Racial and ethnic patterns and differences in health care expenditures among Medicare beneficiaries with and without cognitive limitation or Alzheimer's disease and related dementias: a retrospective cohort study

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Abstract

**Background:** Numerous studies have documented racial and ethnic differences in the prevalence and incidence of Alzheimer's disease and related dementias (ADRD). Less is known, however, about racial and ethnic differences in health care expenditures among older adults at risk for ADRD (cognitive limitation without ADRD) or with ADRD. In particular, there is limited evidence that racial and ethnic differences in health care expenditures change over the trajectory of ADRD or differ by types of service.

**Methods:** We examined racial and ethnic patterns and differences in health care expenditures (total health care expenditures, out-of-pocket expenditures, and six service-specific expenditures) among Medicare beneficiaries without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD. Using the 1996-2017 Medical Expenditure Panel Survey, we performed multivariable regression models to estimate expenditure differences among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD and those with ADRD. Models accounted for survey weights and adjusted for various demographic, socioeconomic, and health characteristics.

**Results:** Asians, and Latinos without cognitive limitation had lower total health care expenditures than whites without cognitive limitation ($10236, $9497, $9597, and $11541, respectively), but there were no racial and ethnic differences in total health care expenditures among those with cognitive limitation without ADRD and those with ADRD. In all populations, however, blacks, Asians, and Latinos tended to have lower out-of-pocket expenditures than whites (except for Asians with cognitive limitation without ADRD). Furthermore, service-specific health care expenditures varied by racial and ethnic groups.

**Conclusions:** Our findings may suggest that racial and ethnic minority groups did not experience limited access to care before and after ADRD diagnosis. Differences in out-of-pocket expenditures and service-specific expenditures may be attributable to racial and ethnic differences in care access and/or care preference based on family structure and cultural/economic factors. Particularly, heterogeneous patterns of service-specific expenditures by racial and ethnic groups underscore the
importance of future research in identifying determinants leading to variations in service-specific expenditures among racial and ethnic groups.

Background
The prevalence of Alzheimer’s disease and related dementias (ADRD) is a growing crisis in the United States (US) that is estimated to increase substantially over the next several decades. In 2010, approximately 3.6 million Americans had been diagnosed with ADRD (1). The number of Americans with ADRD is projected to be 13.8 million in 2050, a 283% increase (1). Furthermore, mean per-person costs for Medicare beneficiaries with ADRD were estimated to be $49,126 in 2016, more than triple the average $15,550 costs for Medicare beneficiaries without ADRD (2). Aggregate costs for Medicare beneficiaries with ADRD are expected to increase from $181 billion in 2010 to $1.1 trillion in 2050 (2). Such a dramatic increase in the costs of ADRD would lead to a substantial burden on the Medicare program.

Numerous studies have documented racial and ethnic differences in the prevalence and incidence of ADRD. Specifically, compared to non-Latino whites (whites), non-Latino blacks (blacks) are approximately two times more likely to have ADRD (3, 4) and Latinos are approximately 1.5 times more likely to have ADRD (3, 5, 6). Recent research found that differences among racial and ethnic groups in the prevalence of ADRD decreased between 2000 and 2012 (7). However, the prevalence rates of ADRD were still found to be higher among blacks and Latinos than among whites (19.3%, 16.3%, and 7.4% for blacks, Latinos, and whites, respectively). Incidence rates of ADRD were also higher among blacks and Latinos than among whites (13.8%, 12.2%, and 10.3% for blacks, Latinos, and whites, respectively) (8).

Less is known, however, about racial and ethnic differences in health care expenditures. To the best of our knowledge, only a few studies have examined how health care expenditures related to ADRD vary among racial and ethnic groups (8–10). One study used Medicare fee-for-service claims data for 2014 and found that compared to whites with ADRD, blacks, Latinos, and “others” with ADRD had higher Medicare expenditures ($27,315, $26,280, $21,649, and $20,199 for blacks, others, Latinos, and whites, respectively) (8). Higher expenditures among racial and ethnic minority groups with
ADRD might be attributable to limited access to care in the early stages of ADRD, which could lead to delays in treatment and diagnosis and greater morbidity from these diseases, incurring higher health care expenditures after receiving a diagnosis of ADRD. Although a few studies have examined health care expenditures among Medicare beneficiaries with mild cognitive limitation, these studies did not analyze differences based on racial and ethnic groups (11, 12).

While it is important to examine differences in total health care expenditures among racial and ethnic groups to ensure equal access to ADRD care, it is also important to understand patterns of type-specific health care expenditures; focusing only on total health care expenditures might lead to overlooking mechanisms that contribute to health care expenditures among members of racial and ethnic minority groups with ADRD. This is more likely to be relevant to patients with ADRD because cultural preferences can affect the optimal clinical setting for individuals with ADRD and their families. Prior research found that caregivers of black patients were less satisfied with hospital discharge planning than caregivers of white patients were, and that caregivers of black patients used formal home care more than caregivers of white patients did (13, 14). Furthermore, there were substantial racial and ethnic differences in the number of individuals who chose to be admitted to nursing homes; usage of nursing homes was particularly low among Latinos (15). However, it is worth noting that these findings may be also attributable to structural barriers. Additionally, choice of care setting for patients with ADRD is critical because evidence suggests that these patients experience inefficient care delivery and health care utilization. A significant factor in health care utilization among those with ADRD is due to transitions to high-cost settings such as an inpatient setting or skilled nursing facility (16-18); some of these transitions have been shown to be unnecessary or preventable (19-22). This suggests that higher expenditures among patients with ADRD might result from inefficient use of care.

To address this gap, we examined racial and ethnic patterns and differences in health care expenditures among Medicare beneficiaries. We estimated such expenditures among Medicare beneficiaries with cognitive limitation without a diagnosis of ADRD and those diagnosed with ADRD. In addition, we examined various types of health care expenditures: total health care expenditures, out-
of-pocket (OOP) expenditures, and six service-specific expenditures.

Our study makes several key contributions to the literature. First, we used data that collects information on race and ethnicity via population survey. Prior research has instead relied on the Medicare claims data. A common concern about the claims data is a lack of in-depth measures of socioeconomic factors that may influence the health care expenditures and racial and ethnic disparities. Using the nationally representative survey data enables us to account for comprehensive measures of demographic and socioeconomic factors. Hence, our finding should be more robust and more accurately predict the racial and ethnic disparities in the amount and pattern of health care expenditures. In addition, we examined racial and ethnic disparities along the trajectory of ADRD (i.e., among Medicare beneficiaries without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD, respectively). We expect that our findings can identify disparities in the early stages of ADRD and advocate for appropriate prevention screenings or treatment to delay the onset of ADRD among racial and ethnic minority beneficiaries.

Methods
Data and Sample
We used data from the 1996–2017 Medical Expenditure Panel Survey (MEPS). MEPS is a nationally representative survey of the US non-institutionalized civilian population. MEPS annually collects information on respondents’ demographic and socioeconomic characteristics, health status, and health care expenditures. Two datasets from MEPS were included in our analyses: the full year consolidated data files and the medical conditions files. The full year consolidated data file contains information on demographic and socioeconomic characteristics and health care expenditures. The medical conditions file provides information on medical conditions associated with medical events from respondents as verbatim text and coded by professional coders using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM). Using an individual unique identifier, we linked the full year consolidated data file to the medical conditions file for each year.
We included Medicare beneficiaries (aged 65 and above) who were non-Latino white, non-Latino black, non-Latino Asian, or Latino. Then, we identified the following three populations: 1) those who reported as not having cognitive limitation, 2) those who reported as having cognitive limitation without a diagnosis of ADRD, and 3) those diagnosed with ADRD. MEPS measured cognitive limitation based on the household respondent’s answers from the individuals in the sample. Cognitive limitation was defined as “confusion or memory loss, had problems making decisions, or required supervision for their own safety.” ADRD cases were identified through three-digit ICD-9-CM diagnostic codes (290, 294, 331, or 797) (12, 23) or three-digit ICD-10 diagnostic codes (F01, F03, G30, and G31) (24).

Because the transition to ICD-10 diagnostic codes was implemented in October 2015, we used the ICD-9-CM diagnostic codes for the data between 1997 and 2015 and the ICD-10 diagnostic codes for the data between 2015 and 2017.

Measurements
Our outcomes included eight health care expenditures: 1) total health care expenditures, 2) OOP expenditures, and 3) six service-specific expenditures. Service-specific expenditures included inpatient expenditures, outpatient expenditures, office-based expenditures, emergency room (ER) expenditures, home health expenditures, and prescription drug expenditures. All health care expenditures were adjusted to 2019 dollars.

The key independent variables were the participant’s race (white, black, Asian, or Latino), presence of cognitive limitation or ADRD, and its interaction terms. To control for differences in sample characteristics among racial and ethnic groups, we included the following variables: age (65–69, 70–74, 75–79, 80–84, or ≥ 85 years old); sex; marital status (married or unmarried); education (less than high school degree, high school degree, some college, or more than college degree); family income as a share of the federal poverty level (FPL; 0-99%, 100-124%, 125-199%, 200-399%, or ≥ 400%); family size (one, two, three, or more than four); private insurance; eligibility for Medicare and Medicaid; area of residence (Northeast, Midwest, South, or West); medical conditions (myocardial infarction, congestive heart failure, diabetes, hypertension, diabetes, renal disease, cancer, and psychiatric disorder); limitations at school, work, or housework; functional limitations; and a proxy
response to an interview (proxy response or self-response).

Statistical Analysis
We first estimated weighted sample characteristics among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD and tested differences using chi-squared tests. Then, we examined unadjusted weighted outcomes among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD and tested differences using an analysis of variance. Finally, we performed multivariable regression models to estimate expenditure differences among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD and those with ADRD. Specifically, because we did not observe Medicare beneficiaries with zero total health care expenditures, we ran generalized linear models with gamma family and log link to estimate differences in total health care expenditures. For other types of health care expenditures, there were those with zero expenditures and thus we ran two-part models to handle zero expenditures. Using marginal effects at representative values, we produced findings that can be interpreted as dollar values (25, 26).
Specifically, we estimated the predicted mean values of the outcomes for each of the racial and ethnic group without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD. Then, we conducted post-estimation tests to examine statistical significance in the differences in the adjusted outcomes among racial and ethnic minority groups relative to non-Latino white. All models account for survey weights and adjusted for the variables described above as well as year-fixed effects. All analyses were conducted using Stata 15.

Results
Our sample consisted of 57057 Medicare beneficiaries without cognitive limitation (39767 whites, 7974 blacks, 2551 Asians, and 6765 Latinos), 10088 Medicare beneficiaries with cognitive limitation without ADRD (5947 whites, 1933 blacks, 523 Asians, and 1685 Latinos), and 3420 Medicare beneficiaries with ADRD (2028 whites, 693 blacks, 120 Asians, and 579 Latinos) (Table 1). There were significant differences in sample characteristics among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD. For all populations,
blacks, Asians, and Latinos were more likely than whites to have less than a high school degree, more likely to have a family income higher lower than 200% of the FPL, more likely to have a family with more than three members, and more likely to have private health insurance or Medicaid. For those without cognitive limitation, there were differences in health status. However, differences were marginal among racial and ethnic groups those with cognitive limitation without ADRD and those with ADRD.

Table 1
Sample characteristics.

| Age (years) | Female | Married | Less than high school degree | High school degree | Some college or more than college |
|-------------|--------|---------|------------------------------|-------------------|---------------------------------|
| 65-69       | 54     | 15      | 0.04                         | 0.73              | 0.18                            |
| 70-74       | 42     | 15      | 0.05                         | 0.73              | 0.18                            |
| 75-79       | 37     | 14      | 0.08                         | 0.73              | 0.18                            |
| 80-84       | 16     | 0.03    | 0.73                         | 0.18              | 0.18                            |
| >= 84       | 6      | 0.03    | 0.73                         | 0.18              | 0.18                            |
| NL white    | 3976   | 1482    | 0.08                         | 0.73              | 0.18                            |
| NL black    | 2551   | 1003    | 0.07                         | 0.73              | 0.18                            |
| NL Asian    | 6765   | 2581    | 0.08                         | 0.73              | 0.18                            |
| NL Latino   | 5947   | 2273    | 0.08                         | 0.73              | 0.18                            |

- *** indicates statistical significance.
| Degree | Family income | 0–99% FPL | 100–124% FPL | 125–199% FPL | 200–399% FPL | >= 400% FPL |
|--------|---------------|-----------|--------------|--------------|--------------|-------------|
|        | ***           | 9.9 2     | 5.3 3        | 16.1 13      | 30.6 9       | 37.9 17     |
|        | ***           | 24.77     | 9.6 9        | 20.58        | 27.09        | 17.48       |
|        | ***           | 12.97     | 6.4 5        | 14.60        | 28.09        | 37.88       |
|        | ***           | 24.68     | 10.2 3       | 22.08        | 27.7 7       | 15.2 3      |
|        | ***           | 16.96     | 9.28 13.65   | 21.68 22.34  | 29.83 19.83  | 22.37 1.3   |
|        | ***           | 37.04     | 8.53 14.29   | 20.35 24.13  | 25.58 21.52  | 6.75 21.03  |
|        | ***           | 20.37     | 8.53 14.29   | 20.35 24.13  | 25.58 21.52  | 6.75 21.03  |
|        | ***           | 33.35     | 8.53 14.29   | 20.35 24.13  | 25.58 21.52  | 6.75 21.03  |
|        | ***           | 17.42     | 10.21 11.68  | 23.22 24.44  | 26.99 21.89  | 30.51 19.76 |
|        | ***           | 32.67     | 5.93 13.81   | 18.64 20.80  | 26.92 21.89  | 30.51 19.76 |
|        | ***           | 41.78     | 5.93 13.81   | 18.64 20.80  | 26.92 21.89  | 30.51 19.76 |
| Family size | *** | 1 32.60 | 2 57.08 | 3 55.62 | 4+ 4.34 |
| Postal code | 1 *** | 17.63 | 46.88 | 11.14 | 9.21 |
| Health insurance | *** | 26.10 | 43.97 | 12.80 | 14.76 |
| Private insurance | *** | 43.91 | 39.69 | 6.76 | 14.76 |
| Medicare/Medicaid | *** | 50.27 | 36.92 | 6.76 | 14.76 |
| US census region | *** | 77.57 | 35.76 | 20.67 | 39.86 |
| Northeast | *** | 14.51 | 17.66 | 12.79 | 14.51 |
| Midwest | *** | 13.29 | 17.66 | 12.79 | 14.51 |
| South | *** | 13.29 | 17.66 | 12.79 | 14.51 |
| West | *** | 37.93 | 37.93 | 37.93 | 37.93 |
| Medical conditions | *** | 37.93 | 37.93 | 37.93 | 37.93 |
There were significant differences in unadjusted health care expenditures among racial and ethnic groups without cognitive limitation, those with cognitive limitation without ADRD, and those with ADRD (Table 2). Blacks, Asians, and Latinos without cognitive limitation had significantly lower total health care expenditures than the equivalent whites. Asians with cognitive limitation without ADRD had significantly lower expenditures than the equivalent whites. However, no significant differences were detected among blacks and Latinos with cognitive limitation without ADRD and blacks, Asians, and Latinos with ADRD. For OOP expenditures, blacks, Asians, and Latinos in all groups had significantly lower expenditures than the equivalent whites. However, there was no significant difference in OOP expenditures between whites and Asians with ADRD. For service-specific expenditures, blacks, Asians, and Latinos without cognitive limitation tended to have lower inpatient, outpatient, office-based, home health, and prescription drug expenditures than the equivalent whites.
However, significant differences were detected in a few types of expenditures among racial and ethnic groups with cognitive limitation without ADRD and those with ADRD (home health expenditures among blacks with cognitive limitation without ADRD, inpatient expenditures among Asians with cognitive limitation without ADRD, outpatient and office-based expenditures among Latinos with cognitive limitation without ADRD, and inpatient and office-based expenditures among Latinos with ADRD).

Table 2
Unadjusted expenditures among Medicare beneficiaries with and without cognitive limitation or ADRD by race/ethnicity.

|                      | Expenditures ($) Mean (SD) |
|----------------------|----------------------------|
|                      | Total                     | Out-of-pocket | Inpatient | Outpatient | Office-based | ER          | Home health | Prescriptio n drug |
| **Without cognitive limitation** |                          |              |           |            |              |            |             |                          |
| NL white (N = 39767)  | 11686 (19001)             | 1876 (2683)  | 3696 (13532) | 2063 (8685) | 5992 (11978) | 247 (1604) | 317 (2718) | 2720 (5323) |
| NL black (N = 7974)   | 10522 (18551)***          | 1217 (3394)  | 3370 (12418) | 1592 (8706) | 4518 (12144) | 284 (1410) | 734 (4701)*** | 2720 (5222) |
| NL Asian (N = 2551)   | 7782 (19638)***           | 1115 (2688)  | 2164 (16959) | 669 (4733)*** | 3999 (8641)*** | 117 (528) | 300 (2696) ** | 2328 (4885)** |
| Latino (N = 6765)     | 9070 (17012)***           | 1032 (2077)  | 2908 (12711) | 947 (4638)*** | 4220 (10430)*** | 269 (2261) | 572 (3989)** | 2380 (3916)*** |
| **With cognitive limitation without ADRD** |                          |              |           |            |              |            |             |                          |
| NL white (N = 5947)   | 21222 (31181)             | 2617 (5319)  | 8464 (23907) | 2188 (10782) | 7150 (15071) | 471 (1637) | 2712 (10424) | 4165 (5905) |
| NL black (N = 1933)   | 21628 (30511)             | 1656 (3729)  | 7871 (20071) | 1994 (11807) | 7135 (20664) | 480 (1653) | 4514 (11259)*** | 4124 (8734) |
| NL Asian (N = 523)    | 15930 (21125)**           | 1429 (5464)  | 4525 (12573)** | 1039 (5299) | 6272 (15183) | 424 (1618) | 3165 (9368) | 3775 (5320) |
| Latino (N = 1685)     | 19425 (30296)***          | 1159 (1994)** | 7437 (23572) | 1384 (6383)*  | 5679 (12715)** | 378 (1377) | 3447 (10719) | 4119 (5766) |
| **With ADRD**         |                           |              |           |            |              |            |             |                          |
| NL white (N = 2028)   | 21830 (27119)             | 4037 (9629)  | 6089 (17392) | 1073 (5054) | 5324 (11214) | 489 (1349) | 6744 (16028) | 4476 (5292) |
| NL black (N = 693)    | 24752 (26767)             | 1897 (4936)*** | 8922 (20413)** | 1060 (6407) | 3983 (8534)*  | 504 (1663) | 8250 (13558) | 4174 (4893) |
| NL Asian (N = 120)    | 20040 (29550)             | 1903 (6406)  | 5441 (22930) | 147 (691)  | 3934 (6762) | 466 (2729) | 6817 (14605) | 4377 (5180) |
| Latino (N = 579)      | 24318 (31543)             | 1415 (3371)*** | 6262 (2346) | 1149 (5986) | 5031 (12812) | 659 (2375) | 9334 (16572) | 4543 (5333) |

Our adjusted analysis showed that blacks, Asians, and Latinos without cognitive limitation had lower total health care expenditures than whites without cognitive limitation ($10236, $9497, $9597, and $11541, respectively), but there were no racial and ethnic differences in total health care expenditures among those with cognitive limitation without ADRD and those with ADRD (Table 3). In
all populations, however, blacks, Asians, and Latinos tended to have lower OOP expenditures than whites (except for Asians with cognitive limitation without ADRD). The magnitude of the differences in OOP expenditures was most pronounced for those with ADRD.

**Table 3**

| Expenditures (s), Mean (95% CI) | Total | Out-of-pocket | Inpatient | Outpatient | Office-based | ER | Home health | Prescriptio n drug |
|---------------------------------|-------|---------------|-----------|------------|--------------|----|-------------|-------------------|
| **Without cognitive limitation**|       |               |           |            |              |    |             |                   |
| NL white (N = 39767)           | 11541 (11759 to 11323) | 1826 (1855 to 1796) | 3634 (3792 to 3476) | 2027 (2118 to 1936) | 5512 (5636 to 5388) | 228 (241 to 216) | 362 (393 to 330) | 2725 (2785 to 2665) |
| NL black (N = 7974)            | 10236 (10839 to 9633) | 1286 (1347 to 1226) | 3388 (3796 to 2979) | 1689 (1914 to 1464) | 4440 (4714 to 4166) | 279 (321 to 237) | 624 (724 to 523) | 2304 (2403 to 2204) |
| NL Asian (N = 2551)           | 9497 (10454 to 8540) | 1444 (1609 to 1278) | 2968 (3853 to 2082) | 941 (1187 to 695) | 4386 (4879 to 3893) | 133 (165 to 101) | 357 (499 to 214) | 2678 (2924 to 2432) |
| Latino (N = 6765)             | 9597 (10139 to 9054) | 1304 (1395 to 1212) | 3082 (3521 to 2643) | 1396 (1618 to 1173) | 4674 (4962 to 4386) | 249 (311 to 187) | 616 (749 to 483) | 2320 (2458 to 2183) |
| **With cognitive limitation without ADRD** |       |               |           |            |              |    |             |                   |
| NL white (N = 5947)           | 21133 (22132 to 20134) | 2420 (2578 to 2262) | 8388 (9148 to 7627) | 2064 (2319 to 1805) | 4629 (5805 to 6508) | 459 (508 to 411) | 3075 (3402 to 2748) | 4422 (4617 to 4222) |
| NL black (N = 1933)           | 21299 (23109 to 19488) | 1722 (1950 to 1494) | 7303 (8339 to 6268) | 2012 (2541 to 1483) | 6881 (7957 to 5805) | 448 (529 to 368) | 4561 (5273 to 3848) | 3948 (4474 to 3422) |
| NL Asian (N = 523)            | 19090 (22858 to 15323) | 1793 (2595 to 991) | 5114 (6863 to 3364) | 863 (1168 to 559) | 5824 (7132 to 4516) | 443 (624 to 262) | 4257 (6215 to 2299) | 4264 (4878 to 3651) |
| Latino (N = 1685)             | 19277 (21106 to 17449) | 1356 (1487 to 1226) | 7435 (9013 to 5857) | 1783 (2239 to 1327) | 6232 (6907 to 5556) | 360 (453 to 268) | 3539 (4208 to 2869) | 3669 (3962 to 3376) |
| **With ADRD**                  |       |               |           |            |              |    |             |                   |
| NL white (N = 2028)           | 21839 (23458 to 20221) | 3394 (3790 to 2998) | 5907 (6896 to 4918) | 1046 (1239 to 853) | 5129 (5864 to 4394) | 465 (537 to 392) | 7780 (8747 to 6814) | 4987 (5328 to 4647) |
| NL black (N = 693)            | 29882 (25283 to 20681) | 2140 (2627 to 1653) | 7223 (8871 to 5576) | 1122 (1765 to 478) | 4417 (5256 to 3578) | 503 (652 to 355) | 9316 (10819 to 7814) | 3899 (4361 to 3436) |
| NL Asian (N = 120)            | 21164 (28226 to 14103) | 1631 (2868 to 394) | 5898 (11199 to 597) | 159 (-18 to 336) | 4252 (7709 to 2796) | 137 (215 to 59) | 6427 (9227 to 3626) | 4790 (6085 to 3496) |
| Latino (N = 579)              | 22832 (25973 to 19691) | 1896 (2414 to 1379) | 5462 (7706 to 3218) | 1063 (1779 to 348) | 5447 (6921 to 3972) | 699 (1028 to 370) | 9025 (10695 to 7356) | 4303 (5024 to 3582) |

Our adjusted analysis also showed that service-specific health care expenditures varied by racial and ethnic groups. Compared to whites without cognitive limitation, the equivalent blacks had lower $338 outpatient expenditures, $1072 office-based expenditures, and $422 prescription drug expenditures,
but higher $50 ER expenditures and $262 home health expenditures. Compared to whites without cognitive limitation, the equivalent Asians had lower $1086 outpatient expenditures, $1126 office-based expenditures, and $95 ER expenditures. Compared to whites without cognitive limitation, the equivalent Latinos had lower $522 inpatient expenditures, $631 outpatient expenditures, $838 office-based expenditures, and $405 prescription drug expenditures, but had higher $21 ER expenditures. Compared to whites with cognitive limitation without ADRD, the equivalent blacks had higher $1486 home health expenditures, the equivalent Asians had lower $1261 outpatient expenditures and $665 office-based expenditures, and the equivalent Latinos had lower $754 prescription drug expenditures. Compared to whites with ADRD, the equivalent blacks had lower $1089 prescription drug expenditures and the equivalent Asians had lower $887 outpatient expenditures and $328 ER expenditures. There were no differences in service-specific health care expenditures between whites and Latinos with ADRD.

Discussion
Our study documented that there were significant differences in total health care expenditures among racial and ethnic groups without cognitive limitation, but racial and ethnic differences in total health care expenditures were insignificant among those with cognitive limitation without ADRD and those with ADRD. This suggests that racial and ethnic minority groups may not experience limited access to care before and after a diagnosis of ADRD. Meanwhile, results showed the discrepancies between unadjusted summary of expenditures and predicted expenditures after adjusting individuals’ demographic and socioeconomic characteristics. First, our unadjusted analysis showed that Asians with cognitive limitation without ADRD had lower total health care expenditures than other racial and ethnic groups. However, this was not observed among Asians with ADRD. These indicate that Asians with cognitive decline but no ADRD may receive fewer health care services, possibly leading to late detection and diagnosis of ADRD. This explanation is likely plausible because Asians are more likely to lack a usual source of care (27, 28), leading to relatively lower health care utilization (29), especially for primary care, and preventive services (30). However, a significant difference was not detected in our adjusted analysis, probably due to a small sample size. Second, our unadjusted analysis showed
that consistent with findings from previous studies (8–10), blacks and Latinos with ADRD had higher total health care expenditures than the equivalent whites. However, significant differences were not observed after adjusting for demographic and socioeconomic status and health status. This phenomenon was found in incidence (31), but our findings confirmed that a similar result was observed in health care expenditures. This implies that higher expenditures among blacks and Latinos with ADRD may partly account for lower socioeconomic status and/or poorer health status.

On the other hand, blacks, Asians, and Latinos had significantly lower OOP expenditures than whites in both populations of those with cognitive limitation without ADRD and those with ADRD. Lower OOP expenditures among the racial and ethnic minority groups are likely to be attributable to differences in insurance coverage. As shown in our study, blacks, Asians, and Latinos were more likely to have additional insurance coverage such as Medicaid or private health insurance than whites. However, our findings should be not simply interpreted as indicating that the racial and ethnic minority groups have lower financial burden than whites. First, insurance premiums were not included in estimating OOP expenditures in this study. This may lead to underestimation of OOP expenditures, especially for the racial and ethnic minority groups who were more likely to have private insurance coverage. Second, the racial and ethnic minority groups may fear high costs of care, and thus have delayed or forgone care, especially for high-cost services that are less likely to be covered by insurance. Indeed, Latinos and Asians were shown to experience more delayed or forgone care than whites (32). Third, the racial and ethnic minority groups may replace high-costs services with informal care by family caregivers. One study found that Latinos and Asians were more likely to use informal home care and less likely to use formal care compared to whites (33). This could be feasible because of a relatively large family size of the racial and ethnic minority groups.

Our findings showed that service-specific expenditures varied by racial and ethnic groups, but similar trends were observed in both populations. First, blacks and Latinos had higher home health expenditures than whites in both populations. This may be attributable to the fact that they prefer home health care due to the presence of family members who can provide informal care (34) or cultural reasons (35). However, blacks and Latinos had lower prescription drug expenditures than
whites. This is likely to be explained by less contact with physicians, possibly resulting in fewer prescriptions being written (36). Research found that blacks and Latinos were more likely to have mental health visits to primary care providers rather than to specialists, leading to fewer prescriptions for psychotropics (37). On the other hand, Asians with cognitive limitation without ADRD had lower inpatient and outpatient expenditures than the equivalent whites. This may raise concern of delayed detection or diagnosis of ADRD as diagnostic services for disease detection are usually provided in inpatient or outpatient settings (8). However, Asians with ADRD had lower outpatient and ER expenditures than the equivalent whites. This may indicate that Asians manage health better as research showed that ADRD patients had rehospitalization or ER visits mainly due to poor care management such as injuries from falls (38). Further investigation is warranted to understand and identify determinants leading to variations in service-specific expenditures among racial and ethnic groups.

Our study has several limitations. First, MEPS surveys the civilian non-institutionalized US population, and thus our estimates did not account for patterns of health care expenditures for the civilian institutionalized US population. Second, MEPS does not include health care expenditures for SNF services. As racial and ethnic minority groups were shown to have lower expenditures for SNF services than whites, this is unlikely to reverse our findings. Third, MEPS reported Asian Americans and Pacific Islanders as a single group during 1999–2002, and thus we could not distinguish each other during this period. However, this is unlikely to affect our findings due to small sample size of Pacific Islanders. Fourth, MEPS provides limited information on ADRD severity, and thus we could not completely control for this factor. Fifth, we controlled for a range of demographic and socioeconomic characteristics, but we could not adjust for all other potential confounding factors. Sixth, the observed prevalence of ADRD may be inaccurate because we were limited to 3-digit ICD-9-CM or ICD-10-CM codes. Finally, our findings should be interpreted with caution as we did not examine whether whites have appropriate health care expenditures. Thus, we cannot rule out the possibility that whites may overutilize health care.

Conclusions
Our study documented that there were significant differences in total health care expenditures among racial and ethnic groups without cognitive limitation, but no significant differences were detected in total health care expenditures among racial and ethnic groups with cognitive limitation without ADRD and those with ADRD. However, there were substantial differences in OOP expenditures and service-specific expenditures among racial and ethnic groups with cognitive limitation without ADRD and those with ADRD. These findings have implications for future research. First, this work emphasizes that service-specific expenditures varied by racial and ethnic groups. Second, heterogeneous patterns of service-specific expenditures by racial and ethnic groups underscore the importance of future research in identifying determinants leading to variations in service-specific expenditures among racial and ethnic groups.

Declarations

**Ethics Approval and Consent to Participate:** Not applicable.

**Consent for Publication:** Not applicable.

**Availability of Data and Materials:** The datasets analyzed during the current study are available at https://meps.ahrq.gov/mepsweb/.

**Competing Interests:** The authors declare that they have no competing interests.

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