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Determinants of Cognitive Health Among Aging Adults in Agincourt, South Africa

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Abstract

This study examines influences on cognitive health, showing how aging increases the odds of cognitive impairment by focusing on orientation to time and person among aging adults in Agincourt, South Africa. The Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in SA (HAALSI) Cohort from the Agincourt data set was used. Binary logistic regression analysis examined factors associated with cognition. Ability to read and/or write positively correlated with the correct recall of year, month, and date. Marital status, HIV status, and hypertension negatively correlated with the correct recall of year, month, and date. Correct recall of a person is influenced by age, duration of residence, ability to read/write, marital status, and hypertension. This study adds to the nascent research on cognitive impairment in Africa. The findings support earlier research on factors that correlate with cognitive impairment. To achieve healthy aging, factors such as hypertension and HIV must be controlled not only among aging adults but people of all ages.

Key Words: cognitive dysfunction, South Africa, healthy aging, high blood pressure, HIV infections.

Introduction

In current decades, there has been an expanded interest in the outcomes of cognitive decline among older populations (Langa et al., 2018). "Cognition, the potential to understand and become aware of one's surroundings, including perceiving, conceiving, remembering, reasoning, judging, imagining, and problem-solving, declines with aging" (Shukla, 2021). The article (Baltes, P. B., Lindenberger, U., 1997) states that maintaining a strong cognitive ability is critical for functional independence as one ages. Dementia, an outcome of cognitive degeneration, is on the rise in low and middle-income countries due to significant increases in aging populations (Chan, Adeloye, Asante, et al., 2019; Kalaria, Maestre, Arizaga, et al., 2008). This study examined factors associated with cognitive health among aging people in Agincourt, South Africa.

Different measures have been used to assess cognition, such as language tasks (picture naming, semantics), memory tasks (orientation, word encoding), self-reports, informant reports, and performance-based measures. While self-report and informant report measures are believed to be problematic, performance-based assessment whereby well-defined functional tasks are rated by direct observation of trained raters tend to be most valid and reliable (Giovannetti et al., 2006).

This study focuses on the factors that significantly impact cognitive health-orientation to time and person and examines the determinants of cognitive functioning among aging adults in Agincourt, South Africa. The following research question guided the study: What factors significantly impact cognitive health - orientation to time and person - in South Africa? Cognitive impairment is measured by memory tasks, focusing on four different orientation measures. Orientation refers to the timing between a person and the "internal representation he/she forms of the corresponding public reference system, i.e., the external world" (Berrios, 1982). In fact, orientation to time, place, and person is an important aspect of cognitive functioning (Dodd & Bucci, 1987: 53). It processes how the self can relate to time (events), person (people), and places (Peer, Salomon, Goldberg, Blanke & Argy, 2015). Cognitive impairment measures used in this study are memory task-focused. These are: a. Orientation to the year (study participants were asked to state the current year). b. Orientation to the month (study participants were asked to state the month). c. Orientation to the date (study participants were asked to state the date). Lastly, d. orientation to the president, where study participants were asked to state the current president.

Literature Review

Our attention to the world around us, recollections of past activities, expertise in language, judgments on how the world works, and abilities to resolve issues all contribute to how we behave and engage with our surrounding environment. Cognition is vital for people as they age to live independently and manage activities of daily living (Murman et al., 2015). There are numerous age-related types of changes in cognition that are a part of the normal aging process. "The population of aging adults may experience declines in performance and cognitive tasks that are crucial for processing and remembering information" (Murman et al., 2015). Salthouse (2004) also observed a positive relationship between vocabulary,

knowledge, and age. While age is a significant determinant of cognition, other factors are strongly associated with cognitive health.

Education has been found to be an important factor (Navarro et al., 2015). "The ability to read and write, think, learn, and remember is an important component of cognition" (Swanson et al., 2003). Barnes et al. (2003) found that aged men and women with better literacy scores completed higher on all measures of cognition and that reading and writing significantly influence cognitive decline in older adults. "Studying and writing should lead directly to the enrichment of neural networks, that can permit humans with higher ranges of literacy to have larger cognitive reserves to process cognitive information more efficiently" (Stern et al., 2002).

Gender is also a significant factor. Studies show that men and women have unique risk elements for age-associated cognitive impairment. "Men may be at a higher risk of experiencing mild cognitive impairment (MCI), the stage of mild memory loss that occurs between everyday aging and dementia, than women" (Mayo Clinic, 2012). Cross-sectional research suggests gender differences in cognitive function and risk of Alzheimer's disease in aging adults. Results in other studies propose that "styles of cognitive decline and occurrence of AD are similar in older males and females" (Barnes et al., 2003).

Marital status is another vast determinant. Being in a relationship with a partner would possibly suggest cognitive and socially demanding situations that have a protecting effect in opposition to cognitive impairment later in life (Hakansson et al., 2009). Chen (2018) tested the affiliation between marital quality and change in cognitive limitations experienced later in life. Results indicate that "better marital experiences are related to a slower increase in cognitive limitations, and the affiliation between negative marital experiences and cognitive barriers is comparable for men and women" (Chen, 2018). This looks at possible motives for the impact of negative marital experiences on the cognitive health of older adults over the years, irrespective of gender.

Duration of residence in different countries has been found to be significant with cognitive decline in older aging adults (Diemer & Blustein, 2007). Residential status and length have been related to numerous determinants of health and

wellbeing. Zang et al. (2017) assessed the changes in cognition among older adults with residential statuses (urban residents, rural-to-urban residents, rural citizens, and urban-to-rural citizens) over a 12-year duration. This study suggests that residential status influences the changes in cognition associated with aging adults. More studies look specifically at older adults with grandchildren residing with them as a cognitive determinant to understand general changes in household composition. (Zimmer, 2005) states that "The number of older adults living with orphaned grandchildren has changed over time since it is suspected that the burden of care for grandchildren is increasing rapidly as a result of the AIDS epidemic in south Africa." This shows how older adults taking on this role to care for grandchildren could be affecting the cognitive decline in less developed countries.

Depression has been proven as a predictor of cognitive decline. Symptoms of depression later in life is a significant health care risk for older adults and a major motive of disability (Fiske, 2009). Despair in older humans may additionally inhibit someone from maintaining activities of daily living. Late-life depression may be associated with deficits in cognitive characteristics, which may vary depending on the duration of the illness (Fiske, 2009). "Cognitive dysfunction in depressed older adults may additionally consist of memory impairment, poor attention, and executive dysfunction" (Fiske, 2009). Many studies assessed the effect of a child's death on cognitive decline in late life, hypothesizing that such adversity could be associated with chronic psychological stress and result in faster cognitive decline (Greene, 2014).

The relationship between blood pressure, cognitive function, and dementia has acquired tons of interest from studies in recent years (Qiu et al., 2005). Cross-sectional research has proven an inverse association between blood pressure and the prevalence of dementia (Reitz et al., 2007). Observational research and scientific trials provide limited evidence for the protecting effect of antihypertensive therapy in opposition to dementia and stroke-associated cognitive decline (McGrath et al., 2017). Atherosclerosis, on account of long-standing hypertension, can be a fundamental biological pathway linking both high blood pressure to cognitive decline and dementia (Jung et al., 2013).

Another health condition associated with cognitive impairment is HIV (Watkins et al., 2015). HIV can result in a severe illness referred to as AIDS (Hardy et al.,

2009). When someone has AIDS, they are more likely to get infections and more vulnerable to cancers and other critical illnesses (Hardy et al., 2009). "In 2016, almost half of the population in America based on areas residing with identified HIV were age 50 and older" (CDC, 2022). The virus can travel to the brain, where it can move the blood mind barrier by way of infecting vascular epithelial cells, allowing it access to the brain, and affecting the daily living of a person (Kamkwalala et al., 2017). Cognitive functioning in aging adults may be influenced by HIV-related ongoing neurodegenerative effects in older adults, "especially if the man or woman is infected late in life and is undiagnosed or untreated for some time after exposure, or if they have lived with the disease for almost their entire life" (Kamkwalala et al., 2017). Specifically, in South Africa, the impact of the HIV epidemic in older people is formed by the social, political, demographic, and economic situations in which they live (Hosegood, 2006). A study in rural KwaZulu-Natal in 2000 found that "two percent of people dying of AIDS with or without tuberculosis were age 60 or more, representing five percent of all deaths in this age group" (Hosegood, 2004).

Setting

The Agincourt population is in the "sub-district of Bushbuckridge district, Mpumalanga Province, within the rural north-east of South Africa, near the eastern border with Mozambique" (Kahn et al., 2007). Almost a third of the study population is of Mozambican origin. Many entered the United States as refugees within the early to mid-eighties during and after the civil conflict. They constituted a large population of self-settled refugees under health and demographic surveillance (Kahn et al., 2007). The population is about 70,000 people in 21 villages and 11,700 households. Most of the population is low-income, and many of the populations with higher burdens of tuberculosis and HIV mortality suffer from poverty. There are a growing number of schools, but most of the older population have little to no education. Agriculture is a completely vital region in South Africa regarding job opportunities in rural regions; however, it also contributes largely to foreign exchange. Agriculture in South Africa is so numerous and wealthy regarding vegetation types, biodiversity, climates, and distinct varieties of soil (Scherr et al., 2008).

Methods

Data in this study came from the Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in SA (HAALSI) Cohort from Agincourt. This is baseline data collected between 2014 and 2015. A binary logistic regression analysis was used to examine factors associated with cognition. Four measures of cognitive health that focus on orientation were used: a. Orientation to the year; b. Orientation to the month; c. Orientation to the date; and d. Orientation to the president. Participants were asked to name the current year, month, date, and president. The answer choices were: 1. Correct; 2: Incorrect, and 3. Don't Know. Answers were recorded into 2 categories: correct and incorrect, by adding the don't know cases to the incorrect category. The dependent and independent variables are shown in Table 1. The dependent variables are the duration of residence in Agincourt, age, depression, number of deceased children, number of grandchildren residing with respondents, HIV serostatus, sex, marital status, blood pressure status, and education.

Results

The sample consisted of participants that were mostly female (53.60%) and married (50.90%). The average age of respondents was 62 years. They had lost on average 1.36 children and had lived in Agincourt for an average of 36 years. Respondents had a little over two grandchildren living with them at the time of the survey and had mostly no formal education (45.70%). While 12.40% were HIV positive, about 42% had ever been told to have high blood pressure.

Table 1

Descriptive Statistics of Variables

	N	Mean	%	SD
Dependent Variables				
Orientation to time –YEAR				
Correct answer	3701		76.50	
Incorrect answer	1139		23.50	
Orientation to time –MONTH				
Correct answer	4035		82.60	
Incorrect answer	850		17.40	
Orientation to time –DATE				
Correct answer	3545		73.30	
Incorrect answer	1294		26.70	
Orientation to person – PRESIDENT				
Correct answer	4063		83.30	
Incorrect answer	1139		16.70	
Independent Variables				
Duration of residence in Agincourt	3265	36.20		14.86
Age	5017	62.43		13.02
Depression score	4936	1.71		1.42
Number of deceased children	4728	1.36		1.74
Number of grandchildren	4054	2.18		2.20
residing with respondent				
Tested positive for HIV				
Yes	623		12.40	
No	4402		87.60	
Sex				
Male	2345		46.40	
Female	2714		53.60	
Marital status				
Married	2575		50.90	
Not married	2482		49.10	
Ever been told to have high BP				
Yes	2118		41.90	
No	2937		58.10	
Education				
No formal education	2306		45.70	
Some primary (1-7 years)	1612		32.00	

Some secondary (8-11 years)	537	10.70
Secondary or more (12+ years)	585	11.60

As shown in Table 2, several factors are significantly associated with orientation to person. Male respondents were almost three times (2.887) more likely to correctly name the president compared to their female counterparts. Married respondents and people who had been told to have high blood pressure were, respectively, 1.6 and 1.7 times more likely to correctly name the president compared to unmarried and people who have never been told to have high blood pressure. Compared with people with at least a secondary school education, respondents with no formal education and those with some primary education were, respectively, 85.5% and 58.3% less to correctly name the president. Age and having lost a child increase the odds of incorrectly naming the president, 3.1% and 8%, respectively.

Table 2

Binary Logistic Regression Results of Orientation to Person – President

	SE	Odds ratio	P-value
Constant	0.492	96.247	0.000
Age	0.006	0.969***	0.000
Duration of residence in Agincourt	0.004	0.998	0.687
Number of deceased children	0.031	0.921** 0.009	
Number of grandchildren residing in home	0.026	1.010	0.714
Depression score	0.039	0.970	0.435
Sex			
Male	0.148	2.887***	0.000
Female	--	--	--
Married status			
Married	0.133	1.626***	0.000
Not married	--	--	--
Ever tested positive for HIV			
Yes	0.185	1.193	0.381
No	--	--	--
Ever been told to have high BP			
Yes	0.114	1.738***	0.000
No	--	--	--

Education

No formal education	0.374	0.145***	0.000
Some primary (1-7 years)	0.385	0.417*	0.023
Some secondary (8-11 years)	0.689	2.242	0.242
Secondary or more (12+ years)	--	--	--
*p<0.05 **p<0.01	***p<0.001		

Table 3 shows factors associated with orientation to year. Age, number of deceased children, depression, and formal education are all negatively associated with correctly naming the year, while gender, marital status, and having been told to have high blood pressure all increase the odds of correctly naming the year. For instance, age and number of deceased children reduced the odds of correctly reporting the year by 3.7% and 9.6%, respectively. Also, compared to people with at least a secondary education, respondents with no education were 92.3% less likely to report the year correctly. Men were 3.6 times more likely to report the year correctly.

Table 3

Binary Logistic Regression Results of Orientation to Time – Year

	SE	Odds ratio	P-value
Constant	0.501	373.640	0.000
Age	0.006	0.963***	0.000
Duration of residence in Agincourt	0.004	1.007	0.083
Number of deceased children	0.031	0.904***	0.001
Number of grandchildren residing in home	0.025	1.029	0.262
Depression score	0.038	0.904**	0.009
Sex			
Male	0.141	3.615***	0.000
Female	--	--	--
Married status			
Married	0.126	1.419**	0.005
Not married	--	--	--
Ever tested positive for HIV			
Yes	0.191	1.185	0.374
No	--	--	--
Ever been told to have high BP			
Yes	0.118	1.828***	0.000
No	--	--	--

Education			
No formal education	0.373	0.077***	0.000
Some primary (1-7 years)	0.391	0.569	0.149
Some secondary (8-11 years)	0.589	1.304	0.653
Secondary or more (12+ years)	--	--	--
*p<0.05 **p<0.01 ***p<0.001			

Table 4 shows the binary logistic regression results of orientation to month. The odds of correctly naming the month are positively associated with gender, marital status, ever been told to have high blood pressure and negatively associated with age, number of deceased children, and formal education, as shown in Table 4. For example, while age reduced the odds of correctly reporting the month by 5%, respondents that had been told to have high BP were 2.2 times more likely to state the month correctly. Also, males were over twice as likely to correctly name the month compared to women.

Table 4

Binary Logistic Regression Results of Orientation to Time – Month

	SE	Odds ratio	P-value
Constant	0.518	163.367	0.000
Age	0.006	0.955***	0.000
Duration of residence in Agincourt	0.004	1.008	0.169
Number of deceased children	0.032	0.924*	0.014
Number of grandchildren residing in home	0.027	1.024	0.363
Depression score	0.041	0.991	0.830
Sex			
Male	0.149	2.164***	0.000
Female	--	--	--
Married status			
Married	0.138	1.734**	0.000
Not married	--	--	--
Ever tested positive for HIV			
Yes	0.214	1.382	0.131
No	--	--	--
Ever been told to have high BP			
Yes	0.128	2.175***	0.000
No	--	--	--
Education			
No formal education	0.397	0.113***	0.000

	SE	Odds ratio	P-value
Some primary (1-7 years)	0.431	1.021	0.962
Some secondary (8-11 years)	0.812	3.037	0.171
Secondary or more (12+ years)	--	--	--

*p<0.05   **p<0.01   ***p<0.001

The binary logistic regression results of orientation to date are shown in Table 5. Age, number of deceased children, and education reduce the odds of correctly naming the date, while gender, marital status, ever been told to have high blood pressure, and having HIV increase the likelihood of correctly naming the date. For example, men were 3.2 times more likely to correctly state the date compared to women. Also, people who were HIV positive (odds ratio = 1.476) and those who had been told to have high BP (odds ratio = 1.314) were more likely to correctly state the date compared to their counterparts who had not ever been told to have high BP and those who were not HIV positive, respectively.

Table 5

Binary logistic regression results of orientation to time– Date

	SE	Odds ratio	P-value
Constant	0.403	105.474	0.000
Age	0.006	0.951***	0.000
Duration of residence in Agincourt	0.004	1.006	0.101
Number of deceased children	0.029	0.930*	0.013
Number of grandchildren residing in home	0.023	1.002	0.935
Depression score	0.036	1.004	0.921
Sex			
Male	0.130	3.165***	0.000
Female	--	--	--
Married status			
Married	0.116	1.348**	0.010
Not married	--	--	--
Ever tested positive for HIV			
Yes	0.182	1.476*	0.032
No	--	--	--
Ever been told to have high BP			
Yes	0.108	1.314*	0.012
No	--	--	--
Education			
No formal education	0.269	0.153***	0.000

Some primary (1-7 years)	0.282	0.750	0.307
Some secondary (8-11 years)	0.418	1.338	0.486
Secondary or more (12+ years)	--	--	--

*p<0.05   **p<0.01   ***p<0.001

Discussion

This study examined factors that are correlated with cognitive health among aging people in Agincourt, South Africa. I was specifically interested in orientation, an aspect of memory tasks that focuses on the four measures of cognitive health a. Orientation to the year; b. Orientation to the month; c. Orientation to the date; and d. Orientation to the president. Participants were asked to name the current year, month, date, and president. Some of the findings support earlier research on factors that correlate with cognitive impairment. For instance, education has been shown to have a positive association with cognitive function (Barnes et al., 2004; Navarro et al., 2015).

In conclusion, it looks like education was also positively associated with orientation among the aging people in Agincourt. Additionally, as indicated in other studies (Mayo Clinic, 2012), women seem to be more affected by cognitive impairment than men in this study. Married respondents were more advantaged than their unmarried counterparts regarding cognitive health. Stressors such as losing a child were harmful to cognitive health as well as depression. Understanding cognition is critical for healthy cognitive improvement, as deficits arise in neuropsychological disorders. Global health challenges are associated with core cognitive problems that constitute key therapeutic objectives for early intervention. Being able to measure and monitor cognition has the potential to permit early interventions that enhance cognitive performance related to the decline in normal aging (Cambridge Cognition, 2015).

Some surprising results were also found. While people who had been told to have high blood pressure showed better cognition than those without high blood pressure, studies on the relationship between cognitive impairment and hypertension have been inconsistent. Some have shown a positive relationship, and others have a negative one. Another surprising result was the positive association between HIV and orientation to date. This could be that people with HIV were younger relative to those without HIV. The study has some limitations.   Data are

cross-sectional and cannot infer causation. Also, data are self-reports, and there may be issues with social desirability. Despite these limitations, this study adds to the discourse on cognitive health among aging people in Africa. To achieve healthy aging, it is important to know factors that negatively impact cognition. More research studies are needed to fully understand the influences on cognitive impairment in Africa.

References

Baltes, P. B., Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult life span: A new window to the study of cognitive aging? *Psychology and Aging*, *12*(1), 12-21. https://doi.org/10.1037/0882-7974.12.1.12

Barnes, H.L. (2003). The relationship between working memory and writing in younger and older adults. *Reading and Writing* 16, 759-784. https://doi.org/10.1023/A:1027320226283

Berrios, G.E. (1982). Disorientation states and psychiatry. *Comprehensive Psychiatry*, *23*(5), 479-491. https://doi.org/10.1016/0010-440X(82)90161-4

Cambridge Cognition. (2015, August 19). What is cognition? [web log]. Retrieved from https://www.cambridgecognition.com/blog/entry/what-is-cognition.

Centers for Disease Control and Prevention. (2022, January 12). HIV among people aged 50 and over. Centers for Disease Control and Prevention. https://www.cdc.gov/hiv/group/age/olderamericans/index.html

Chan, K. Y., Adeloye, D., Asante, K. P. et al. (2019). Tackling dementia globally: The Global Dementia Prevention Program (GloDePP) collaboration. *Journal of Global Health*, *9*(2) https://doi.org/10.7189/jogh.09.020103

Chen, B., Zhong, X., Mai, N., Peng, Q., Wu, Z., Ouyang, C., Zhang, W., Liang, W., Wu, Y., Liu, S., Chen, L., & Ning, Y. (2018). Cognitive impairment and structural abnormalities in late life depression with olfactory identification impairment: An Alzheimer's disease-like pattern. *The*

International Journal of Neuropsychopharmacology, 21(7), 640-648.
https://doi.org/10.1093/ijnp/pyy016

Diemer, M. A., & Blustein, D. L. (2007). Vocational hope and vocational identity: Urban adolescents' career development. *Journal of Career Assessment, 15*(1), 98-118. https://doi.org/10.1177/1069072706294528

Dodd, M & Bucci, W. (1987). The relationship of cognition and affect in the orientation process. *Cognition, 27*(1), 53-71. https://doi.org/10.1016/0010-0277(87)90035-7

Fiske, A., Wetherell, J. L., & Gatz, M. (2009). Depression in older adults. *Annual Review of Clinical Psychology*, *5,* 363-389. https://doi.org/10.1146/annurev.clinpsy.032408.153621

Giovannetti, T, Schmidt, K. S., Gallo, J. L., Sestito, K & Libon, D. J. (2006). Everyday action in dementia: Evidence for differential deficits in Alzheimer's disease versus subcortical vascular dementia. *Journal of International Neuropsychological Society, 12*, 45-53. https://doi.org/10.1017/S1355617706060012

Greene, D., Tschanz, J. T., Smith, K. R., Ostbye, T., Corcoran, C., Welsh-Bohmer, K. A., Norton, M. C., & Cache County Investigators (2014). Impact of offspring death on cognitive health in late life: the Cache County study. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry, 22*(11), 1307-1315. https://doi.org/10.1016/j.jagp.2013.05.002

Haalsi Data. Data. (n.d.). Retrieved February 24, 2022, from https://haalsi.org/data

Håkansson, K., Rovio, S., Helkala, E. L., Vilska, A. R., Winblad, B., Soininen, H., Nissinen, A., Mohammed, A. H., & Kivipelto, M. (2009). Association between mid-life marital status and cognitive function in later life: Population-based cohort study. *BMJ (Clinical research ed.),* 339, b2462. https://doi.org/10.1136/bmj.b2462

Hardy, D.J., & Vance, D.E. (2009). The neuropsychology of HIV/AIDS in older adults. *Neuropsychol Rev* 19, 263. https://doi.org/10.1007/s11065-009-9087-0

Hosegood, V., McGrath, N., Herbst, K, & Timaeus, I.M. (2004). The impact of adult mortality on household dissolution and migration in rural South Africa. *AIDS, 18*(11), 1585-1590. https://doi.org/10.1097/01.aids.0000131360.37210.92

Hosegood, V, Timaeus, I.M. (2006). HIV/AIDS and older people in South Africa. In: National Research Council (US) Committee on Population; Cohen B, Menken J. (Eds.). *Aging in Sub-Saharan Africa: Recommendation for Furthering Research*. Washington (DC): National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK20298

Jung, H. W., & Kim, K. I. (2013). Blood pressure variability and cognitive function in the elderly. *Pulse (Basel, Switzerland), 1*(1), 29-34. https://doi.org/10.1159/000348622

Kahn, K., Tollman, S. M., Collinson, M. A., Clark, S. J., Twine, R., Clark, B. D., Shabangu, M., Gómez-Olivé, F. X., Mokoena, O., & Garenne, M. L. (2007). Research into health, population, and social transitions in rural South Africa: Data and methods of the Agincourt Health and Demographic Surveillance System. *Scandinavian Journal of Public Health.* Supplement, 69, 8-20. https://doi.org/10.1080/14034950701505031

Kamkwalala, A., & Newhouse, P. (2017). Mechanisms of cognitive aging in the HIV-positive adult. *Current Behavioral Neuroscience Reports, 4*(3), 188-197. https://doi.org/10.1007/s40473-017-0122-9

Langa, K.M. (2018, June 26). Cognitive aging, dementia, and the future of an aging population. In: National Academies of Sciences, Engineering, and Medicine; Division of Behavioral and Social Sciences and Education; *Future Directions for the Demography of Aging: Proceedings of a Workshop*. Washington (DC): National Academies Press (US).

McGrath, E. R., Beiser, A. S., DeCarli, C., Plourde, K. L., Vasan, R. S., Greenberg, S. M., & Seshadri, S. (2017). Blood pressure from mid-to-late life and risk of incident dementia. *Neurology, 89*(24), 2447-2454. https://doi.org/10.1212/WNL.0000000000004741

Murman D. L. (2015). The Impact of age on cognition. *Seminars in Hearing, 36*(3), 111-121. https://doi.org/10.1055/s-0035-1555115

Navarro, J. J., García-Rubio, J., & Olivares, P. R. (2015). The relative age effect and its influence on academic performance. *PLOS ONE, 10*(10). https://doi.org/10.1371/journal.pone.0141895

Peer, M. Salomon, R., Goldberg, I., Blanke, O. & Argy, S. (2015). Brain system for mental orientation in space, time, and person. *PNAS, 112*(35), 11072-11077. https://doi.org/10.1073/pnas.1504242112

Qiu, C, Winblad, B, & Fratiglioni, L. (2005). The age-dependent relation of blood pressure to cognitive function and dementia. *The Lancet Neurology*, *4*(8), 487-499. https://doi.org/10.1016/S1474-4422(05)70141-1

Reitz, C., & Luchsinger, J.A. (2007). Relation of blood pressure to cognitive impairment and dementia. *Current Hypertension Reviews*, *3*(3), 166-176. https://doi.org/10.2174/157340207781386747

Salthouse, T.A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*(3), 403-428. https://doi.org/10.1037/0033-295X.103.3.403

Salthouse, T.A. (2004). What and when of cognitive aging. *Current Directions in Psychological Science, 13*(4), 140-144. https://doi.org/10.1111/j.0963-7214.2004.00293.x

Scherr, S. J., & McNeely, J.A. (2008). Biodiversity conservation and agricultural sustainability: towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical Transactions of the Royal Society B, Biological Sciences, 363*(1491), 477-494. https://doi.org/10.1098/rstb.2007.2165

Stern, Y. (2002). What is cognitive reserve? Theory and research application of the reserve concept. *Journal of the International Neuropsychological Society, 8*(3), 448-460. https://doi.org/10.1017/S1355617702813248

Shukla, A. (2021, April 10). Cognition 101: Executive functions, cognitive processes & abilities. Cognition Today. Retrieved from https://cognitiontoday.com/what-is-cognition-executive-functions-and-cognitive-processes/

Zhang, X., Dupre, M. E., Qiu, L., Zhou, W., Zhao, Y., & Gu, D. (2017). Urban-rural differences in the association between access to healthcare and health outcomes among older adults in China. *BMC Geriatrics, 17*(1), 151. https://doi.org/10.1186/s12877-017-0538-9

Zimmer, Z., & Dayton, J. (2005). Older adults in Sub-Saharan Africa living with children and grandchildren. *Population Studies*, *59*(3), 295-312. https://doi.org/10.1080/00324720500212255