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Cohort Profile

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Cohort Profile: Health and Ageing in Africa: A Longitudinal Study of an INDEPTH Community in South Africa (HAALSI)

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Why was the Cohort set up?

Population ageing is a global phenomenon. The United Nations estimates that the world population aged over 60 will have increased 3-fold from 1950 to 2050, to reach 21% of the population.[1] This compositional shift is happening fastest in low- and middle-income countries (LMIC).[2] South Africa in particular is undergoing a dramatic demographic and epidemiological transition, and little is known about the socioeconomic determinants or consequences of transition. This study, following important findings in previous studies in Agincourt[3–6] and South Africa in general,[7–9] is set up to inform us about morbidity, mortality and aetiological factors shaping these trends. Various ageing studies, including the Studies on Global Ageing and Adult Health (SAGE) and the 2015 Global Burden of Disease, found that non-communicable diseases, driven mainly by population growth and ageing, have become leading causes of death and disability globally, including in LMIC such as South Africa.[10–14] At the same time, the share of the population 60 and above in South Africa is estimated to increase from 7.8% in 2012 to 14.8% in 2050,[15] and the population aged 50 and over living with HIV will triple by 2040.[16] We established the cohort 'Health and Ageing in Africa: A Longitudinal Study of an INDEPTH Community' in South Africa (HAALSI) in the INDEPTH Health and Demographic Surveillance System (HDSS) site of Agincourt, as a harmonized sister study to the Health and Retirement Study (HRS) in the USA[17] and other similar studies worldwide, including ELSA in the UK,[18]

TILDA in Ireland,[19] SHARE in Europe,[20] CHARLS in China[21] and LASI in India.[22] We aim to describe biological, social and economic determinants and consequences of health and ageing in rural South Africa, as well as to build capacity to explore cross-country differences in risk factors for health and well-being.

What does the study cover?

HAALSI is an interdisciplinary study aiming to longitudinally monitor social, economic and biological risks for chronic health conditions, whether infectious or non-infectious, in a random sample of adults in Agincourt, South Africa. HAALSI focuses on cardiovascular disease, HIV, cognitive functioning and dementia, as these are of special interest in South Africa as it undergoes profound epidemiological and demographic transitions.

Who is in the cohort?

HAALSI was created to establish a population-based longitudinal cohort of men and women aged 40 and over in a rural South African community.[23] The cohort consists of 5059 people ($n = 2345$ men and 2714 women). This relatively young starting age was chosen for two reasons. First, life expectancy at birth is low in South Africa, mainly due to HIV. Second, a central aim is to observe longitudinally the pre-disease pathways that evolve in middle age and affect later life health.

Study design

HAALSI is a population-based community observational study with longitudinal follow-up at 3-year intervals. Embedded in the study are several randomized experiments and evaluations of public policies. HAALSI includes virtually complete mortality ascertainment, using state-of-the-art algorithms for verbal autopsies.[24]

Study setting

The study was conducted in the Agincourt sub-district in Mpumalanga Province, South Africa, where the MRC/Wits Rural Public Health and Health Transitions Research Unit has been running the Agincourt HDSS since 1992. The HDSS conducts an annual census of all households and collects vital events for all household members (births, deaths and migration), and residency status. Sociodemographic characteristics are collected in alternating years.[23] The study area consists of 31 villages and covers approximately 450 km^2; the total population is approximately 116 000 people. The primary health care system consists of six clinics, two health centres and three district hospitals. Despite the Apartheid legacy of underdevelopment and inadequate education, the social situation of this community has improved in the past 22 years as South Africa experienced political change to a democratic governance system. However, there are still gaps in access to electricity, water and tarred roads.[23] Unemployment rates are high, leading to high rates of labour migration with reliance on remittances as an important source of income.[25] The demographic profile of the HAALSI cohort is typical of rural South Africa; life expectancy at older ages has improved in Agincourt as well as elsewhere in rural South Africa,[26,27] though continued high fertility has led to overall slower compositional ageing than in the national population.[28]

Study population

Of the 116 000 people living in the study setting, 12 875 men and women met eligibility criteria for the study: aged 40 and older as of 1 July 2014 and permanently living in the study site for 12 months preceding the 2013 HDSS census. Using these inclusion criteria, a sampling frame of the 12 875 (8974 women and 3901 men) was identified and 6281 people were randomly selected to participate in HAALSI; gender-specific sampling fractions were developed to ensure a gender-balanced cohort.

Recruitment

Sampled individuals were interviewed at home between November 2014 and November 2015. Once identified, potential participants were asked to provide informed consent in xiTsonga, the local language, or in English. Participants unable to read had a witness and used an inked fingerprint as signature.

From the selected 6281 men and women, 5059 completed home interviews; a response rate of 85.9% (Figure 1). A total of 391 (6%) of the sample were ineligible due to death or out-migration from the surveillance area before interview. Of the remaining 5890 eligible, 353 (6%) were not found, 48 (1%) were unable to participate and 430 (7%) refused (Figure 1). Those who refused to participate were more likely to be women, were younger, had more education and were more likely to be native South Africans. A brief interview with a proxy was conducted for 116 (2.3%) participants who were too ill or unable to respond to the full interview.

Follow-up

The HAALSI cohort has been contacted twice a year following baseline. At the beginning of each year, each participant is contacted by phone or home visit to verify

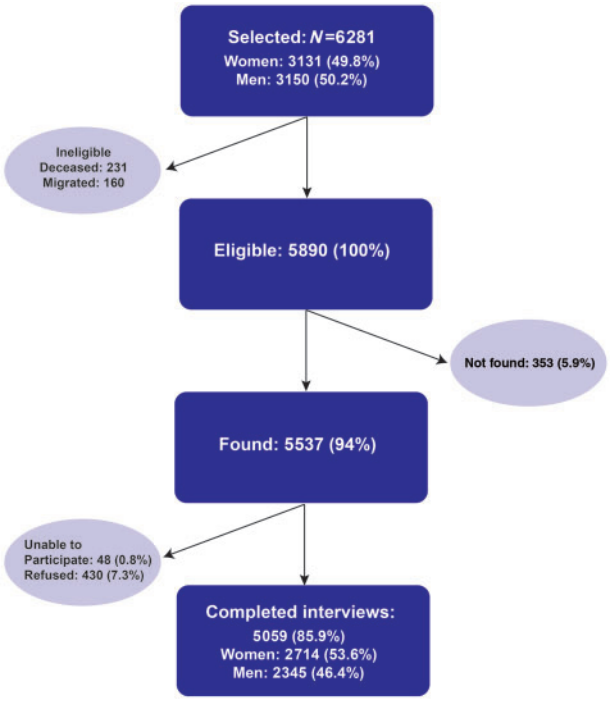

Figure 1. Flow-chart of HAALSI sample.

phone number, address and vital status. Approximately 6 months later, the annual HDSS census is conducted, reaching all participants who still reside in the study area. HAALSI cohort members who have permanently moved outside the study site since baseline are contacted by phone and remain in the cohort.

Deaths of HAALSI participants are identified through these biannual contacts and reported to the verbal autopsy team (VA team). The VA team visits households of every deceased person within 12 months of the death, and interviews caregivers of the deceased using a World Health Organization (WHO) standardized VA questionnaire.[29] Probable cause of death is established using InterVA-4.[24]

Field team training

The HAALSI baseline field team comprised experienced local fieldworkers and supervisors. The 1-month training included study objectives, household and individual computer-assisted personal interviews (CAPI), anthropometrics, performance measurements, dried blood spot and point of care blood-based measurements, and referrals to health facilities when indicated.

Quality control and quality assurance

Data were captured via CAPI during interview. To ensure data completeness and accuracy, internal checks were embedded in the system. Study team analysts produced weekly and monthly field check tables to support field-based teams for continuous progress and data quality monitoring.

Ethics

The study received ethical approvals from the University of the Witwatersrand Human Research Ethics Committee (ref. M141159), the Harvard T.H. Chan School of Public Health, Office of Human Research Administration (ref. C13–1608–02) and the Mpumalanga Provincial Research and Ethics Committee.

What has been measured?

The interview lasted 2.5–3 hours and consisted of household and individual questionnaires. A summary of all data collected is presented in Table 1. The household questionnaire included a household roster, consumption, income and assets. The individual questionnaire included sociodemographic items, self-reported health and health behaviours, and performance assessments of physical and cognitive function.

We collected anthropometric measurements and biomarkers via point of care and dried blood spots. Table 2 presents detailed descriptions of devices used to take these measurements, field procedures and thresholds used to categorize these objective measures.

Although HAALSI follows HRS sister studies in balancing assessments of health and functioning with social, economic and behavioural conditions, it measures more deeply critical features of HIV/AIDS infection, cardiometabolic disorders, and family and social networks than do many comparable sister studies. The baseline assessment consists of seven sections described below.

Social conditions: early childhood, family, social networks, mobility, migration, household characteristics

HAALSI gathered information about participants' demographics and family information: age, literacy, education, religion, marital status, timing of marriage and marital dissolution. Participants were asked about living children and their sex, age and current residence; and number, age and residence of grandchildren and siblings. The interview included questions about participants' early life, place of birth, duration of residence in area, parents' union status at participant's birth, parents' current vital state, age and residence. Participants were asked about paternal schooling and occupation.

The individual interview contained a rich set of questions on social networks and social support. Formal egocentric social network structure was modelled after the United

Table 1. Data collected during household and individual interviews in the HAALSI study in Agincourt, South Africa

INDIVIDUAL		
Demographics	**Employment**	**Social conditions**
Age	Employment status	Social networks, social support, interactions
Sex	Occupation	Caregiving/care receiving
Education	Wages	**Psychological well-being**
Marital status	Income for unemployment:	Gallup (Well-being)
Religion	Insurance	Center for Epidemiological Studies Depression scale
Nationality	Disability/pensions	Post-traumatic stress disorder
Ethnicity		**Expectations**
		Survival
		HIV infection
Cognition	**Self-reported health**	**Health behaviours**
Orientation	Vision and hearing	Tobacco use
Word recall	Diagnosis and treatment:	Alcohol consumption
Immediate	Hypertension	Diet (fruit, vegetables, bread, soft drinks)
Delayed	Glycaemia	International Physical Activity Questionnaire
Numeracy, number series	HIV	Vigorous, moderate exercise, sedentary activity
Self-rated memory	TB	Sexual behaviour
	Stroke	Morisky Medication Adherence Scale
	Angina	
	Myocardial infarction	
	High cholesterol	
	Kidney disease	
	Male circumcision	
	Brief Pain Inventory	
	Pittsburgh Sleep Quality Index	
	Activities of Daily Living	
Health care utilization	**Physical examinations: function**	**Point of care: blood assays**
Type of health facility used	Blood pressure	Total cholesterol, HDL, LDL, Triglycerides
Number of visits	Pulse	Glucose
	Grip strength	Haemoglobin
	Height and weight	HIV
	Body mass index	Viral load
	Waist and hip circumference,	Antiretroviral therapy (3TC, FTC)
	Waist-hip ratio	High-sensitivity C-reactive protein
	Walk time	
	Balance	
HOUSEHOLD		
Members	**Consumption**	**Income and assets**
Age	Food	Household member employment status
Sex	Communication	Household member wages
Relationship to household head	Transport	Business
Education	Rent, mortgage	Subsidies, pensions
	Consumables	Gifts
	Celebrations, funerals	Rentals
	Education	Durable goods (TV, fridge . . .)
	Health care	Properties (dwelling, land . . .)
	Transfers (including charity)	Livestock

Table 2. Anthropometry, physical performance and point of care measures, procedures for data collection and threshold values

Anthropometry	Equipment	Field procedures	Thresholds: measurements	
Blood pressure[50]	Omron©	Three measurements, 2 min apart, after 5-min rest. Final blood pressure: average of second and third measures	Hypertension: diastolic ≥ 90 OR systolic ≥ 140 OR on hypertension medication	
Waist circumference[51]	SECA© flexible tape	Tape at the navel, waist measured at mid distance between the iliac crest and the lowest rib, on a horizontal plane with participant standing	Men: Women:	Increased: ≥ 94 cm AND < 102 cm; Substantially increased: ≥12 0 cm Increased: ≥80 cm AND < 88 cm; Substantially increased: ≥88 cm
Hip circumference	SECA© flexible tape	Tape at the hip joint, circle around the widest portion of the buttocks on a horizontal plane with participant standing		
Waist/hip ratio[51]		Ratio of the waist and hip measurement	Men: Women:	Increased waist/hip ratio: ≥0.90 Increased waist/hip ratio: ≥0.85
Height	Genesis Growth Management Scale©, Patient Focus Africa	Measured in centimetres with one decimal point, using a height sensor placed on top of participant's head connected via infrared to the weight scale		
Weight	Genesis Growth Management Scale©, Patient Focus Africa	Measured in kilograms with one decimal point		
Body mass index (BMI)[52]		Weight in kilograms / (height in metres)[2]	Underweight < 18.5; normal 18.5–24.9	Overweight 25–29.9; obese > 30.00
Physical Performance				
Walking course	Century digital timer: Jumbo©	Participant walks 2.5 m, and repeats, at their usual speed using any walking aid needed	Mean walk time (5 m/s) = 5/(time 1 + time 2)	
Semi-tandem		Participant stands with the heel of one foot beside the other, touching the toe of the other foot and holds for 10 s		
Tandem		If semi-tandem was completed: participant stands with the heel of one foot touching the toe of the other foot, with feet in one line and holds for 60 s i < 70 years of age, or 30 s if >70 years		
Side by side		If semi-tandem was not completed: participant stands with both feet together, side by side, with the inside of both feet touching, and holds for 10 s		
Grip strength	Smedley© Digital Hand Dynamometer (12–0286)	Participant sits upright with feet flat on the floor, legs uncrossed and elbow at a 90-degree angle with arm close to body and forearm parallel to the floor. Results of grip recorded in kg with one decimal point	Mean of the 2 measures per hand if difference between measures is <10 kg; strongest measure per hand if mean difference >10 kg	
Point of care				
Total cholesterol, LDL, HDL, triglycerides[53,54]	Cardio Chek© PA (Silver version)	Finger prick using PTS Panel #1710 lipid panel test strips	High total cholesterol > 6.21 mmol/L, high LDL > 4.1 mmol/L	Low HDL < 1.19 mmol/L, high triglycerides > 1.7 mmol/L

(continued)

Table 2. Continued

Anthropometry	Equipment	Field procedures	Thresholds: measurements	
Glycaemia[55]	CareSens© N Monitor	CareSens N blood glucose test strips	Diabetes:	Glucose ≥ 11.1 mmol/L no fasting Glucose ≥ 7 mmol/L fasting Glucose < 7 mmol/L on diabetes medication
Haemoglobin[56]	Hemocue© Hb 201 + Analyser	Finger prick using Hemocue Hb 201 + microcuvette	Men:	Normal > 12.9 g/dl; mild anaemia ≤ 12.9 g/dl and ≥11 g/dl, moderate anaemia < 11 g/dl and ≥ 8 g/dl
			Women:	Normal > 11.9 g/dl, mild anaemia ≤ 11.9 g/dl and ≥ 11 g/dl, moderate anaemia < 11 g/dl and ≥8 g/dl, severe anaemia <8 g/dl

States National Social Life, Health and Ageing Project (NSHAP),[30] in which participants nominate up to six individuals close to them and describe interactions.

Economic conditions and productivity

The household interview included: consumption and expenditures; labour income; business income; government transfers; remittances; housing characteristics; ownership of durable goods, land, livestock and financial assets; and food security. A wealth index was created from principal components analysis of household characteristics and ownership of household items, vehicles and livestock.[31] Individual participants were asked about their own work status, working hours, income, unemployment, disability income and pensions.

Cognition and mental health

Specific measures included the eight-item Center for Epidemiological Studies Depression (CES-D) scale for depressive symptoms,[32] a short screening scale for post-traumatic stress disorder[33] and Gallup World Values Survey questions on subjective well-being and life satisfaction.[34] In assessing cognitive functioning, we harmonized with HRS, including items on orientation, immediate and delayed recall, and numeracy.[35,36] Domain-specific cognitive assessments developed by Humphreys for low-literacy settings were administered with tablets to about half the HAALSI cohort.[37]

Health

This was assessed primarily by self-report. Participants were asked about doctor, nurse or other health professional diagnosis and treatment of cardiovascular and metabolic conditions (high cholesterol, high blood pressure, stroke, heart failure, angina, myocardial infarction), diabetes, tuberculosis, HIV infection and kidney disease (Table 1). Health care utilization and expenditures questions were asked. Other indices include the Pittsburgh Sleep Quality Index[38] and Brief Pain Inventory.[39]

Health behaviours

Participants were asked about tobacco use (present and past, quantity, frequency, duration, type of tobacco) and alcohol consumption (ever consumed, daily quantity when consumed, type of alcoholic drink and binge drinking behaviour). Show-cards and a table of equivalent alcohol units per drink were used to ensure accuracy. Show-cards were used to collect information on dietary consumption, frequency and quantity of fruit, vegetables, bread and soft drinks taken.

To capture physical activity, we administered the International Physical Activity Questionnaire (IPAQ)[40] which includes type of work, exercise (vigorous, moderate) and sedentary activity. For each activity, we enquired about amount of time spent during weekdays and weekends.

Information on sexual activity and partnerships included number and type of partners and condom use. Participants self-reported whether they had ever been tested for HIV, and disclosed their HIV status, knowledge of antiretroviral therapy (ART) and whether they were receiving ART.

Physical function and performance

Activities of daily living (ADLs) measures included difficulty in walking, eating, bathing, getting in/out of bed and using the toilet. Function measures included a 5-m timed walk and balance tests. We measured grip strength of both hands twice using the Smedley© Digital Hand Dynamometer (12–0286).

Anthropometry and biomarkers

We collected a comprehensive set of measures including: weight, height, hip and waist circumferences; blood pressure; and point of care and dried blood spot (DBS) assays (Table 2).

Blood pressure (systolic, diastolic) and pulse were collected three times, 2 min apart, after the participant had been seated for 5 min, using the OMRON© Automatic blood pressure monitor M6W. Final blood pressure and pulse were calculated using the average of the second and third readings. Hip and waist circumferences were

measured in centimetres with participants in the standing position.

Eight blood drops were collected from a finger prick. Three blood drops were used to measure: point of care total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol and triglycerides (Cardio Chek© PA Silver version); haemoglobin (Hemocue© Hb 201 + Analyser); and glucose (CareSens© N Monitor). Five dried blood spots (DBS) on Whatman 903 TM filter paper were kept at room temperature (approximately 23°C) for 1–3 weeks and then sent to Global Labs in Durban and stored at -20°C. DBS assays measured high-sensitivity C-reactive protein (hsCRP),[41] HIV status and, when HIV-positive, viral load and traces of emtricitabine (FTC) and lamivudine (3TC) using levels higher than 0.02 µg/ml for positivity for both drugs.

The HIV results were determined by first conducting Vironostika Uniform 11 (Biomeriuex, France) screening assay. If positive, confirmation was done using Roche Elecsys, USA. If the confirmatory test was positive, the final result was considered positive and viral loads were calculated and reported. In those few cases that were weakly positive, final results were considered positive and viral load calculated.

What has it found?

Sociodemographic characteristics and health

A gender comparison of sample demographic characteristics and socioeconomic conditions including age, education, nationality, employment, marital union status, household composition, consumption per capita quintile rank and household asset index quintile rank is presented in Table 3. Results show a mean age for both men and women of 61.7 years. Women attained fewer years of education compared with men, fewer women are married and more widowed compared with men. More men are employed than women, fewer women are in single-member households compared with men and more women are in households ranked lowest on household consumption per capita.

Prevalence by gender of key health conditions, self-reported diseases, behavioural risk factors, function and cognitive measures is shown in Table 4. Below we discuss specific findings related to cognitive function, sexual behaviour and HIV, physical function and cardiometabolic risk factors.

Table 3. Comparison of sociodemographic characteristics by gender among HAALSI participants

Variables	Male		Female	
	N	%	*N*	%
Age group*				
40–49	418	17.8	500	18.4
50–59	624	26.6	786	29.0
60–69	643	27.4	661	24.4
70–79	446	19.0	432	15.9
80+	214	9.1	335	12.3
Years of education*				
No formal education	957	40.9	1349	49.9
Primary (1–7 years)	833	35.6	883	32.7
Some secondary (8–11 years)	314	13.4	260	9.6
Secondary or more (12+ years)	234	10.0	212	7.8
Nationality of origin				
South African	1663	70.9	1865	68.8
Mozambican/other	682	29.1	844	31.2
Union status*				
Never married	166	7.1	124	4.6
Separated/divorced	300	12.8	350	12.9
Widowed	276	11.8	1264	46.6
Currently married/cohabitating	1602	68.3	973	35.9
Household composition*				
Living alone	330	14.0	204	7.5
Living with 1 other person	257	11.0	281	10.3
Living in 3–6 person household	1055	45.0	1383	51.0
Living in 7+ person household	703	30.0	846	31.2
Employment status*				
Employed	443	18.9	362	13.4
Unemployed	1709	73.1	2010	74.2
Homemaker	186	8.0	335	12.4
Household consumption per capita*				
Quintile 1 (lowest)	456	19.5	591	21.8
Quintile 2	444	18.9	580	21.4
Quintile 3	468	20.0	553	20.4
Quintile 4	464	19.8	511	18.8
Quintile 5 (highest)	513	21.9	479	17.7
Household asset index				
Quintile 1 (lowest)	502	21.4	544	20.0
Quintile 2	455	19.4	546	20.1
Quintile 3	450	19.2	541	19.9
Quintile 4	457	19.5	550	20.3
Quintile 5 (highest)	481	20.5	533	19.6

Missing data for years of education: 17, nationality of origin: 5, union status: 4 and employment status: 14.

*Chi-square *P*-value < 0.001.

Cognition

Our approach to assessing cognition rests on both: novel assessments using tablets for low literacy and numeracy tests;[37] and on standard assessments (attention, immediate and delayed recall) harmonized with sister studies in the US, Mexico, China and India. HAALSI provides an opportunity to test whether educational attainment is strongly associated with cognition—as has been reported in many other countries[42–44]—in a setting where many people could not attend school. We report that a higher proportion of people with no formal education have low cognitive function in a number of domains compared with their counterparts with any formal education, regardless of age.[37] In an analysis of early life

Table 4. Prevalence of cardiovascular risk factors, self-reported cardiovascular diseases, behavioural risk factors and physical function

Indicators	Male		Female	
	N	(%)	*N*	(%)
HIV-positive[a]	483	(23.0)	565	(22.9)
Hypertension[b]				
Self-reported medication or systolic ≥ 140 or diastolic ≥ 90 mmHg**	1227	(54.3)	1616	(61.3)
Self-reported high blood pressure or systolic ≥ 140 or diastolic ≥ 90 mmHg**	1319	(58.4)	1768	(67.1)
Mean systolic BP	137.9		138.1	
Mean diastolic BP	81.9		82.3	
Diabetes[c]				
Self-reported medication or glucose ≥ 11.1 mmol/L*	153	(7.2)	219	(8.8)
Self-reported medication or glucose > 7 mmol/L fasting or ≥ 11.1 mmol/L*	197	(9.3)	276	(11.1)
Self-reported diabetic or glucose > 7 mmol/L fasting or ≥11.1 mmol/L*	224	(10.5)	309	(12.4)
Anthropometric measurements				
Overweight (BMI ≥ 25–29.9) or obese (BMI ≥ 30)[d]**	948	(44.0)	1751	(69.6)
High waist circumference (men ≥ 94 cm; women ≥ 80 cm)[e]**	725	(32.9)	2128	(83.7)
High waist/hip ratio (men ≥ 0.90; women ≥ 0.85)[f]**	1351	(61.6)	1859	(73.4)
Lipids				
High cholesterol ≥6.21 mmol/L)[g]**	79	(4.2)	196	(8.5)
High triglycerides (>2.25 mmol/L)[h]	388	(20.4)	504	(21.8)
High LDL (>4.1 mmol/L)[i]**	36	(2.1)	105	(5.0)
Low HDL (<1.19 mmol/L)[j]**	594	(31.3)	520	(22.5)
C-reactive protein[k]				
Elevated CRP (>2 mg/dl)**	1009	(51.5)	1387	(59.2)
Anaemia[l]				
Moderate (<11 g/dl–≥8 g/dl)/severe anaemia (<8 g/dl)**	235	(11.4)	544	(22.5)
Self-reported measures[m]				
High cholesterol	10	(0.5)	20	(0.7)
High blood pressure**	797	(34.0)	1321	(48.7)
Stroke	64	(2.7)	85	(3.1)
Heart failure	12	(0.5)	21	(0.8)
Angina*	42	(1.8)	77	(2.8)
Myocardial infarction	10	(0.4)	11	(0.4)
Diabetes	145	(6.2)	192	(7.1)
Tuberculosis**	258	(11.0)	188	(6.9)
Kidney disease	97	(4.1)	117	(4.3)
Behavioural risk factors[m]				
Currently drinks alcohol**	912	(38.9)	259	(9.6)
Currently uses tobacco**	450	(19.2)	10	(0.4)
Physical function[n]				
Mean walk time (s/5 m)**	12.7		13.5	
Activities of daily living (ADL)	210	(9.0)	246	(9.1)
Mean grip strength (kg)**	28.6		20.9	

BP, blood pressure.

[a]4560 consented to HIV testing and had valid dried blood spot results.

[b]4895 had blood pressure readings.

[c]4626 had glucose biomarker results.

[d]4670 had valid height and weight measurements.

[e]4744 had a valid waist measurement.

[f]4728 had valid hip and waist measurements.

[g]4195 had a valid cholesterol reading.

[h]4214 had a valid triglyceride reading.

[i]3820 had a valid LDL cholesterol reading.

[j]4212 had a valid HDL cholesterol reading.

[k]4302 had CRP dried blood spot results.

[l]4493 had valid haemoglobin results.

[m]Questionnaire responses were missing for: high cholesterol (6), high blood pressure (4), stroke (3), heart failure (3), angina (4), myocardial infarction (3), diabetes (6), tuberculosis (7), kidney disease (5), currently drinks alcohol (3), currently uses tobacco (5).

[n]Walk time assessed for 4694 and grip strength assessed for 4699.

*Chi-square/t-test *P*-value < 0.05; **chi-square/t-test *P*-value < 0.001.

conditions, older adults with poor self-reported childhood health or whose father worked in unskilled manual labour had relatively poor cognitive outcomes.[45] These findings suggest that education can provide cognitive reserve, even in a setting where access to education was restricted.

Sexual behaviour and HIV

A recent HAALSI study[46] reports that many older adults are still sexually active. In contrast to stereotypes, more than half of HAALSI participants (57%) reported at least one sex partner in the past 2 years. The proportion was higher among men (77%) compared with women (40%), and generally decreased with age. Over one in 10 of these recent partners (12%) were classified as either casual or anonymous, and only a quarter of participants (25%) reported ever using condoms with their most recent partner. In an HIV-hyperendemic community like the Agincourt study area—with 23% HIV prevalence in this sample—these sexual behaviours are consistent with both HIV transmission risk and HIV acquisition risk.

Physical function

Measured physical performance in the HAALSI sample was associated with socioeconomic conditions—higher school attainment and increased household wealth were both strongly associated with higher hand grip strength and faster gait speed.[47] In order to place the HAALSI cohort in international context, we compared its functioning and self-reported physical health with HRS and sister studies in Mexico and China. HAALSI respondents had better self-reported health and lower rates of reported ADL limitation than most other countries.[47] However, the HAALSI sample had overall lower age-adjusted physical performance outcomes.[47]

Cardiometabolic risk factors

Hypertension prevalence was high (58.4%), and significantly increased with age.[48] We observed high levels of overweight/obesity, affecting 70% of women and 44% of men. Total cholesterol levels were twice as high among women as compared with men (8.5% vs 4.2%) and women self-reported higher levels of most conditions including a higher prevalence of angina (2.8% vs 1.8%). The fact that self-reported levels are lower than measured levels is a reflection of the low level of awareness of some cardiovascular risk factors among HAALSI participants. In our recent paper on cardiometabolic risk,[48] we observed that HIV-negative people had higher levels of cardiometabolic risk factors than HIV-positive people, with the HIV-negative presenting higher prevalence of hypertension (men: 59.2% vs 38.7% and women: 67.2% vs 43.8%), diabetes (men: 10.9% vs 7.3% and women: 13.1% vs 7.9%), overweight (men: 29.3% vs 22.7% and women 28.7% vs 26.2); and obesity [body mass index (BMI) 30–34.9] (men: 12.9% vs 8.6% and women: 23.9% vs 18.6%). The absolute 10-year cardiovascular risk scores ranged from 7.7–9.7% for women and from 12.5–15.3% for men.[48] Comparing the cardiometabolic risks of the HAALSI cohort with the national South Africa National Health and Nutrition Examination Survey (SANHANES), we found that the HAALSI lipid profile is similar, although HDL levels and the waist hip ratio were higher in the HAALSI cohort and men reported a higher rate of smoking.[48]

Measured blood pressure

The 2883 participants with high blood pressure (defined as systolic ≥ 140 mmHg, diastolic ≥ 90 mmHg, or self-reported antihypertensive medication use) were generally older (mean age of 64.1 ± 12.7 years). We found high rates of hypertension treatment among those who were aware, with nearly half of those treated having controlled blood pressure.[49] Multivariable regression results showed that hypertension awareness was associated with higher socioeconomic status, previous cardiovascular disease (CVD), non-immigrant status, literacy and physical limitation, and awareness was higher for women compared with men.[47–49] The HAALSI cohort showed higher levels of awareness, treatment rates and control levels than previously published data in the region, possibly due to increased awareness following previous studies in the area which focused on stroke and hypertension.[3–6]

What are the main strengths and weaknesses?

The HAALSI cohort was established as a population-based study representative of the Agincourt sub-district. The strength of this cohort lies in the ability to identify a broad range of social, economic, behavioural and biological risk factors and their associations with a range of health outcomes through longitudinal follow-up. Though not a nationally representative sample, HAALSI findings are likely to be mirrored in similar rural communities. The fact that this study is embedded in the Agincourt HDSS, where the population has been followed since 1992, is a major strength. The field and research teams have extensive experience implementing fieldwork, and the HDSS allows for annual cohort follow-up, death registration and cause of death ascertainment. Future waves of HAALSI promise an exceptional combination of health, sociodemographic, cognitive and economic information that will enhance our understanding of the complex nature of rapid epidemiological and demographic transitions in this rural setting.

Can I get hold of the data? Where can I find out more?

The HAALSI baseline data are publicly available at the Harvard Center for Population and Development Studies (HCPDS) programme website [www.haalsi.org]. Data are also accessible through the Inter-university Consortium for Political and Social Research (ICPSR) at the University of Michigan [www.icpsr.umich.edu] and the INDEPTH Data Repository [http://www.indepth-ishare.org/index.php/catalog/113]. The release includes documentation of baseline data. Further details can be obtained by e-mailing the corresponding author of this paper.

Profile in a nutshell

- The HAALSI study addresses the knowledge gap regarding health and ageing in South Africa as it undergoes epidemiological and demographic transitions. It is designed as a harmonized sister study to the US Health and Retirement Study (HRS).
- In-person interviews were conducted from November 2014 through November 2015 in the Agincourt subdistrict, Mpumalanga Province, South Africa, where the INDEPTH Agincourt Health and Demographic Surveillance System has been run since 1992. The cohort consists of 5059 men ($n = 2345$) and women ($n = 2714$) aged 40 and older, with planned longitudinal follow-up at 3-year intervals.
- HAALSI is closely harmonized with the global HRS sister studies in assessments of health, functioning and social, economic and behavioural conditions. HAALSI goes into more depth on HIV, cardiometabolic disorders, family dynamics and social networks. It is designed to identify social and economic determinants of health. Broad sections of the baseline assessment include: general health; physical function; cognition; mental health; anthropometrics and biomarkers; behavioural risks; social conditions; economic conditions; and productivity.
- HAALSI is a collaboration between the Harvard Center for Population and Development Studies and the MRC/Wits Rural Public Health and Health Transitions Research Unit, a member centre of the INDEPTH Network. Data are in the public domain.

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References

1. United Nations. *World Population Aging 2009*. New York, NY: Department of Economic and Social Affairs, United Nations, 2009.
2. United Nations. *Report of the World Assembly on Aging, 1982*. New York, NY: Department of Economic and Social Affairs, United Nations, 1982.
3. Connor MD, Thorogood M, Casserly B, Dobson C, Warlow CP. Prevalence of stroke survivors in rural South Africa: results from the Southern Africa Stroke Prevention Initiative (SASPI) Agincourt field site. *Stroke* 2004;**35:**627–32.
4. Fowkes FG, Thorogood M, Connor MD, Lewando-Hundt G, Tzoulaki I, Tollman SM. Distribution of a subclinical marker of cardiovascular risk, the ankle brachial index, in a rural African population: SASPI study. *Eur J Cardiovasc Prev Rehabil* 2006; **13:**964–69.
5. Thorogood M, Connor M, Tollman S, Lewando Hundt G, Fowkes G, Marsh J. A cross-sectional study of vascular risk factors in a rural South African population: data from the Southern African Stroke Prevention Initiative (SASPI). *BMC Public Health* 2007;**7:**326.
6. Thorogood M, Connor MD, Lewando-Hundt G, Tollman S, Ngoma B. Secondary prevention of stroke – results from the Southern Africa Stroke Prevention Initiative (SASPI) study. *Bull World Health Organ* 2004;**82:**503–08.
7. Phaswana-Mafuya N, Peltzer K, Chirinda W *et al*. Self-reported prevalence of chronic non-communicable diseases and associated factors among older adults in South Africa. *Glob Health Action* 2013;**6:**20936.
8. Peltzer K, Phaswana-Mafuya N. Depression and associated factors in older adults in South Africa. *Glob Health Action* 2013;**6:**1–9.
9. Williams DR, Herman A, Stein DJ *et al*. Twelve-month mental disorders in South Africa: prevalence, service use and demographic correlates in the population-based South African Stress and Health Study. *Psychol Med* 2008;**38:**211–20.
10. Suzman R. Guest Editorial: The INDEPTH WHO-SAGE multicentre study on ageing, health and well-being among people aged 50 years and over in eight countries in Africa and Asia. *Glob Health Action* 2010;**3(Suppl 2):**5–7.
11. Risk Factors Collaborators GBD. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*.2016;**388:**1659–724.
12. Dalys GBD and Collaborators HALE. Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016;**388:**1603–58.

13. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* 2016;**388:**1459–544.
14. Kowal P, Kahn K, Ng N, *et al*. Ageing and adult health status in eight lower-income countries: the INDEPTH WHO-SAGE collaboration. *Glob Health Action* 2010, Sep 27. doi: 10.3402/gha.v3i0.5302.
15. United Nations. *Aging in the Twenty-First Century: A Celebration and A Challenge*. New York, NY: United Nations Population Fund (UNFPA), 2012.
16. Hontelez JA, de Vlas SJ, Baltussen R *et al*. The impact of antiretroviral treatment on the age composition of the HIV epidemic in sub-Saharan Africa. *AIDS* 2012;**26(Suppl 1):**S19–30.
17. Sonnega A, Faul JD, Ofstedal MB, Langa KM, Phillips JW, Weir DR. Cohort Profile: The Health and Retirement Study (HRS). *Int J Epidemiol* 2014;**43:**576–85.
18. Steptoe A, Breeze E, Banks J, Nazroo J. Cohort Profile: The English longitudinal study of ageing. *Int J Epidemiol* 2013;**42:**1640–48.
19. Kearney PM, Cronin H, O'Regan C *et al*. Cohort Profile: The Irish Longitudinal Study on Ageing. *Int J Epidemiol* 2011;**40:**877–84.
20. Borsch-Supan A, Brandt M, Hunkler C *et al*. Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE). *Int J Epidemiol* 2013;**42:**992–1001.
21. Zhao Y, Hu Y, Smith JP, Strauss J, Yang G. Cohort Profile: The China Health and Retirement Longitudinal Study (CHARLS). *Int J Epidemiol* 2014;**43:**61–68.
22. Arokiasamy P, Bloom D, Lee J, Feeney K, Ozolins M. Longitudinal ageing study in India: vision, design, implementation, and preliminary findings. In: *National Research Council (US) Panel on Policy Research and Data Needs to Meet the Challenge of Aging in Asia*. Washington, DC: National Academies Press, 2012.
23. Kahn K, Collinson MA, Gomez-Olive FX *et al*. Profile: Agincourt health and socio-demographic surveillance system. *Int J Epidemiol* 2012;**41:**988–1001.
24. Byass P, Kahn K, Fottrell E, Collinson MA, Tollman SM. Moving from data on deaths to public health policy in Agincourt, South Africa: approaches to analysing and understanding verbal autopsy findings. *PLoS Med* 2010;**7:**e1000325.
25. Collinson MA. Striving against adversity: the dynamics of migration, health and poverty in rural South Africa. *Glob Health Action* 2010;**3:**1–14.
26. Bor J, Herbst AJ, Newell M-L, Bärnighausen T. Increases in adult life expectancy in rural South Africa: valuing the scale-up of HIV treatment. *Science* 2013;**339:**961–65.
27. Kabudula CW, Houle B, Collinson MA *et al*. Progression of the epidemiological transition in a rural South African setting: findings from population surveillance in Agincourt, 1993–2013. *BMC Public Health* 2017;**17:**424.
28. Garenne ML, Tollman SM, Collinson MA, Kahn K. Fertility trends and net reproduction in Agincourt, rural South Africa, 1992–2004. *Scand J Public Health Suppl* 2007;**69:**68–76.
29. World Health Organization. *Verbal Autopsy Standards: the 2014 WHO Verbal Autopsy Instrument*. Geneva: World Health Organization, 2015.
30. Cornwell B, Schumm LP, Laumann EO, Graber J. Social networks in the NSHAP Study: rationale, measurement, and preliminary findings. *J Gerontol B Psychol Sci Soc Sci* 2009;**64(Suppl 1):**i47–55.
31. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data – or tears: an application to educational enrollments in states of India. *Demography* 2001;**38:**115–32.
32. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Appl Psychol Measurement* 1977;**1:**385–401.
33. Breslau N, Peterson EL, Kessler RC, Schultz LR. Short screening scale for DSM-IV posttraumatic stress disorder. *Am J Psychiatry* 1999;**156:**908–11.
34. Deaton A. Income, health, and well-being around the world: evidence from the Gallup World Poll. *J Econ Perspect* 2008;**22:**53–72.
35. Weir D, Lay M, Langa K. Economic development and gender inequality in cognition: a comparison of China and India, and of SAGE and the HRS sister studies. *J Econ Aging* 2014;**4:**114–25.
36. Samieri C, Proust-Lima C, Glymour MM *et al*. Subjective cognitive concerns, episodic memory, and the APOE epsilon4 allele. *Alzheimers Dement* 2014;**10:**752–59 e1.
37. Humphreys GW, Duta MD, Montana L *et al*. Cognitive function in low-income and low-literacy settings: validation of the tablet-based Oxford Cognitive Screen in the Health and Ageing in Africa: a longitudinal study of an INDEPTH community in South Africa (HAALSI). *J Gerontol B Psychol Sci Soc Sci* 2017;**72:**38–50.
38. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;**28:**193–213.
39. Cleeland C. Measurement of pain by subjective report. In: Chapman CR, Loeser JD (eds). *Issues in Pain Measurement*. New York, NY: Raven Press, 1989.
40. Craig CL, Marshall AL, Sjostrom M *et al*. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003;**35:**1381–95.
41. McDade TW, Burhop J, Dohnal J. High-sensitivity enzyme immunoassay for C-reactive protein in dried blood spots. *Clin Chem* 2004;**50:**652–54.
42. Glymour MM, Kawachi I, Jencks CS, Berkman LF. Does childhood schooling affect old age memory or mental status? Using state schooling laws as natural experiments. *J Epidemiol Community Health* 2008;**62:**532–37.
43. Langa KM, Larson EB, Karlawish JH *et al*. Trends in the prevalence and mortality of cognitive impairment in the United States: is there evidence of a compression of cognitive morbidity? *Alzheimers Dement* 2008;**4:**134–44.
44. Reuser M, Willekens FJ, Bonneux L. Higher education delays and shortens cognitive impairment: a multistate life table analysis of the US Health and Retirement Study. *Eur J Epidemiol* 2011;**26:**395–403.
45. Kobayashi LC, Glymour MM, Kahn K *et al*. Childhood deprivation and later-life cognitive function in a population-based study of older rural South Africans. *Soc Sci Med* 2017;**190:**20–28.
46. Rosenberg MS, Gomez-Olive FX, Rohr JK *et al*. Sexual behaviors and HIV status: a population-based study among older adults in rural South Africa. *J Acquir Immune Defic Syndr* 2017;**74:**e9–17.

47. Payne CF, Gómez-Olivé FX, Kahn K, Berkman L. Physical function in an aging population in rural South Africa: findings from HAALSI and cross-national comparisons with HRS sister studies. *J Gerontol B Psychol Sci Soc Sci* 2017;**72:** 665–79.
48. Gaziano TA, Abrahams-Gessel S, Gomez-Olive FX *et al*. Cardiometabolic risk in a population of older adults with multiple co-morbidities in rural South Africa: the HAALSI (Health and Ageing in Africa: longitudinal studies of INDEPTH communities) study. *BMC Public Health*.2017;**17:**206.
49. Thiago Veiga Jardim, Sheridan Reiger, Shafika Abrahams-Gessel, Gomez-Olive FX *et al*. Hypertension management in a population of older adults in rural South Africa. *J Hypertens* 2017. doi: 10.1097/HJH.0000000000001312.
50. Seedat YK, Rayner BL. South African Hypertension Guideline 2011. *S Afr Med J* 2012;**102:**57–84.
51. WHO. *Waist Circumference and Waist–hip Ratio*. Geneva: World Health Organization, 2008.
52. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. Geneva: WHO, 2000.
53. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA* 2001;**285:**2486–97.
54. Klug EQ, Raal FJ, Marais AD *et al*. South African Dyslipidaemia Guideline Consensus Statement. A joint statement from the South African Heart Association (SA Heart) and the Lipid and Atherosclerosis Society of Southern Africa (LASSA). *S Afr Med J* 2012;**102:**177–88.
55. American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care* 2013;**36:**S11–66.
56. Shisana O, Labadarios D, Rehle T *et al. South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town: Human Science Research Council Press, 2013.