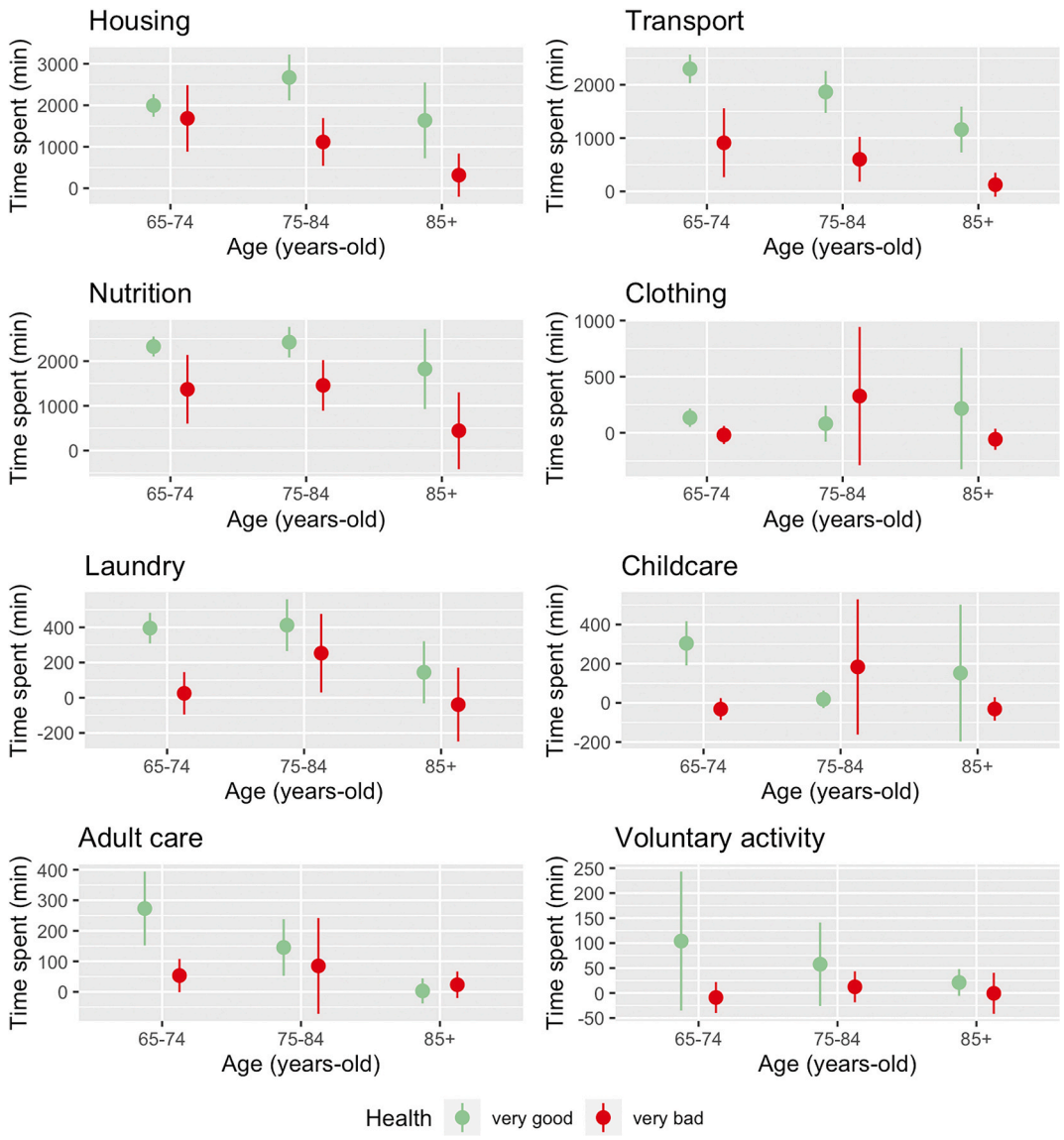

Fig. 2. Distribution of predictive values of survey-weighted generalized linear models for monthly time spent (in minutes) by non-market productive activities, by age and by self-perceived health, in the United Kingdom 2014–15. Control variables: sex, marital status, employment status and education.

may not capture the full range of potential health improvements achievable through targeted health investments. Future studies should make use of longitudinal time use data sets or other exogenous variation in health status to predict minutes spent in different activities. Nevertheless, we believe this work is valuable as a proof of concept. It is also important to highlight the lack of specificity of self-perceived health questions, being a multidimensional concept that clearly measures something more—and something less—than objective medical ratings as stated by Maddox and Douglass (Maddox and Douglass, 1973; Simon et al., 2005; Au and Johnston, 2014). Therefore, future work should explore associations between time use and other more objective health measures. Additionally, many other unobserved factors might affect how individuals spend their time, with potentially important omitted variable bias. Lastly, the monetisation of the non-market productive activities was based on household satellite accounts which do not consider variability across individuals or across activities within broad categories in terms of the actual values of these activities.

We propose a new methodology to assess the economic value of health at older ages by monetising the time spent in non-market productive activities. Future work can not only improve on the methodology itself but may also consider using these types of estimates for cost-benefit analyses to inform decisions about specific health-related interventions. Incorporating more objective health measures into international surveys, including time-use surveys, would enable more targeted analysis and a better understanding of the mechanisms linking health to time use, informing policy development. The approach can factor into estimates of the aggregate benefit of large-scale interventions that affect health, particularly among older people, helping to further the economic case for interventions or policies related to healthy ageing.

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Conflicts of interest/Competing interests

None.

Availability of data and material

The data that support the findings of this study are available from the Centre of Time Use Research and were collected through the United

Kingdom Time Use Survey 2014–2015. Restrictions apply to the availability of these data, which were used under license for this study. Derived data supporting the findings are available from the authors upon reasonable request and with the permission of Centre of Time Use Research.

Authors' contributions

Both authors contributed to study design, data preparation, analysis and interpretation, drafted and revised the paper and approved its final version. Both authors contributed equally to this article as co–first authors.

Consent for publication

All authors provided consent for this publication.

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.116451.

References

Au, N., Johnston, D.W., 2014. Self-assessed health: what does it mean and what does it hide? Soc. Sci. Med. 121, 21–28.

Becker, G.S., 2007. Health as human capital: synthesis and extensions. Oxf. Econ. Pap. 59, 379–410.

Bloom, D.E., Khoury, A., Algur, E., Sevilla, J.P., 2020. Valuing productive non-market activities of older adults in Europe and the US. Economist 168, 153–181.

Centre for Time Use Research, 2016. United Kingdom Time Use Survey 2014-15. Centre for Time Use Research, Oxford.

Cylus, J., Al Tayara, L., 2021. Health, an ageing labour force, and the economy: does health moderate the relationship between population age-structure and economic growth? Soc. Sci. Med. 287, 114353.

Feyrer, J., 2007. Demographics and productivity. Rev. Econ. Stat. 89, 100–109.

Feyrer, J., 2008. Aggregate evidence on the link between age structure and productivity. Popul. Dev. Rev. 34, 78–99.

Folbre, N., 2009. Valueing Non-market Work. UN Development Programme. Human Development Reports. Research Paper 2009/16.

Gauthier, A.H., Smeeding, T.M., 2003. Time use at older ages: cross-national differences. Res. Aging 25, 247–274.

Goldschmidt-Clermont, L., 1993. Monetary valuation of non-market productive time methodological considerations. Rev. Income Wealth 39, 419–433.

Grossman, M., 1972. On the concept of health capital and the demand for health. J. Polit. Econ. 80, 223–255.

Holloway, S., Short, S., Tampling, S., 2022. Household Satellite Account (Experimental) Methodology. National Statistics.

Kim, J.H., 2019. Productive aging of Korean older people based on time use. Soc. Sci. Med. 229, 6–13.

Kydland, Finn, E., Pretnar, Nick, 2019. The Costs and Benefits of Caring: Aggregate Burdens of an Aging Population. NBER Working Paper No. w25498. Available at SSRN: https://ssrn.com/abstract=3328321.

Lee, R., 2003. The demographic transition: three centuries of fundamental change. J. Econ. Perspect. 17, 167–190.

Lee, Y., 2021. Activity profiles among older adults: latent class analysis using the Korean time use survey. Int. J. Environ. Res. Publ. Health 18, 8786.

Lee, R., Mason, A., 2011. Cheltenham (UK): Edward Elgar Publishing, International Development Research Centre.

Leijten, F.R., de Wind, A., van den Heuvel, S.G., Ybema, J.F., van der Beek, A.J., Robroek, S.J., Burdorf, A., 2015. The influence of chronic health problems and work-related factors on loss of paid employment among older workers. J. Epidemiol. Community Health 69, 1058–1065.

Maddox, G.L., Douglass, E.B., 1973. Self-assessment of health: a longitudinal study of elderly subjects. J. Health Soc. Behav. 14, 87–93.

Morris, S., Humphrey, A., Cabrera Alvarez, P., D'Lima, O., 2016. The UK Time Diary Study 2014 - 2015 Technical Report. NatCen Social Research, London.

Office for National Statistics [Internet] Household Satellite Account [accessed in: 01.03.2023]. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/methodologies/householdsatelliteaccountexperimental.

Okun, M.A., 1993. Predictors of volunteer status in a retirement community. Int. J. Aging Hum. Dev. 36, 57–74.

Oliva-Moreno, J., Peña-Longobardo, L.M., Vilaplana-Prieto, C., 2015. An estimation of the value of informal care provided to dependent people in Spain. Appl. Health Econ. Health Pol. 13, 223–231.

Oliva-Moreno, J., Peña-Longobardo, L.M., García-Mochón, L., Del Río Lozano, M., Mosquera Metcalfe, I., García-Calvente, M.D.M., 2019. The economic value of time of informal care and its determinants (The CUIDARSE Study). PLoS One 14, e0217016.

Reeuwijk, K.G., van Klaveren, D., van Rijn, R.M., Burdorf, A., Robroek, S.J., 2017. The influence of poor health on competing exit routes from paid employment among older workers in 11 European countries. Scand. J. Work. Environ. Health 43, 24–33.

Saltman, R.B., Dubois, H.F.W., 2004. The historical and social base of social health insurance systems. In: Saltman, R.B., Busse, R., Figueras, J. (Eds.), Social Health Insurance Systems in Western Europe. Open University Press, Maidenhead, pp. 21–32.

Scharn, M., Sewdas, R., Boot, C.R.L., Huisman, M., Lindeboom, M., van der Beek, A.J., 2018. Domains and determinants of retirement timing: a systematic review of longitudinal studies. BMC Publ. Health 18, 1083.

Simon, J.G., De Boer, J.B., Joung, I.M.A., et al., 2005. How is your health in general? A qualitative study on self-assessed health. Eur. J. Publ. Health 15, 200–208.

Spillman, B.C., Lubitz, J., 2000. The effect of longevity on spending for acute and long-term care. N. Engl. J. Med. 342, 1409–1415.

Stalling, I., Albrecht, B.M., Doerwald, F., Bammann, K., 2020. Time allocation to active domains, physical activity, and health indicators in older adults: cross-sectional results from the OUTDOOR ACTIVE study. BMC Publ. Health 20, 1580.

Temple, J.B., Rice, J.M., McDonald, P.F., 2017. Ageing and the economic life cycle: the National Transfer Accounts approach. Australas. J. Ageing 36, 271–278.

Tsuchiya, A., 2000. QALYs and ageism: philosophical theories and age weighting. Health Econ. 9, 57–68.

United Nations, 2019. Department of Economic and Social Affairs, Population Division.

van Rijn, R.M., Robroek, S.J., Brouwer, S., Burdorf, A., 2014. Influence of poor health on exit from paid employment: a systematic review. Occup. Environ. Med. 71, 295–301.

Victorino, C.C., Gauthier, A.H., 2005. Are Canadian seniors becoming more active? Empirical evidence based on time-use data. Can. J. Aging 24, 45–56.

Vilhelmson, B., Thulin, E., Elldér, E., 2021. Is ageing becoming more active? Exploring cohort-wise changes in everyday time use among the older population in Sweden. Eur. J. Ageing 19, 447–461.

Williams, G.A., Cylus, J., Al Tayara, L., Roubal, T., Tsilaajav, T., Barber, S.L., 2022. Can healthy ageing moderate the effects of population ageing on economic growth and health spending trends in Mongolia? A modelling study. Health Res. Pol. Syst. 20 (Suppl. 1), 122.