Social Science & Medicine 358 (2024) 117217

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Impact of the South African Child Support Grant on memory decline and dementia probability in rural and low-income mothers, 2014–2021

Erika T. Beidelman [a,*], Rishika Chakraborty [b], Janet Jock [c], Chodziwadziwa Whiteson Kabudula [d], Meredith L. Phillips [a], Kathleen Kahn [d,e], Katherine Eyal [f], Darina T. Bassil [g], Lisa Berkman [d,g], Lindsay C. Kobayashi [d,h], Molly Rosenberg [a,d]

[a] Department of Epidemiology and Biostatistics, Indiana University School of Public Health-Bloomington, Bloomington, IN, USA
[b] School of Nursing, George Washington University, Washington D.C., USA
[c] Auburn University, Department of Political Science, Auburn, AL, USA
[d] MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[e] Department of Epidemiology and Global Health, Umeå University, Umeå, Sweden
[f] Southern Africa Labour and Development Research Unit, School of Economics, University of Cape Town, Cape Town, South Africa
[g] Harvard Center for Population and Development Studies, Harvard University, Cambridge, MA, USA
[h] Center for Social Epidemiology and Population Health, Department of Epidemiology, University of Michigan School of Public Health, Ann Arbor, MI, USA

ARTICLE INFO

Handling Editor: Winnie Yip

Keywords:
South Africa
Cash transfer
Dementia
Alzheimer's disease
Cognitive decline
Memory

ABSTRACT

Introduction: Aging populations across sub-Saharan Africa are rapidly expanding, leading to an increase in the burden of Alzheimer's disease and related dementias (ADRD). Cash transfer interventions are one plausible mechanism to combat ADRD at a population-level in low-income settings. We exploited exogenous variation in eligibility for South Africa's Child Support Grant (CSG) to estimate the longitudinal association between potential CSG benefit and cognitive trajectories in rural mothers with <10 children (n = 1090).

Methods: South Africa's CSG delivers monthly cash payments to primary caregivers, predominantly mothers, to offset the costs associated with child rearing. This study implemented a quasi-experimental design using data (2014–2022) from a rural, low-income cohort in the Agincourt research area, South Africa. We fit linear mixed effects models and generalized linear models to estimate the association of potential CSG benefit per eligible child with memory decline and dementia probability, respectively. We stratified all models by the mother's total number of children (1–4 and 5–9) and examined effect modification by household wealth and the mother's education level.

Results: Having above median CSG per eligible child was associated with higher baseline memory scores (β = 0.12 SD units, 95% CI = 0.02, 0.22) but steeper memory decline (β = −0.02 SD units, 95% CI = −0.04, -0.00) compared to below median CSG. Within stratified analyses, this effect was primarily observed among mothers with 5–9 children. No associations were observed between potential CSG per eligible child and dementia probability.

Conclusions: Our findings support the use of large-scale cash transfers as a promising intervention to promote healthy cognitive aging in mid-life women within rural, low-income settings. However, we found evidence that the CSG in its current structure may not be sufficient support for women to sustain measurable cognitive benefits over the long-term.

1. Introduction

Since 1950, the absolute number of adults over the age of 60 has more than quadrupled across sub-Saharan Africa (Lekoubou et al., 2014). Given this demographic transition, the increasing burden of Alzheimer's disease and related dementias (ADRD) pose a significant

* Corresponding author. Department of Epidemiology and Biostatistics, Indiana University School of Public Health-Bloomington, 1025 E 7th St, Bloomington, IN 47405, USA.
E-mail address: ebeidelm@iu.edu (E.T. Beidelman).

https://doi.org/10.1016/j.socscimed.2024.117217
Received 30 October 2023; Received in revised form 28 July 2024; Accepted 8 August 2024
Available online 17 August 2024

public health threat in this rapidly aging population (Mavrodaris et al., 2013). The number of people living with dementia in sub-Saharan Africa is projected to reach approximately 7.6 million people by 2050 (Guerchet et al., 2017). Furthermore, being female and having low socioeconomic status are potential risk factors for cognitive impairment and dementia in this setting (Mavrodaris et al., 2013; Kobayashi et al., 2019; Peltzer and Phaswana-Mafuya, 2012). Despite this increasing public health challenge, little research is available on protective and modifiable risk factors for ADRD among women in low-income sub--Saharan African settings like rural South Africa (Akinyemi et al., 2022).

Poverty and economic hardship are consistently linked to an increased risk of dementia, cognitive decline, and low cognitive function (Yu et al., 2021; Mani et al., 2013; Trani et al., 2022; Zeki Al Hazzouri et al., 2017; Larnyo et al., 2022). Additionally, there is preliminary evidence that these associations are only partially attributable to the differences in the prevalence of modifiable lifestyle factors like smoking, alcohol intake, and diet observed across income levels (Röhr et al., 2022a, 2022b). This suggests that direct income-based interventions, instead of siloed lifestyle interventions, could be impactful in reducing dementia risk. A potential mechanism via which income-based interventions may be protective of cognitive decline is through cognitive reserve. Cognitive reserve is a theoretical construct that posits that cognitively stimulating exposures across one's life course may improve one's ability to cope with age-related deterioration of the brain (Stern et al., 2020). Higher income allows individuals to access better nutrition and housing, alleviate poverty-related stress, access better education, and increase decision-making abilities among other positive benefits, all of which can help accrue cognitive reserve (Stern et al., 2020; Stern, 2012). Previous cross-sectional work also supports this notion, revealing positive associations between access to income-based social protection programs and cognitive function in adults in South Africa, the United States, and China (Jock et al., 2023; Ayyagari and Frisvold, 2016; Peng et al., 2023; Chakraborty et al., 2024). However, the limited longitudinal evidence from older adults in Mexico and China has found conflicting results for the association between cash transfers and cognitive trajectories (Peng et al., 2023; Aguila and Casanova, 2020; Nikolov and Hossain, 2023). Yet still, few studies have directly explored whether cash transfers can prevent cognitive decline over time, particularly in rural South Africa (Chakraborty et al., 2024; Aguila and Casanova, 2020; Nikolov and Hossain, 2023). It is critical to further quantify this longitudinal relationship, both as a whole and within rural sub-Saharan African settings, to better evaluate the potential of cash transfer programs to promote healthy cognitive aging within low-resource environments.

South Africa's Child Support Grant (CSG) is among the sub-continent's largest social protection program, delivering monthly cash payments to the predominantly female caregivers of over 12 million eligible children living in poverty (Twine et al., 2007; Children's Institute: University of Cape Town, 2023). The program rolled out in 1998 and subsequently underwent several expansions to broaden the beneficiary age eligibility from under 7 years at its start in 1998 to 18 years by 2012 (DSD and UNICEF, 2012) (see Fig. 1). In this longitudinal analysis, we exploited these changes in CSG age-eligibility as an exogenous source of variation in the total amount of CSG coverage mothers would be eligible to receive on behalf of their children. We used this natural quasi-experimental design to estimate the longitudinal association between the potential cumulative CSG benefit received by mothers and two cognitive outcomes (episodic memory and dementia probability) among a sample of mid-life mothers with at least one child.

2. Methods

2.1. Parent study and setting

This study used longitudinal data collected at Wave 1 (baseline, 2014/15), Wave 2 (2017/18), and Wave 3 (2021/22) of the 'Health and Ageing in Africa: Longitudinal Studies in South Africa" (HAALSA) cohort (Xavier Gómez-Olivé et al., 2018). HAALSA is a longitudinal cohort study set in the rural Agincourt research area of Bushbuckridge, Mpumalanga province, South Africa. The random sample for HAALSA was selected from a fully enumerated sampling frame, the Agincourt Health and socio-Demographic Surveillance System (HDSS). The Agincourt HDSS is an annual census run by the MRC/Wits Rural Public Health and Health Transitions Research Unit. This research area has been under continuous surveillance since 1992 and currently covers the complete community living across 31 villages (~117,000 people) (Kahn et al., 2012a).

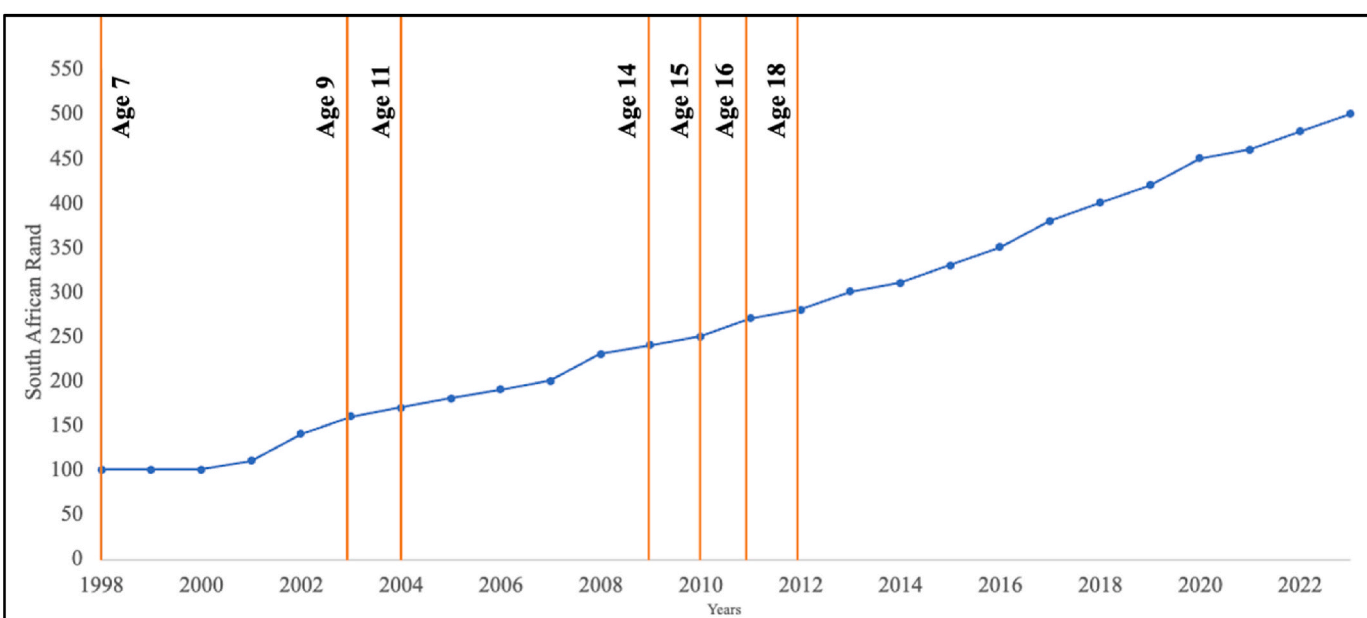


Fig. 1. Illustration of CSG age eligibility expansions and changes in monthly cash value over time (1998–2023).
Footnote: Each orange vertical line represents the year at which an expansion in CSG age eligibility occurred. At each of these timepoints, children less than the specified age would be eligible to receive the CSG. The blue line represents the monthly cash value (in Rand) of the CSG during each year.

Of the 117,000 people living in the area, 12,875 adults were eligible for participation in HAALSA. Study eligibility criteria included adults aged 40 years and older as of July 1st, 2014, who were permanently living in the study area in the year prior to the 2013 Agincourt HDSS census. Of the eligible adults, 6281 men and women were randomly selected to participate, and the final sample included 5059 adults (~86% response rate) (Xavier Gómez-Olivé et al., 2018). Survey data in HAALSA were collected using computer-assisted personal interviews by trained local fieldworkers in the local language, Xitsonga. The primary aim of the HAALSA cohort is to monitor health trends in an aging sub-population within the context of South Africa's ongoing demographic and epidemiologic transitions (Xavier Gómez-Olivé et al., 2018). Data were collected on a wide variety of demographic characteristics, health behaviors, anthropometric measures, and biomarkers. The HAALSA protocol was reviewed and approved by the Mpumalanga Provincial Research and Ethics Committee, the University of the Witwatersrand Human Research Ethics Committee (ref. M141159), and the Harvard T.H. Chan School of Public Health Office of Human Research Administration (ref. C13–1608–02) (Xavier Gómez-Olivé et al., 2018). Ethical approval for this secondary data analysis was sought from the Indiana University Institutional Review Board where it was deemed not human subjects research (ref. #2002584956).

The Child Support Grant (CSG) is a means tested but otherwise unconditional cash transfer program designed to alleviate poverty and improve child development by offsetting the costs associated with raising children. This is accomplished through the provision of direct monthly cash payments to primary caregivers (Delany et al., 2008). CSG benefits stack so that primary caregivers can receive the benefit for each individual child who is eligible during each month. In low-income communities, this grant is oftentimes the only source of predictable income for CSG-recipient households with approximately 27% of households in Mpumalanga reporting government grants as their primary source of income as of 2022 (Luthuli et al., 2022; Zembe-Mkabile et al., 2015, Stats, 2022). Eligibility for the CSG is determined by the age of the child beneficiary and the caregivers' income which should fall below a means-tested level (~10 times the grant amount for single caregivers).

Since its implementation in 1998, the age-eligibility criteria have expanded at multiple timepoints. When it began in 1998, only children under 7 years old were eligible. In 2003, the age threshold was raised to 9; in 2004, 2005, 2009, and 2011, to 11, 14, 15, and 16 respectively; and in 2012, age eligibility was further expanded to include children under age 18, the age cutoff where it remains to date (see Fig. 1) (Mcewen et al., 2009). From its inception to 2008, the CSG amount was about the same at around 100 Rand (~12 USD) per month. However, since 2008, it has increased in a stepwise manner to match inflation; and as of April 2023, it is 500 Rand (~26 USD) per child per month for biological children (SASSA. South African Government, 2023). In comparison, as of 2015, 26% of households in the Mpumalanga province were living below the food poverty line of 441 Rand per person per month (Statistics South Africa, 2017) and as of 2023 the food poverty line was more than the value of the CSG at 760 Rand (Statistics South Africa, 2023).

2.2. Study sample

This study included HAALSA women who had at least one child. In South Africa, over 90% of the primary caregivers of CSG-eligible children are their biological mothers (Twine et al., 2007) and, therefore, this study restricted the sample to maternal recipients only. Due to the low-income environment of the Agincourt research area, we assumed that the women participating in this study had household incomes that fall below the means-tested income requirement for CSG receipt. The Agincourt research site has been classified as a low-income community with high unemployment since the beginning of CSG rollout in 1998, therefore, we assume mothers were income-eligible across the entire study period (Kabudula et al., 2017; Kahn et al., 2012b). From the full HAALSA sample (N = 5059), we excluded men (N = 2345), women with no children (N = 224), and women with implausible childbirth ages (N = 2). From this, we identified 2488 HAALSA women with at least one child over the analysis period (2014/15 to 2021/22) (see Fig. 2).

To make valid inference about CSG impacts, we further excluded women who were 60 years and older at HAALSA baseline or had more than 10 children (n = 1387). We excluded women in this older age category because these older CSG-eligible women are likely not representative of other later-life women in this population (Chakraborty et al., 2024). In 1998, when the CSG first rolled out, peak childbearing age range was between 20 and 34 (Department of Health/South Africa and Macro International, 2002). HAALSA women age 60+ would have been age 44+ at the earliest date of CSG eligibility in 1998. To be CSG-eligible, these older women would have needed to have children outside of their typical reproductive period. We excluded women with 10 or more children because there were few women in this group, and they are also likely to be significantly different from rest of the sample. Approximately 50% of the sample had grand-multiparity and the median number of children in this sample was 5 (SD: 2.2). Therefore, women with great grand-multiparity (≥10 children) were likely to be outliers in terms of their CSG eligibility as well as the sociodemographic causes and consequences of their extreme multiparity.

We further removed 11 participants due to data discrepancies (e.g., missing data, implausible birth dates) and arrived at a final analytic sample of 1090 women (see Fig. 2). From this, we created two subsamples for all analyses: women with 1–4 children (n = 555) and women with 5–9 children (n = 535). This cut-point was chosen as it was both the median number of children for this sample and the point of grand-multiparity, as grand-multiparity is associated with poorer health outcomes compared to women with less than five children (Mgaya et al., 2013). Additionally, we limited this stratification to two sub-groups to preserve sample size. Segmenting our sample by number of children allowed us to account for non-positivity in number of children by duration of CSG eligibility and to help reduce the effects of non-random factors related to a women's total number of children that could influence CSG eligibility at the upper and lower ends of the distribution.

2.3. Key measures

1. Exposure: Average potential cumulative CSG benefit per child, in decades (pCSG)

Our exposure of interest was the potential cumulative duration of exposure to the CSG benefit (in decades) (pCSG) that each mother was eligible to receive by their HAALSA Wave 1 interview (2014/15). pCSG is an estimate of the *potential* benefit duration a mother could be exposed

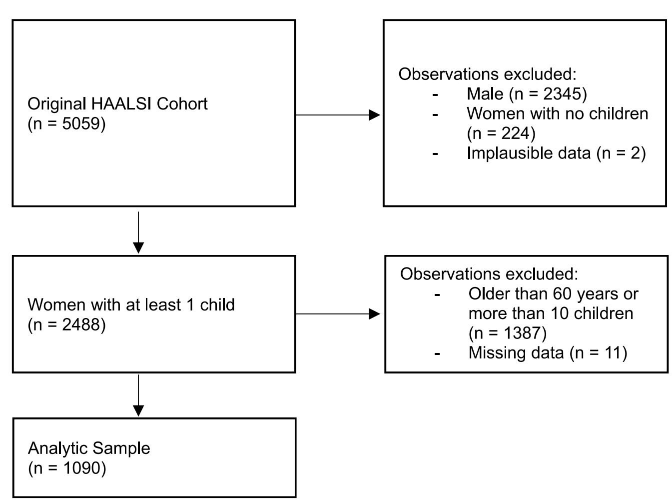


Fig. 2. Sample inclusion flow chart.

to as our calculation was based on CSG eligibility criteria rather than confirmed CSG receipt. Cumulative CSG exposure stacks across all eligible children and, thus, can exceed the time period under study. We time-fixed this exposure at the HAALSA Wave 1 start date to ensure that the calculated exposure occurred prior to outcome ascertainment. This variable was constructed based on each child's date of birth and triangulated against CSG age-eligibility expansion years. Female HAALSA participants were linked to all biological children and their birth dates via Agincourt HDSS census records. This ensured all biological children were accounted for regardless of their living or household status at the time of HAALSA Wave 1. First, for each mother, we calculated the potential cumulative benefit in years for each CSG-eligible child. We then summed the total number of years of eligibility across all eligible children for each mother. The exposure was then scaled by 10 years to estimate pCSG in decades. Finally, we divided this by the women's total number of eligible children to produce an estimate of the average pCSG per eligible child. Ineligible children are not considered in this calculation. Women with no eligible children were assigned a value of 0 for their pCSG exposure.

Additionally, we transformed the continuous pCSG exposure into a dichotomous exposure (below vs. above median pCSG) at the sample median which was confirmed via a data-driven threshold analysis. This approach was motivated by the hypothesis that individuals may need to reach a certain threshold of additional income to derive benefit rather than there being a direct linear relationship between the amount of additional income and cognitive benefit. Threshold cut-points were calculated relative to each sub-sample under analysis. We bucketed the continuous CSG exposure into deciles as well as quartiles and then plotted the relationship with our outcomes of interest. Clear thresholds in the amount of CSG received were visible and associated with a distinct change in cognitive memory scores. Results between the decile and quartile analyses were consistent. This threshold occurred at different quartiles across our sub-groups of interest, however, the absolute value of this threshold was consistent and occurred at approximately 0.9 decades of pCSG per eligible child. This was equivalent to the full sample median which was ultimately chosen as the cut-point for the dichotomous pCSG exposure.

pCSG per eligible child estimated the average cumulative years of CSG eligibility per mother per child, though not all mothers would have collected CSG funds during each eligible year. Thus, our exposure calculated an "intent-to-treat" estimate of the relationship between pCSG and cognitive outcomes, leveraging the exogenous variation in CSG eligibility duration based on birth timing and number of children. The "intent-to-treat" estimation assumes that all women who were eligible went on to physically receive their allocated CSG. The source of exogenous variation in CSG duration comes from various expansions in age-eligibility for child recipients. This results in women with the same age and number of children having different pCSG durations. This variation in pCSG duration is then primarily related to the random differences in children's birth dates which allows us to implement a quasi-experimental design that helps limit confounding and bias from the exposure assignment.

2. Outcome: Memory decline

Memory scores were calculated based on immediate and delayed word recall trials of a 10-word list read out loud by the interviewer at each HAALSA wave. The number of trials and their administration differed across waves. To account for this, we constructed memory factor scores at each time point using confirmatory factor analysis, and then z-standardized the scores to the Wave 1 distribution, such that Wave 1 memory scores had a mean of 0 and standard deviation of 1 (Gross et al., 2015). Memory decline was defined as the slope of the memory scores over time, estimated as described in the statistical analysis section below.

3. Outcome: Dementia probability scores

Our second outcome of interest was the probability of dementia at the HAALSA Wave 3 interview. Dementia probability scores ranged from 0 to 100% and were estimated using a "gold standard" sample of consensus-based diagnoses from the HAALSA Dementia sub-cohort (n = 635) (Farell et al., 2023). A logistic regression predictive model for consensus-based dementia diagnosis was developed from the HAALSA Dementia sub-cohort using variables collected for all HAALSA Wave 2 participants. Variables in the predictive model included cognitive measures such as immediate and delayed recall, orientation score, self-rated memory, verbal fluency, a sum score of days of the week forward and backward, and Instrumental Activities of Daily Living (Farell et al., 2023). The predictive model had an area under the ROC of 0.79. Coefficients from the predictive model were then applied to all HAALSA Wave 3 participants to estimate their probability of dementia.

4. Covariates

We used the following covariates to contextualize our study population, adjust for confounding, and stratify our results. Sociodemographic characteristics included age (coded continuously), total number of children (coded continuously, and categorically at 1–4 and 5–9 children), number of CSG-eligible children (factor variable), number of CSG-ineligible children (factor variable), suboptimal birth spacing (binary variable indicating suboptimal (Lekoubou et al., 2014) or optimal (0) average birth spacing), literacy (able to read and/or write or not able to read and write), education level (none; some primary or secondary; or 12+ years), household wealth (in quintiles), and country of birth (South Africa or other). Time was measured at each wave in exact years since the participant's Wave 1 interview. Suboptimal birth spacing was defined according to World Health Organization's recommendation for women to have at least 33 months between two live births (World Health Organization (WHO), 2006). We calculated the average birth interval across all births for each mother and coded the binary variable based on whether the average interval was less than 33 months (suboptimal). Women with only one child were considered to have optimal birth spacing. Household wealth was measured using a survey instrument querying the presence/absence of various household assets (e.g., household characteristics, vehicles, and livestock) (Xavier Gómez-Olivé et al., 2018). Absolute scores were converted to a wealth index score using principal components analysis and then categorized in quintiles (Xavier Gómez-Olivé et al., 2018). For analyses examining effect modification by household wealth, we categorized the continuous wealth index scores into a binary variable representing below median and above median household wealth.

2.4. Statistical analysis

We fit mixed effects linear regression models to estimate the association between the dichotomous pCSG exposure and latent memory scores. Models were fit separately for both sub-samples of interest: women with 1–4 children and women with 5–9 children. Additionally, we stratified the models by household wealth (below vs. above median) and educational level (no education or primary-level education vs. secondary education or more) to assess potential effect modification. Supplementary analyses using the continuous pCSG exposure were performed with results reported in the supplementary materials (see Tables S1 and S2).

All mixed effects models were fit with a random slope for time, random intercept for the individual, and inverse probability weights for attrition and mortality over time. Inclusion of the random effects allowed us to account for correlation between an individual's observations over time. Practice effects (i.e., improvements in test scores resulting from repeat testing) for memory scores were observed between Waves 1 and 2. We accounted for this using a binary indicator variable representing observations from Wave 1 (Weuve et al., 2015). We modeled memory decline with an interaction between pCSG per eligible child and time. To account for known structural determinants of CSG eligibility, we adjusted all models (including stratified models) for maternal age and number of CSG-ineligible children. Additional covariates included in the models were: wealth index, education, literacy, country of birth, suboptimal birth spacing, and marital status. To assess the relationship between CSG eligibility and dementia probability scores, we fit generalized linear models. Like the memory score analysis, models were fit separately for both sub-samples of interest (women with 1–4 children and women with 5–9 children) and were stratified by wealth index and education. We adjusted these models for maternal age, number of CSG-ineligible children, household wealth, education, literacy, country of birth, suboptimal birth spacing, and marital status.

Due to the high percentage of non-South African mothers and Mozambican refugees in this population (~30%), we conducted a sensitivity analysis where we restricted the sample to only South African-born mothers. We performed this sensitivity analysis because as non-residents it may have been more difficult for women not born in South Africa to access CSG funds. Therefore, our definition of CSG eligibility may not approximate actual CSG receipt for these women. All statistical analyses were performed in RStudio version 4.1.1 (R Core Team, 2023). The mixed effects models were estimated using the lme4 package (Bates and Bolker, 2012). Statistical significance was set at 0.05.

3. Results

3.1. Study population

We identified 1090 female HAALSA participants from the original Wave 1 cohort who had a minimum of one and a maximum of nine children. On average, women were 50.6 years old (SD: 5.6) at Wave 1 and had 5 children (SD: 2.1) (Table 1). Over one-quarter of this sample (29%) reported no formal education and 71% were born in South Africa. Average memory scores across the sample were 0.34 (SD: 0.92) at Wave 1, 0.71 (SD: 0.88) at Wave 2, and 0.60 (SD: 0.64) at Wave 3. The average probability of dementia for the sample was 8% at Wave 3.

3.2. CSG and memory scores over time

Having above median pCSG per eligible child was associated with a 0.12 SD unit higher memory score at Wave 1 compared to below median pCSG (β = 0.12 SD units, 95% CI = 0.02, 0.22) (see Table 2). However, above median exposure was also associated with steeper decline in memory scores over time (β = −0.02 SD units, 95% CI = −0.04, -0.00). When stratifying by number of children, this association was not observed among women with 1–4 children. Among women with 5–9 children, the associations observed in the full sample increased in magnitude. In this group, above median pCSG was associated with a 0.18 SD unit increase in memory scores at Wave 1 (β = 0.18 SD units, 95% CI = 0.04, 0.32). For women with 5–9 children, the slope of memory decline was steeper for those with above median pCSG compared to below median pCSG (β = −0.03 SD units, 95% CI = −0.06, -0.00). The relationship between above median pCSG and higher Wave 1 memory scores was strongest for women with 5–9 children in above median wealth households (β = 0.24 SD units, 95% CI = 0.04, 0.44) and those with less than a secondary level education (β = 0.22 SD units, 95% CI = 0.06, 0.38). Fig. 3 displays predicted memory scores over time for the full sample and sub-samples. The direction of effect was similar using the continuous exposure, although estimates were generally smaller and not consistently significant (see Table S1).

3.3. CSG and dementia probability score

No significant associations were observed for the relationship between pCSG exposure and probability of dementia across the full sample, women with 1–4 children, and women with 5–9 children (see Table 3). Results of similar magnitude were observed across all subgroups of education and household wealth, although these results were not statistically significant.

3.4. Sensitivity analysis

After restriction of the sample to only women born in South Africa, the estimated effects decreased in magnitude but retained the same direction of association (see Table S3). However, many of these estimates were generally attenuated and crossed the null. Results of the dementia probability models remained consistent across the full sample and both sub-groups (see Table S4). The stratified analyses decreased largely in sample size across all models.

Table 1
Sociodemographic characteristics[a] and outcomes for women aged <60 years with 1–9 children across below and above median pCSG per eligible child categories.

Characteristic	Overall N = 1090[b]	Below Median N = 555[b]	Above Median N = 535[b]	P-Value
Age (years)	50.6 (5.6)	51.8 (5.7)	49.3 (5.2)	**<0.001**
Total # of Children	4.6 (2.2)	4.3 (2.2)	5.0 (2.1)	**<0.001**
# of Eligible Children	2.1 (1.7)	1.5 (1.8)	2.7 (1.5)	**<0.001**
# of Ineligible Children	2.5 (2.0)	2.8 (2.1)	2.3 (2.0)	**<0.001**
Suboptimal Birth Spacing	209 (19%)	144 (26%)	65 (12%)	**<0.001**
Education				**0.03**
No Education	319 (29%)	176 (32%)	143 (27%)	
Some Education	587 (54%)	300 (54%)	287 (54%)	
12 + Years Education	183 (17%)	78 (14%)	105 (20%)	
Missing	1	1	0	
Literate	769 (71%)	376 (68%)	393 (73%)	**0.04**
Missing	1	1	0	
Place of Birth				0.8
South Africa	768 (71%)	393 (71%)	375 (70%)	
Other	319 (29%)	160 (29%)	159 (30%)	
Missing	3	2	1	
Wealth Quintile				0.7
1	205 (19%)	98 (18%)	107 (20%)	
2	204 (19%)	104 (19%)	100 (19%)	
3	202 (19%)	110 (20%)	92 (17%)	
4	227 (21%)	118 (21%)	109 (20%)	
5	252 (23%)	125 (23%)	127 (24%)	
Wave 1 Memory Score	0.34 (0.92)	0.24 (0.87)	0.45 (0.96)	**<0.001**
Wave 2 Memory Score	0.71 (0.88)	0.68 (0.90)	0.74 (0.86)	0.3
Missing	117	63	54	
Wave 3 Memory Score	0.60 (0.64)	0.55 (0.61)	0.65 (0.66)	**0.02**
Missing	166	86	80	
Wave 3 Dementia Probability	0.08 (0.07)	0.08 (0.07)	0.08 (0.07)	0.14
Missing	332	159	173	

NB: pCSG = potential cumulative Child Support Grant benefit; Median pCSG = 0.9 decades per child.
[a] Sociodemographic characteristics measured at HAALSA Wave 1.
[b] Mean (SD); n (%).

Table 2
Effect of above median pCSG per eligible child on memory scores for female HAALSA participants aged <60 years with 1–9 children, stratified by number of children.[a].

		Full Sample N = 2885	1-4 Children N = 1434	5-9 Children N = 1451
Full Sample	Above Median pCSG	**0.12 (0.02, 0.22)**	0.03 (−0.13, 0.18)	**0.18 (0.04, 0.32)**
	Time (years)	**−0.03 (-0.06, -0.01)**	**−0.04 (-0.07, 0.00)**	−0.03 (−0.06, 0.01)
	Time*pCSG	**−0.02 (-0.04, 0.00)**	−0.01 (−0.04, 0.02)	**−0.03 (-0.06, 0.00)**
Education: None or Primary		*N = 1885*	*N = 802*	*N = 1083*
	Above Median pCSG	**0.16 (0.03, 0.28)**	−0.01 (−0.22, 0.20)	**0.22 (0.06, 0.38)**
	Time (years)	0.00 (−0.03, 0.03)	−0.01 (−0.06, 0.04)	0.00 (−0.04, 0.05)
	Time*pCSG	**−0.02 (0.05, -0.00)**	−0.01 (−0.05, 0.03)	**−0.04 (-0.07, -0.00)**
Education: Secondary or More		*N = 1000*	*N = 632*	*N = 368*
	Above Median pCSG	0.06 (−0.12, 0.24)	0.03 (−0.21, 0.26)	0.16 (−0.13, 0.45)
	Time (years)	**−0.09 (-0.13, -0.04)**	**−0.07 (-0.13, -0.01)**	**−0.12 (-0.19, -0.04)**
	Time*pCSG	−0.01 (−0.05, 0.03)	−0.02 (−0.06, 0.03)	0.00 (−0.06, 0.06)
Household Wealth: Below Median		*N = 1449*	*N = 685*	*N = 764*
	Above Median pCSG	0.06 (−0.09, 0.20)	−0.05 (−0.28, 0.18)	0.13 (−0.06, 0.33)
	Time (years)	**−0.03 (-0.07, -0.00)**	−0.04 (−0.10, 0.01)	−0.02 (−0.07, 0.03)
	Time*pCSG	−0.01 (−0.04, 0.02)	0.01 (−0.04, 0.05)	−0.02 (−0.06, 0.02)
Household Wealth: Above Median		*N = 1481*	*N = 774*	*N = 707*
	Above Median pCSG	**0.19 (0.05, 0.33)**	0.14 (−0.08, 0.35)	**0.24 (0.04, 0.44)**
	Time (years)	−0.03 (−0.06, 0.01)	−0.04 (−0.09, 0.01)	−0.02 (−0.07, 0.03)
	Time*pCSG	**−0.03 (-0.06, -0.00)**	−0.04 (−0.08, 0.01)	−0.04 (−0.08, 0.01)

NB: All models include a binary indicator variable representing observations at Wave 1 to control for observed practice effects, a random slope for time, and a random intercept for the individual. Above median pCSG is equivalent to a duration of approximately 0.9+ cumulative decades of per eligible child. pCSG = potential cumulative Child Support Grant benefit. Ns represent total observations across all time points.

[a] Adjusted for maternal age, number of CSG-ineligible children, household wealth index, maternal education level, maternal literacy, maternal country of birth, suboptimal birth spacing, and maternal marital status.

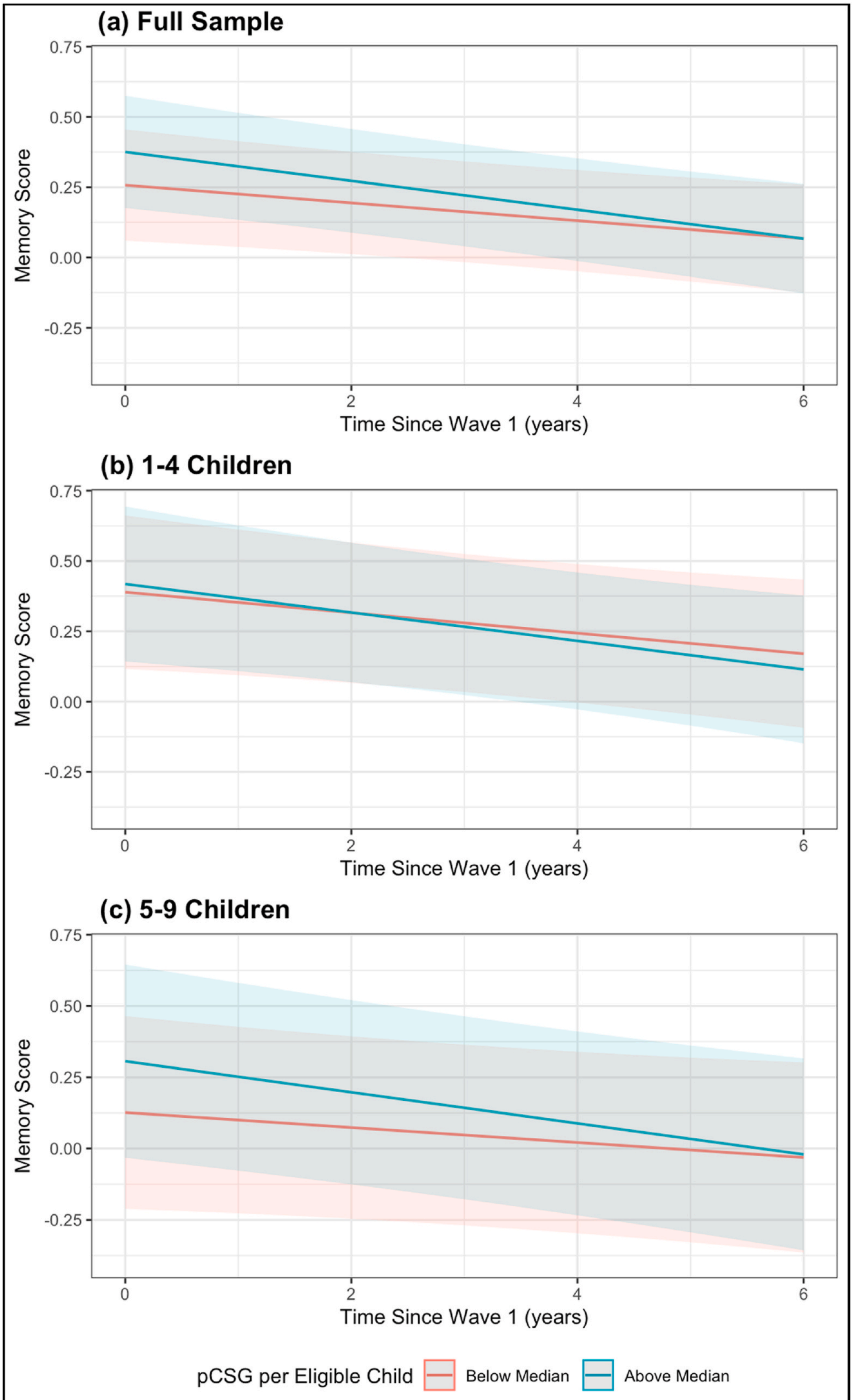
4. Discussion

This study is among the first to examine the longitudinal association between a large-scale cash transfer program and the cognitive health of mothers in a rural sub-Saharan African setting. In this analysis, we used two robust measures (episodic memory scores and dementia probability scores) to quantify the cognitive trajectories of female HAALSA participants who experienced exogenous differences (based on timing and number of births) in their eligibility for CSG. The use of this quasi-experimental design strengthened our analysis and helped us to isolate the effects of pCSG through reductions in confounding and bias. Overall, we found consistent evidence that exposure to more than 0.9 decades of pCSG per eligible child was associated with positive cognitive outcomes for women at HAALSA baseline compared to lower pCSG exposure. However, this positive baseline cognitive performance among women with above median pCSG was not maintained over time. These women experienced steeper memory decline and regressed to the average memory score of the below median pCSG group by study end. These results were observed in the full sample of women and further magnified among the sub-group of women with 5–9 children.

Our results suggest that receiving cash transfers, even in mid-life, could help preserve cognitive function in the short-term and promote healthy memory function in women in later-life. Eligibility for approximately 9 years of CSG per eligible child was associated with a protective effect on baseline memory function, the magnitude of which would offset the equivalent of 4 years of cognitive aging among this sample. Among women with 5–9 children, this protective effect was amplified to the equivalent of a 6 years of cognitive aging. These full sample findings are similar in magnitude to a cross-sectional analysis in the same population (Chakraborty et al., 2024). However, unlike this previous cross-sectional study, we found this effect to be primarily concentrated among women with grand-multiparity. Previous literature has shown that having five or more children is consistently linked to greater odds of dementia and poorer cognitive function (Bae et al., 2020a, 2020b; Saenz et al., 2021). Grand-multiparity could contribute to cognitive decline in women through reductions in disposable household income, limitations on employment opportunities, increases in daily stressors, and the hormonal and structural brain changes associated with pregnancy (Bae et al., 2020a; Saenz et al., 2021; Ning et al., 2020; Ohrnberger et al., 2020). Therefore, additional income for women with 5–9 children may be more impactful compared to women with 1–4 children who are not experiencing as large parity-related cognitive deficits.

Receipt of the CSG is frequently associated with positive outcomes among child beneficiaries including improved food security, educational outcomes, and anthropometric indicators of nutritional status (DSD and UNICEF, 2012). However, relatively few studies have estimated the impact of CSG transfers on adult recipients and even less research is available on its relationship with cognitive health specifically. One hypothesized pathway through which CSG may impact the cognitive health of mothers is the accrual of cognitive reserve. Cognitive reserve is accumulated across the life course via cognitively stimulating exposures such as education, higher income, and occupation, among others (Richards and Deary, 2005). In this rural South African population, CSG recipients tend to be low-income mothers with less than a secondary school education. Historically, these women have lacked control of household financial resources with CSG receipt increasing their financial autonomy and decision-making power (Granlund and Hochfeld, 2019). Additionally, CSG receipt has been associated with higher household income, higher probability of employment, higher spending on food, and positive mental health effects for female recipients (Delany et al., 2008; Ohrnberger et al., 2020; Eyal and Woolard, 2011). These pathways could contribute to building cognitive reserve, which in turn, can protect cognitive function and prevent or delay dementia risk (Richards and Deary, 2005). In line with this theorized pathway, we found that mothers with above median pCSG had higher estimated memory scores across most timepoints despite the steeper rate of decline over time.

Yet, despite higher memory scores at individual time points, higher pCSG exposure was consistently associated with quicker rates of memory decline over time. While these findings may seem contradictory, they align with previous research. Higher baseline memory scores accompanied by decline over time was also observed in a study that looked at the effect of moving from a low-skills to high-skills occupation among our same population (Yu et al., 2024). These studies are comparable as both examine exposures (pCSG and movement to a high-skills occupation) that improve an individual's income during mid-life; thus, providing consistency for the observed results. It is possible that these observed associations are explained by statistical phenomena such as regression to the mean. Alternatively, income boosts in mid-life may produce a short-term effect on memory function whereby individuals return to their pre-exposure function levels once receipt ends or shortly thereafter. This points to a hypothesis that income effects are not sustainable over time once receipt ends. It is important to note that despite



(caption on next page)

Fig. 3. Plot of predicted memory scores (with 95% confidence intervals) across time (in years) for the full sample (Panel a), women with 1–4 children (Panel b), and women with 5–9 children (Panel c).

Footnote: Each plot displays the predicted memory scores over time (in years since Wave 1) associated with below median and above median pCSG per eligible child. Memory scores are predicted as z-scores relative to the Wave 1 distribution. The models used for prediction included a random intercept for the individual and a random slope for time. Models were adjusted for maternal age, number of CSG-ineligible children, household wealth index, maternal education level, maternal literacy, maternal country of birth, suboptimal birth spacing, and maternal marital status. The mean value for each covariate was used for prediction. pCSG = potential cumulative Child Support Grant benefit.

Table 3
Effect of Above Median pCSG per Eligible Child on the Probability of Dementia for Female HAALSA Participants Aged <60 Years with 1–9 Children, Stratified by Number of Children.[a]

Full Sample	Full Sample N = 753	1-4 Children N = 357	5-9 Children N = 396
	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.02)	0.00 (−0.01, 0.02)
Education: None or Primary	*N = 523*	*N = 221*	*N = 302*
	0.00 (−0.01, 0.02)	0.01 (−0.01, 0.04)	0.00 (−0.02, 0.02)
Education: Secondary or More	*N = 230*	*N = 136*	*N = 94*
	0.00 (−0.01, 0.01)	−0.01 (−0.02, 0.01)	0.01 (−0.02, 0.03)
Household Wealth: Below Median	*N = 368*	*N = 168*	*N = 200*
	0.00 (−0.01, 0.02)	0.01 (−0.02, 0.03)	0.00 (−0.02, 0.02)
Household Wealth: Below Median	*N = 385*	*N = 189*	*N = 196*
	0.00 (−0.01, 0.01)	0.00 (−0.02, 0.02)	0.01 (−0.01, 0.02)

NB: All models include a binary indicator variable representing observations at Wave 1 to control for observed practice effects, a random slope for time, and a random intercept for the individual. Above median pCSG is equivalent to a duration of approximately 0.9+ cumulative decades of per eligible child. pCSG = potential cumulative Child Support Grant benefit.

[a] Adjusted for maternal age, number of CSG-ineligible children, household wealth index, maternal education level, maternal literacy, maternal country of birth, suboptimal birth spacing, and maternal marital status.

the steeper decline, the average memory score of the above median pCSG group does not fall below the average memory score of the below median group by the end of the study period. This supports a regression to the mean hypothesis or the short-term effect hypothesis, rather than there being a direct negative effect of increased income exposure. Further research is needed to determine if the declines in memory function associated with above median pCSG persist to a point where this group's average memory function drops below that of the below median CSG group.

In contrast to the results of our memory score analysis, we did not find an association between pCSG and dementia probability. To offset the probability of dementia, which is a more severe outcome, a higher level of baseline cognitive reserve prior to intervention may be necessary for cash transfers to exert a protective effect. Additionally, a large amount of the CSG benefit is likely not going towards purchases that may impact a mother's dementia probability directly. Together with the evidence of steeper memory decline, this indicates that the current cash value or structure of the CSG benefit may not be high enough to produce sustained, long-term cognitive benefits for mothers in this population.

The results of this study are primarily limited by the restricted sample used within the analysis. It is possible that the observed effects do not extend to women older than 59 years and those who have more than 10 children. However, the number of women excluded from the analysis due to these reasons account for a minimal proportion of the total population and were excluded for concerns about their lack of representativeness of the larger group. Additionally, our exposure definition of pCSG may not approximate actual CSG receipt as closely as hypothesized. Still, the results of our sensitivity analysis, where we restricted the sample to the group most likely to receive CSG (South African-born mothers), produced results similar to our main analysis. The precision of our analyses was limited by the low sample sizes within each constructed sub-sample. This may have contributed to the fact that while the magnitude of our results was consistent across many sub-samples, not all produced statistically significant results. Our analysis also only includes information about children living with the mother, it does not factor in any non-biological children. Despite these limitations, our analysis was strengthened by rigorous and rich longitudinal data on sociodemographic characteristics, two separate but complementary measures of cognitive health, and the employment of a natural quasi-experimental design.

5. Conclusion

In this longitudinal analysis, we found evidence that higher levels of accumulated eligibility for South Africa's CSG may prove protective against memory decline in women with less than 10 children. Even though the CSG is designed to support the health and well-being of child beneficiaries, these results signal the potential for lasting impacts on the cognitive health of female adult recipients. This effect potentially lasts for several years after eligibility ends. However, based on our results, we hypothesize that the CSG in its current structure is not sufficient support for women to retain this benefit over longer time horizons. Still, our findings support the use of cash transfers as a promising intervention to promote healthy cognitive aging in mid-life women, particularly those with grand multi-parity. Future research should explore how the structure and annual value of the cash transfer influence cognitive outcomes as well as examine effects across a longer time horizon.

Ethics approval statement

The HAALSA protocol was reviewed and approved by the Mpumalanga Provincial Research and Ethics Committee, the University of the Witwatersrand Human Research Ethics Committee (ref. M141159), and the Harvard T.H. Chan School of Public Health Office of Human Research Administration (ref. C13–1608–02) (Xavier Gómez-Olivé et al., 2018). Ethical approval for this secondary data analysis was sought from the Indiana University Institutional Review Board where it was deemed not human subjects research (ref. #2002584956).

CRediT authorship contribution statement

Erika T. Beidelman: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis. **Rishika Chakraborty:** Writing – review & editing, Writing – original draft, Formal analysis. **Janet Jock:** Writing – review & editing, Methodology. **Chodziwadziwa Whiteson Kabudula:** Writing – review & editing, Resources, Data curation. **Meredith L. Phillips:** Writing – review & editing, Formal analysis. **Kathleen Kahn:** Resources, Data curation. **Katherine Eyal:** Writing – review & editing, Methodology. **Darina T. Bassil:** Writing – review & editing, Methodology, Data curation. **Lisa Berkman:** Writing – review & editing, Resources, Data curation. **Lindsay C. Kobayashi:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Molly Rosenberg:** Writing – review &

editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Data availability

Data is available on an online repository, this has been detailed in the attached files.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2024.117217.

References

Aguila, E., Casanova, M., 2020. Short-term impact of income on cognitive function: evidence from a sample of Mexican older adults. J. Aging Health 32 (7–8), 591–603. https://pubmed.ncbi.nlm.nih.gov/30947596/. (Accessed 30 March 2023).

Akinyemi, R.O., Yaria, J., Ojagbemi, A., Guerchet, M., Okubadejo, N., Njamnshi, A.K., et al., 2022. Dementia in Africa: current evidence, knowledge gaps, and future directions. Alzheimer's Dementia 18 (4), 790–809. Available from: https://onlinelibrary.wiley.com/doi/full/10.1002/alz.12432. (Accessed 17 September 2023).

Ayyagari, P., Frisvold, D., 2016. The Impact of Social Security Income on Cognitive Function at Older Ages 2 (4), 463–488. https://www.journals.uchicago.edu/doi/10.1162/AJHE_a_00058. (Accessed 3 April 2023).

Bae, J.B., Lipnicki, D.M., Han, J.W., Sachdev, P.S., Kim, T.H., Kwak, K.P., et al., 2020a. Parity and the risk of incident dementia: a COSMIC study. Epidemiol Psychiatr Sci [Internet]. ;29:e176. Available from: https://pubmed.ncbi.nlm.nih.gov/33077022/. (Accessed 5 July 2023).

Bae, J Bin, Lipnicki, D.M., Han, J.W., Sachdev, P., Kim, T.H., Kwak, K.P., et al., 2020b. Does parity matter in women's risk of dementia? A COSMIC collaboration cohort study. BMC Med. 18 (1), 1–11 [Internet]. https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-020-01671-1. (Accessed 5 July 2023).

Bates, Maechler, Bolker, 2012. lme4 Package for R.

Chakraborty, R., Kobayashi, L.C., Jock, J., Wing, C., Chen, X., Phillips, M., et al., 2024. Child support grant expansion and cognitive function among women in rural South Africa: findings from a natural experiment in the HAALSI cohort. PLoS One 19 (3). Available from: https://pubmed.ncbi.nlm.nih.gov/38446751/. (Accessed 5 May 2024).

Children's Institute: University of Cape Town, 2023. Statistics on children in South Africa. Child Support Grants.

Delany, A., Ismail, Z., Graham, L., Ramkissoon, Y., 2008. Review of the Child Support Grant: Uses, Implementation and Obstacles. Johannesburg, South Africa. www.case.org.za. (Accessed 30 March 2023).

Department of Health/South Africa, Macro International, 2002. South Africa Demographic and Health Survey 1998. Pretoria, South Africa. https://dhsprogram.com/pubs/pdf/FR131/FR131.pdf. (Accessed 3 April 2023).

DSD, S.A.S.S.A., UNICEF, 2012. The South African Child Support Grant Impact Assessment: Evidence from a Survey of Children, Adolescents and Their Households. Pretoria.

Eyal, K., Woolard, I., 2011. Throwing the Book at the CSG. Cape Town. (A Southern Africa Labour and Development Research Unit. Report No.: 53.

Farell, M.T., Bassil, D.T., Guo, M., Glymour, M. M., Wagner, R.G., Tollman, S., et al., 2023. Estimating dementia prevalence using remote diagnoses and algorithmic modeling: a population-based study of a rural region in South Africa. Lancet Global Health, In Press.

Granlund, S., Hochfeld, T., 2019. That child support grant gives me powers. Exploring Social and Relational Aspects of Cash Transfers in South Africa in Times of Livelihood Change 56 (6), 1230–1244. https://www.tandfonline.com/doi/abs/10.1080/00220388.2019.1650170. (Accessed 5 July 2023).

Gross, A.L., Power, M.C., Albert, M.S., Deal, J.A., Gottesman, R.F., Griswold, M., et al., 2015. Application of latent variable methods to the study of cognitive decline when tests change over time. Epidemiology 26 (6), 878. Available from:/pmc/articles/PMC4819068/. (Accessed 29 March 2023).

Guerchet, M.M., Mayston, R., Lloyd-Sherlock, P., Prince, M.J., Aboderin, I., Akinyemi, R., et al., 2017. Dementia in sub-saharan Africa challenges and opportunities [internet]. www.leahbeach.com. (Accessed 30 March 2023).

Jock, J., Kobayashi, L., Chakraborty, R., Chen, X., Wing, C., Berkman, L., et al., 2023. Effects of pension eligibility expansion on men's cognitive function: findings from rural South Africa. J Aging Soc Policy [Internet] 1–20. (Accessed 30 March 2023).

Kabudula, C.W., Houle, B., Collinson, M.A., Kahn, K., Tollman, S., Clark, S., 2017. Assessing changes in household socioeconomic status in rural South Africa, 2001–2013: a distributional analysis using household asset indicators. Soc Indic Res [Internet] 133 (3), 1047. Available from:/pmc/articles/PMC5579134/. (Accessed 9 December 2021).

Kahn, K., Collinson, M.A., Xavier Gómez-olivé, F., Mokoena, O., Twine, R., Mee, P., et al., 2012a. Profile: Agincourt health and socio-demographic surveillance system. Int. J. Epidemiol. 41 (4), 988–1001. Available from: https://pubmed.ncbi.nlm.nih.gov/22933647/. (Accessed 10 December 2021).

Kahn, K., Collinson, M.A., Xavier Gómez-olivé, F., Mokoena, O., Twine, R., Mee, P., et al., 2012b. Profile: Agincourt health and socio-demographic surveillance system. Int. J. Epidemiol. 41 (4), 988–1001. Available from: https://academic.oup.com/ije/article/41/4/988/690287. (Accessed 3 October 2022).

Kobayashi, L.C., Mateen, F.J., Montana, L., Wagner, R.G., Kahn, K., Tollman, S.M., et al., 2019. Cognitive function and impairment in older, rural South African adults: evidence from "health and aging in Africa: a longitudinal study of an INDEPTH community in rural South Africa.". Neuroepidemiology 52 (1–2), 32–40. https://www.karger.com/Article/FullText/493483. (Accessed 30 March 2023).

Larnyo, E., Dai, B., Nutakor, J.A., Ampon-Wireko, S., Larnyo, A., Appiah, R., 2022. Examining the impact of socioeconomic status, demographic characteristics, lifestyle and other risk factors on adults' cognitive functioning in developing countries: an analysis of five selected WHO SAGE Wave 1 Countries. Int. J. Equity Health 21 (1). /pmc/articles/PMC8876754/. (Accessed 3 April 2023).

Lekoubou, A., Echouffo-Tcheugui, J.B., Kengne, A.P., 2014. Epidemiology of neurodegenerative diseases in sub-Saharan Africa: a systematic review. BMC Publ. Health 14 (1). Available from: https://pubmed.ncbi.nlm.nih.gov/24969686/. (Accessed 30 March 2023).

Luthuli, S., Haskins, L., Mapumulo, S., Horwood, C., 2022. Does the unconditional cash transfer program in South Africa provide support for women after child birth? Barriers to accessing the child support grant among women in informal work in Durban, South Africa. BMC Publ. Health 22 (1), 1–11. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-022-12503-7. (Accessed 10 September 2023).

Mani, A., Mullainathan, S., Shafir, E., Zhao, J., 2013. Poverty impedes cognitive function. Science 341 (6149), 976, 1979. https://www.science.org/doi/10.1126/science.1238041. (Accessed 30 March 2023).

Mavrodaris, A., Powell, J., Thorogood, M., 2013. Prevalences of dementia and cognitive impairment among older people in sub-Saharan Africa: a systematic review. Bull World Health Organ [Internet] 91 (10), 773. Available from:/pmc/articles/PMC3791658/. (Accessed 30 March 2023).

Mcewen, H., Kannemeyer, C., Woolard, I., 2009. Social Assistance Grants: Analysis of the NIDS Wave 1 Dataset (National Income Dynamics Study Discussion Paper). Report No.: 10. Available from: http://www.sassa.gov.za. (Accessed 30 March 2023).

Mgaya, A.H., Massawe, S.N., Kidanto, H.L., Mgaya, H.N., 2013. Grand multiparity: is it still a risk in pregnancy? BMC Pregnancy Childbirth [Internet] 13, 241. Available from:/pmc/articles/PMC3878019/. (Accessed 12 April 2024).

Nikolov, P., Hossain, M.S., 2023. Do pension benefits accelerate cognitive decline in late adulthood? Evidence from rural China. J. Econ. Behav. Organ. 205, 594–617.

Ning, K., Zhao, L., Franklin, M., Matloff, W., Batta, I., Arzouni, N., et al., 2020. Parity is associated with cognitive function and brain age in both females and males. Sci. Rep. 10 (1). Available from:/pmc/articles/PMC7142076/. (Accessed 5 July 2023).

Ohrnberger, J., Fichera, E., Sutton, M., Anselmi, L., 2020. The effect of cash transfers on mental health – new evidence from South Africa. BMC Publ. Health 20 (1). Available from:/pmc/articles/PMC7118950/. (Accessed 5 July 2023).

Peltzer, K., Phaswana-Mafuya, N., 2012. Cognitive functioning and associated factors in older adults in South Africa. S. Afr. J. Psychiatr. 18 (4), 157–164. Available from: https://go.gale.com/ps/i.do?p=AONE&sw=w&issn=16089685&v=2.1&it=r&id=GALE%7CA312403162&sid=googleScholar&linkaccess=fulltext. (Accessed 30 March 2023).

Peng, C., Burr, J.A., Han, S.H., 2023. Cognitive function and cognitive decline among older rural Chinese adults: the roles of social support, pension benefits, and medical insurance. Aging Ment Health [Internet] 27 (4). Available from: https://pubmed-ncbi-nlm-nih-gov.proxyiub.uits.iu.edu/35702759/. (Accessed 3 April 2023).

R Core Team, 2023. R: A Language and Environment for Statistical Computing [Internet]. R Foundation for Statistical Computing, Vienna, Austria. Available from: https://www.R-project.org.

Richards, M., Deary, I.J., 2005. A life course approach to cognitive reserve: a model for cognitive aging and development? Ann Neurol [Internet] 58 (4), 617–622. (Accessed 8 July 2023).

Röhr, S., Pabst, A., Baber, R., Engel, C., Glaesmer, H., Hinz, A., et al., 2022a. Socioeconomic inequalities in cognitive functioning only to a small extent attributable to modifiable health and lifestyle factors in individuals without dementia. J Alzheimers Dis 90 (4), 1523–1534 [Internet]. https://pubmed.ncbi.nlm.nih.gov/36278347/. (Accessed 30 March 2023).

Röhr, S., Pabst, A., Baber, R., Engel, C., Glaesmer, H., Hinz, A., et al., 2022b. Social determinants and lifestyle factors for brain health: implications for risk reduction of cognitive decline and dementia. Sci. Rep. 12 (1) [Internet]. https://pubmed.ncbi.nlm.nih.gov/35902604/. (Accessed 30 March 2023).

Saenz, J.L., Díaz-Venegas, C., Crimmins, E.M., 2021. Fertility history and cognitive function in late life: the case of Mexico. J Gerontol B Psychol Sci Soc Sci [Internet] 76 (4). E140–52. Available from: https://pubmed.ncbi.nlm.nih.gov/31603514/. (Accessed 5 July 2023).

SASSA. South African Government, 2023. Child support grant [cited 2023 Jul 8]. https://www.gov.za/services/child-care-social-benefits/child-support-grant.

Statistics South Africa, 2017. Poverty Trends in South Africa: An examination of absolute poverty between 2006 and 2015 [Internet]. Pretoria. http://www.statssa.gov.za/publications/Report-03-10-06/Report-03-10-062015.pdf. (Accessed 25 May 2022).

Statistics South Africa, 2023. National Poverty Lines 2023. Pretoria. http://www.statssa.gov.za/publications/P03101/P031012021.pdf.

Stats, S.A., 2022. General Household Survey 2022. Pretoria, South Africa.

Stern, Y., 2012. Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol. 11 (11), 1006. Available from:/pmc/articles/PMC3507991/. (Accessed 29 March 2022).

Stern, Y., Arenaza-Urquijo, E.M., Bartrés-Faz, D., Belleville, S., Cantilon, M., Chetelat, G., et al., 2020. Whitepaper: defining and investigating cognitive reserve, brain reserve and brain maintenance. Alzheimers Dement 16 (9), 1305. Available from:/pmc/articles/PMC6417987/. (Accessed 8 April 2022).

Trani, J.F., Moodley, J., Maw, M.T.T., Babulal, G.M., 2022. Association of multidimensional poverty with dementia in adults aged 50 Years or older in South Africa. JAMA Netw. Open 5 (3), E224160. Available from: https://pubmed.ncbi.nlm.nih.gov/35333360/. (Accessed 30 March 2023).

Twine, R., Collinson, M.A., Polzer, T.J., Kahn, K., 2007. Evaluating access to a child-oriented poverty alleviation intervention in rural South Africa 1. Scand J Public Health 35 (Suppl. 69), 118–127.

Weuve, J., Proust-Lima, C., Power, M.C., Gross, A.L., Hofer, S.M., Thiébaut, R., et al., 2015. Guidelines for reporting methodological challenges and evaluating potential bias in dementia research. Alzheimers Dement 11 (9), 1098–1109 [Internet]. https://pubmed.ncbi.nlm.nih.gov/26397878/. (Accessed 29 March 2023).

World Health Organization (WHO), 2006. Policy Brief: Birth Spacing — Report from a WHO Technical Consultation. Geneva, Switzerland.

Xavier Gómez-Olivé, F., Montana, L., Wagner, R.G., Kabudula, C.W., Rohr, J.K., Kahn, K., et al., 2018. Cohort profile: health and ageing in Africa: a longitudinal study of an INDEPTH community in South Africa (HAALSI). Int. J. Epidemiol. 47 (3), 689–690j. Available from: https://academic.oup.com/ije/article/47/3/689/4791962. (Accessed 30 November 2021).

Yu, X., Zhang, W., Kobayashi, L.C., 2021. Duration of poverty and subsequent cognitive function and decline among older adults in China, 2005-2018. Neurology 97 (7), E739–E746. Available from: https://pubmed.ncbi.nlm.nih.gov/34099525/. (Accessed 30 March 2023).

Yu, X., Kabudula, C.W., Wagner, R.G., Bassil, D.T., Farrell, M.T., Tollman, S.M., et al., 2024. Mid-life employment trajectories and subsequent memory function and rate of decline in rural South Africa, 2000–22. Int. J. Epidemiol. 53 (2) https://doi.org/10.1093/ije/dyae022. (Accessed 17 April 2024).

Zeki Al Hazzouri, A., Elfassy, T., Sidney, S., Jacobs, D., Pérez Stable, E.J., Yaffe, K., 2017. Sustained economic hardship and cognitive function: the coronary artery risk development in young adults study. Am J Prev Med [Internet] 52 (1), 1–9. Available from: https://pubmed.ncbi.nlm.nih.gov/27692543/. (Accessed 30 March 2023).

Zembe-Mkabile, W., Surrender, R., Sanders, D., Jackson, D., Doherty, T., 2015. The experience of cash transfers in alleviating childhood poverty in South Africa: mothers' experiences of the Child Support Grant. Glob Public Health 10 (7), 834. Available from:/pmc/articles/PMC4536939/. (Accessed 5 May 2024).