

A Review of Data Sources for the Study of Ageing

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Abstract—The understanding of human ageing contributes to the overall improvement of healthcare and opens the door to the increase of life expectancy and quality of life. Studies on human ageing, which are evidence-based, require data. Although some efforts have been put to concentrate datasets in single reference points, many datasets remain hidden in articles, studies and research projects websites.

In this paper, we aim at identifying those datasets that have been used for the study of human ageing and make them easy to find to researchers in the field. To do so, we have analysed well-known literature databases, previous reviews, and specialised sources. We have reviewed the available data and, as a result, we have identified and discussed 28 datasets. Hence, this article provides an organised reference point to datasets for researchers interested in the study of human ageing and contributes to their visibility.

Index Terms—healthy aging, datasets, open data, smart health

I. INTRODUCTION

Ageing involves the physical, metabolic, mental and functional transformations that occur as a consequence of the action of time on living organisms [1]. Closely related to ageing, longevity is the ability to develop long life cycles. Species have typical values for longevity [2] and, therefore, longevity is related to life expectancy. Population's longevity depends on the percentage of members that approach the maximum potential life span that characterizes each species. In humans, this time span is around 100 ± 15 years; thus, people over 85 years old are referred as long-lived individuals [3]. From a statistical point of view, the life expectancy of humankind has increased significantly in recent years [4]. Consequently, specific problems related to aging are gaining importance.

Research and innovation on aging will have a prominent position in national agendas of most countries over the next decade, and will become a primary topic in the international cooperation arena, since population aging is a global phenomenon and mitigating its damaging consequences will require a global effort [5]. Aging constitutes a topic of global interest. Hence, the strategy and global action plan in health and aging of the World Health Organization from 2020 to 2030 is based on scientific data from global reports on aging and health and, it targets a number of priority action

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areas [6], namely raising awareness of healthy ageing, aligning health systems with the needs of the elderly, and improving the monitoring of aging to name a few. In this sense, the 2020 World Report on Aging and Health [7] indicates that action must be taken around a better understanding of healthy aging trajectories and what can be done to improve them. Therefore, healthy ageing and care will be characterized by prediction, prevention, personalisation and participation, with the incorporation of health promotion strategies based on early intervention with support for individual risk factors [8].

A. The study of aging

The study of aging is gaining momentum. Researchers in the area recognise that intervention medicine (*i.e.* for the cure of diseases) entails spending large amounts of resources, mainly focused on improving conditions, over the entire people's lifespan. Thus, better understanding aging will fuel the prevention of chronic diseases and the extension of life expectancy. In general, since biological aging occurs before the development of a disease, the study of apparently healthy individuals and those that are on a path of accelerated aging will allow interventions at a time when compensatory mechanisms can still have an effect [9].

The study of aging poses interesting challenges because it considers the analysis of physical and mental aspects, as well as their social and environmental implications [1]. Hence, the most relevant discoveries (and the ones likely to become clinical applications) are those that are developed with technologies that can provide precise and quantitative measurements of relevant variables in humans [9].

Medical and biomedical studies generally involve the acquisition of data from individuals: physiological parameters, biomarkers, and qualitative attributes are gathered by means of a variety of techniques such as surveys and samples analyses (*e.g.*, of blood and tissues). Scientists statistically analyse the obtained data sets with the aim of proving their hypotheses, testing the performance of drugs and treatments, or discovering illness causes and effects. In addition, the use of smartphones and cutting-edge sensors to collect both patient-centric and contextual data is proving useful, and ushers in the massive collection of personalised data. In this line, the adoption of the *Smart Healthcare* (s-Health) concept [10], an evolution of the electronic and mobile health paradigms, paves the way for new means of data acquisition, in real time, from a large variety of

sources, and from virtually millions of individuals. Also, the growing interest in cognitive environments will maximise the collection of information and people’s participation [11] [12].

The availability and quality of data sources foster the use of innovative technologies for their analysis. Particularly, big data and artificial intelligence technologies play a key role in the discovery of knowledge [13], [14].

B. Methods used to study aging

Over decades, many studies related to human aging have been undertaken. Those studies can be mainly classified in two groups: (i) *Longitudinal studies*, with a research design that involves repeated observations of the same variables over short or long periods, and (ii) *cross-sectional studies*, which compare measurable parameters across different sets of people.

The values for the observed attributes for each individual, tests, and analyses are arranged in datasets, which, in general, take the form of electronic files. As a result, scientists can count with a wide variety of data sources generated under the umbrella of research projects, tests, studies and scientific contributions. These data sets can be publicly available, either in the form of a public-access files on a website, or upon request. For the sake of reproducibility, research data should be accessible in case different researchers need to apply the same or different methodologies on the data.

C. Contribution and Plan of this Article

The study of ageing requires evidence-based approaches based on data, which is generally stored in electronic datasets. These datasets tend to be dispersed and it might be difficult for researchers to find them.

In this article, we have analysed well-known literature databases and specialised sources with the aim to identify datasets that have been used for the study of ageing. We have reviewed the data available from projects, studies and research articles and, as a result, we have identified 28 datasets containing data that has been used for the study of ageing. We have studied them, and we provide a descriptive summary including their focus, number of subjects, methods used, data collected, etc. Hence, this article provides an organised reference to datasets for researchers interested in the study of human ageing.

The rest of the article is organised as follows: Section II describes our methodology. Section III overviews and discusses the datasets. Finally, the article concludes with some comments in Section IV.

II. METHODOLOGY

This section describes the methodology followed to identify datasets for the study of human aging (from now on, we will refer to *datasets* but synonyms as database or data file may be used, too). The process, described in Figure 1, encompasses three search strategies to identify those datasets:

- **Datasets in previous reviews:** We aim to identify reviews on datasets for the study of aging, using the following query on the Web of Science, Scopus and PubMed:

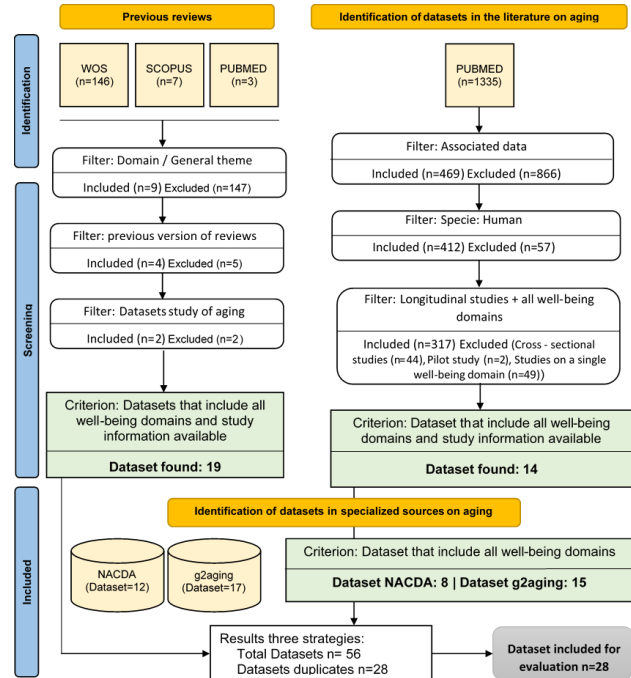


Fig. 1. Synthesis of the search and selection process.

(“data source” OR “database” OR “dataset”) AND (“ageing” OR “aging”) AND (“review” OR “study”).

- **Datasets in the literature on aging:** We use web searches on PubMed using the query: (“longitudinal”) AND (“study”) AND (“ageing” OR “aging”)
- **Datasets from specialized sources:** We review the data available at the National Archive of Computerized Data on Aging (NACDA) from the United States¹, and at the Gateway to Global Aging Data², two initiatives whose mission is to advance research on aging by helping researchers to profit of a broad range of datasets.

The inclusion criteria for the datasets were: (i) the dataset includes data related to all wellness domains, indicated by the World Health Organisation as part of its definition of healthy aging: physical, mental, cognitive, social, nutritional [15]; and (ii) datasets whose focus is the study of aging. It is worth mentioning that we have followed a conservative approach, hence, inclusion criteria are willingly broad.

III. RESULTS

The analysis of previous reviews led us to consider [16] and [17], which reported on 19 datasets on ageing. The identification of datasets in the literature resulted in 14 datasets, and the specialised sources returned 23 datasets. After filtering out duplicates, we ended up with 28 datasets that are next classified and discussed (*cf.*, Figure 1).

We analysed the selected datasets focusing on the following features: collected variables, temporal-spatial framework in

¹<https://www.icpsr.umich.edu/web/pages/NACDA>

²<https://g2aging.org>

which the study was performed, design of the study, population, format and continuity in time, accessibility, and freedom of publication of the findings. We have classified the datasets into three categories according to their conceptual framework and national or international scope.

The first category includes studies with an approach common to large-scale longitudinal studies on aging in the world. They use the well-known model of innovations in design and measurement of the Health and Retirement Study (HRS). The data collection method includes comprehensive face-to-face/telephone interviews, and considers health status assessment and the collection of bio-markers. Also, they include demographics, health conditions, cognition, health care use and costs, employment status, income and assets, housing, and expectations. These datasets are specially useful for comparative studies. Within this category we classify the following datasets: Health and Retirement Study (HRS) [18], Mexican Health and Aging Study (MHAS) [19], English Longitudinal Study of Ageing (ELSA) [20], China Health and Retirement Longitudinal Study (CHARLS) [21], Korean Longitudinal Study of Aging (KLoSA) [22], Costa Rican Longevity and Healthy Aging Study (CRELES) [23], Brazilian Longitudinal Study of Aging (ELSI) [24], Japanese Study of Aging and Retirement (JSTAR) [25], Longitudinal Aging Study in India (LASI) [26], The Irish Longitudinal Study on Ageing (TILDA) [27], Survey of Health, Ageing and Retirement in Europe (SHARE) [28], Study on Health, Aging and Retirement in Thailand (HART) [29], Northern Ireland Cohort Study on Ageing (NICOLA) [30], Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa (HAALSI) [31].

The second category includes international studies, carried out in parallel in different countries with an intentional multinational sample that follows the same protocol. This category includes the Study on Global AGEing and Adult Health (SAGE) [32], Survey on Health, Well-Being and Aging in Latin America and the Caribbean (SABE) [33], Global Ageing Survey (GLAS) [34]. The aforementioned SHARE [28] can be also classified in this category. The third category includes the datasets of local and national initiatives for the study of aging: Australian Longitudinal Study of Ageing (ALSA) [35], Baltimore Longitudinal Study of Aging (BLSA) [36], Canadian Longitudinal Study on Aging (CLSA) [37], Italian Longitudinal Study on Aging (ILSA) [38], Longitudinal Aging Study Amsterdam (LASA) [39], National Health and Aging Trends Study (NHATS) [40], Nihon University Japanese Longitudinal Study of Aging (NUJLSOA) [41], Chinese Longitudinal Healthy Longevity Survey (CLHLS) [42], National Social Life, Health and Aging Project (NSHAP) [43].

Resulting from our comprehensive review, other datasets have been selected from the National Health and Nutrition Examination Survey (NHANES) [44] and the China Health and Nutrition Survey (CHNS) [45]. Although their approach is not exclusively oriented to the study of ageing, they allow health-related assessments across different age groups.

In ageing studies, it is fundamental to collect data about

three main dimensions: economic, social, and health. Moreover, many studies/datasets consider active cohorts, which allow the studies to transcend time, thus studying the evolution of the aging process. For example, CLHLS allows the study of "centenarians" because this dataset collects data focused on this segment of the population. The attributes collected in the selected datasets have been categorised as follows:

- *Demographic data*: income, employment, consumption, expectations, work, assets, pension plans, health insurance, disability.
- *Functional rating*: caregiver, individual physiological.
- *Anthropometric*: weight, blood pressure, height, hip circumference, waist circumference.
- *Physical*: cardiovascular, hearing, vision, respiratory, musculoskeletal, reproductive.
- *Biological samples*: blood, saliva, urine.
- *Lifestyle*: dietary habits, physical activity, smoking and drinking habits.
- *Socio-economic*: education, ethnicity, family status, housing and accommodation, income and finances, informal support, marital status, employment, unpaid care.
- *Health service utilization*: formal health and social care service utilization including private care.
- *Brain related measures*: behavior, cognitive function, mental health, neurological.

Tables I and II distil the contribution of this article and are a reference point to ease the study of ageing. They present a summary of each dataset, including the acronym, the focus of the study, the number of involved subjects, the study start and end dates, the subjects age, the method used to collect information, the data collected according to the aforementioned groups, the population scope and the availability.

IV. CONCLUSIONS

For decades, many global initiatives have been devoted to the creation of datasets, and the development of studies to understand aging processes. New methods for data collection and the ability to store, share and analyse data open new avenues for research on aging populations. Large public data sets provide essential evidence on aging processes that can hardly be obtained individually. Thus, the sharing of research data contributes to the improvement of research and facilitates the exchange of ideas. Unfortunately, many relevant datasets remained hidden in specific publications and project studies.

In this article, we have conducted an extensive analysis of publications, projects and specialised sources with the aim to collect, in a single reference point, the most relevant datasets used for the study of ageing. Overall, we ease the access to these datasets and increase their visibility, hopefully resulting in better and more comprehensive studies on human ageing.

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Acronym	Focus	Subjects	Period	Access	Age	Method	Data collected	Population Scope
ALSA	Study on social, biomedical & environmental factors in aging people	2087	1992 - 2014	Public	70+	Comprehensive personal interviews, functional assessment, self completion questionnaire, telephone interviews	Brain related measures, functional rating, anthropometric, physical	Australia
BLSA	Study on physiological and psychological aspects of human aging	10000	1958 - ongoing	By request	20+	Physiological assessments, self-completed questionnaires, personal interviews	Functional rating, anthropometric, biological samples, physical, lifestyle, socio-economic, brain related measures	Baltimore - United States
CHARLS	Study on elderly households, elderly respondents and their spouses	17500	2008 - 2018	Public	45+	Computer-assisted interviews, health status assessment, collection of biomarkers	Physical, health service utilization, Demographic data, as well as information on local health facilities of the community and government policies	China
CLHLS	Study to determine which factors, play an important role in healthy longevity	96,805	1998 - 2018	By request	65+	Coded on-site observation, cognitive assessment test, face-to-face interview, questionnaire	Functional rating, anthropometric, physical, biological samples, genotyping, lifestyle, socio-economic, health service utilisation	China
CLSA	Study on changing biological, medical, psychological, social, lifestyle and economic aspects in old age	50000	2008 - 2018	By request	45 to 85	Comprehensive questionnaires, tracking questionnaires, physical assessments	Functional rating, anthropometric, biological samples, physical, lifestyle, socio-economic, brain related measures	Canada
CRELES	Study on longevity and health determinants	9500	2005 - 2012	Public	60+	Face-to-face interview, on-site questionnaire	Functional rating, anthropometric, biological samples, physical, lifestyle, socio-economic, brain related measures, nutrition, health service utilization	Costa Rica
ELSA	Economic, social, psychological and health study in old age	23132	2002 - ongoing	Public	50+	Interviews, health status, life-history interview	Household and individual demographics data, functional rating, anthropometric, lifestyle, brain related measures, socio-economic	England
ELSI	Study on health and functioning economic position, social participation and well-being, impact of environment and genetic factors in old age	9412	2015 - 2018	Public	50+	Comprehensive personal interviews, telephone interviews, collection of biomarkers, measurement of wellbeing	Demographic data, functional rating, anthropometric, biological samples, physical, lifestyle, socio-economic, brain related measures	Brazil
GLAS	Study on health and retirement, attitudes, behaviours and expectations	110000	2005 - 2008	Not available	40 to 80	Self-completion questionnaire	Demographic data, brain related measures, functional rating, anthropometric, physical, socio-economic	25 countries Asia, America, Europe & Africa
HAALSI	Study to examine and characterize the population with respect to health, physical and cognitive function, aging and well-being	13000	2014 - 2019	Public	40+	Computer-assisted interview	Functional rating, anthropometric, physical, biological samples, lifestyle, socio-economic	South Africa
HART	Provides information on health status and quality of life of the elderly	5600	2009 - 2017	By request	45+	Paper-and-pencil instrument, computer-assisted personal interview instrument for face-to-face interview	Functional rating, anthropometric, physical, biological samples, lifestyle, socio-economic	Thailand
HRS	Changes in labour force participation and health transitions	30000	1992 - ongoing	Public	50+	Face-to-face interviews, telephone, mail and web questionnaires, collection of biomarkers and genetic information	Demographic data, brain related measures, functional rating, anthropometric, physical, socio-economic, health service utilization	United States

TABLE I
DATASET CHARACTERISTICS

Acronym	Focus	Subjects	Period	Access	Age	Method	Data collected	Population Scope
ILSA	Study of the prevalence and incidence rates of common chronic conditions in the older population	5632	1992 - 1995	Public	65 to 84	Personal interviews, health assessment (physical exams, laboratory test)	Health and disease, brain related measures, functional rating, anthropometric, physical	Italy
JSTAR	Study on economic, social and health aspects in old age	4200	2007 - 2013	Public	50 to 75	Self-completion questionnaire, computer-assisted personal interviews	Functional rating, anthropometric, physical, biological samples, lifestyle, socio-economic	Japan
KLoSA	Study on work, income and health, disability and family transfers in old age	10000	2006 - 2016	Public	45+	Computer-assisted personal interviews, collection of biomarkers, measurement of wellbeing	Socio-economic, Physical, Demographic data, Anthropometric and includes detailed questions on family transfers	South Korea
LASA	Scientific study to determine predictors and consequences of aging	5000	1991 - 2019	By request	55+	Interview and medical checking, with clinical measurements	Physical, brain related measures, Lifestyle	Netherlands
LASI	Study on adult health, population ageing processes	72250	2009 - ongoing	Public	45+	Comprehensive personal interviews, computer-assisted personal interviews, collection of biomarkers, measurement of wellbeing	Demographics, family and social networks, health, healthcare utilization, Socio-economic	India
MHAS	Study on health and socio-economics aspects in old age	15000	2001 - 2018	Public	50+	Comprehensive personal interviews, collection of biomarkers, measurement of wellbeing	Health measures, background, socio-economic, housing environment, anthropometric	Mexico
NHATS	Provides information on late-life functioning, reasons for disability, changes in physical, cognitive and sensory capacity	Not avail.	2011 - 2017	Public	65+	Computer-assisted personal interview	Physical, cognitive, emotional and social functioning	United States
NICOLA	Study on health and socio-economics in old age	8300	2013 - ongoing	By request	50+	Health assessment, computer-assisted personal interview	Functional rating, anthropometric, physical, biological samples, genotyping, lifestyle, socio-economic	United Kingdom
NSHAP	Population-based study of health and social factors, aiming to understand the well-being of older	10000	2005 - 2016	Public	57 to 85	Face-to-face questionnaire, bi-measure collection, self-administered questionnaire	Brain related measures, functional rating, anthropometric, physical, sexuality	United States
NUJLSOA	Study on levels of and changes in health status of Japanese elderly	6700	1999 - 2003	By request	65+	Interviews face to face	Brain related measures, functional rating, anthropometric, physical, socio-economic, lifestyle	Japan
SABE	Study to collect information on the health of elderly populations	No information	1999 - 2000	Public	65+	Face-to-face interview, self-enumerated questionnaire	Brain related measures, functional rating, anthropometric, physical	Argentina, Barbados, Brazil, Chile, Cuba, Mexico, and Uruguay
SAGE	Study on the health and well-being of adult populations and the ageing process	40000	2002 - 2019	Public	18+	Comprehensive personal interviews, collection of biomarkers, measurement of wellbeing	Health measures, background, socio-economic, housing environment, anthropometric	China, Ghana, India, Mexico, Russian Federation and South Africa
SHARE	Study on health, socio-economic status, social and family networks in depth in 20 European countries	60000	2004 - ongoing	By request	50+	Computer-assisted personal interviews & selfcompletion questionnaire, collection of biomarkers, measurement of wellbeing	Demographics, health, brain related measures, health service utilization, socio-economic, housing, and expectations.	26 continental countries of the European Union, Switzerland, and Israel
TILDA	Study on health, social and economic circumstances	10000	2009 - 2016	By request	50+	Computer-assisted personal interviews & selfcompletion questionnaire, full health assessment, measurement of wellbeing	Demographics, health, social connectedness, socio-economic, health service utilization and aging perceptions	Republic of Ireland

TABLE II
DATASET CHARACTERISTICS