Journal of Alzheimer's Disease 95 (2023) 275–285
DOI 10.3233/JAD-230374
IOS Press

Reliability and Validity of Self-Reported Vascular Risk Factors: Hypertension, Diabetes, and Heart Disease, in a Multi-Ethnic Community Based Study of Aging and Dementia

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Accepted 21 June 2023
Pre-press 20 July 2023

Abstract.

Background: Queries for the presence of cardiovascular and cerebrovascular risk factors are typically assessed through self-report. However, the reliability and validity of self-reported cardiovascular and cerebrovascular risk factors remain inconsistent in aging research.

Objective: To determine the reliability and validity of the most frequently self-reported vascular risk factors: hypertension, diabetes, and heart disease.

Methods: 1,870 individuals aged 65 years or older among African Americans, Caribbean Hispanics, and white non-Hispanic individuals were recruited as part of a community study of aging and dementia. We assessed the reliability, validity, sensitivity, specificity, and percent agreement of self-reported hypertension, diabetes, and heart disease, in comparison with direct measures of blood pressure, hemoglobin A1c (HbA1c), and medication use. The analyses were subsequently stratified by age, sex, education, and ethnic group.

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Results: Reliability of self-reported hypertension, diabetes, and heart disease was excellent. Agreement between self-reports and clinical measures was moderate for hypertension (kappa: 0.58), good for diabetes (kappa: 0.76–0.79), and moderate for heart disease (kappa: 0.45) differing slightly by age, sex, education, and ethnic group. Sensitivity and specificity for hypertension was 88.6%–78.1%, for diabetes was 87.7%–92.0% (HbA1c $\geq$6.5%) or 92.7%–92.8% (HbA1c $\geq$7%), and for heart disease was 85.8%–75.5%. Percent agreement of self-reported was 87.0% for hypertension, 91.6%–92.6% for diabetes, and 77.4% for heart disease.

Conclusion: Ascertainment of self-reported histories of hypertension, diabetes, and heart disease are reliable and valid compared to direct measurements or medication use.

Keywords: Alzheimer's disease, diabetes, heart disease, hypertension, reliability and validity, vascular risk factors

INTRODUCTION

Cardiovascular and cerebrovascular risk factors are frequent among elderly adults and their presence is associated with increased risk of Alzheimer's disease [1, 2]. Self-reported questionnaires are often used to gather information about antecedent risk factors, including cardiovascular and cerebrovascular risk, for Alzheimer's disease in observational studies [2, 3] due to convenience and lower cost relative to clinical diagnosis [4]. It is the only feasible way of obtaining information on the disease in the absence of clinical or medical records. However, the reliability, validity, and overall accuracy of self-reports may be affected by the participant's understanding of the diagnosis, willingness to report it, and ability to recall their personal information, which can be of concern among elderly individuals [4]. Well-validated and reliable self-reported information of disease risks is important for understanding the cause of the disease and may provide clues to preventive strategies.

Hypertension, diabetes, and heart disease are major cardiovascular risk factors leading to an increased burden of cardiovascular and cerebrovascular diseases [5, 6] and risk of dementia and Alzheimer's disease [1, 2]. The validity of self-reported information regarding vascular risk factors found in several studies [3, 4, 7–15] was found to be uncertain and highly variable reflecting differences in study population, sociodemographic characteristics, and the use of clinical measurements or treatments. There is also limited information available on the reliability and validity of self-reported hypertension, diabetes, and heart disease among racially and ethnically diverse older adults.

The Washington Heights, Hamilton Heights, Inwood Columbia Aging Project (WHICAP) is a community-based longitudinal study of aging and dementia in elderly individuals living in northern Manhattan [16, 17]. This cohort includes older adults who identify as non-Hispanic Black or African American, Caribbean Hispanic, and non-Hispanic White, and it also provides an opportunity to assess differences by educational level, sex, clinical, and genetic factors in relation to age-related diseases [18]. We previously reported higher prevalence and incidence rates of cerebrovascular disease and dementia among non-Hispanic Black and Hispanic older adults compared to non-Hispanic white individuals in WHICAP [17, 19]. Thus, understanding whether the reliability and validity of self-reported vascular risk factors differs by racial and race/ethnic group is an important objective.

Among older participants in this multi-ethnic community-based WHICAP cohort, the validity of self-reported hypertension, diabetes, and heart disease was investigated using Cohen's kappa, sensitivity, specificity, and percent agreement by comparing participant responses to direct measurements or reviewing disease-specific medications use. We also investigated the reliability of self-reports using longitudinal data, and whether the validity of self-reported hypertension, diabetes, and heart disease differed by age, sex, education, or ethnic group.

METHODS

Participants

Participants were from WHICAP, a community-based longitudinal study of aging and dementia in a multiethnic cohort of individuals aged 65 years or older residing in northern Manhattan [16, 17]. Participants were initially recruited as non-demented by self-report in waves in 1992, 1999, and 2009 using similar sampling strategies, assessments, and study design and procedures [17].

Consent statement

The study was approved by the Institutional Review Boards of Columbia University. All participants provided written informed consent. A detailed description of the study was previously published [16].

Cardio- and cerebrovascular risk factors (vascular risk factors)

At the initial and each follow-up visit, self-reported medical history, self-reported use of disease-specific medications, and physical examinations were recorded. Evaluations were conducted in English or Spanish, based on the language preference of the participant. Self-reported information on hypertension, diabetes, and heart disease was obtained from each participant at last visit by three questions "Have you ever had a hypertension / diabetes / heart disease?" (Ever Had or Never Had).

Clinical measures were also obtained by direct measurement in a subset of the most recent WHICAP participants and from available information obtained at the interviews. For hypertension we used two approaches. First, we used the measurement of blood pressure defined as systolic blood pressure $\geq$140 mmHg, diastolic blood pressure $\geq$90 mmHg [20], based on the World Health Organization guidelines [21]. If no measurement of blood pressure was available, we used information regarding the use of anti-hypertension medications. For diabetes we considered two reference definitions: *definition 1:* measurement of hemoglobin A1C level $\geq$6.5% at last visit or the use of any medications to manage diabetes at the initial or follow-up visits; *definition 2:* hemoglobin A1C level $\geq$7% at last visit or diabetes medication use at the initial or follow-up visits. Cut-points for hemoglobin A1C level were based on the current American Diabetes Association guidelines [22] ($\geq$6.5%) and current Department of Veterans Affairs' recommendations ($\geq$7%) [23, 24]. For heart disease we relied entirely on the use of medications to manage heart disease at the initial or follow-up visits. The use of medications was classified as follows: *Hypertension*: angiotensin-converting enzyme inhibitors, beta-blockers, calcium channel blockers, or diuretics; *Diabetes*: glitazones, insulin, metformin, oral hypoglycemics, or sulfonylurea; *Heart disease*: digitalis or digoxin, anti-anginal agents, nitrates, or other anti-arrhythmics/anginals. The reported use of medications was recorded as "Taken or Not Taken".

Covariates

Information on age at last visit, sex, education, and ethnic group was queried. Years of education was self-reported and ranged from 0 to 20. The determination of ethnic group was self-reported using the 2000 US Census [25] as a guide. We excluded the small number of individuals who did not identify as non-Hispanic Black, Caribbean Hispanic or non-Hispanic white ($n = 24$).

Statistical analyses

Reliability [26, 27] of self-reported hypertension, diabetes, and heart disease was assessed at the individual level for participants with at least two visits by fitting a mixed effects logistic regression model with fixed effects including age, sex, educational level, and ethnicity and a random intercept for each individual using rpt function in R package rptR [26]. We assessed the reliability of each self-reported vascular factor beginning from the first interview at which there was an affirmative response. We also investigated the reliability of self-reported risk factors at the individual level for participants with at least two visits excluding the first negative reports if they later had a positive self-report. The reliability value ranges from 0 to 1 and the value of less than 0.40 was considered poor, 0.40–0.59 as fair, 0.60–0.74 as good, and 0.75–1.00 as excellent reliability.

Validity of self-reported risk factors data was compared to measured hypertension, diabetes and heart disease using Cohen's kappa [28], sensitivity [29], specificity [29], and percent agreement [28]. Cohen's kappa was used to measure the agreement between self-reported and measured risk factor by taking into account the agreement expected to occur by chance. The kappa value ranges from –1 to 1 and the value of less than or equal to 0 was considered no, 0.01–0.40 as poor-to-fair, 0.41–0.60 as moderate, 0.61–0.80 as good, and 0.81–1.00 as excellent agreement [28]. Sensitivity was defined as the proportion of participants who self-reported to ever had a risk factor among those with positive measured risk factor. Specificity was defined as the proportion of participants who self-reported to never had a risk factor in whom we found no evidence of the measured risk factor. False negative rate (1-sensitivity) and false positive rate (1-specificity) were used to examine the proportion of under-reported and over-reported, respectively, for risk factors. Percent agreement was defined as the proportion of all participants with pos-

itive self-report with positive measured risk factor or negative self-report with negative measured risk factor [28]. We compared the percent agreement for hypertension, diabetes, and heart disease.

Stratified analyses of the validity measures for self-reported hypertension, diabetes, and heart disease were subsequently compared across several demographic variables (age, sex, education, and race/ethnic group). Participants were stratified by median age of 80.9 years, younger (65 years $\leq$ age <80.9 years) and older (age $\geq$80.9 years). Participants were categorized into three groups of educational level using cut-points based on the education quartiles of the samples, low (education <6), medium (6 $\leq$ education <12), and high (education $\geq$12 years of education) [30]. Exact method [31–33] was used to compute the confidence intervals. Kappa statistic and its confidence interval were computed using epi.kappa function in R package epiR [34]. Sensitivity and specificity and its confidence intervals were computed using BDtest function in R package bdpv [35]. Difference between two proportions was tested using two-proportions z-test using prop.test function in R package stats [36]. A p-value less than 0.05 was considered significant. The false discovery rate (FDR) of 0.05 was used to correct for multiple testing. All statistical analyses were performed using R [36] version 4.1.3.

Table 1
Participant demographics and clinical characteristics of the study sample

Characteristic	Total Sample (n = 1,870)
Age (y), mean, median (SD)	81.16, 80.9 (7.18)
65 $\leq$ Age <80.9, *n* (%)	847 (45%)
Age $\geq$80.9, *n* (%)	1,023 (55%)
Sex	
Women, *n* (%)	1,212 (65%)
Men, *n* (%)	658 (35%)
Education (y), mean (SD)	9.39 (4.79)
Low: Education <6, *n* (%)	436 (23%)
Medium: 6 $\leq$ Education <12, *n* (%)	616 (33%)
High: Education $\geq$12, *n* (%)	818 (44%)
Race/ethnic group	
Non-Hispanic white, *n* (%)	483 (26%)
African American, *n* (%)	635 (34%)
Caribbean Hispanic, *n* (%)	752 (40%)
Self-reported	
Hypertension, *n* (%)	1459 (78%)
Diabetes, *n* (%)	462 (25%)
Heart disease, *n* (%)	670 (36%)
Measured	
Hypertension, *n* (%)	1573 (84%)
Diabetes (*definition 1*), *n* (%)	405 (22%)
Diabetes (*definition 2*), *n* (%)	386 (21%)
Heart disease, *n* (%)	346 (19%)

SD, standard deviation; definition 1, hemoglobin A1C level $\geq$6.5% at last visit or the use of any medications to manage diabetes at initial or follow-up visits; definition 2, hemoglobin A1C level $\geq$7% at last visit or diabetes medication use at initial or follow-up visits.

RESULTS

A total of 1,870 participants were 65 years or older and had complete data on self-reported and measured hypertension, diabetes, and heart disease, in addition to age at last visit, sex, education, and race/ethnic group. The demographics characteristics of this cohort are in Table 1. The frequency of individuals with self-reported vascular risk factors: hypertension, diabetes, and heart disease are also listed in Table 1 and Supplementary Table 1. The clinical measures showed a higher frequency of hypertension ($p < 0.001$) and lower frequencies for diabetes ($p = 0.030$ for *definition 1* and $p = 0.003$ for *definition 2*) and heart disease ($p < 0.001$) than the self-reported assessments (Supplementary Table 1).

The 1,870 participants had a total of 4,743 self-reported hypertension assessments and 4,739 self-reported diabetes and heart disease assessments at the initial and follow-up visits. Of those, when we restricted to participants with at least two visits, 1,307 participants had self-reported hypertension assessments with a total of 4,183 visits, 1,306 participants had self-reported diabetes with a total of 4,178 visits, and 1,307 participants had self-reported heart disease with a total of 4,179 visits (Supplementary Table 2). When we excluded the first negative self-reports of participants when they later had positive self-report due to a change in health status, after restricting to participants with at least two visits, 1,240 participants had self-reported hypertension with a total of 3,860 visits, 1,269 participants had self-reported diabetes with a total of 3,985 visits, and 1,222 participants had self-reported heart disease with a total of 3,795 visits (Supplementary Table 2). The self-reported hypertension, diabetes, and heart disease were assessed from three visits per individual on average. The distribution of the proportion of positive self-reported risk factors among individuals is shown in Supplementary Table 2.

The reliability of self-reports was excellent for hypertension (0.96 and 0.97), diabetes (0.98 and 0.99), and heart disease (0.95 and 0.95) unadjusted and adjusted for age, sex, education, and ethnicity, respectively (Table 2). The subsequent reliability of self-reports was excellent for hypertension (0.987),

Table 2
Reliability of self-reported hypertension, diabetes, and heart disease among individuals, before and after excluding the first consecutive negative self-reports of participants when they later consistently had positive self-reports

Before exclusion	Hypertension	Diabetes	Heart disease
Unadjusted	0.959	0.983	0.948
Adjusted for sex, age, education, and ethnicity	0.968	0.987	0.951
After exclusion	Hypertension	Diabetes	Heart disease
Unadjusted	0.987	0.995	0.986
Adjusted for sex, age, education, and ethnicity	0.987	0.995	0.986

diabetes (0.995), and heart disease (0.986) when unadjusted and adjusted for age, sex, education, and ethnicity (Table 2).

The validity of self-reported against measured hypertension, diabetes, and heart disease is shown in Table 3. The agreement between self-reported and measured vascular risk factors was moderate for hypertension (kappa: 0.58, 95% confidence interval (CI): 0.53–0.63), good for diabetes (kappa: 0.76, 95% CI: 0.73–0.80 for *definition 1*; kappa: 0.79, 95% CI: 0.76–0.82 for *definition 2*), and moderate for heart disease (kappa: 0.45, 95% CI: 0.40–0.50). Our agreement for diabetes was higher than that of hypertension ($p = 0.013$ for *definition 1*; $p = 0.004$ for *definition 2*) and heart disease ($p < 0.001$ for *definition 1* and *2*). Sensitivity and specificity for hypertension was 88.6% (95% CI: 86.9–90.1) and 78.1% (95% CI: 73.0–82.7), that of diabetes for *definition 1* was 87.7% (95% CI: 84.0–90.7) and 92.7% (95% CI: 91.2–94.0), that of diabetes for *definition 2* was 92.0% (95% CI: 88.8–94.5) and 92.8% (95% CI: 91.4–94.1), and that of heart disease was 85.8% (95% CI: 81.7–89.3) and 75.5% (95% CI: 73.3–77.7), respectively, resulting in over-reporting and under-reporting of 21.9% and 11.4% for hypertension, 7.3% and 12.3% for diabetes for *definition 1*, 7.2% and 8.0% for diabetes for *definition 2*, and 24.5% and 14.2% for heart disease. Percent agreement for hypertension, diabetes, and heart disease were 87.0%, 91.6% for *definition 1* and 92.6% for *definition 2*, and 77.4%, respectively, and diabetes had a higher percent agreement than hypertension ($p < 0.001$) and heart disease ($p < 0.001$) for *definition 1* and *2*.

When stratified by sex, age, education, or ethnic group, the sensitivity of hypertension was higher for older, than younger adults (91.5% versus 85.6%, $p = 0.0003$) and higher for women, than men (90.3% versus 85.2%, $p = 0.004$) (Table 3). Specificity of hypertension was higher for non-Hispanic Whites, than Hispanics (89.7% versus 71.9%, $p = 0.007$), that of diabetes was higher for participants with high education, than low education (95.2% versus 90.2%, $p = 0.006$ for *definition 1*; 95.3% versus 90.4%, $p = 0.006$ for *definition 2*), that of diabetes was higher for non-Hispanic white individuals, than Hispanics (95.7% versus 90.8%, $p = 0.015$ for *definition 1*; 95.8% versus 90.8%, $p = 0.013$ for *definition 2*), and that of heart disease was lower for older, than younger adults (72.2% versus 78.5%, $p = 0.006$). Percent agreement of hypertension was higher for older, than younger adults (89.6% versus 84.3%, $p = 0.001$) and higher for women, than men (88.8% versus 83.6, $p = 0.002$), that of diabetes was higher for participants with high education, than medium education (94.4% versus 90.9%, $p = 0.046$ for *definition 2*) and higher for non-Hispanic white individuals, than non-Hispanic Black participants and Hispanics (95.2% versus 91.7%, $p = 0.038$; 95.2% versus 91.8%, $p = 0.038$ for *definition 2*), that of heart disease was lower for older, than younger adults (75.2% versus 79.6%; $p = 0.026$). There were no significant differences in Cohen's kappa, sensitivity, specificity, and percent agreement of the risk factors for the other strata.

DISCUSSION

This investigation assessed the reliability of self-reported vascular risk factors and the validity when compared with directly measured hypertension, diabetes, and heart disease in a community-based study of older individuals of African and Hispanic ancestry, and non-Hispanic white individuals of European ancestry. We found excellent reliability of self-reported hypertension, diabetes, and heart disease with and without adjustment for age, sex, education, and ethnicity. We also found good agreement between self-reports of vascular risk factors and measured HbA1c, and moderate agreement for measured hypertension and medication use for heart disease. Sensitivity, specificity, and percent agreement were high for diabetes and moderate for hypertension and heart disease. In stratified analyses, sensitivity and

Table 3
Validity of self-reported against measured hypertension, diabetes, and heart disease stratified by participants characteristics

		Hypertension					
Variable	Group	Cohen's kappa	Sensitivity (%)	Specificity (%)	Underreported	Overreported	%agree
All		0.58 (0.53–0.63)	88.6 (86.9–90.1)	78.1 (73.0–82.7)	11.4 (9.9–13.1)	21.9 (17.3–27.0)	87.0
Age	65–80.9	0.56 (0.49–0.62)	85.6 (82.9–88.0)	79.0 (72.2–84.7)	14.4 (12.0–17.1)	21.0 (15.3–27.8)	84.3
	≥80.9	0.60 (0.52–0.67)	91.5 (89.4–93.3)*	76.9 (68.3–84.0)	8.5 (6.7–10.6)*	23.1 (16–31.7)	89.6*
Sex	Women	0.59 (0.52–0.65)	90.3 (88.3–92.0)	78.9 (71.8–84.9)	9.7 (8.0–11.7)	21.1 (15.1–28.2)	88.8
	Men	0.56 (0.48–0.63)	85.2 (81.9–88.2)*	77.2 (69.2–84.0)	14.8 (11.8–18.1)*	22.8 (16.0–30.8)	83.6*
Education	<6	0.51 (0.40–0.63)	89.8 (86.2–92.7)	67.2 (54.3–78.4)	10.2 (7.3–13.8)	32.8 (21.6–45.7)	86.5
	6–12	0.57 (0.48–0.66)	89.8 (86.9–92.3)	76.7 (66.4–85.2)	10.2 (7.7–13.1)	23.3 (14.8–33.6)	88.0
	≥12	0.61 (0.54–0.67)	87.0 (84.3–89.5)	83.7 (76.7–89.3)	13.0 (10.5–15.7)	16.3 (10.7–23.3)	86.4
Ethnicity	Whites	0.63 (0.55–0.71)	85.0 (81.0–88.4)	89.7 (81.9–94.9)	15.0 (11.6–19.0)	10.3 (5.1–18.1)	85.9
	AfAm	0.57 (0.47–0.66)	90.9 (88.2–93.2)	73.3 (62.6–82.2)	9.1 (6.8–11.8)	26.7 (17.8–37.4)	88.5
	Hispanics	0.53 (0.45–0.62)	88.9 (86.2–91.2)	71.9 (62.7–79.9)*	11.1 (8.8–13.8)	28.1 (20.1–37.3)*	86.3
		Diabetes (definition 1)					
Variable	Group	Cohen's kappa	Sensitivity (%)	Specificity (%)	Underreported	Overreported	%agree
All		0.76 (0.73–0.80)	87.7 (84.0–90.7)	92.7 (91.2–94.0)	12.3 (9.3–16.0)	7.3 (6.0–8.8)	91.6
Age	65–80.9	0.78 (0.73–0.82)	91.2 (86.6–94.6)	91.7 (89.4–93.6)	8.8 (5.4–13.4)	8.3 (6.4–10.6)	91.6
	≥80.9	0.75 (0.70–0.80)	83.6 (77.5–88.6)	93.7 (91.7–95.3)	16.4 (11.4–22.5)	6.3 (4.7–8.3)	91.6
Sex	Women	0.77 (0.72–0.81)	86.6 (81.9–90.5)	93.2 (91.4–94.7)	13.4 (9.5–18.1)	6.8 (5.3–8.6)	91.7
	Men	0.76 (0.70–0.82)	89.5 (83.3–94.0)	91.8 (89.1–94.1)	10.5 (6.0–16.7)	8.2 (5.9–10.9)	91.3
Education	<6	0.78 (0.71–0.84)	91.6 (85.1–95.9)	90.2 (86.4–93.3)	8.4 (4.1–14.9)	9.8 (6.7–13.6)	90.6
	6–12	0.75 (0.69–0.81)	89.4 (83.1–93.9)	90.7 (87.8–93.2)	10.6 (6.1–16.9)	9.3 (6.8–12.2)	90.4
	≥12	0.77 (0.71–0.82)	82.8 (75.6–88.5)	95.2 (93.4–96.7)*	17.2 (11.5–24.4)	4.8 (3.3–6.6)	93.0
Ethnicity	Whites	0.74 (0.65–0.83)	80.3 (68.7–89.1)	95.7 (93.3–97.4)	19.7 (10.9–31.3)	4.3 (2.6–6.7)	93.6
	AfAm	0.74 (0.67–0.80)	84.3 (77.2–89.9)	92.3 (89.6–94.5)	15.7 (10.1–22.8)	7.7 (5.5–10.4)	90.6
	Hispanics	0.79 (0.74–0.84)	92.5 (87.9–95.7)	90.8 (88.1–93.1)*	7.5 (4.3–12.1)	9.2 (6.9–11.9)	91.2
		Diabetes (definition 2)					
Variable	Group	Cohen's kappa	Sensitivity (%)	Specificity (%)	Underreported	Overreported	%agree
All		0.79 (0.76–0.82)	92.0 (88.8–94.5)	92.8 (91.4–94.1)	8.0 (5.5–11.2)	7.2 (5.9–8.6)	92.6
Age	65–80.9	0.80 (0.75–0.84)	94.7 (90.7–97.3)	91.8 (89.5–93.7)	5.3 (2.7–9.3)	8.2 (6.3–10.5)	92.4
	≥80.9	0.78 (0.73–0.83)	88.8 (83.2–93.0)	93.8 (91.8–95.4)	11.2 (7.0–16.8)	6.2 (4.6–8.2)	92.8
Sex	Women	0.80 (0.76–0.84)	91.9 (87.8–95.0)	93.3 (91.5–94.8)	8.1 (5.0–12.2)	6.7 (5.2–8.5)	93.0
	Men	0.78 (0.72–0.83)	92.1 (86.3–96.0)	91.9 (89.2–94.1)	7.9 (4.0–13.7)	8.1 (5.9–10.8)	91.9

Education	<6	0.80 (0.74–0.86)	95.6 (90.1–98.6)	90.4 (86.6–93.4)	4.4 (1.4–9.9)	9.6 (6.6–13.4)	91.7
	6–12	0.76 (0.70–0.82)	91.3 (85.3–95.4)	90.8 (87.8–93.2)	8.7 (4.6–14.7)	9.2 (6.8–12.2)	90.9
	≥12	0.81 (0.75–0.86)	89.6 (83.1–94.2)	95.3 (93.5–96.8)*	10.4 (5.8–16.9)	4.7 (3.2–6.5)	94.4*
Ethnicity	Whites	0.79 (0.71–0.88)	91.4 (81.0–97.1)	95.8 (93.4–97.5)	8.6 (2.9–19.0)	4.2 (2.5–6.6)	95.2
	AfAm	0.76 (0.70–0.82)	88.7 (82.1–93.5)	92.4 (89.8–94.6)	11.3 (6.5–17.9)	7.6 (5.4–10.2)	91.7*
	Hispanics	0.80 (0.75–0.85)	94.4 (90.1–97.2)	90.8 (88.1–93.1)	5.6 (2.8–9.9)	9.2 (6.9–11.9)	91.8*
				Heart disease			
Variable	Group	Cohen's kappa	Sensitivity (%)	Specificity (%)	Underreported	Overreported	%agree
All		0.45 (0.40–0.50)	85.8 (81.7–89.3)	75.5 (73.3–77.7)	14.2 (10.7–18.3)	24.5 (22.3–26.7)	77.4
Age	65–80.9	0.43 (0.36–0.51)	86.9 (79.9–92.2)	78.5 (75.5–81.3)	13.1 (7.8–20.1)	21.5 (18.7–24.5)	79.6
	≥80.9	0.45 (0.39–0.51)	85.2 (79.7–89.6)	72.2 (68.8–75.5)*	14.8 (10.4–20.3)	27.8 (24.5–31.2)*	75.2*
Sex	Women	0.45 (0.39–0.50)	83.3 (77.8–87.9)	76.1 (73.4–78.8)	16.7 (12.1–22.2)	23.9 (21.2–26.6)	77.5
	Men	0.46 (0.38–0.54)	90.8 (84.1–95.3)	74.4 (70.5–78.0)	9.2 (4.7–15.9)	25.6 (22.0–29.5)	77.4
Education	<6	0.48 (0.38–0.58)	80.2 (70.2–88.0)	79.4 (74.8–83.5)	19.8 (12–29.8)	20.6 (16.5–25.2)	79.6
	6–12	0.45 (0.37–0.53)	87.9 (80.6–93.2)	74.4 (70.3–78.2)	12.1 (6.8–19.4)	25.6 (21.8–29.7)	76.9
	≥12	0.43 (0.36–0.50)	87.5 (81.0–92.4)	74.3 (70.9–77.6)	12.5 (7.6–19.0)	25.7 (22.4–29.1)	76.7
Ethnicity	Whites	0.42 (0.33–0.51)	91.2 (83.4–96.1)	70.2 (65.4–74.6)	8.8 (3.9–16.6)	29.8 (25.4–34.6)	74.1
	AfAm	0.44 (0.36–0.52)	84.2 (75.6–90.7)	77.9 (74.1–81.4)	15.8 (9.3–24.4)	22.1 (18.6–25.9)	78.9
	Hispanics	0.48 (0.41–0.55)	83.8 (77.0–89.2)	76.9 (73.3–80.2)	16.2 (10.8–23.0)	23.1 (19.8–26.7)	78.3

Whites, Non-Hispanic Whites; AfAm, African Americans; %agree, Percent agreement; definition 1, hemoglobin A1C level ≥6.5% at last visit or the use of any medications to manage diabetes at initial or follow-up visits; definition 2, hemoglobin A1C level ≥7% at last visit or diabetes medication use at initial or follow-up visits. *significant at p-value <0.05.

percent agreement of hypertension were highest in older adults and women. The specificity of hypertension and diabetes was slightly higher in non-Hispanic white individuals compared with Hispanic individuals. Individuals with more education also had higher specificity for diabetes. The specificity of heart disease was lowest for the oldest individuals. Percent agreement of diabetes was higher among individuals with more education, and higher in non-Hispanic White individuals, than African-Americans or Hispanics.

The agreement for hypertension was within the range of prior studies in older adults where kappa ranged from 0.44 to 0.62 [8, 10–12]. The sensitivity was higher than that observed in previous studies which ranged from 82.0% to 86.0% [7, 9, 11, 13]. The sensitivity for non-Hispanic White (85.0%) and non-Hispanic Black individuals (90.9%), and Hispanics (88.9%) were similar to previously reported older US-born adults [13]. The specificity and the percent agreement of self-reported hypertension was within the range of with prior studies where specificity ranged from 64.5% to 92.0% [7, 9, 11, 13] and percent agreement ranged from 81.1% to 88.4% [7, 9, 11, 13]. It is possible that these participants were 15–20 years older than in previous studies [7, 9, 13] and perhaps more accustomed to reporting the presence of hypertension [37–39].

For diabetes, agreement for both categories of HbA1c was within the range of prior studies in older adults where kappa ranged from 0.76 to 0.80 [8, 11, 12]. The sensitivity was higher than that observed in previous studies in older adults which ranged from 55.9% to 86.0% [8, 11, 12]. The specificity and the percent agreement were similar to prior studies where specificity ranged from 96.4% to 99.0% [8, 11, 12] and percent agreement ranged from 90.6% to 96.0% [9, 11]. Only a few studies compared self-reported diabetes with hemoglobin HbA1c [8, 12, 40]. The intensive intervention, lifestyle management in terms of diet and exercise, and use of medications required for diabetes may explain the higher awareness of diabetes [11].

The agreement for heart disease was within the range of previous studies where kappa for myocardial infarction ranged from 0.45 to 0.80 [10–12] and kappa for heart failure ranged from 0.19 to 0.46 [7, 9–12]. Self-reported heart failure has been difficult to validate compared with clinical measures throughout the literature [41]. The low agreement may reflect the complexity of diagnosing and classifying various types of heart disease and conveying these diagnoses to patients [41]. Despite these limitations, the sensitivity was reasonable and within the range of previous reports on myocardial infarction and heart failure which ranged from 43.0% to 88.0% [7, 9, 11, 12]. The specificity and the percent agreement were lower than that observed in previous studies where specificity ranged from 95.0% to 98.0% [7, 9, 11, 12] and the percent agreement ranged from 91.0% to 96.3% [7, 9, 11, 42]. A possible explanation for the difference was the definition of heart disease. Medical documentation was not available for the heart disease in this study. This required that we rely entirely on the reported use of medications to manage all types of heart disease. Another explanation could be limited knowledge about types of heart disease [12]. It has been shown that awareness for heart failure is lower than for other heart conditions in the general population [43].

Previous studies have investigated the validity of self-reported cardiovascular risk factors in populations at risk for stroke [4, 18]. Similar to our investigation, data were extracted from questionnaires and compared with direct measurements or medical records. Overall accuracy was best for hypertension and diabetes, but not for hypercholesterolemia. The sensitivities for hypertension reported in other studies reviewed by Bowlin et al. [44] were slightly lower than those reported here. However, high sensitivity and specificity were found in older non-Hispanic Blacks, Hispanics, and non-Hispanic Whites in the Health and Retirement Study [13]. This suggests that the accuracy of self-reported vascular risk factors is variable but not limiting.

Strengths of our study include the use of a large, well-characterized, longitudinal, multi-ethnic cohort that allowed us to evaluate the reliability and validity of self-reported risk factors among a diverse group of older adults. Moreover, the use of HbA1c to assess the validity of self-reported diabetes is important because using this measure is recommended for the diagnosis of diabetes by the American Diabetes Association [22].

Despite these strengths, our study is subject to potential limitations. The study was conducted in older population aged 65 years or older living in northern Manhattan with a high frequency of cardio- and cerebrovascular risk factors. This may have limited generalizability to other age groups or cohorts with lower morbidity. The medical documentation of heart disease was not available, and we relied entirely on self-reported medication use. This may have resulted in lower specificity and lower per-

cent agreement than the previous literatures. Hispanic individuals have fewer years of education than non-Hispanic Black and non-Hispanic White individuals, which can affect the accuracy of self-reports [45]. Though this study was restricted to hypertension, diabetes, and heart disease and did not assess all relevant vascular risk factors, these were the key risk factors associated with Alzheimer's disease.

Validated and reliable self-reported vascular risk factors, such as hypertension, diabetes, and heart disease can help to improve the quality of research and practice in similar populations. The use of self-reported vascular risk factors with proven validity and reliability will improve the estimation of health indices (such as incidence and prevalence) of chronic diseases or identification of individuals who are at risk of developing chronic diseases or Alzheimer's disease.

Our results indicate that there is excellent reliability among older individuals for self-reported hypertension, diabetes, and heart disease. Furthermore, agreement, sensitivity, specificity, and percent agreement of self-reported diabetes were good and that of hypertension and heart disease were moderate when using clinical measures as validation. Establishing reliability and validity will also augment efforts to harmonize data across similar epidemiological studies.

ACKNOWLEDGMENTS

The authors have no acknowledgments to report.

FUNDING

This research is supported by National Institutes of Health grants R01AG037212, R01AG072474, R25GM143298, and U24AG074855.

CONFLICT OF INTEREST

The authors have no conflict of interest to report.

DATA AVAILABILITY

The data supporting the findings of this study are available on request at https://www.neurology.columbia.edu/research/research-centers-and-programs/alzheimers-disease-research-center-adrc/investigators/investigator-resources.

SUPPLEMENTARY MATERIAL

The supplementary material is available in the electronic version of this article: https://dx.doi.org/10.3233/JAD-230374.

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