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HEALTH & DEMOGRAPHIC SURVEILLANCE SYSTEM PROFILE

Profile: Agincourt Health and Socio-demographic Surveillance System

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The Agincourt health and socio-demographic surveillance system (HDSS), located in rural northeast South Africa close to the Mozambique border, was established in 1992 to support district health systems development led by the post-*apartheid* ministry of health. The HDSS (90 000 people), based on an annual update of resident status and vital events, now supports multiple investigations into the causes and consequences of complex health, population and social transitions. Observational work includes cohorts focusing on different stages along the life course, evaluation of national policy at population, household and individual levels and examination of household responses to shocks and stresses and the resulting pathways influencing health and well-being. Trials target children and adolescents, including promoting psycho-social well-being, preventing HIV transmission and reducing metabolic disease risk. Efforts to enhance the research platform include using automated measurement techniques to estimate cause of death by verbal autopsy, full 'reconciliation' of in- and out-migrations, follow-up of migrants departing the study area, recording of extra-household social connections and linkage of individual HDSS records with those from sub-district clinics. Fostering effective collaborations (including INDEPTH multi-centre work in adult health and ageing and migration and urbanization), ensuring cross-site compatibility of common variables and optimizing public access to HDSS data are priorities.

Keywords Sub-Saharan Africa, population pyramids, health transition, mortality, morbidity, cause of death, fertility, migration, census, HIV, tuberculosis, non-communicable diseases, households

Why was the Agincourt Health and Socio-Demographic Surveillance System set up?

The Agincourt Health and Socio-Demographic Surveillance System (HDSS), located in rural northeast South Africa close to the Mozambique border, provides the foundation for the Rural Public Health and Health Transitions Research Unit of the Medical Research Council (MRC) and University of the Witwatersrand, South Africa (the MRC/Wits-Agincourt Unit). Its origins lie in the university's 'Health Systems Development Unit' that in the early 1990s focused on district health systems development, sub-district health centre networks and referral systems and training of clinically oriented primary health care nurses.[1–2] This was done to guide critical re-organization of the country's health system alongside democratic political change and the dismantling of South Africa's ubiquitous 'Bantustan' system, which had spawned duplicate and inefficient health departments concurrently with systematically marginalizing the rural poor. However, efforts were seriously hampered by the lack of reliable population-based information for programme planning and resource allocation.

Influenced by Sidney and Emily Kark's vision of 'community-oriented primary care', as well as visits to health and demographic surveillance sites in Bangladesh (Matlab) and Senegal (Niakhar), we established the Agincourt HDSS to address this information gap. In 1992, a baseline census was conducted in 20 contiguous villages chosen for their rural living conditions, limited access to public sector services, underperforming primary care clinics and communities of Mozambican refugees displaced by the civil war.[3–4]

Three phases followed the baseline census: (i) decentralized health systems development that provided a prototype for national policy in response to limited experience in delivering rural services (1993–97),[1,5] (ii) reorientation to an interdisciplinary health and population research initiative to better understand the dynamics of health, population and social transitions and address serious weaknesses in the rural evidence base (1998–2002)[3–4,6] and (iii) an established university and MRC-linked field research and training programme supporting multiple investigations into the causes and consequences of critical findings from the HDSS (2004 onwards) (www.wits.ac.za/academic/health/publichealth/agincourt/).[7–8]

The Agincourt HDSS was a founding member of the International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) (www.indepth-network.org) and provides leadership to INDEPTH multi-centre initiatives in adult health and ageing[9] and migration and health.[10]

What does it cover now?

The Agincourt HDSS constitutes a platform for research programmes that elucidate causal pathways and test interventions across the life course. Figure 1 outlines the organizational framework, indicating major research themes and links between them. Critical questions relate to (i) the dynamics of rapidly evolving health, population and social transitions—including inequalities between individuals and communities and social and biological explanations, (ii) determinants of vulnerability and resilience along the life course and (iii) implications for policy, programmes and services.

Efforts have been made to deepen observational work, extend a portfolio of intervention research and enhance capacity of the platform to support research training with PhD, post-doctoral and selected masters projects nested within established research areas.

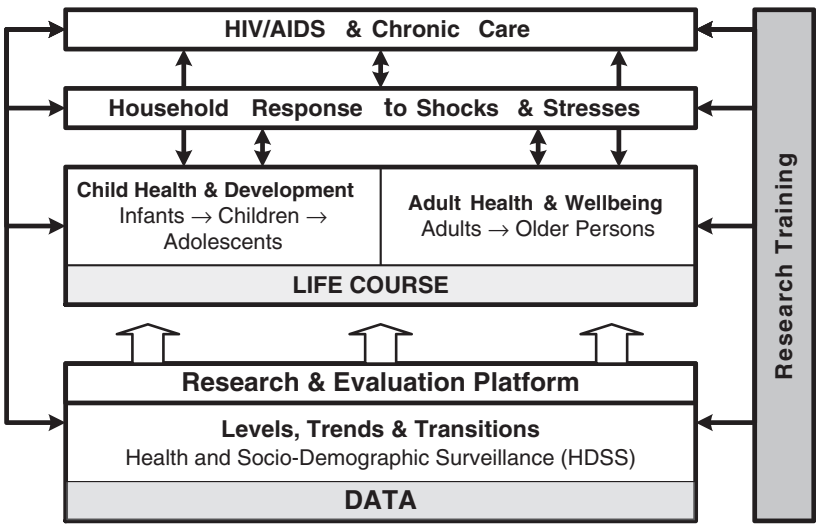

Figure 1 Research themes supported by the Agincourt HDSS, South Africa

Deepening observational work

Several cohorts are nested within the population under surveillance and generally focus on subgroups at different stages along the life course (Table 1).

The HDSS contributes to evaluation of national policy at population, household and individual levels. Examples include the following: introduction of the Rotarix® and pneumococcal conjugate vaccines into the Expanded Programme on Immunization, impact of social support grants (old age pension and child support grant) on the health and well-being of grant recipients and other household members, and the population impact of decentralized delivery of highly active anti-retroviral therapy (HAART) through public and private health systems.

In addition, a portfolio of work examines household responses to shocks and stresses and the resulting pathways influencing child and adult health and well-being. This includes the care and support roles of older women, intra- and inter-household social connections, use of natural resources and diverse migration and livelihood strategies.

Extending a portfolio of intervention research

Ongoing trials target critical problems affecting the health and well-being of children and adolescents. The *Kulani* ('strength') cluster randomized trial evaluated a primary school-based intervention, developed by a non-governmental organization and conducted by the Provincial Department of Education, to improve psychological and educational outcomes of children aged 10–12 years (in partnership with the University of Oxford, UK, and Soul City Institute for Health and Development Communication, South Africa). The *Swa Koteka* ('we can') multi-level HIV prevention trial aims to reduce HIV transmission in adolescent girls by encouraging girls to remain in high school through a conditional cash transfer (individual randomization) and by influencing gender norms through community mobilization focused on men (village cluster randomization) (with the Universities of North Carolina and San Franciso, USA, and the Wits Reproductive Health and HIV Institute and Sonke Gender Justice, South Africa). The forthcoming *Ntshembo* trial ('hope') aims to reduce the intergenerational transfer of metabolic disease risk through community health worker-delivered interventions to pre-pregnant adolescent girls, which are reinforced during pregnancy and infancy. Formative studies to-date address growth and nutrition, physical activity, body image preferences, beliefs and practices regarding pregnancy, delivery and infant feeding, community food vendors and adolescent health services (with the MRC/Wits Developmental Pathways for Health Research Unit, South Africa and the Universities of Cambridge and Oxford, UK, Umeå, Sweden, and North Carolina, USA).

Enhancing capacity of the Agincourt research platform

Efforts to ensure rigour and extend analytic possibilities include application of automated measurement techniques to cause-of-death estimation by verbal autopsy,[11–13] full 'reconciliation' of in- and out-migrations, follow-up of migrants who depart the study area and recording of extra-household social connections. Linkage of individual records in the HDSS with those from sub-district clinics is based on conventional identifiers (name, date of birth, village, ID, cell number and other household members); fingerprint matching was used to validate these variables in correctly matching clinic patients with their HDSS records.

Where is the HDSS area?

Maps in Figure 2 indicate the location of the Agincourt HDSS in northeast South Africa close to the border with Mozambique (Figure 2a), the boundary of the study site abutting on the Kruger National Park conservation area (Figure 2b) and the villages and health and education facilities within the site (Figure 2c).

The Agincourt HDSS covers an area of 420 km^2 comprising a sub-district of 27 villages with traditional and elected leadership. Since the democratic transition in 1994, infrastructure development has proceeded but at a rate below expectations: electricity is available in all villages, but the cost is too high for many households; few gravel roads have been tarred within the sub-district; a dam was constructed nearby, but to-date, there is no piped water to dwellings, and sanitation is rudimentary. Every village has a primary school and most a high school; however, the quality of education remains poor.[14] Although almost all children enrol, educational progress is often delayed with few post-secondary opportunities.

The area is dry in winter (from May to October), with soil more suited to game farming than agriculture. Households generally purchase maize and other foods, supplementing this with home-grown crops and collection of wild foods.[15] South Africa's non-contributory social grant system is a vital source of household income, notably the old age pension[16] and child support grant.[17–18] There are two health centres and six clinics within the sub-district, with three district hospitals 25–60 km away.

Who is covered by the HDSS, and how often have they been followed up?

At baseline in 1992, 57 600 people were recorded in 8900 households in 20 villages[3]; by 2006, the

Table 1 Features of cohorts nested within the Agincourt HDSS

Cohort description		Sample				
Cohort name	Aim	Size	Type	Assessments to date Frequency of follow-up	Inclusion criteria	Sampling unit
OBSERVATIONAL COHORTS						
Ntshembo ('Hope')	To measure metabolic disease risk in adolescent girls	600	Closed	Cohort recruited in 2007 Follow-up 2009 and 2012	Boys and girls aged 7/8, 11/12 and 14/15 years	Individual
Ha Nakekela ('We care')	To measure HIV and non-communicable disease prevalence and their risk factors	7428	Closed	Baseline in 2010/2011 Repeat planned for 2013	Men and women 15 years and older Permanent residents	Individual
INDEPTH-SAGE (Survey on global AGEing and adult health)	To assess health status, well-being and health seeking behaviour of older persons	4509	Open	Baseline in 2006 Follow-up in 2010 Repeat planned in 2013	Population 50 years and older Permanent residents	Individual
SEEDS (Study of the Epidemiology of Epilepsy)	To understand the burden of epilepsy, pattern of seizures, and excess mortality in persons with epilepsy	310	Closed	Nine rounds completed Follow-up every 3 months	All ages diagnosed with epilepsy following screening in 2008	Individual
SUCSES (Sustainability in Communal Socio-Ecological Systems)	To examine (i) household income, resource use, response to shocks on household livelihoods, (ii) how livelihood capital migration and use of natural resources shape household resilience and (iii) how poverty influences child nutrition	590 individuals and their households	Closed	Round 1—2010 Round 2—2011 Round 3—2012	Sample stratified by gender and age Four individuals selected per age/gender group in nine villages	Individual (households interviewed)
INTERVENTION COHORTS						
Kulani ('Grow strong')	Cluster randomized trial to test school-based interventions to promote social and emotional wellbeing of children 10–12 years	988 individuals in 10 schools	Closed	Cohort recruited in 2009 Post-intervention follow-up end-2010 Next follow-up in 2013	Boys and girls in grades 5 and 6	Schools
Swa Koteka ('We can')	Randomized trial to determine whether young women who receive cash transfers conditional on school attendance have a lower incidence of HIV and HSV2 infection over time	2900	Closed	Cohort recruited in 2011/2012 Annual follow-up for 3 years	Young women aged 13–20 years, in school grades 8–11, one girl per household	Individual

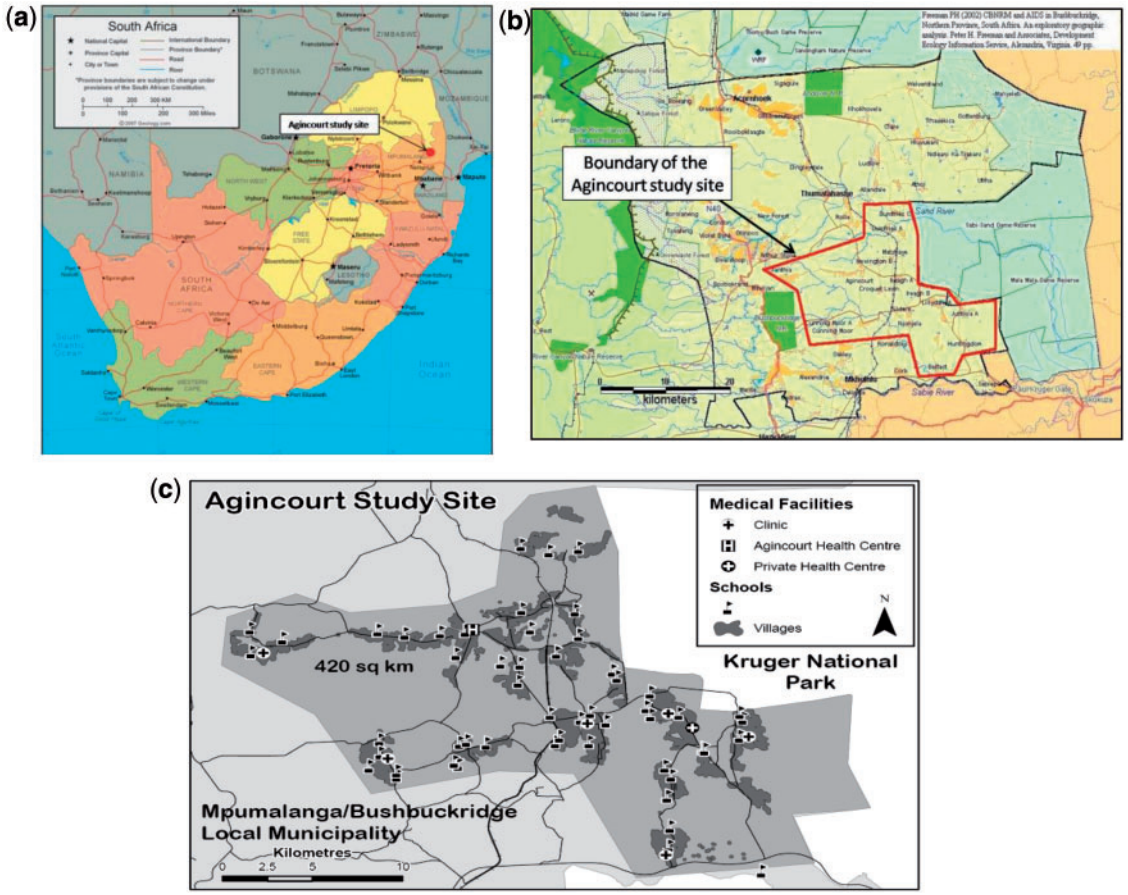

Figure 2 (a) Location of Agincourt HDSS and sub-district within South Africa, near the Mozambique border. (b) Boundary of the Agincourt HDSS study site adjacent to the Kruger National Park, South Africa. (c) Agincourt HDSS study site and sub-district indicating positions of villages and health and education facilities

population had increased to ~70 000 people in 11 700 households.[8] This increase is partly due to Mozambican in-migrants overlooked in the baseline survey and to a new settlement established as part of the post-*apartheid* government's *Reconstruction and Development Programme*. In 2007, the study area was extended to include the catchment area of a new privately supported community health centre established to provide HIV treatment before public sector roll-out of HAART. By mid-2011, the population under surveillance comprised 90 000 people residing in 16 000 households in 27 villages (Table 2). Households are self-defined as 'people who eat from the same pot of food'. Given sustained high levels of temporary labour migration in southern Africa, we included temporary migrants residing for <6 months per year who retain close ties with their rural homes in the HDSS. There have been 17 census and vital event update rounds conducted strictly annually since 2000. Participation is virtually complete, with only two households refusing to participate in 2011.

The LINC (Learning, Information dissemination and Networking with Community) office, responsible for community liaison, has built a 20-year relationship with study communities and their leaders based on mutual trust and respect. Key points of engagement include regular 'community entry' and feedback. Community entry ranges from meetings with civic and traditional leaders to public meetings depending on the nature and sensitivity of research. Annual feedback of HDSS and project findings is to open village meetings; local service providers—health, education, social services and municipality—generally participate, creating a platform for information sharing between these institutions and the community. Selected findings are presented to service providers in the sub-district, local government and provinces.

What has been measured, and how have the HDSS databases been constructed?

The primary instrument is a rigorous annual update of resident status and vital events involving every member of the sub-district (Table 3). Well-supervised

Table 2 Features of the Agincourt HDSS population, South Africa

Feature at 1 July 2011	No. or %
Total population	
de facto population (permanent residents)	66 876
de jure population (permanent residents + temporary migrants resident <6 months/year)	90 036
Sex ratio (male:female)	
de facto population[a]	0.77
de jure population	0.92
At birth	1.01
Percentage under 5 years	
de facto population	13.74
de jure population	11.81
Percentage under 15 years	
de facto population	40.49
de jure population	33.59
Percentage 65 years and over	
de facto population	5.95
de jure population	4.65
Mean household size (based on de jure population)	
Total households	16 121
Mean no. of members	5.58
Percentage temporary migrants (no. of temporary migrants/de jure population)[b]	
Male	32.67
Female	19.31

Basic vital statistics	1994	2004	2009
Life expectancy at birth—females	72.7	59.4	64.4
Life expectancy at birth—males	68.2	53.3	55.7
Infant mortality rate per 1000 live births	24.7	39.0	39.1
Under-five mortality rate per 1000 live births—females	37.9	50.7	51.0
Under-five mortality rate per 1000 live births—males	38.2	71.5	45.0
Adult mortality rate—females 15–59 years	164.8	456.6	382.4
Adult mortality rate—males 15–59 years	276.1	539.6	505.9
Total fertility rate	3.71	2.61	2.34

Death registration	Percent registered	
Period	Children 0–4 years	Adults 20+
1992–96	15.2	60.9
1997–2001	24.7	85.5
2002–06	27.8	93.2
2007–10	45.8	96.1

[a]This reflects disproportionately high male labour migration.
[b]Mostly labour migrants working in towns and cities, in the mining sector or on large agricultural estates.

fieldworkers visit each household and, following verbal consent, interview the most knowledgeable respondent. They verify existing data and record all new events experienced by each household member—pregnancy outcomes, deaths and in- and out-migrations[8]; this is supplemented by a maternity history for in-migrant women aged 15–54 years. Update rounds involve four teams comprising a supervisor and eight fieldworkers (one dedicated to migration reconciliation); teams work from Geographic Information System-based maps that list every dwelling. Quality control measures include fieldworker self-checks,

Table 3 Variables collected during annual resident status and vital events update, Agincourt HDSS

Main data item	Specific information
Household roster	
Village number; dwelling number	
Name, surname and gender	Recorded for each individual
Date of birth	Noted if estimate
Mother's identification and location	Vital status and where she lives
Father's identification and location	Vital status and where he lives
Relationship of individual to household head	
Nationality/refugee status	If Mozambican, when arrived in sub-district
Months resident in last year	Number of months resided in rural household
Residence status	Migrant (<6 months in area over past year)
	Permanent (>6 months in area over past year)
	Visitor (not member of household)
Education status	Highest level completed
Pregnancy status	Currently pregnant or not; expected delivery month
Type of grant	Non-contributory social grants received (includes old age, child support)
National ID number	
Pregnancy outcome	
Antenatal clinic attendance	Number of visits
Contraceptive use before/after pregnancy	
Delivery	Date, location, name hospital, birth attendant and complications
Outcome	Live birth, stillbirth, abortion and multiple births
Duration pregnancy	
Infant	Gender, birthweight, breastfeeding and birth registration
Death	
Date of death	Noted if estimate
Location of death	Home, clinic, health centre, hospital (+name) and accident site
Maternal death	Death during pregnancy or delivery or within 42 days
Death registration	
Migration	
Details of in- or out-migrants	Name, national ID
Move date	Noted if estimate
Place migrated from and to	
Main reason for migration	
Sector of work for job-related moves	
Maternity History	
Full childbirth history of all women	Information on each child not listed in household roster
Union Status	
Record of all marriages/unions	Partners' details, union start/end dates, civil registration, traditional/civil ceremony, reason for union ending

cross-checks and supervisor random checks; forms are then sent to a dedicated quality checker before data entry.

Using a locally validated instrument, a dedicated verbal autopsy team (supervisor and four specially trained fieldworkers) interview the closest caregiver of the deceased to establish the probable cause of death.[19] The interview is conducted 1–11 months after a death and then reviewed independently by two medical doctors who assign probable underlying,

immediate and contributory causes-of-death. Equivalent diagnoses are accepted as the probable cause-of-death. When diagnoses differ, the physicians confer in an effort to reach a consensus; when this is not possible, the verbal autopsy is reviewed by a third physician blind to the others' assessments.

Additional modules and 'status observations' gather individual and household data pertinent to the scientific programme (Table 4).[8] These generate information at regular, but less frequent, intervals (e.g. health care utilization, food security and labour participation) or provide limited information on the entire population to inform clinical studies.

How have HDSS databases been constructed?

The database is designed to store and manipulate data describing the interrelated life histories of all individuals and their households. Data are stored in a relational database, with a schema closely following that of the 'Reference Demographic Surveillance System Data Model'.[20] The database is implemented on the Microsoft SQL Server relational database management platform and hosted in the field site. Integrity constraints, range and type checks and triggers on specific tables check data being entered in a manner that will ensure consistency with existing data. Data are entered using a custom-built data entry frontend and are extracted using custom-written SQL queries. Routine extractions are performed to update basic indicators, whereas tailored data extractions support specific analyses.

Key findings and publications

Rural South Africa is in the midst of multiple interrelated transitions that have led to marked changes in population structure over two decades (Figure 3). Fuelled by fast-declining fertility and by the HIV/AIDS epidemic causing an increase in child mortality, the mid-1990s to mid-2000s saw rapid narrowing of the pyramid base.[8] By 2011, this pattern was reversing, partly reflecting the population effects of prevention-of-mother-to-child transmission programmes and stabilizing of fertility trends. Spatial patterns of mortality reflect inequalities between former Mozambican refugees and South African host communities.[21–22] Despite a recent slight upswing, fertility remains at near replacement level.[23]

There is evidence of increased cardiometabolic disease risk across the life course (Table 5). In children, we find early stunting (one-third of 1–year-olds) and adolescent overweight and obesity (20–25% in older girls) in the same socio-geographic population.[24] Central obesity increased from ~15% of girls during puberty to 35% at the end of puberty, indicating elevated risk for metabolic disease that is associated with higher socio-economic status.[24,25] In adults, evidence for a cardiovascular disease transition is clear despite the massive increase in deaths from AIDS and tuberculosis.[26] High blood pressure and obesity in middle-aged women are at unprecedented levels, fostered by changes in lifestyle, diet and occupation.[27]

In rural settings, primary care management of non-communicable disease and associated risk factors is limited,[32] and chronic infectious disease is dominating service development. The rising mortality and risk for non-communicable diseases, notably among older women,[33] alongside pervasive HIV/AIDS mitigated by expanding HAART availability, argue for integrated approaches to community-oriented provision of long-term care.[26] Although women experience greater longevity, they consistently report a poorer quality of life.[34]

More rural women are migrating for work than ever before.[35] Mortality, mainly from AIDS and tuberculosis, is highest among recently returned migrants of both sexes, imposing high demands on local health services and communities.[36] Older women play key roles supporting child care and schooling while having to meet health care and funeral costs.[17,37] Pressure on the 'near-old'—women aged <60 years and not yet eligible for a pension—can be considerable,[17,38] whereas self-reported health and quality of life in pension-eligible older women are markedly improved.[39] Infant and child survival are profoundly affected by a mother's death,[22,40] as is child mobility,[41] and fostering by women pensioners is clearly advantageous.[16–17] Food security among poorer households remains precarious, with harvesting of natural resources acting as an important buffer against 'shocks' such as death of a breadwinner.[42] Among the poorest households, reliance on natural resources is high, no matter what the specific cause of adult death.[28] See the Agincourt website for a listing of publications: www.wits.ac.za/academic/health/publichealth/agincourt/.

Future analysis plans

Ongoing work seeks to deepen understanding of health, population and social transitions, their effects at stages along the life course and relationships with livelihood strategies. Analyses derived largely from the HDSS database will highlight inequalities and vulnerable sub-groups to better inform rural health and development policy.

Current mortality analyses include trends in adult and child mortality by sex, socio-economic status and cause-of-death; infant survival both before and after a mother's death; the impact of household structure and socio-economic status on child health and survival; and case definitions and estimates of the maternal mortality ratio. Investigation of the fertility transition includes analyses of fertility decline and stall, and patterns of marital and premarital fertility. We are also comparing fertility patterns between the local South African population and

Table 4 Add-on modules and status observations included in update rounds, Agincourt HDSS, 1992–2012

Census year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Household or individual level; target group
Modules																						
Education	■					■					■				■			■			■	All individuals
Labour participation									■				■				■				■	⩾15 years
Household assets										■		■		■		■		■		■		All households
Temporary migrations											■					■					■	All households
Child care grants											■			■			■			■		All households
Health care utilization												■			■				■			All (2003); <5 years (2006); ⩾50 years (2010)
Food security													■			■			■			All households
Adult health															■				■		■	⩾50 years
Unions														■	■	■	■	■	■	■	■	All adults
Father support																■	■					All households
All social grants																				■		All households
Vital documents														■		■						All individuals
National ID numbers																■	■	■	■	■	■	All individuals
Cellphone numbers																				■	■	All individuals
Other names																				■	■	All individuals
Status observations																						
Chronic cough								■														⩾10 years
One-sided weakness										■												⩾ 15 years
Pregnancy status															■	■	■	■	■	■	■	Females 12–49 years
Epilepsy (seizures)															■	■	■	■	■	■	■	All individuals

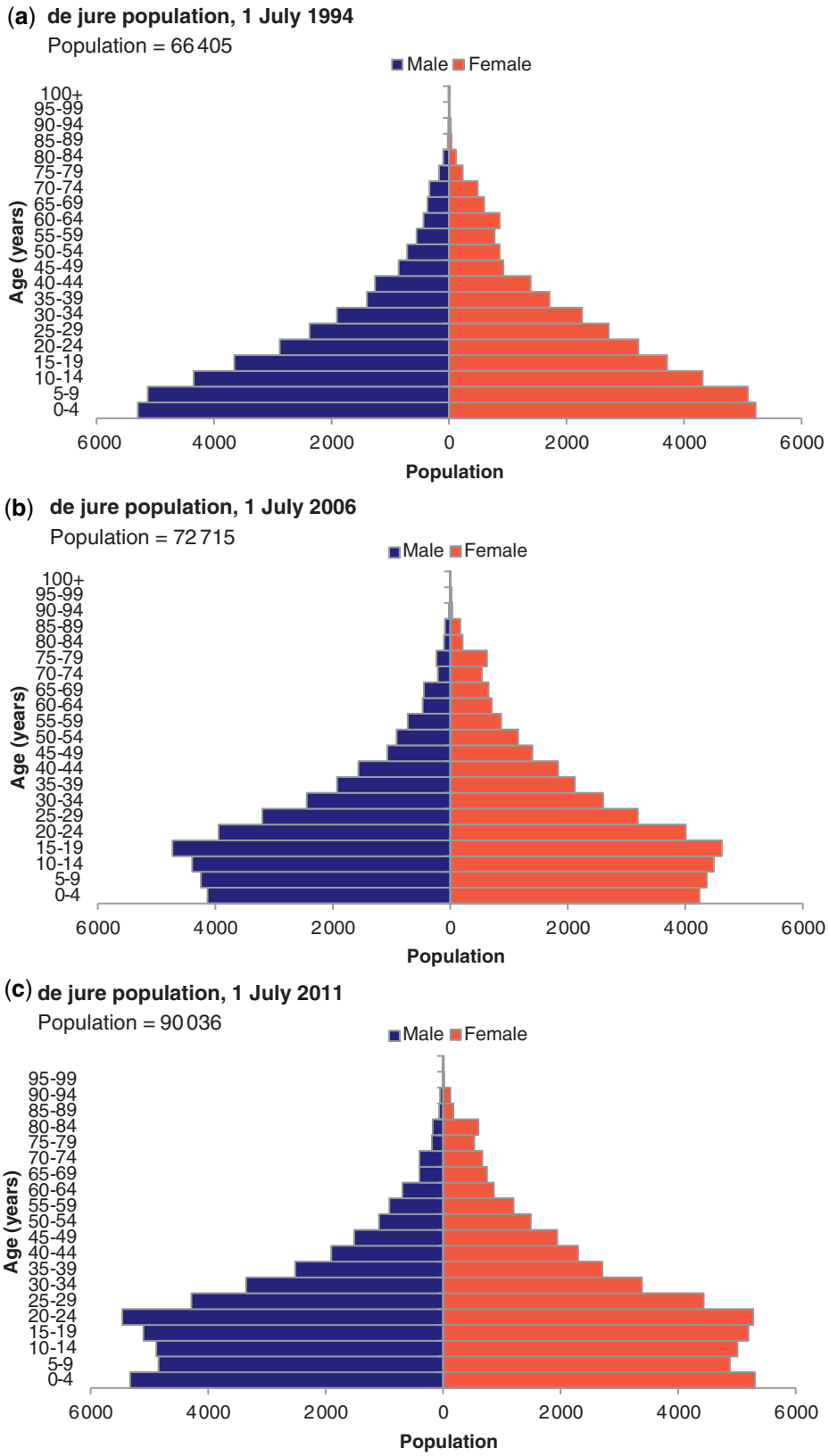

Figure 3 Population pyramids of the Agincourt HDSS population: 1994, 2006 and 2011. (a) de jure population, 1 July 1994; population = 66 405. (b) de jure population, 1 July 2006; population = 72 715. (c) de jure population, 1 July 2011; population = 90 036

Table 5 Indicators of cardiometabolic risk across the life course 2002–07, Agincourt sub-district, South Africa

Indicator	Children[24] 2007		Adolescents[24,25] 2007		Adults 35+ years[27] 2003		Adults 50+ years 2007	
	Male	Female	Male	Female	Male	Female	Male	Female
Stunting	35[a]	30[a]	14.5[c]	4[c]				
Overweight and obesity	15[b]	5[b]	2–6[d]	20–25[d]			47.6	72.9
Abdominal obesity[f]			0	35[e]	3.8	32.7	46.3	90.3
Waist/hip ratio							73.5	81.0
Body mass index (mean)					22.4	26.8		
Hypertension[30]					44.2	42.2	50.9	47.9
Ankle brachial index[31] (ABI)[g]					11.4	13.1		
ABI > 65 years[27]					32			

All figures given as % except for body mass index.
[a]At 1 year.
[b]At 2 years.
[c]14–15 years.
[d]18–20 years.
[e]Assessed at Tanner Stage 5: pubertal self-rating scale defined by male genital development and female breast development.[24]
[f]Abdominal obesity: waist circumference >102 cm in males and >88 cm in females (adults),[27] and ⩾94 cm in males and ⩾80 cm in females (adolescents).[24]
[g]ABI ⩽ 0.9 is associated with other cardiovascular disease indicators such as angina pectoris and carotid stenosis.[31]

former Mozambican refugees. Temporary or circular migration is pervasive in southern Africa. We are examining the association of different migration patterns with fertility outcomes and with mortality trends and causes of death, particularly HIV and non-communicable diseases. Work on the association of child mobility with immunization status is planned. Analyses of natural resource use as a livelihood strategy are ongoing.

The HDSS provides a platform for research across the life course. Examples of analytic work with adolescents include analyses of body composition and other cardiometabolic disease risk factors and levels, and facilitators and barriers to physical activity. In the populations aged ⩾15 years, we are analysing HIV and non-communicable disease risk factors prevalence, as well as their interactions. In older adults, we are analysing the association between self-reported non-communicable diseases and health care utilization.

Work on linking HDSS data with data from Statistics South Africa is underway to validate national census and vital registration data, especially completeness of population count and coverage of demographic events. We plan to inform policy by evaluating coverage and impact of health and social interventions and provide an early warning system to detect crises among vulnerable populations such as rising food insecurity or sudden peaks in mortality.

Cost-effectiveness will be a feature of intervention evaluations, and HDSS data can be used to model differential costs and benefits before field trials. For example, work to define the burden of epilepsy in disability-adjusted life years will inform cost-effectiveness analyses of potential interventions to address the treatment gap.

In several areas—including epidemiological and demographic transitions, physical and cognitive function in older adults and migration and health—comparative and pooled multi-centre analyses as part of INDEPTH initiatives are a major feature.

Strengths and weaknesses

The value of the Agincourt HDSS is enhanced by its longevity and context—almost 20 years spanning profound political change and post-*apartheid* economic development and also the full force of the HIV/AIDS epidemic. This provides a robust sampling frame and research infrastructure to support a range of study designs.[8] Verbal autopsies, on all age groups, have been validated locally using district hospital cases as gold standard.[19]

Further strengths include a university base with a strong graduate training programme; productive partnerships with scientists based in Africa, Asia, UK/Europe and North America; ongoing engagement with village leaders, study communities, local government and non-governmental organizations and public personnel, and increasing collaboration with Statistics South Africa.

Efforts are underway to strengthen the HDSS platform, including real-time electronic data entry, a comprehensive Geographic Information System platform coupled with natural resource and environmental monitoring, and reconciliation of internal migrants. Rural southern Africa is characterized by extensive labour migration that provokes research questions

and methodological challenges. The Agincourt data system did not initially track migrants within the study site. We now apply a system of 'migration reconciliation' (MR) to account for migration and strengthen our analytical database. Undertaking retrospective MR from 2000, we have matched around 70% of internal migrations; with prospective MR, we are achieving >90% of matches. We are also following out-migrants to better understand loss to follow-up in our cohorts. Union status was not recorded until 2007, when we retrospectively collected these data on all—with prospective monitoring since then.

As is the case with many HDSSs, we use a proxy respondent when updating the household roster and vital events. This may reduce the accuracy of some individual-level information (e.g. date of birth) and limits collection of sensitive data such as contraceptive use. We update vital events annually, with the risk of underestimating perinatal and infant mortality, particularly when birth and death occur between consecutive household visits. We limit this possibility by careful probing for pregnancies and births since the last recorded child and since 2006, by asking about pregnancy status of every woman of childbearing age.

As the number and range of projects increase, with multiple follow-up visits and biomarker measurements, we are concerned about overloading households and the potential for refusal rates to increase in the HDSS, as well as in nested studies. Efforts to ensure full documentation of household recruitments to studies are a priority.

Data sharing and collaboration

Fostering effective collaborations, ensuring cross-site compatibility of common variables and optimizing public access to HDSS data are priorities. The Agincourt data website (http://www.agincourt.co.za/DataSection/index.htm) contains full documentation, including questionnaires, data dictionaries and metadata associated with the Agincourt HDSS, as well as an anonymized 10% sample that retains the relational, temporal and data integrity of the full database.[29] Researchers may request a customized data extraction (contact Dr Xavier Gómez-Olivé; xavier@agincourt.co.za); details of application procedures with forms are available on the data website. The questionnaires, metadata and '1-in-10' sample database help users to prepare the detailed data request needed for a customized extraction.

The MRC/Wits-Agincourt Unit participates in data sharing initiatives that yield datasets that can be freely downloaded. The INDEPTH-WHO SAGE study (Study on global AGEing and adult health) is available on the *Global Health Action* and INDEPTH websites (http://www.globalhealthaction.net/index.php/gha/rt/suppFiles/5302/6049 and http://www.indepth-network.org/index.php?option=com_content&task=view&id=1215&Itemid=1059). Agincourt data in the INDEPTH-iShare data repository include a subset of core demographic data exported to a common data model and stored in a central database; this will soon be available for download on its own or with similar data from other INDEPTH centres (http://www.indepth-ishare.org/).

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KEY MESSAGES

- The Agincourt health and socio-demographic surveillance system in rural northeast South Africa, established in 1992 just before socio-political change and emergence of the HIV/AIDS epidemic, captures the dynamics of rapidly evolving health, population and social transitions; these do not conform to the patterns predicted by classical transition theory.
- The epidemiological transition is well underway in rural South Africa, with evidence of persisting high levels of infectious conditions (mainly HIV and tuberculosis), as well as emerging non-

communicable diseases. This poses major challenges for primary health care services, which are ill-equipped to provide quality, integrated long-term care.

- A dual nutritional burden is characterized by marked stunting of children aged <2 years (approaching one-third of children), together with high levels of overweight and obesity in adolescent females (close to 25% by 18 years of age). This indicates elevated risk for metabolic disease in later life and is positively associated with higher socio-economic status.
- In collaboration with Statistics South Africa, the HDSS is used to validate national census and vital registration data and to analyze causal pathways that drive trends seen nationally.

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