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Abstract

This study provides, for the first time, normative data on cognitive functioning and physical performance, health and health behaviors, and diseases from a population-based sample of 244 centenarians and near-centenarians (M age = 100.5 years, range 98-108, 84.8% women, 21.3% African American) from the Georgia Centenarian Study. Data are presented by the four key dimensions of gender, race, residence, and educational attainment. Results illustrate the profound range of functioning in this age group and indicate considerable differences as a function of each dimension. Bivariate models generally suggest that cognitive functioning and physical performance is higher for: men than women; whites than African Americans; community than facility residents; those with more than high school education than those with less than high school education. Multivariate models elaborate that differences in educational attainment generally account for the largest proportion of variance in cognitive functioning and residential status generally accounts for the largest proportion of variance in physical performance measures. Addition of health variables seldom increases variance accounted for in each domain beyond these four dimensions.

Centenarians provide an excellent model for aging by virtue of the fact that they have come very close to reaching the maximum lifespan. They afford an opportunity to examine questions about both normal and pathological components of aging and longevity. Although they represent an ever growing proportion of the older adult population, centenarians remain

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extremely rare. Most publicly available data resources on aging include data from few, if any, centenarians. Even fewer provide information across a wide range of content areas including physical and functional capacity, cognition, and diseases.

Exceptional longevity is a heterogeneous phenotype. Sebatiani and colleagues (2010) recently reported that even the genetics of exceptional longevity are complex. Their genome wide association scan identified 150 single nucleotide polymorphisms (SNPs) which were more common in centenarians than controls. These SNPs could be further clustered into 19 different genotypes. These genotypes, in turn, had different associations with age at death, likelihood of age-associated diseases, and age of disease onset.

To date, we know very little about the extent of heterogeneity in cognitive function, physical performance, health and health behaviors, and diseases among centenarians, particularly in the population-based context and differences across major demographic variables such as gender, race, residential status, and educational attainment. Two previous papers in Experimental Aging Research have included extensive normative data on neuropsychological test performance with stratification by multiple age groups and education (Dore et al., 2007; Au et al., 2004), but neither reported normative data for persons over 100 years of age.

The absence of normative data for the oldest old is related to the fact that measurement of cognitive and functional capacity, health and disease has received scant attention. This is unfortunate because centenarians are at particular risk of functional impairment which results in considerable utilization of health care resources (Krach, DeVaney, DeTurk, & Zink, 1996; Muller, Fahs, & Schechter, 1989; Rock et al., 1996) and is strongly predictive of both institutionalization and mortality (Fried et al., 1998; Inouye et al., 1998; Ogawa, Iwasaki, & Yasumura, 1993; Sonn, 1996; Worrall, Chaulk, & Briffett, 1996). Status on cognitive and physical functioning measures remains poorly documented with this age group but is of critical importance in maintaining a satisfactory quality of life in exceptional longevity. Knowledge of critical factors affecting everyday functioning can permit development of effective interventions which capitalize on or enhance retained abilities, facilitating recovery, maintenance, or improvement of functional capacity (e.g., Fortinsky, Covinsky, Palmer, & Landefeld, 1999). Earlier research with centenarians has often been limited to small sample sizes or subsets of the population such as those with intact cognition or male veterans (e.g., Evert et al., 2003; Gondo et al., 2006; Holtsberg et al., 1995; Selim et al., 2005; Silver et al., 2001). Consequently, we present normative data for cognitive and physical performance measures gathered in the Georgia Centenarian Study in order to expand the age groups for which norms on neuropsychological test scores, functional abilities, and disease comorbidities are available. Growth in the centenarian population has also been staggering. In 2000, there were an estimated 50,454 centenarians in the US, representing approximately one in 5,000 members of their birth cohort, but this number is projected to rise to well over 800,000 by 2050 (Krach & Velkoff, 1999), making normative data of vital importance.

Projections from Vaupel and colleagues (Christensen et al., 2009) suggest that fully half of all children born in industrialized nations today can expect to live until their 100th birthday. The current study provides much needed normative data for centenarians and serves to highlight the continued importance of differences along the axes of gender, race, residence, and educational attainment. More importantly, it suggests that centenarians have considerable levels of physical and cognitive limitations, and often survive to these ages despite substantial burden of disease.

Methods

Sample

Centenarians and near centenarians (age 98 and older) were recruited from a 44-county area of northern Georgia using a sampling plan with two components. The first called for a census of all skilled nursing facilities (SNFs) and personal care homes (PCHs) located in the 44-county area and for the identification of all residents of a sample of those facilities who are age 98 and older. The second component relied on lists of registered voters, again across the entire 44-county area, and using the date-of-birth information contained on those lists to identify individuals who were age 98 and older. There was some overlap between these components (that is, some residents of SNFs and PCHs were also found on voter registration lists), but the voter registration lists contained a much higher proportion of the non-institutionalized than of the institutionalized.

To achieve control over the number of participants and maximize the proportion of respondents who were over age 100, the 44 counties were divided into four strata, defined to be mostly contiguous and with approximately the same number of centenarians according to the 2000 census population enumeration. The target population for each of the four strata was defined as persons residing within the geographic boundaries of the stratum who were age 98 or older by the beginning of the field period for that stratum which were spaced approximately 6 months apart. Some parameters of this design such as sampling fractions were intentionally left flexible to permit modifications to be made over the data collection period to allow the targeted sample sizes to be achieved while maintaining control over costs.

Lists were generated of SNFs and PCHs in each of the 44 counties and of the number of beds in each of those facilities. Interviewers called each of the selected facilities, explained the study, and requested the names of all centenarians and (if called for by the sample specifications) near-centenarians currently residing in that facility. To implement the second component of the sample design, we listed all centenarians and near-centenarians (that is, all individuals who had their 98th birthday on or before the date of the start of data collection in a given stratum), who were on the voter registration file and whose address indicated that they resided in one of the counties in that stratum. Overall, we succeeded in identifying and recruiting 244 of the estimated 1244 (19%) of all centenarians living within the 44 county region. Comparison with special census tabulations indicated that, barring some minor differences, our sample appeared broadly representative of the characteristics of centenarians within this region (see Arnold et al., 2010 and Poon et al., 2007 for further details).

Procedures

The comprehensive nature of this study required that a data collection team meet centenarians at their place of residence. To keep the testing burden to a minimum, data collection was divided into four sessions, each of which could be completed within two hours.

Measures

Demographic Variables

Data were compared across the major demographic variables of gender (men, n = 37; women, n = 207), race (white, n = 192; African American, n = 52), residence (community, n = 91; skilled nursing facility or personal care home, n = 153), and educational attainment (less than high school, n = 84; some high school, n = 31; high school graduate, n = 59; more than high school, n = 63, and n = 7 unknown).

Cognitive Functioning

Tests and assessments were designed to capture the wide range of cognitive functioning that was expected in this group and to include measures which would be valid for individuals with sensory impairment. Measures included the Mini-Mental State Examination (MMSE) (Folstein et al., 1975), Global Deterioration Scale (Reisberg et al., 1982), Severe Impairment Battery (Saxton et al., 1990), Fuld Object Memory Evaluation (FOME, Fuld 1981), Wechsler Adult Intelligence Scale-III, Similarities sub-test (Wechsler, 1997), Finger Tapping (Reitan & Wolfson, 1993), Behavioral Dyscontrol Scale (DBS, Grigsby et al., 1992), ILS Health and Safety Scale (Loeb, 1992), and Controlled Oral Word Association Test (Benton & Hamsher, 1997).

Physical Performance

Grip strength was assessed using the Jamar (Detecto, Jackson, MI) hand grip dynamometer. Peak force was recorded to the nearest tenth kilogram (0.1 kg) for each hand. Analyses use the average peak value across both hands (average values correlated $r > .97$ with values obtained from each hand). Knee extensor strength was tested using a manual muscle manometer (Nichols, Lafayette, IN). Peak force to the nearest tenth kilogram (0.1 kg) was calculated for each leg. Analyses use the average peak value across both legs (average values correlated $r > .98$ with values obtained from each leg).

Physical functional capacity was measured with the NIA Short Physical Performance Battery (SPPB, Guralnik,1994) and Physical Performance and Mobility Examination (PPME, Winograd et al., 1994). A performance-based measure included selected subtests of the Direct Assessment of Functional Status-Revised (DAFS-R, Loewenstein 1989) measuring basic (BADL) and instrumental (IADL) activities of daily living. Self-reported BADLs and IADLs were also assessed using the OARS (Fillenbaum, 1988).

Health and Health Habits

The Mini Nutritional Assessment was used to assess risk factors related to poor nutritional status such as physical and mental health, anthropometrics, and food intake (Guigoz et al., 1996). The original scale was adapted to impute from other data sources information related to neuropsychological problems, psychological stress and acute disease. Original summary score ranges from 0 to 30, but our scale had a maximum of 28 because individuals were not asked to provide a self-report of their nutritional status (2 points).

Current height and weight were measured with a scale and stadiometer, recorded from the medical chart, or from self or proxy report as possible for the participant and used to calculate body mass index (BMI) in kg/m^2. National Heart, Lung, and Blood Institute (1998) criteria were further used to define under weight ($< 18.5\ kg/m^2$), normal weight ($18.5\text{-}24.9\ kg/m^2$), overweight ($25\text{-}29.9\ kg/m^2$), and obese ($\geq 30\ kg/m^2$).

Non-fasting blood samples were collected. Plasma vitamin B12 was measured by Quantaphase II Vitamin B12/Folate Radioassay (Bio-Rad, Richmond, CA; Johnson et al., 2010). Serum total homocysteine was analyzed by capillary gas chromatography-mass spectrometry (Stabler et al., 1988; Allen et al., 1993; Johnson et al., 2010). Systolic and diastolic blood pressure measures were obtained once with a brachial cuff and used to calculate pulse pressure (systolic BP - diastolic BP) in either sitting ($n = 215$) or reclining ($n = 26$) as possible for the participant; there were no differences in values as a function of posture. History of tobacco and alcohol use was also assessed.

Lifetime Prevalence of Reported Diseases

A physical examination included questions about the diagnoses of numerous classifications of diseases across a variety of organ systems including depression, cardiovascular disease, psychiatric illness, cancer, neurological disorders, kidney disease, osteoporosis, diabetes, hypertension and stroke. Multiple sources could be consulted to obtain this information from the best available source or sources. These included self-report, proxy report, health care professionals, and medical records.

Statistical Analysis Plan

Analyses were conducted using Fisher's exact test, Kruskal-Wallis rank tests, t-tests (homogenous or heterogeneous variances, as appropriate), one-way analyses of variance (Sidak post-hoc comparisons for significant omnibus tests), factorial ANOVAs, ANCOVAs, and correlations as appropriate to question, level of measurement, and assumptions. Tests used for each analysis are indicated in each table of results.

Results

Results are presented separately according to four dimensions: gender (men, women), race (white, African American), residence (community, facility), and educational attainment (less than high school, some high school, high school graduate, more than high school). Bivariate analyses are followed by a summary of the factorial ANOVAS and multiple regression models. Bivariate correlations between cognitive and physical performance measures across each demographic dimension are presented in the Appendix.

Comparison of GCS Sample with Nationally Representative Data

Table 1 compares the age distributions of the GCS sample with the Health and Retirement Study / Aging and Health Dynamics among the Oldest Old (HRS/AHEAD, N = 30,888, taken at their oldest age of interview), and National Long-Term Care Survey 2004 (NLTCS, N = 20,474, including an oversample of those 95+) and presents characteristics of the GCS sample along dimensions of gender, race, residential status, and educational attainment. As can be seen, the GCS has data from more individuals than the HRS/AHEAD and NLTCS at all ages between 99 and 106. It compares favorably in terms of mean age of the sample, proportion of women, and has the largest proportion of African Americans of the three data sources.

Gender

Results comparing men and women are presented in Table 2. Men showed better cognitive function on the MMSE, GDRS, FOME recognition and retention, on the SIB, and MNA. Men also showed better physical performance in terms of grip strength, leg extension strength, OARS BADLs, DAFS BADLs and IADLs, and the PPME. With regard to health and health habits, men were more likely than women to be former or current smokers and to report former and current alcohol use. Differences in lifetime disease categories were such that women were more likely than men to report depression, psychiatric illness, and osteoporosis whereas men were more likely to have a neurological disorder.

Race

Results comparing whites and African Americans are presented in Table 3. Whites showed better cognitive functioning than African Americans on the MMSE, GDRS, FOME recall, recognition, and retention, WAIS similarities, COWAT, handtaps, BDS, SIB, ILS, and MNA. Whites also showed better physical performance in terms of grip strength, OARS BADLs, IADLs, DAFS BADLs and IADLs, SPPB, and PPME. With regard to health and health habits, whites had lower diastolic blood pressure than African Americans, African Americans were

more likely to report being former or current smokers, and to be overweight or obese. Differences in lifetime disease categories were such that whites were more likely to report osteoporosis whereas African Americans were more likely to report diabetes, hypertension, and stroke.

Residence

Results comparing individuals living in community and facility settings are presented in Table 4. Community residents showed better cognitive functioning than facility residents on all measures. Community residents also showed better physical performance in terms of grip strength, OARS BADLs and IADLs, DAFS BADLs and IADLs, the SPPB and PPME. With regard to health and health habits, community residents had higher systolic blood pressure and were more likely to report current alcohol use whereas facility residents were more likely to report former alcohol use. Differences in lifetime disease categories were such that facility residents were more likely to report depression, psychiatric illness, kidney disease, osteoporosis, and congestive heart failure.

Education

Results comparing individuals by educational attainment are presented in Table 5. Those with less than high school education had significantly poorer cognitive functioning than the other three educational categories on the MMSE, GRDS, FOME retention, SIB, Handtaps, COWAT, and ILS. Those with less than high school education had significantly poorer cognitive functioning than those with either some high school and those with more than high school education on FOME recall and the BDS. Those with less than high school education had significantly lower functioning on the WAIS similarities than the other three educational categories; Those with more than high school education also had significantly higher functioning on the WAIS similarities than those with some high school and those who completed high school. With regard to physical performance, those with less than high school education had significantly lower performance on grip strength, IADLs, and PPME than those with more than high school education. Individuals with less than high school education also had significantly lower scores on the DAFS than those with some high school, high school graduates, and those with more than high school education. There no differences in health and health habits as a function of educational attainment. In terms of disease categories, there was only one significant association such that individuals having either less than high school education or more than high school education were more likely to have diabetes (18% of those with less than high school education and 8% of those with more than high school)

Multifactorial ANOVA

Separate factorial ANOVAs were estimated for each of the cognitive function and physical performance measures, and the significance of each main effect is shown in Table 6. As can be seen, no gender differences remained significant for any of the cognitive measures. In terms of physical performance, gender differences remained significant for grip strength, leg extension strength, and DAFS IADL. Race differences were significant only for the GDRS in terms of cognitive measures and only or DAFS BADL for physical performance. Differences as a function of residential status were much more robust, remaining significant for cognitive functioning in terms of the MMSE, FOME recall, WAIS similarities, and the SIB. In terms of physical performance, residential status differences remained significant for the OARS IADL, DAFS BADL and IADL, SPPB, and PPME. Differences as a function of educational attainment were also quite robust for differences in cognitive functioning, remaining significant for the MMSE< GDRS, FOME recall and retention, WAIS similarities, COWAT, Handtapping, BDS, and SIB. In terms of physical performance, differences by educational attainment remained only for the DAFS IADL.

Contribution of Disease Comorbidity in Cognitive and Functional Measures: R2 Values

Results from a series of multiple regression models in Table 7 provide the proportion of variance accounted for in cognitive functioning and physical performance measures first by each factor separately, all factors together, and all factors with the addition of comorbid disease variables (diabetes mellitus, stroke, coronary artery disease, hypertension, congestive heart failure, current smoker, depression, and obesity, all coded as yes/no). For each, the increment in R2 associated with the inclusion of health characteristics is also provided. Gender accounts for between .1% (COWAT) and 2.3% (FOME recognition) of the variance in cognitive measures and between .5% (OARS BADL) and 12.4% (leg extension strength) of the variance in physical performance measures. Race accounts for between 3.6% (COWAT) and 10.4% (BDS) of the variance in cognitive measures and between .5% (leg extension strength) and 6.5% (DAFS IADL) of the variance in physical performance measures. Residential status accounts for between 4.7% (GDRS) and 12.1% (MMSE) of the variance in cognitive measures and between 1.1% (leg extension strength) and 16.4% (PPME) of the variance in physical performance measures. Educational attainment accounts for between 2.8% (FOME recognition) and 25.1% (WAIS similarities) of the variance in cognitive measures and between 2.4% (OARS IADL) and 13.7% (DAFS IADL) of the variance in physical performance measures. Overall, these four factors account for between 7.8% (FOME recognition) and 32.8% (WAIS similarities) of the variance in cognitive measures and between 7.5% (OARS IADL) and 26.2% (DAFS IADL) of the variance in physical performance measures. Addition of the health variables increased variance accounted for only for FOME recall among the cognitive measures and only for leg extension strength, SPPB, and PPME among physical performance measures.

Discussion

Our objective was to present normative data across dimensions of physical and cognitive performance as well as a range of disease classifications as a function of gender, race, residence, and educational attainment. Overall, our results point to clear and highly consistent differences as a function of these variables, suggesting that differences and disparities observed with younger samples (Au et al., 2004; Dore et al., 2007) are also observed into the second century of life.

Analysis of gender differences point toward better physical and cognitive functioning for male centenarians compared with female centenarians. Where gender differences exist in terms of diseases, the pattern is largely similar, with the exception that male centenarians are more likely to experience neurological disorders than female centenarians, and to report use of alcohol and tobacco, although data such as these may also be subject to considerable under-reporting (Graham, 1986).

With regard to race differences, the pattern is largely similar, with more consistent evidence that white centenarians experience better physical and cognitive functioning than do African Americans. This is true for the small number of diseases for which there are racial differences. Most notably, diabetes and hypertension are much more prevalent among African American than white centenarians (Mokdad et al., 2003). On the other hand, white centenarians are much more likely to have osteoporosis (Looker et al., 1997). Differences in blood pressure are limited to DBP. African Americans are more likely to report past or current smoking than whites (Husten et al., 1997 reported that smoking cessation rates were higher among whites than African Americans), and to be overweight or obese (Mokdad et al., 2003).

Community versus institutional living forms yet another consistent axis that differentiates physical and cognitive functioning and disease among centenarians. As would be expected community-living centenarians reported considerably better physical functioning than their

institutional-living counterparts on nearly every measure and on every cognitive measure administered. Those living in facilities were more likely to have used alcohol in the past, whereas those in the community were more likely to report current alcohol use. Prevalence of disease was also much higher among centenarians living in institutions than in the community, although it is important to recognize that the institutional setting also provides great opportunities for recognition and diagnosis than community residence. There is also considerable potential for confounding effects in the association between disease categories and residential status. The same characteristic (e.g., lack of partner) may be a risk factor for both nursing home placement and depression.

Educational attainment provided the final dimension across which differences were considered. Here, the most consistent differences were found as a function of those with less than high school versus those with more than high school education, followed by those with less than high school education compared with those having at least some high school education. It is important to note, however, that for many domains, individuals who completed high school had lower performance than individuals with at least some high school, although it is not clear why this should be the case. One possibility is that individuals forced to leave high school prior to graduation had different opportunities and experiences than those who graduated but did not continue to college, making them effectively more similar to individuals with education beyond high school. Most studies employ years of formal education as controls, but do not include other proxies for education. It is extremely important to adjust for education and proxies for education when comparing ethnic/racial groups (Aiken-Morgan, Sims, & Whitfield, 2008). The work of Aiken-Morgan et al.(2008) makes it clear that years of formal education is far from a pure or reliable indicator of “true education level,” and that reading ability is a very important control in this respect. These investigators found that magnitude of differences in performance between African American samples and European American samples decreased with adjustment for reading ability, although they were not attenuated. These investigators urge the use of multiple proxy variables for education in studies involving comparisons between African American samples and cognitive performance. It is clear that a much more concerted effort is needed with respect to studies of African American cohorts and other ethnic groups. If this effort is made, cross-sectional designs will generate important hypotheses for further studies, especially the prospective and longitudinal studies that are needed.

Only a single difference was observed in terms of educational attainment and disease, such that prevalence of diabetes was highest among those with the lowest and highest levels of educational attainment. This differs somewhat from previous research with younger samples which has suggested only that low educational attainment is associated with higher risk of diabetes mellitus (Bachman et al., 2003; Steinvil et al., 2008). Although prevalence in the former groups was still more than twice as high as in the second group, this does suggest that clinicians may wish to pay attention to the possibility of diabetes mellitus among this highly educated group which may possess knowledge of appropriate health behaviors but also a surfeit of resources that may lead to diabetes, greater opportunity for business and social activities that involve consumption of enjoyable but non-nutritional and cholesterol lowering food and drink. With regard to diseases and health habits, it may not be sufficient to focus only on those individuals with the lowest levels of education but also on those with greater access to resources.

Multivariate analyses elaborate on these bivariate associations in two key ways. First, they suggest that many of the associations with gender and race can likely be attributable to differences in residential status and / or educational attainment. In multifactorial ANOVAs, all of the cognitive differences associated with gender vanish, leaving differences only in two measures of strength and direct assessment of IADLs. Similarly, race differences are limited to scores on the GDRS as the only cognitive domain and on direct assessment of BADLs for

physical performance. Not surprisingly, the remaining differences are greatest for residential status in terms of physical performance and greatest for educational attainment for cognitive status. Second, adding health variables to our model, generally added little over and above the importance of these four dimensions. This is similar to the findings of an earlier paper on norms for cognitive measures using younger samples (Dore et al., 2007). Overall, our multivariate models generally account for roughly one quarter of the variance in cognitive and physical performance measures (median values .26 and .24, respectively, compared with a median value for cognitive measures of .16 in Dore et al., 2007), suggesting important systematic sources of variation within this sample of centenarians.

It is difficult to over-state the importance of population aging for society, or to fully capture the extent of changes which are occurring as a result of these demographic shifts. It is only recently that living until old age has become a normal and expected aspect of the life-cycle; and, recent demographic research suggests that these changes are likely to continue for the foreseeable future, with critical importance for cognitive functioning, physical performance, health and health behaviors and lifetime history of disease. Using Perls and colleagues' (Evert et al. 2004) classifications of New England Centenarian Study (NECS) centenarians as survivors (onset of chronic disease prior to age 80), delayers (onset of chronic disease after age 80) or escapers (absence of chronic disease), Arnold and colleagues (2010) have found that the modal category is survivor (43%) with only 17% of centenarians reaching this centenarian status as escapers. These proportions are similar to both the NECS study with 19% escapers data and a Danish study of the 1905 birth cohort with 19% escapers (Engberg et al., 2009). Olshansky et al. (2009) suggest that official government projections are even likely to underestimate the extent of population aging in the coming decades because they do not account for likely advances in biomedical technology that can delay the onset and progression of major fatal diseases or perhaps slow the aging process itself.

Similarly, existing assessment tools may not be adequate to capture the full range of cognitive functioning and physical performance in centenarians. Recently, Cress and colleagues (2010) have demonstrated how multiple physical performance indicators can be combined using item response theory methods in order to derive a continuously scaled measure of physical performance that has greater concurrent and predictive (of mortality) validity than existing scales developed for use with younger samples. Further, these methods appear useful with the younger samples as well, providing the possibility of cross-walking measures across samples of different ages or which differ in terms of underlying functioning. The broad range of cognitive measures available in the Georgia Centenarian Study suggests this may be a fruitful future area of inquiry. Similarly, it may be worthwhile to consider the possibility of developing ways to equate measures across the many disparate data sets which include centenarians in order to derive meaningful estimates across pooled samples, or to compare different cohorts of centenarians on cognitive and physical performance measures. Because this sample represents approximately .02% of the members of their birth cohort, it is important to bear in mind that this sample is already highly selected. Selection forces out of the population may diminish as larger proportion of future cohorts reach centenarian status, changing definitions of what is “normal” (i.e., primary aging) as well as what is “normative” (i.e., prevalent) in a sample for which a majority (57%) have scores on the Global Deterioration Rating Scale between 4 and 7, suggesting high rates of cognitive impairment. It might be argued that data for persons 98 years and beyond cannot be described as normal; consequently, we have only presented descriptive data not norms. We counter this argument with three observations. This notion comes from a psychometric tradition, e.g., the Wechsler Adult Intelligence Scale, suggesting that what is true for youth is the norm. Second, norms do not imply a standard that applies to most people. It cannot be argued that surviving into very old age is not normal, or we would not see this phenomenon. Given the large number of persons surviving into their second century of life, it is imperative that the neuropsychologists to be able to compare the

cognitive ability and function with those of their patients and to do so relative to their own age cohort. First and foremost, our normative data are provided for the clinical neuropsychologist, neurologists, psychologists, and health professionals involved in cognitive and functional diagnostics with these exceptional individuals. Finally, we note several limitations in the present study. Although ideal, longitudinal data are difficult to collect with this age group, and fraught with selective attrition. Similarly, many measures appropriate for use with younger samples cannot be used with a large proportion of our sample due to ceiling and floor effects, or because they would have been too taxing in light of all of the other constructs evaluated in this study. Additionally, some variables were obtained, of necessity, by self-report. Centenarians may have limited availability of proxy reporters and self-report may be difficult to obtain due to sensory or cognitive impairments. Finally, we did not have access to measures of premorbid intelligence such as reading ability and so had to rely instead on educational attainment.

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Table 1

Comparison of Georgia Centenarian Study Sample with Health and Retirement Study and National Long-Term Care Survey 2004 by Ages 98+

	N (Column %) by Source		
Age in Years	**GCS**	**HRS/AHEAD (All)**	**NLTCS 2004**
98	29 (11.9)	56 (39.2)	93 (36.8)
99	64 (26.2)	27 (18.9)	55 (21.7)
100	49 (20.1)	24 (16.8)	36 (14.2)
101	38 (15.6)	16 (11.2)	26 (10.3)
102	20 (8.2)	10 (7.0)	19 (7.5)
103	23 (9.4)	3 (2.1)	6 (2.4)
104	10 (4.1)	2 (1.4)	11 (4.3)
105	5 (2.0)	1 (0.7)	2 (0.8)
106	3 (1.2)	2 (1.4)	2 (0.8)
107	0 (0.0)	1 (0.7)	3 (1.2)
108	1 (0.4)	1 (0.7)	0 (0)
109	2 (0.8)	0 (0)	0 (0)
Total	244	143	253
Mdn Age	100	99	99
Mean Age	100.5	99.6	99.7
% Female	84.8	81.1	86.6
% Non-white	21.3	17.5	11.9

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Table 2

Descriptive Statistics by Gender

	Men					Women					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
MMSE[b]	37	18.81	7.75	0	30	207	15.73	8.92	0	30	0.050
GDRS[d]	37	3.51	1.39	1	6	203	4.15	1.72	1	7	0.036
FOME Delayed recall[b]	37	3.32	2.73	0	9	198	2.83	3.13	0	10	0.368
FOME Delayed recognition[b]	37	3.86	2.29	0	8	198	2.85	2.46	0	9	0.021
FOME Retention[b]	37	7.19	3.61	0	10	198	5.68	4.09	0	10	0.038
WAIS Similarities[b]	37	9.14	8.76	0	26	201	6.70	7.85	0	30	0.090
COWAT[b]	37	4.19	4.05	0	17	198	3.91	3.54	0	15	0.666
Handtaps[b]	37	32.93	17.74	0	59	199	27.69	18.14	0	60.5	0.107
Behavior Dyscontrol Scale[b]	37	9.89	6.06	0	19	195	7.95	6.60	0	19	0.100
Severe Impairment Battery[c]	37	85.51	18.85	20	100	203	75.42	30.94	0	100	0.009
Independent Living Scale[b]	37	23.51	11.78	0	39	194	20.53	12.32	0	40	0.175
Mini Nutritional Assessment[b]	32	18.70	2.50	13.5	22	183	17.40	3.00	7	22.5	0.017
Physical Functioning											
Grip strength (kg)[c]	37	18.21	12.65	0	60	206	8.91	9.47	0	52	0.001
Leg strength (kg)[c]	27	12.23	8.46	3.25	35	126	7.18	4.15	1.55	25.8	0.005
OARS BADL[b]	36	11.64	3.67	0	15	177	10.93	4.02	0	15	0.045
OARS IADL[b]	35	9.89	3.34	0	14	177	8.38	4.15	0	14	0.096
DAFS BADL[b]	36	18.56	6.75	0	23	192	16.09	8.32	0	23	0.015
DAFS IADL[b]	37	32.76	16.31	0	58	191	24.72	18.52	0	58	0.034
SPPB[b]	37	2.22	3.42	0	6	207	2.09	2.64	0	6	0.835
PPME[b]	35	2.17	2.66	0	9	203	1.31	2.12	0	10	0.034
Health and Health Habits											
Systolic blood pressure[b]	37	129.68	14.60	110	170	204	127.40	15.58	90	190	0.410
Diastolic blood pressure[b]	37	73.76	9.91	58	100	204	73.79	9.24	38	100	0.982

	Men					Women					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Pulse pressure[b]	37	55.92	12.44	34	80	204	53.60	15.76	24	110	0.398
Homocysteine (μmol/L)[b]	36	15.52	7.15	8	41.10	189	14.12	6.57	5.7	72.3	0.248
Vitamin B12 (pmol/L)[b]	36	359.73	350.20	73.70	1986.22	197	413.88	439.79	73.7	4830.3	0.485
Smoking[a]	37%					204%					
Never smoked		37.83					77.94				
Former smoker		56.75					19.61				
Current smoker		5.40					2.45				0.001
Alcohol[a]	37%					205%					
Never used		43.24					65.37				
Formerly used		29.73					19.02				
Currently uses		27.02					15.61				0.030
BMI (kg/m^2)[c]	36%	23.75	3.38	16.62	35.25	201%	22.41	4.79	13.11	51.87	0.046
Underweight		5.55					19.90				
Optimal weight		66.67					55.72				
Overweight		25.00					18.41				
Obese		2.78					5.97				[a]0.123
Lifetime prevalence of reported diseases											
Depression[a]	37	0.03	0.16	0	1	207	0.16	0.37	0	1	0.037
Cardiovascular disease[a]	37	0.54	0.51	0	1	207	0.66	0.48	0	1	0.195
Psychiatric[a]	37	0.03	0.16	0	1	207	0.21	0.41	0	1	0.005
Cancer[a]	37	0.05	0.23	0	1	207	0.05	0.21	0	1	1.000
Neurological[a]	37	0.11	0.31	0	1	207	0.03	0.17	0	1	0.048
Kidney disease[a]	37	0.11	0.31	0	1	207	0.03	0.18	0	1	0.067
Osteoporosis[a]	37	0.03	0.16	0	1	207	0.28	0.45	0	1	0.001
Diabetes[a]	37	0.08	0.28	0	1	207	0.09	0.28	0	1	1.000
Anxiety[a]	37	0.03	0.16	0	1	207	0.06	0.24	0	1	0.701
Psychosis[a]	37	0.00	0.00	0	0	207	0.03	0.17	0	1	0.595

	Men					Women					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Hypertension[a]	37	0.32	0.47	0	1	207	0.47	0.50	0	1	0.108
Stroke[a]	37	0.03	0.16	0	1	207	0.00	0.07	0	1	0.281
Coronary artery disease[a]	37	0.00	0.00	0	0	207	0.02	0.14	0	1	1.000
Congestive heart failure[a]	37	0.19	0.40	0	1	207	0.15	0.36	0	1	0.627
Peripheral artery disease[a]	37	0.16	0.37	0	1	207	0.20	0.40	0	1	0.659
Cardiomegaly[a]	37	0.00	0.00	0	0	207	0.00	0.07	0	1	1.000
Cardiac symptoms[a]	37	0.05	0.23	0	1	207	0.06	0.24	0	1	1.000

[a] Fisher's Exact

[b] t-test with equal variances

[c] t-test with unequal variances

[d] Kruskal-Wallis

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Table 3

Descriptive Statistics by Race

	White					African American					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
MMSE[b]	192	17.4	8.38	0	30	52	11.77	9.01	0	30	0.001
GDRS[d]	188	3.78	1.64	1	7	52	5.02	1.49	2	7	0.001
FOME Delayed recall[b]	184	3.11	3.11	0	10	51	2.18	2.85	0	9	0.055
FOME Delayed recognition[b]	184	3.26	2.44	0	9	51	2.12	2.35	0	8	0.003
FOME Retention[b]	184	6.37	3.89	0	10	51	4.29	4.23	0	10	0.001
WAIS Similarities[c]	186	8.23	8.30	0	30	52	2.96	5.26	0	25	0.001
COWAT[b]	183	4.32	3.66	0	17	52	2.67	3.15	0	10	0.004
Handtaps[b]	184	30.85	17.32	0	60.5	52	20.23	18.74	0	59	0.001
Behavior Dyscontrol Scale[b]	181	9.38	6.39	0	19	51	4.29	5.47	0	17	0.001
Severe Impairment Battery[d]	188	80.91	26.11	0	100	52	62.75	36.65	0	100	0.001
Independent Living Scale[b]	182	22.55	11.68	0	40	49	15.27	12.77	0	36	0.001
Mini Nutritional Assessment[b]	173	17.70	2.80	9.5	22.5	42	17.20	3.30	7	22	0.329
Physical Functioning											
Grip strength (kg)[b]	191	11.09	10.80	0	60	52	7.50	9.05	0	40	0.029
Leg strength (kg)[c]	131	8.23	5.77	1.55	35	22	7.17	3.32	1.7	14.2	0.230
OARS BADL[c]	168	11.57	3.35	0	15	45	9.11	5.31	0	15	0.005
OARS IADL[c]	168	8.98	3.78	0	14	44	7.30	4.82	0	14	0.034
DAFS BADL[c]	179	17.50	7.37	0	23	49	12.76	9.65	0	23	0.002
DAFS IADL[b]	178	28.51	18.00	0	58	50	17.20	17.16	0	58	0.001
SPPB[c]	192	2.32	2.68	0	6	52	1.33	2.94	0	6	0.020
PPME[b]	188	1.60	2.38	0	10	50	0.84	1.40	0	6	0.005

	White					African American					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Health and Health Habits											
Systolic blood pressure[c]	190	126.82	14.54	90	180	51	131.22	18.09	90	190	0.110
Diastolic blood pressure[b]	190	72.95	8.99	38	100	51	76.92	9.97	60	100	0.001
Pulse Pressure[b]	190	53.87	15.42	25	110	51	54.29	14.97	24	100	0.860
Homocysteine (μmol/L)[c]	182	14.31	7.06	5.7	72.3	43	14.49	4.75	6.6	24.9	0.840
Vitamin B12 (pmol/L)[c]	187	401.93	458.83	73.7	4830.3	46	420.06	263.33	73.7	1288.28	0.720
Smoking[a]	192%					49%					
Never smoked		74.48					61.22				
Former smoker		23.96					30.61				
Current smoker		1.56					8.16				0.025
Alcohol[a]	191 %					51%					
Never used		59.69					70.59				
Formerly used		20.42					21.57				
Currently uses		19.90					7.84				0.123
BMI (kg/m^2)[c]	187%	22.16	3.97	13.11	34.96	50%	24.33	6.28	14.65	51.87	0.024
Underweight		18.72					14.00				
Optimal weight		60.96					44.00				
Overweight		17.11					28.00				
Obese		3.21					14.00				[a]0.007
Lifetime prevalence of reported diseases											
Depression[a]	192	0.15	0.36	0	1	52	0.10	0.30	0	1	0.373
Cardiovascular disease[a]	192	0.61	0.49	0	1	52	0.75	0.44	0	1	0.073
Psychiatric[a]	192	0.18	0.39	0	1	52	0.17	0.38	0	1	1.000
Cancer[a]	192	0.06	0.23	0	1	52	0.02	0.14	0	1	0.470
Neurological[a]	192	0.04	0.19	0	1	52	0.06	0.24	0	1	0.448
Kidney disease[a]	192	0.04	0.19	0	1	52	0.08	0.27	0	1	0.254

	White					African American					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Osteoporosis[a]	192	0.28	0.45	0	1	52	0.08	0.27	0	1	0.002
Diabetes[a]	192	0.06	0.23	0	1	52	0.19	0.40	0	1	0.004
Anxiety[a]	192	0.07	0.25	0	1	52	0.02	0.14	0	1	0.312
Psychosis[a]	192	0.02	0.12	0	1	52	0.06	0.24	0	1	0.113
Hypertension[a]	192	0.41	0.49	0	1	52	0.62	0.49	0	1	0.008
Stroke[a]	192	0.00	0.00	0	0	52	0.04	0.19	0	1	0.045
Coronary artery disease[a]	192	0.02	0.12	0	1	52	0.02	0.14	0	1	1.000
Congestive heart failure[a]	192	0.18	0.38	0	1	52	0.10	0.30	0	1	0.202
Peripheral artery disease[a]	192	0.18	0.39	0	1	52	0.25	0.44	0	1	0.325
Cardiomegaly[a]	192	0.01	0.07	0	1	52	0.00	0.00	0	0	1.000
Cardiac symptoms[a]	192	0.07	0.25	0	1	52	0.04	0.19	0	1	0.744

[a] Fisher's Exact

[b] t-test with equal variances

[c] t-test with unequal variances

[d] Kruskal-Wallis

Table 4

Descriptive Statistics by Residential Status

	Facility Resident					Non-Facility Resident					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
MMSE[c]	153	13.84	8.92	0	30	91	20.16	7.06	0	30	0.001
GDRS[d]	150	4.33	1.73	1	7	90	3.58	1.49	1	7	0.001
FOME Delayed recall[b]	145	2.14	2.78	0	10	90	4.14	3.13	0	10	0.001
FOME Delayed recognition[c]	145	2.72	2.61	0	9	90	3.48	2.13	0	9	0.017
FOME Retention[c]	145	4.86	4.15	0	10	90	7.62	3.25	0	10	0.001
WAIS Similarities[b]	148	5.20	7.22	0	30	90	10.17	8.37	0	29	0.001
COWAT[b]	147	3.33	3.42	0	17	88	5.00	3.71	0	14	0.001
Handtaps[c]	89	36.03	14.81	0	59	147	23.96	18.50	0	60.5	0.001
Behavior Dyscontrol Scale[b]	143	7.06	6.52	0	19	89	10.19	6.13	0	19	0.001
Severe Impairment Battery[c]	149	69.63	32.67	0	100	91	89.01	18.31	0	100	0.001
Independent Living Scale[b]	143	17.88	12.26	0	40	88	26.08	10.49	0	39	0.001
Mini Nutritional Assessment[b]	137	16.90	2.70	7	22.5	78	18.70	3.00	11	21	0.001
Physical Functioning											
Grip strength (kg)[b]	152	8.41	10.58	0	45	91	13.52	9.72	0	60	0.001
Leg strength (kg)[b]	72	7.45	4.96	1.55	35	81	8.62	5.89	1.65	25.8	0.189
OARS BADL[c]	86	12.00	3.31	0	15	127	10.40	4.24	0	15	0.002
OARS IADL[c]	88	9.43	3.53	0	14	124	8.06	4.32	0	14	0.012
DAFS BADL[c]	86	19.42	5.86	0	23	142	14.70	8.79	0	23	0.001
DAFS IADL[b]	86	34.10	17.01	0	58	142	21.13	17.49	0	58	0.001
SPPB[c]	153	1.29	2.89	0	6	91	3.49	1.86	0	6	0.001
PPME[b]	147	0.73	1.60	0	10	91	2.57	2.60	0	9	0.001
Health and health habits											
Systolic blood pressure[c]	151	125.99	12.85	100	180	90	130.70	18.69	90	190	0.030
Diastolic blood pressurc[b]	151	73.84	8.55	38	97	90	73.70	10.55	58	100	0.951

	Facility Resident					Non-Facility Resident					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Pulse Pressure[c]	151	52.15	14.01	25	110	90	57.00	16.88	24	102	0.860
Homocysteine (μmol/L)[c]	140	14.10	5.25	5.7	41.1	85	14.74	8.53	6.4	72.3	0.530
Vitamin B12 (pmol/L)[c]	142	394.78	305.94	73.7	2587.31	91	422.25	568.16	73.7	4830.3	0.670
Smoking[a]	150%					91%					
Never smoked		71.33					72.53				
Former smoker		26.67					23.08				
Current smoker		2.00					4.40				0.530
Alcohol[a]	151%					91%					
Never used		63.58					59.00				
Formerly used		25.17					13.19				
Currently uses		11.26					27.47				0.002
BMI (kg/m^2)[c]	151%	22.22	4.82	13.11	51.87	86%	23.31	4.20	14.65	33.66	0.080
Underweight		19.87					13.95				
Optimal weight		59.60					53.49				
Overweight		15.89					25.58				
Obese		4.64					6.98				[a]0.197
Lifetime prevalence of reported diseases											
Depression[a]	153	0.20	0.40	0	1	91	0.03	0.18	0	1	0.001
Cardiovascular disease[a]	153	0.64	0.48	0	1	91	0.64	0.48	0	1	1.000
Psychiatric[a]	153	0.25	0.44	0	1	91	0.05	0.23	0	1	0.001
Cancer[a]	153	0.05	0.22	0	1	91	0.04	0.21	0	1	1.000
Neurological[a]	153	0.07	0.25	0	1	91	0.00	0.00	0	0	0.015
Kidney disease[a]	153	0.07	0.25	0	1	91	0.01	0.10	0	1	0.057
Osteoporosis[a]	153	0.30	0.46	0	1	91	0.13	0.34	0	1	0.003
Diabetes[a]	153	0.10	0.31	0	1	91	0.05	0.23	0	1	0.240
Anxiety[a]	153	0.07	0.26	0	1	91	0.03	0.18	0	1	0.263
Psychosis[a]	153	0.04	0.19	0	1	91	0.00	0.00	0	0	0.087

	Facility Resident					Non-Facility Resident					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Hypertension[a]	153	0.44	0.50	0	1	91	0.47	0.50	0	1	0.690
Stroke[a]	153	0.01	0.11	0	1	91	0.00	0.00	0	0	0.530
Coronary artery disease[a]	153	0.03	0.16	0	1	91	0.00	0.00	0	0	0.300
Congestive heart failure[a]	153	0.21	0.41	0	1	91	0.08	0.27	0	1	0.006
Peripheral artery disease[a]	153	0.16	0.37	0	1	91	0.25	0.44	0	1	0.098
Cardiomegaly[a]	153	0.00	0.00	0	0	91	0.01	0.10	0	1	0.373
Cardiac symptoms[a]	153	0.07	0.26	0	1	91	0.04	0.21	0	1	0.426

[a] Fisher's Exact

[b] t-test with equal variances

[c] t-test with unequal variances

[d] Kruskal-Wallis

Table 5

Descriptive Statistics by Educational Attainment

	0 to 8					9 to 11					12					13+				
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
MMSE[b]	84	12.19	8.99	0	28	31	18.55	7.58	0	29	59	17.53	7.76	0	30	63	20.38	7.12	0	30	0.001
GDRS[c]	82	4.80	1.61	1	7	31	3.55	1.50	1	7	58	3.83	1.59	1	7	62	3.29	1.48	1	6	0.001
FOME Delayed recall[b]	80	1.98	2.66	0	10	29	4.21	2.97	0	10	57	2.89	2.90	0	10	62	3.84	3.39	0	10	0.001
FOME Delayed recognition[b]	80	2.58	2.71	0	9	29	3.10	2.11	0	7	57	3.53	2.40	0	8	62	3.39	2.18	0	9	0.098
FOME Retention[b]	80	4.55	4.29	0	10	29	7.31	3.11	0	10	57	6.42	3.87	0	10	62	7.23	3.43	0	10	0.001
WAIS Similarities[b]	83	2.94	4.72	0	20	30	7.40	7.29	0	27	56	7.07	6.54	0	26	62	13.23	9.47	0	30	0.001
COWAT[b]	82	2.20	2.80	0	10	30	4.83	3.20	0	14	54	4.56	3.14	0	12	62	5.74	4.07	0	17	0.001
Handtaps[b]	82	21.98	19.38	0	54.5	30	34.03	16.28	0	60.5	55	32.66	14.26	0	59	62	33.39	16.55	0	57.5	0.001
Behavior Dyscontrol Scale[b]	79	5.72	5.86	0	19	30	10.74	6.07	0	19	54	8.27	6.26	0	19	62	11.04	6.37	0	19	0.001
Severe Impairment Battery[b]	84	63.14	35.24	0	100	30	85.84	24.59	0	100	57	84.18	18.21	2	99	62	89.48	18.21	12.49	100	0.001
Independent Living Scale[b]	80	15.08	12.22	0	39	30	24.30	11.95	0	40	54	23.31	9.32	0	36	61	26.72	10.56	0	40	0.001
Mini Nutritional Assessment[b]	74	17.10	2.90	7	22	30	18.00	2.50	13	22	50	17.90	3.00	11	22.5	55	17.90	3.00	9.5	22	0.322
Physical Functioning																					
Grip strength (kg)[b]	84	8.88	10.61	0	52	31	9.77	7.32	0	27	58	9.80	9.07	0	34	63	14.10	12.35	0	60	0.021
Leg strength (kg)[b]	44	8.58	6.81	1.7	35	22	9.66	6.85	2.4	25.8	38	6.79	3.36	1.65	13.55	48	7.93	4.72	1.55	23.15	0.232
OARS BADL[b]	70	9.91	4.95	0	15	27	11.56	3.36	0	15	53	11.64	3.27	2	15	59	11.76	2.97	0	15	0.023
OADS IADL[b]	69	7.86	4.56	0	14	28	9.07	3.82	0	14	51	9.25	3.60	0	14	60	9.13	3.63	0	14	0.173
DAFS BADL[b]	78	14.06	9.19	0	23	29	19.66	6.91	0	23	53	17.30	6.88	0	23	61	18.85	5.91	0	23	0.001
DAFS IADL[b]	79	18.04	16.80	0	58	30	32.07	16.92	0	55	53	28.75	17.53	0	56	59	33.76	16.93	0	58	0.001
SPPB[b]	82	0.96	1.78	0	8	30	2.00	2.67	0	9	57	1.54	2.37	0	10	62	1.85	2.37	0	8	0.051
PPME[b]	82	1.94	2.16	0	6	30	2.67	2.25	0	6	57	2.44	2.20	0	6	62	3.02	1.95	0	6	0.026
Health and Health Habits																					
Systolic blood pressure[b]	84	129.13	15.94	90	190	31	124.68	14.58	98	180	58	126.66	15.34	90	170	62	128.31	15.65	90	165	0.520
Diastolic blood pressure[b]	84	74.45	8.73	46	100	31	73.06	7.81	58	90	58	74.10	10.38	58	100	62	72.94	10.04	38	100	0.760

	0 to 8					9 to 11					12					13+					
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Pulse Pressure[b]	84	54.68	14.72	24	102	31	51.61	14.63	34	110	58	52.55	15.74	25	95	62	55.37	16.23	30	96	0.590
Homocysteine (μmol/L)[b]	77	14.04	5.34	5.7	41.1	28	14.55	6.91	6.5	40.8	55	14.56	5.20	7.5	34.3	59	14.32	9.02	6.4	72.3	0.970
Vitamin B12 (pmol/L)[b]	78	382.67	244.88	73.7	1288.28	29	326.82	196.72	73.7	995.54	58	487.01	729.27	73.7	4830.3	62	381.45	279.78	73.7	1986.22	0.320
Smoking[a]	82%					31%					59%					63%					
Never smoked		63.41					77.42					81.36					74.60				
Former smoker		30.49					19.35					16.95					25.40				
Current smoker		6.10					3.23					1.69					0.00				0.141
Alcohol[a]	83%					31%					59%					63%					
Never used		66.27					51.61					66.10					53.97				
Formerly used		22.89					25.81					16.95					20.63				
Currently uses		10.84					22.58					16.95					25.40				0.227
BMI (kg/m^2)[b]	81%	23.34	5.57	13.98	51.87	31%	22.66	3.93	15.55	33.66	57%	22.64	4.79	13.11	34.96	61%	21.84	3.34	15.23	30.5	0.308
Underweight		17.28					16.13					19.30					18.03				
Optimal weight		46.91					61.29					52.63					70.49				
Overweight		27.16					19.35					21.05					9.84				
Obese		8.64					3.23					7.02					1.64				[a]0.163
Lifetime prevalence of reported diseases																					
Depression[a]	84	0.15	0.36	0	1	31	0.03	0.18	0	1	59	0.19	0.39	0	1	63	0.11	0.32	0	1	0.180
Cardiovascular disease[a]	84	0.65	0.48	0	1	31	0.71	0.46	0	1	59	0.61	0.49	0	1	63	0.63	0.49	0	1	0.823
Psychiatric[a]	84	0.24	0.43	0	1	31	0.06	0.25	0	1	59	0.19	0.39	0	1	63	0.13	0.34	0	1	0.114
Cancer[a]	84	0.06	0.24	0	1	31	0.03	0.18	0	1	59	0.07	0.25	0	1	63	0.03	0.18	0	1	0.795
Neurological[a]	84	0.06	0.24	0	1	31	0.03	0.18	0	1	59	0.02	0.13	0	1	63	0.02	0.13	0	1	0.520
Kidney disease[a]	84	0.07	0.26	0	1	31	0.06	0.25	0	1	59	0.02	0.13	0	1	63	0.03	0.18	0	1	0.399
Osteoporosis[a]	84	0.25	0.44	0	1	31	0.19	0.40	0	1	59	0.22	0.42	0	1	63	0.29	0.46	0	1	0.768
Diabetes[a]	84	0.18	0.39	0	1	31	0.03	0.18	0	1	59	0.00	0.00	0	0	63	0.08	0.27	0	1	0.001
Anxiety[a]	84	0.06	0.24	0	1	31	0.06	0.25	0	1	59	0.05	0.22	0	1	63	0.06	0.25	0	1	1.000
Psychosis[a]	84	0.05	0.21	0	1	31	0.00	0.00	0	0	59	0.00	0.00	0	0	63	0.02	0.13	0	1	0.305

	0 to 8					9 to 11					12					13+				
Cognitive Functioning	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**N**	**M**	**SD**	**Min**	**Max**	**p-value**
Hypertension[a]	84	0.46	0.50	0	1	31	0.48	0.51	0	1	59	0.47	0.50	0	1	63	0.43	0.50	0	1	0.948
Stroke[a]	84	0.02	0.15	0	1	31	0.00	0.00	0	0	59	0.00	0.00	0	0	63	0.00	0.00	0	0	0.501
Coronary artery disease[a]	84	0.04	0.19	0	1	31	0.03	0.18	0	1	59	0.00	0.00	0	0	63	0.00	0.00	0	0	0.203
Congestive heart failure[a]	84	0.19	0.40	0	1	31	0.19	0.40	0	1	59	0.19	0.39	0	1	63	0.08	0.27	0	1	0.203
Peripheral artery disease[a]	84	0.20	0.40	0	1	31	0.26	0.44	0	1	59	0.15	0.36	0	1	63	0.19	0.40	0	1	0.671
Cardiomegaly[a]	84	0.00	0.00	0	0	31	0.00	0.00	0	0	59	0.00	0.00	0	0	63	0.02	0.13	0	1	0.646
Cardiac symptoms[a]	84	0.06	0.24	0	1	31	0.13	0.34	0	1	59	0.07	0.25	0	1	63	0.03	0.18	0	1	0.349

[a] Fisher's Exact

[b] ANOVA

[c] Kruskal-Wallis

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Table 6

Summary of Significant Main Effects from the ANOVA Analysis

Variable	Gender	Race	Residence	Education
		Cognitive Functioning		
MMSE			**	***
GDRS		*		**
FOME Delayed recall			*	*
FOME Delayed recognition				
FOME Retention				*
WAIS Similarities			*	***
COWAT				***
Handtaps				*
Behavior Dyscontrol Scale				*
Severe Impairment Battery			*	*
		Physical Performance		
Grip strength (kg)	***			
Leg strength (kg)	*			
OARS BADL				
OARS IADL			**	
DAFS BADL		*	*	
DAFS IADL	*		**	**
SPPB			***	
PPME			***	

Note. Gender, race, residential status, and educational attainment were controlled for each other and the two-, three-, and four-way interactions.

* $p < .05$;

** $p < .01$;

*** $p < .001$.

Table 7

Proportion of Variance (R^2) in the Cognitive Test Measures Accounted for by Gender, Race, Residential Status, and Educational Attainment, Separately and Together, and Improvement in Prediction with Addition of Health Variables and Depression

Variable	Gender	Race	Residence	Education	G+R+R+E	G+R+R+E+H	ΔR^2
				Cognitive Functioning			
MMSE	0.016*	0.069***	0.121***	0.152***	0.268***	0.306***	0.038
GDRS	0.019*	0.092***	0.047***	0.143***	0.216***	0.259***	0.043
FOME Delayed Recall	0.003	0.016	0.101***	0.079***	0.163***	0.259***	0.096**
FOME Delayed Recognition	0.023*	0.037**	0.022*	0.028	0.078**	0.113*	0.034
FOME Retention	0.018*	0.045***	0.110***	0.089***	0.198***	0.265***	0.067
WAIS Similarities	0.012	0.074***	0.090***	0.251***	0.328**	0.367**	0.039
COWAT	0.001	0.036**	0.050***	0.166***	0.194***	0.253***	0.059
Handtaps	0.011	0.059***	0.104***	0.093***	0.202***	0.263***	0.061
Behavior Dyscontrol Scale	0.012	0.104***	0.055***	0.123***	0.218***	0.280***	0.062
Severe Impairment Battery	0.015	0.064***	0.101***	0.162***	0.252***	0.272***	0.020
				Physical Performance			
Grip strength (kg)	0.101***	0.020*	0.055***	0.041*	0.176***	0.228***	0.052
Leg strength (kg)	0.124***	0.005	0.011	0.028	0.156***	0.255***	0.099*
OARS BADL	0.005	0.064***	0.039**	0.045*	0.114***	0.119*	0.004
OARS IADL	0.019*	0.029*	0.028*	0.024	0.075*	0.121*	0.046
DAFS BADL	0.012	0.058***	0.079***	0.081***	0.174***	0.215***	0.041
DAFS IADL	0.026*	0.065***	0.117***	0.137***	0.262***	0.304***	0.042
SPPB	0.019*	0.019*	0.161***	0.034	0.205***	0.268***	0.062*
PPME	0.008	0.024*	0.164***	0.040*	0.203***	0.283***	0.081**

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