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Featured Article

Racial disparities and temporal trends in dementia misdiagnosis risk in the United States

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Abstract

Introduction: Systematic disparities in misdiagnosis of dementia across racial/ethnic groups have implications for health disparities. We compared the risk of dementia under- and overdiagnosis in clinical settings across racial/ethnic groups from 2000 to 2010.

Methods: We linked fee-for-service Medicare claims to participants aged ≥70 from the nationally representative Health and Retirement Study. We classified dementia status using an algorithm with similar sensitivity and specificity across racial/ethnic groups and assigned clinical dementia diagnosis status using ICD-9-CM codes from Medicare claims. Multinomial logit models were used to estimate relative risks of clinical under- and overdiagnosis between groups and over time.

Results: Non-Hispanic blacks had roughly double the risk of underdiagnosis as non-Hispanic whites. While primary analyses suggested a shrinking disparity over time, this was not robust to sensitivity analyses or adjustment for covariates. Risk of overdiagnosis increased over time in both groups.

Discussion: Our results suggest that efforts to reduce racial disparities in underdiagnosis are warranted.

Keywords: Dementia; Alzheimer's disease; Clinical diagnosis; Disparities; Health and retirement study

1. Introduction

There is substantial clinical misdiagnosis of dementia in the United States (US) [1,2]. Misdiagnosis has costs. Underdiagnosis prevents timely access to treatment and linkage to resources, which tend to be most impactful when provided in the early stages of the disease [3]. False-positive diagnoses of dementia (i.e., overdiagnosis) may result in undue burden from stigma, which has been found to be stronger among minority groups [4,5]. Thus, systematic disparities in under- or overdiagnosis of dementia across racial/ethnic groups may have important implications for perpetuating or exacerbating existing racial/ethnic disparities in dementia in the US [5–9].

While substantial evidence suggests racial/ethnic disparities in misdiagnosis are likely, the extent to which the degree of under- or overdiagnosis of dementia differs across racial/ethnic groups in the US, and whether this has changed over time, remains unclear. Studies have shown clinical dementia screening tools to be less reliable for racial minorities [3,10–12]. Similarly, evidence showing racial/ethnic minorities to be more impaired at first dementia diagnosis may suggest that diagnosis occurs at a later stage of the disease for these groups [13–15]. However, many existing

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studies of dementia underdiagnosis were conducted in small, nonrepresentative samples that may not generalize to the broader US population [16]; while existing studies in approximately US-representative samples do not provide sufficient information on racial/ethnic disparities in misdiagnosis and associated time trends, due to small sample size ($N < 600$), cross-sectional design, and other methodological limitations [1,2,14,17]. Thus, we aimed to quantify the prevalence and trends in the risk of under- and overdiagnosis of prevalent dementia by race/ethnicity from 2000 to 2010 using data from participants in the US nationally representative Health and Retirement Study (HRS) enrolled in fee-for-service (FFS) Medicare.

2. Methods

2.1. Data

The HRS is a longitudinal, nationally representative study of US adults aged 50 and older that began in 1992 [18]. Six separate cohorts of participants have been enrolled to date. Biennial interviews have been conducted since 1998, with approximately 19,000 respondents at every wave. The HRS collects broad information from participants, including demographics, socioeconomic characteristics, and health data. To minimize loss to follow-up, HRS attempts to conduct proxy interviews when participants are unable or unwilling to complete any given interview.

2.2. Dementia status

We assigned dementia status to all person-wave observations using a logistic regression algorithm (which we label the "Expert Model") that we developed previously for the purpose of conducting race/ethnicity dementia disparities research [19]. This algorithm was developed using data from HRS linked to data from its substudy, the Aging, Demographics, and Memory Study (ADAMS) that included formal, in-person dementia assessment [20]. Using various sociodemographic, health, social engagement, and cognition variables from HRS, the algorithm estimates a probability of dementia for each observation, which is then used to assign dementia status to participants using race/ethnicity-specific probability thresholds. This model achieves 75%–78% sensitivity, 89%–93% specificity, and 86%–91% overall accuracy across non-Hispanic whites, non-Hispanic blacks, and Hispanics [19]. Importantly, while algorithmic diagnoses are not gold-standard diagnoses, which are too costly to implement at scale in large nationally representative surveys, this algorithm is appropriate for the purpose of this study because it performs similarly across race/ethnicity groups (i.e., it achieves $\leq$3 and $\leq$5 percentage point difference in sensitivity and specificity respectively in pairwise comparisons between the three groups). However, due to the small sample size and lack of representativeness of the Hispanic ADAMS sample used to develop the algorithm [19], we are less confident about using the algorithm to make inferences about the Hispanic population and have therefore focused our primary analysis on comparisons between non-Hispanic whites and blacks and provide results comparing Hispanics and non-Hispanic whites as a sensitivity analysis in the Supplementary Material.

2.3. Clinical (Medicare) dementia diagnosis

Over 96% of HRS participants from the 2000–2010 interviews aged 70 or older consented to Medicare records linkage. A Medicare claim is recorded for any episode of FFS Medicare-reimbursed care that beneficiaries receive; it includes dates of service, and primary and several secondary ICD-9-CM diagnoses codes, which can be used to identify dementia diagnoses received in clinical settings [2]. Recognizing that dementia may be diagnosed in multiple settings, we linked HRS participants to the exhaustive set of Medicare files available, including Medicare part A, Medicare part B (outpatient and carrier), home health, skilled nursing facility, hospice, and durable medical equipment files.

For each HRS visit, we determined whether someone had a clinical diagnosis of dementia based on the presence of a dementia ICD-9-CM code (Supplementary Material) as a primary or secondary diagnosis in any Medicare claim recorded up to 3 years leading to, and 1 year following the month of the HRS interview. This assessment look-back period was based on previous recommendations that 3 years of data is sufficient to identify prevalent dementia in Medicare claims [1], and our analysis of the ADAMS baseline data that showed the estimated median time since onset for persons with prevalent dementia to be approximately 3 years. The look-forward period was determined through the algorithm used to assign dementia status, which used HRS data to predict dementia status approximately 12 months later at the time of the in-person ADAMS assessment. As Medicare claims are only consistently available for those covered by traditional FFS Medicare, we excluded beneficiaries enrolled in Medicare Advantage (MA) plans at any time during each associated 4-year claims observation period described above.

2.4. Statistical analyses

We limited our primary analysis sample to non-Hispanic white and non-Hispanic black individuals aged over 70 at the time of interview at each HRS wave from 2000 to 2010 with sufficient data to assign a Medicare-based and an algorithm-based dementia classification. Overall, 3% of observations from age- and race/ethnicity-eligible HRS participants were excluded due to lack of Medicare linkage. Of the remaining observations, 28% were excluded from our primary analyses due to the participant being enrolled in MA at any point during the Medicare claims observation period. Of note, MA participation rose from 25% among HRS participants in 2000 to 35% in 2010. Although both groups experienced similar increasing trends in MA participation over

time, on average 27% of observations from non-Hispanic whites and 34% of those from non-Hispanic blacks were excluded due to MA participation. Among those for whom we could generate a Medicare-based dementia diagnosis, less than 1.3% were missing data necessary to generate an algorithmic dementia diagnosis using the Expert Model at any given wave.

At each HRS wave, we classified participants as likely being misdiagnosed or correctly diagnosed based on having discordant or concordant algorithmic and Medicare claims dementia classifications. Specifically, we labeled those with a positive algorithmic dementia classification but no Medicare diagnosis as "underdiagnosed." Similarly, we labeled those with a negative algorithmic dementia classification and a Medicare claims diagnosis as "overdiagnosed." Participants with concordant algorithmic and Medicare claims diagnoses (either positive or negative) were labelled "correctly diagnosed."

We compared the relative distribution of correctly diagnosed, underdiagnosed, and overdiagnosed individuals at each HRS wave across racial groups and ran unadjusted, multinomial logit models stratified by wave to estimate the relative prevalence of under- and overdiagnosis between non-Hispanic blacks and whites at each time point. We then estimated the adjusted relative prevalence of under- or overdiagnosis risk across time and racial groups, after controlling for (a) temporal shifts in the composition of the at-risk population (by gender, age, and education), and (b) changing patterns in inpatient, outpatient, and clinician visits, cohabitation status, and HRS proxy status, recognizing that those with more encounters with the health care system or a partner have higher likelihood of receiving a diagnosis. To quantify the cross-group differences in temporal evolution of misdiagnosis risk, we collapsed the data across years and ran both unadjusted and adjusted multinomial logit models including a non-Hispanic black indicator, a linear term for time, and an interaction term between non-Hispanic black and time. Finally, we compared estimates from our primary analyses to corresponding estimates from multinomial probit models to confirm that potential violation of the independence of irrelevant alternatives assumption did not introduce bias in our primary analyses [21]. As differences in estimated effects between the multinomial logit models and multinomial probit models were negligible, we report results from the multinomial logistic models throughout.

We conducted a number of sensitivity analyses. First, we reran our analyses using an expanded sample, including all those who were enrolled in traditional FFS Medicare for at least 1 month during the 4-year Medicare claims observation period. Second, we re-evaluated risk of over- and underdiagnosis in Medicare based on two alternate observation periods: including up to 5 years leading to and 1 year following the month of HRS interview, and including 1 year leading to and 1 year following the month of HRS interview. Third, we applied two other algorithms developed for use in racial/ethnic disparities work (the LASSO and modified Hurd algorithms), which were also shown to be similarly appropriate for examining dementia disparities between non-Hispanic whites and blacks, although less reliable for analyses involving Hispanics [19]. Finally, we expanded our sample to include Hispanic HRS participants and repeated our primary analyses to examine whether risk of under- and overdiagnosis differed between Hispanics and non-Hispanic whites.

All analyses were weighted using HRS person-level analysis weights and were conducted in SAS 9.4 and R 3.4.3. HRS participants provided informed consent at data collection. This study was approved by the George Washington University Institutional Review Board.

3. Results

Our primary analyses included approximately 5000 observations per HRS wave (Table 1). On average across all waves, the mean age was 79, and 10% required a proxy to complete the HRS interview. The majority of the participants were female and non-Hispanic white; approximately half-lived with a spouse or partner. Notably, the sample became more educated and had increasing Medicare part B claims over time.

Table 1
Weighted characteristics of Health and Retirement Study (HRS) participants aged 70+ with Medicare fee for service and nonmissing algorithmic dementia classification at each HRS wave, 2000–2010

Model predictors and dementia status	2000 (N = 5031)	2002 (N = 5059)	2004 (N = 5201)	2006 (N = 5048)	2008 (N = 4789)	2010 (N = 4647)
Age (mean)	78.4	78.5	78.6	79.0	79.1	79.2
Male (%)	39	40	40	39	40	41
Non-Hispanic white (%)	92	92	91	92	93	93
Non-Hispanic black (%)	8	8	9	8	7	7
Education less than high school degree (%)	31	28	26	23	20	18
Living with spouse or partner (%)	49	49	50	49	49	51
Proxy respondent (%)	14	13	11	9	8	9
Number of Inpatient (part A) claims (mean)	1.3	1.4	1.4	1.4	1.3	1.3
Number of outpatient (part B) claims (mean)	14.2	15.1	16.5	17.5	18.3	19.1
Number of carrier (part B) claims (mean)	78.1	84.7	91.1	97.5	100.7	104.2

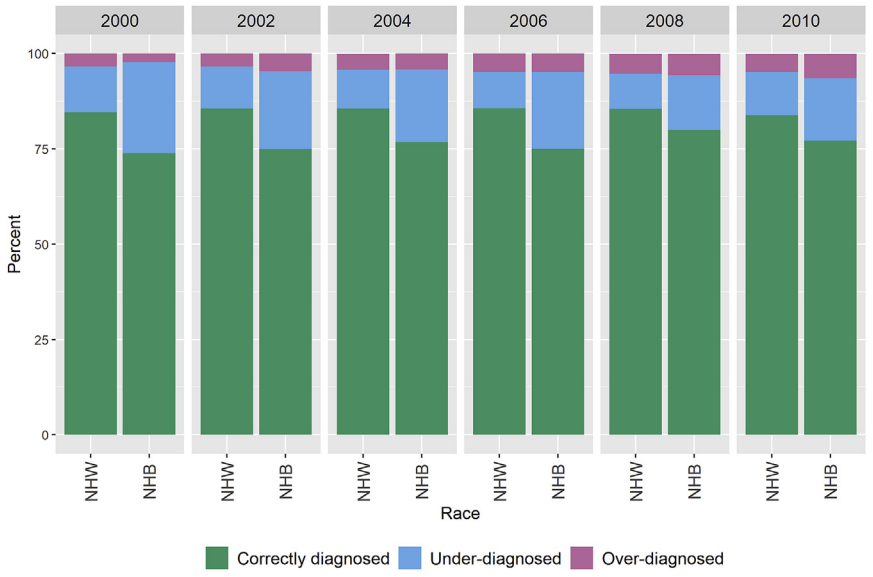

Fig. 1. Weighted distributions of concordant and discordant* dementia classification across algorithmic and Medicare-based dementia ascertainment in non-Hispanic black and white Health and Retirement Study participants with Medicare FFS, 2000–2010. * Underdiagnosed is defined as having an algorithmic dementia diagnosis but no Medicare-claim-based dementia diagnosis, while overdiagnosed is defined as having a Medicare-claim-based dementia diagnosis but no algorithmic diagnosis. Persons with concordant Medicare and algorithmic dementia status are considered correctly diagnosed. Abbreviations: FFS, fee for service; NHW, non-Hispanic white; NHB, non-Hispanic black.

Non-Hispanic whites were consistently more likely to be "correctly diagnosed" (i.e., have concordant algorithmic and Medicare dementia diagnoses) than non-Hispanic blacks from 2000 to 2010 (Fig. 1). Non-Hispanic blacks were more likely to be "underdiagnosed" (i.e., have an algorithmic but no Medicare diagnosis) but similarly likely to be "overdiagnosed" (i.e., have a Medicare but no algorithmic diagnosis) compared with non-Hispanic whites at each wave.

Non-Hispanic blacks had approximately double the risk of underdiagnosis compared with non-Hispanic whites at all waves (range of PRs: 1.58 to 2.4, Fig. 2, Table 2), and this finding was robust across sensitivity analyses (Supplementary Table 1). While there was some evidence to support a linear decline in the magnitude of this disparity over time in our primary analyses ($P = .03$, Fig. 2, Table 2), this was not robust to sensitivity analyses (Supplementary Table 1). There was no evidence to suggest differences in overdiagnosis by race at any time between 2000 and 2010, and no evidence of a time trend in this association in our primary analyses (Fig. 2, Table 2). Overall, findings regarding racial disparities in overdiagnosis were not materially changed in sensitivity analyses (Supplementary Table 1).

The association between race and risk of underdiagnosis at each wave was attenuated after adjusting for participant characteristics (Fig. 2, Table 2). While the association between black race and risk of underdiagnosis was nonsignificant in 2010 in primary analyses, it remained significant in multiple sensitivity analyses (Supplementary Table 1). There was no evidence to support a linear time trend in the racial disparity in underdiagnosis after accounting for participant characteristics in primary ($P = .2$, Fig. 2, Table 2) or sensitivity analyses (Supplementary Table 1). As in unadjusted analyses, there was no association between race and risk of overdiagnosis at any wave and no evidence to suggest a time trend in this association in primary analyses (Fig. 2, Table 2), and findings in sensitivity analyses were largely consistent (Supplementary Table 1).

In sensitivity analyses, we expanded our analyses to consider Hispanics (Supplementary Table 2) but report these analyses in the Supplementary Material, reflecting our lesser confidence in algorithm performance in Hispanics. We excluded a greater proportion of observations from Hispanics (44%) due to MA participation relative to non-Hispanic whites (27%) or blacks (34%). Hispanic participants with FFS Medicare appeared to have greater risk of overdiagnosis compared with non-Hispanic white participants at most waves (Supplementary Fig. 1). There were no significant differences in risk of underdiagnosis between Hispanics and non-Hispanic whites, but Hispanics had significantly higher risk of overdiagnosis in 2002, 2004, and 2010, with similar effect estimates across unadjusted and adjusted models (Supplementary Table 3). There was no evidence of time trends in associations between Hispanic ethnicity and risk of misdiagnosis (Supplementary Fig. 1, Supplementary Table 3).

4. Discussion

This study sought to examine systematic disparities in misdiagnosis of dementia across racial/ethnic groups over time. We found that non-Hispanic blacks had approximately double the risk of underdiagnosis of dementia compared with non-Hispanic whites, a disparity that is

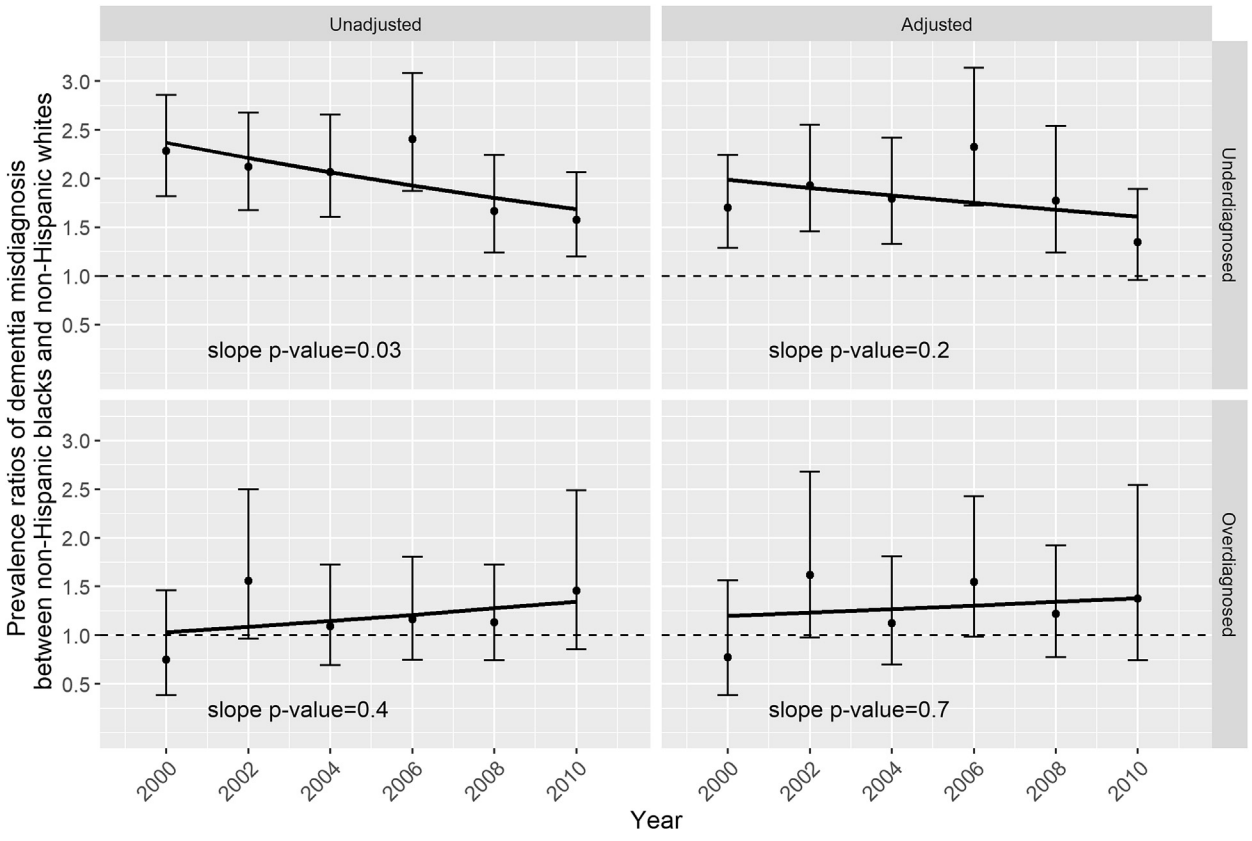

Fig. 2. Unadjusted and adjusted relative risk of misdiagnosis comparing non-Hispanic black to non-Hispanic white participants in Health and Retirement Study participants with Medicare FFS, 2000–2010*. * Relative risk at each year are estimated from regression models stratified by wave. The slope of the temporal trends in relative risk across years are estimated from the race × time interaction term in unstratified regression models.

not fully attributable to differences in sociodemographic characteristics and health care utilization. While the primary analyses suggested a shrinking black-white disparity in risk of underdiagnosis over time, this result was not robust to sensitivity analyses, and there was no evidence of a trend over time after controlling for sociodemographic factors and health care utilization. The observed increase in risk of over diagnosis over time was consistent across racial/ethnic groups. Sensitivity analyses suggest that Hispanics had higher risk of overdiagnosis. However, these results should be interpreted with caution given our lower confidence in the use of algorithmic dementia classifications for making inferences about Hispanics [19] and high MA participation.

Our findings have important practical implications. Individuals with undiagnosed dementia receive fewer health services than those with diagnosed dementia [2,22]; thus higher risk of underdiagnosis result in lower likelihood of receiving adequate care for dementia among non-Hispanic black patients. This exacerbates existing racial disparities in receipt of medication to ameliorate the symptoms of dementia (which is significantly higher among non-Hispanic white dementia patients [9]), dementia care outcomes, and access to clinical trials. Although the rate of overdiagnosis is generally low, diagnosis is associated with stigma and higher health care utilization, and thus adversely affects the quality of life and the efficiency of health resources allocation.

Racial differences in whether a person receives a clinical dementia diagnosis may be attributed to group differences in dementia etiology, risk factors, presentation of clinical symptoms, performance in cognitive tests, cultural perceptions, and care-seeking patterns [5,10,11,14,23,24]. Studies have found that screening tools used for dementia diagnosis in clinical settings may be less accurate among racial minorities [3,10,11,23,25]. For example, the commonly used Mini-Mental Status Exam (MMSE) has lower specificity and thus leads to overdiagnosis of dementia among non-Hispanic blacks [5,10,11,26]. Conversely, using the Informant Questionnaire for Cognitive Decline in the Elderly (IQCODE), informants of black patients tend to report lower degree of cognitive decline relative to informants of white patients with similar impairments and thus contribute to greater underdiagnosis [12]. Similarly, non-Hispanic blacks appear more likely than whites to have vascular dementia [4,5], which may be less likely to be diagnosed than Alzheimer's dementia [27]. Furthermore, evidence showing racial/ethnic minorities to be more impaired at diagnosis may suggest that diagnosis occurs at a later stage of disease progression for these groups [13–15]. Efforts to better understand and eliminate disparities in clinical dementia diagnosis—especially in underdiagnosis—are warranted.

Table 2
Relative risk of under- and overdiagnosis for non-Hispanic blacks relative to non-Hispanic whites in Health and Retirement Study (HRS) participants with Medicare FFS, 2000–2010, N = 29,775

	Model 1 (unadjusted)				Model 2 (adjusted*)			
	Underdiagnosis		Overdiagnosis		Underdiagnosis		Overdiagnosis	
HRS year	PR (95% CI)	*P* value	PR (95% CI)	*P* value	PR (95% CI)	*P* value	PR (95% CI)	*P* value
2000†	2.28 (1.82–2.86)	<.0001	0.75 (0.38–1.46)	.40	1.70 (1.29–2.24)	.0002	0.77 (0.38–1.56)	.47
2002†	2.12 (1.68–2.68)	<.0001	1.56 (0.97–2.50)	.07	1.93 (1.46–2.55)	<.0001	1.62 (0.98–2.68)	.06
2004†	2.07 (1.61–2.66)	<.0001	1.09 (0.69–1.73)	.71	1.79 (1.33–2.42)	.0001	1.12 (0.70–1.81)	.63
2006†	2.40 (1.87–3.08)	<.0001	1.16 (0.75–1.81)	.51	2.33 (1.72–3.14)	<.0001	1.55 (0.99–2.43)	.06
2008†	1.67 (1.24–2.24)	.001	1.13 (0.75–1.73)	.56	1.77 (1.24–2.54)	.002	1.22 (0.78–1.92)	.39
2010†	1.58 (1.20–2.07)	.001	1.46 (0.85–2.49)	.17	1.35 (0.96–1.90)	.09	1.38 (0.74–2.55)	.31
Year × race interaction‡	0.97 (0.94–0.997)	.03	1.03 (0.96–1.09)	.40	0.98 (0.95–1.01)	.24	1.01 (0.95–1.08)	.67

Abbreviations: PR, prevalence ratio; FFS, fee for service.
*adjusted for age, gender, education, cohabitation status, HRS proxy respondent status, total inpatient claims, total outpatient claims, total carrier claims.
†Estimated from models fully stratified by wave.
‡Estimated from models including all waves of data.

Our overall findings are consistent with prior comparisons of formal dementia ascertainment versus Medicare claims data, which found Medicare claims to have 29% to 87% sensitivity and 89% to 95% specificity in identifying dementia, suggesting a greater degree of underdiagnosis than overdiagnosis [1,2]. However, these findings contrast those from the two recent studies of factors associated with dementia underdiagnosis in approximately US-representative samples. Similar to our approach, investigators used NHATS dementia classification criteria (with 66% overall sensitivity) to assign dementia status to 585 NHATS participants at the 2011 baseline visit and classified persons as undiagnosed in the absence of a dementia-related FFS Medicare claim up to 3 years prior to the interview [14]. The risk of underdiagnosis was greater in participants of Hispanic/other race (RR: 3.32, 95% CI: 1.71, 6.45) but not in non-Hispanic black participants (PR: 1.35, 95% CI: 0.95, 1.92) compared with non-Hispanic whites. However, these findings may be biased due to cross-group differences in sensitivity or specificity of the NHATS criteria [28], which, unlike the algorithms we use here, has not been evaluated across racial groups. Furthermore, the NHATS criteria relies partly on self- or proxy report of clinician diagnosis [14], which biases estimates toward the null by making the algorithmic and Medicare claims-based dementia classifications more similar. The sample size was also relatively small, resulting in insufficient power to detect small differences. The second study found no association between nonblack race and awareness of a dementia status when comparing ADAMS in-person dementia classifications to informant-reported history of physician-diagnosed dementia diagnosis [17]. However, awareness of dementia entails both the receipt of a clinical diagnosis and informant awareness of the diagnosis, and because informant awareness may be influenced by numerous factors [14], their results are not directly comparable with ours.

Use of an algorithmic dementia classification developed and validated to have similar performance across racial/ethnic groups, minimizing differential misclassification by race/ethnicity, is both a strength and a limitation. Ideally, we would have used study-based assessment of dementia according to research criteria to identify persons with dementia; however, such information simply is not available at scale in representative samples. Thus, use of an algorithm allows us to leverage the large, nationally representative HRS sample. While we acknowledge that algorithmic diagnoses are not equivalent to gold-standard diagnoses, and that estimates of concordance and discordance between algorithmic and clinical diagnoses are not equivalent to absolute rates of over- and underdiagnosis, we stress that the algorithms used here are appropriate for the purposes of this study (i.e., to quantify racial differences): because they are designed to have similar degrees of misclassification by race/ethnic group, they minimize bias in our estimates of relative misdiagnosis across racial groups. Thus, we believe that our findings on racial disparities in dementia misdiagnosis risk are more reliable than those from existing studies cited previously. Other strengths include the multiple sensitivity analyses to confirm robustness of findings. Additionally, by using data from the large and diverse nationally representative HRS across six survey waves, this study is the first, to our knowledge, to make inferences about cross-group and temporal trends in risk of clinical misdiagnosis of dementia in a Medicare FFS-representative population. Other limitations include the potential lack of generalizability to the growing population of Medicare MA enrollees that is disproportionately represented by racial/ethnic minorities. In addition, given our reliance on algorithmic dementia classification, we were unable to make clear inferences about Hispanics or other non-Hispanic, nonblack, nonwhite populations.

In conclusion, non-Hispanic black persons with dementia and fee-for-service Medicare were at higher risk of underdiagnosis than their non-Hispanic white counterparts in the US from 2000 to 2010, highlighting the necessity in reducing racial disparities in underdiagnosis.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.trci.2019.11.008.

RESEARCH IN CONTEXT

1. Systematic review: There is substantial evidence in the peer-reviewed literature to suggest that clinical screening tools are less reliable for racial/ethnic minorities, suggesting that racial/ethnic disparities in clinical misdiagnosis are likely. However, the degree to which under- or overdiagnosis of dementia differs across racial/ethnic groups, and whether this has changed over time remains unclear due to limitations in existing studies.
2. Interpretation: Our study is the first to find that non-Hispanic black individuals with dementia and fee-for-service Medicare have approximately double the risk of underdiagnosis compared with their non-Hispanic white counterparts, and that this disparity persisted over time from 2000 to 2010.
3. Future directions: Our findings suggest that future efforts should focus on better understanding and eliminating racial disparities in clinical dementia underdiagnosis to ameliorate disparities in linkage to health care, resources, and clinical trial enrollment.

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