HHS Public Access

Author manuscript

J Racial Ethn Health Disparities. Author manuscript; available in PMC 2017 September 01.

Published in final edited form as:

J Racial Ethn Health Disparities. 2017 June ; 4(3): 462–471. doi:10.1007/s40615-016-0247-7.

A National Assessment of Medication Adherence to Statins by the Racial Composition of Neighborhoods

Andrew M. Davis, MD, MPH[1],
Division of General Internal Medicine, University of Chicago, Chicago, Illinois

Michael S. Taitel, PhD,
Clinical Outcomes and Analytic Services, Walgreen Co, Deerfield, Illinois

Jenny Jiang, PhD,
Clinical Outcomes and Analytic Services, Walgreen Co, Deerfield, Illinois

Dima M Qato, PharmD, MPH, PhD,
Department of Pharmacy Systems, Outcomes, and Policy, Center for Pharmacoepidemiology and Pharmacoeconomic Research, University of Illinois College of Pharmacy, Chicago, IL

Monica E. Peek, MD, MPH,
Division of General Internal Medicine, University of Chicago, Chicago, Illinois

Chia-Hung Chou, PhD, and
Division of General Internal Medicine, University of Chicago, Chicago, Illinois

Elbert S. Huang, MD, MPH
Division of General Internal Medicine, University of Chicago, Chicago, Illinois

Abstract

Adherence to statins is lower in black and Hispanic patients, and is linked to racial/ethnic disparities in cardiovascular mortality. Poverty, education, and prescription coverage differentials are typically invoked to explain adherence disparities, but analyses at the level of neighborhoods and their pharmacies may provide additional insights. Among individuals filling new statin prescriptions in a national pharmacy chain (N=326,171), we compared adherence for patients residing in mostly minority neighborhoods to those living in mainly white areas. In analyses adjusting for patient-level factors associated with poor adherence, including age, insurance, payer, prescription cost and convenience, patients residing in black and Hispanic neighborhoods had 2-3 weeks less statin therapy over one year, a pattern not seen in Asian areas. In black and Hispanic neighborhoods, good adherence was associated with copays under $10, the use of 90-day refills,

[1]Corresponding author - amd@uchicago.edu, 5841 S. Maryland Ave, MC3051, Chicago, IL 60637; 773-834-5921, 773-834-3945 (fax).

Conflict of Interest: Michael S. Taitel and Jenny Jiang are employees of Walgreen Company. The remaining authors (Davis, Peek, Chou, Qato, and Huang) all declare that they have no conflicts of interest.

Compliance with Ethical Standards:

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

IRB Review: The study protocol was approved by the Quorum Review IRB. All analysis was conducted on aggregate, deindentified data.

and payers other than Medicaid. Efforts to improve medication adherence for vulnerable populations may benefit from interventions at the level of local pharmacies, as well as medication benefit redesign.

Keywords

racial and ethnic disparities; medication adherence; statin therapy; cardiovascular disease; neighborhood; pharmacies

Introduction

Chronic diseases affect more than half of the U.S. adult population and are associated with three quarters of all hospitalizations.(1-3) Adherence to medications is critical to the prevention of hospitalizations related to these chronic diseases.(4) In the area of cardiovascular disease, better adherence to HMG-Co-A reductase inhibitors, or “statins,” leads to significant reductions in cardiovascular hospitalization, revascularization, mortality, (5-9) and lower overall health care costs.(10, 11)

Medication adherence to cardiovascular medications is lower among black and Hispanic patients. (12-15) and likely contributes to a persistent 7 year lower overall life expectancy in blacks relative to whites.(16, 17) Interventions designed to improve cardiac risk factor control among minorities appear to mitigate racial and ethnic disparities in cardiovascular health outcomes in some studies.(18, 19)

Factors associated with better medication adherence have been extensively studied,(20-22) and include those linked to the patient, their medical condition, therapy, insurance, care providers, and socioeconomic status. (4, 23-28) The challenge of improving disparities in medication adherence has typically focused on individual patient characteristics, such as age, education, health literacy, and insurance, with socioeconomic factors less explored.(4, 29)

Efforts to mitigate differentials in cardiovascular health outcomes and reduce health disparities in the United States could benefit from insights derived from geospatial analysis, and greater attention to the potential role of local retail pharmacies in minority neighborhoods. Residential segregation of ethnic/racial groups in the United States is well-documented, with blacks and Hispanics disproportionately cared for by a relatively small group of physicians(30) and hospitals.(31) Recent work from the Multi-Ethnic Study of Atherosclerosis (MESA) suggests that greater racial/ethnic segregation is associated with greater incident cardiovascular disease, even after adjusting for individual social economic position and cardiac risk factors.(32) Less appreciated is that ethnic and racial minorities are often receiving prescriptions from a select group of pharmacies, because of this segregation. The identification of relationships between neighborhoods, pharmacies, and medication adherence would have important implications for efforts designed to improve medication adherence.

This study takes advantage of the fact that over 86% of all U.S. blacks and Hispanics live within 5 miles of a retail pharmacy belonging to one national network, and leverages block group level socioeconomic data from the recent U.S. census to characterize the neighborhoods where these pharmacy customers reside. This allowed us to investigate predictors of medication adherence in a large well-defined national sample of patients with an initial prescription for statin therapy in 2012.

Our study aims to answer two important questions. First, in a national cohort of new statin users, are individuals residing in predominantly minority communities less likely to adhere to therapy, ***even after*** accounting for previously described patient-level factors associated with poor adherence, including age, insurance, payer, prescription cost and convenience. Second, we sought to identify predictors of high statin adherence among patients living in predominantly black and Hispanic neighborhoods.

Methods

We conducted a retrospective analysis of one-year medication adherence among patients filling a statin prescription for the first time between 1/1/12 and 3/31/12 at Walgreens, a national chain pharmacy with over 8,200 drugstores in all 50 states, the District of Columbia, Puerto Rico and the U.S. Virgin Islands. The Walgreens enterprise data warehouse contains patient and prescription records for all of its pharmacy transactions. The pharmacy record contains data related to the patient (age, gender, address, and preferred language), drug (therapeutic class, dose, quantity, and number of days' supply), primary payer type (private insurance, Medicare, Medicaid, and self-pay/uninsured), finance (sold date, cost, plan pay, and co-pay), and pharmacy (location and hours of operation). Race/ethnicity data were not routinely collected for individual patients.

We used the patient address from the pharmacy record as input to a geographic information system (GIS) to define the location as longitude, latitude and Federal Information Processing Standards (FIPS) code. The FIPS code was then merged with 2010 US census block level data. The census data included block-level demographic variables such as race/ethnicity (White, Black, Asian, and Hispanic), household income, education levels, and average household members. In addition, we used the Rural-Urban Commuting Area Codes (RUCAs) to determine urbanicity (metro, micro, rural, and small town). A typical block group has 1500 (600-3000) residents, a census area five-fold finer than the zip code or census tract, allowing more reliable attribution of neighborhood characteristics to each patient.

The percentage of incomes below the Federal poverty level for each patient's neighborhood of residence was defined using 2010 U.S. Census Bureau Poverty Thresholds, which are derived from the average household income and the average number of household members in each block group. (www.census.gov/hhes/www/poverty/about/overview/measure.html)

Measures

Patient medication adherence was estimated based on prescription fill records, which are a common proxy for actual adherence.(33) In this study, we defined adherence as 'patient days

on therapy' (PDOT) for their statin medication. PDOT is calculated by counting the number of days when a patient has medication available during the one-year observation period that spans from the index fill date to the index fill date plus 365 days. We also expressed our findings as the percentage of patients achieving 80% adherence.(34) For this calculation, we determined proportion of days covered (PDC) which is PDOT/365 and defined a patient as adherent if their ratio was greater than or equal to 80%. Patients were defined as new-to-therapy (NTT) if they had no record of a statin prescription in the prior 36 months in the pharmacy database.

A generalized linear model quantified the association between patient statin adherence (PDOT) at 12 months and block group racial composition (Black, Hispanic, and Asian), adjusting for individual factors of age, gender, payer (Medicaid, Medicare, private insurance, self-pay/uninsured), co-pay amount ($0, >$0.00-$5.00, >$5.00-$10.00, >$10.00-$15.00, > $15.00), use of 30-day vs. 90-day refills, as well as urbanicity, the neighborhood characteristics of urban (metro and micro) vs. other (rural and small town) location, educational attainment (% of residents with some college), and poverty level.

In addition, we used a logistic regression model to evaluate the predictors for adherent statin patients (PDC>=0.8) living in majority black or Hispanic neighborhood areas, and a generalized linear regression model to measure the relationship between adherence and copayment levels. All data analyses were performed with SAS 9.2 software (SAS Institute Inc, Cary, North Carolina). The level of significance for hypothesis testing was set at 0.05. The study protocol was approved by the Quorum Review IRB.

Results

Sample Description

There were 391,668 patients identified as new to therapy for a statin medication during the first 3 months of 2012; 332,193 of these patients had a valid home address that mapped to a FIPS code. A total of 326,171 patients had complete payer data and constituted the study cohort. Their mean age was 60.2 years, and 49.5% were female.

The study cohort closely paralleled U.S. census distributions. For example, of the block groups represented by the study cohort, 8.9% had at least 50% Black residency, compared to 8.8% of all U.S. residents in the 2010 US census; for Hispanic majority block groups, the figures were 9.9% of the cohort, compared to 10.0% in the census. When we analyzed the distribution by patient home address, rather than block group, 8.0 – 9.9% of study patients resided in block groups with at least 50% minority representation.

Descriptive Analysis

Characteristics of the study cohort are shown in table 1. Patients living in block groups with at least 50% black residency tended to be younger, female, have lower copays, use more Medicaid, have lower incomes, be less educated, and more likely reside in an urban area, compared to patients living in neighborhoods with lower proportions of black residents. A similar pattern was seen for patients residing in majority Hispanic block groups. For patients residing in majority Asian block groups, age was similar, but there were fewer females,

lower copays, more private insurance, higher income, better education, and greater urbanicity, compared to study cohort patients residing in block groups with lower proportions of Asian population. Greater numbers of patients residing in majority Hispanic and Asian block groups expressed a preference for 'communication in a language other than English'. Use of a 90-day supply at the time of the initial prescription fill was less likely for patients residing in majority black and Hispanic neighborhoods. We also examined differential continuity within the pharmacy chain as an alternative explanation for reduced adherence. Only modest differences were found, with 77% of those from Hispanic neighborhoods, and 79% of those from black majority neighborhoods filling prescriptions in the pharmacy chain in the following calendar year (2013), compared to a 81% rate in more white neighborhoods.

Modeling Results

Patients residing in majority black and Hispanic block groups had lower statin adherence compared to patients residing in non-minority block groups, even after controlling for multiple confounders. For patients residing in block groups with at least 50% black population, the 12 month mean PDOT was 161.0 days compared to 184.9 for patients living in block groups with a lower proportion of blacks. Similarly, patients residing in block groups with at least 50% Hispanic residency had a 12 month mean PDOT of 165.2 days compared to 180.7 for patients in non-Hispanic block groups. There was no effect seen for those residing in predominantly Asian block groups (Table 2).

Restricting the analyses to patients living in block groups with higher concentrations (50% or more) of black or Hispanic residents, we compared patients with excellent adherence (defined as PDC >=80%) to the overall cohort of patients living in that same block group. In multivariate logistic regression models, more adherent patients residing in either majority black or Hispanic block groups were significantly older, male, on Medicare, taking more than one chronic medication, and less likely to pay cash, to have a 90-day refill policy and lower copays. More adherent patients residing in majority Hispanic block groups were also more likely to speak English (Tables 3, 4). The finding that patients residing more than 5 miles from the closest pharmacy had higher adherence was accounted for by higher rates of residence in rural and suburban areas, in areas with less poverty, as well as greater use of 90 day refills, and lower rates of Medicaid coverage.

Discussion

In this paper we have documented large and clinically significant differentials in medication adherence in a large national cohort of patients beginning statin therapy in 2012, for individuals residing in predominantly Black and Hispanic neighborhoods. These differentials remained even after adjusting for payer, co-pay amount, complexity of medication regimen, as well as two key census tract proxies associated with social disadvantage, median household income, and percent of residents with some college. These statistical adjustments are important to better understand racial and ethnic differentials in cardiovascular outcomes, given the complex associations of race and ethnicity with education and poverty.

Our findings are consistent with prior research evaluating the association of neighborhood characteristics and cardiovascular medication adherence and outcomes. For instance, one paper assessed adherence to cardiovascular therapy following admission for acute coronary syndrome and demonstrated clear neighborhood differentials in southeastern Michigan. (35) While a recent MESA study showing greater incident CVD for blacks living in racially segregated neighborhoods,(32) we demonstrate poorer medication adherence in both black and Hispanic predominant neighborhoods. Recent research has also described 'pharmacy deserts', areas with poorer access to pharmacy service, as more often located in segregated black communities, as well as in low-income communities and federally designated Medically Underserved Areas.(36)

Our study methodology provides a useful advance in addressing knowledge gaps around residential segregation and CVD disparities,(37) as these and the majority of adherence studies have been limited geographically, with many focusing only on insured populations. Race and ethnic data are not consistently collected in national prescription databases, by managed care, or in specialty society cardiovascular therapy quality collaboratives.(38) Pharmacy administrative database predictors of medication adherence on their own have not performed especially well in predicting statin adherence, (39) and a more nuanced approach which includes both pharmacy and socioeconomic variables is also supported by recent research linking statin adherence in peripheral artery disease(38) and the cardiovascular outcome of survival after cardiac surgery, to socioeconomic position,(40) rather than to race per se.

The higher levels of non-adherence to preventive medications by individuals residing in predominantly black and Hispanic neighborhoods may offer avenues to monitor and test strategies to mitigate racial and ethnic health disparities. Pharmacies in predominantly minority neighborhoods have been shown to offer less access to pain medications(41), and nicotine replacement therapy(42). Patients who have participated in brief face-to-face counseling sessions with a community pharmacist at the beginning of statin therapy demonstrate greater medication adherence and persistency(43), and more aggressive and tailored approaches to improve adherence are beginning to be explored(44-48). Neighborhood pharmacies located in minority neighborhoods, are potentially well positioned to serve as the locus for community level interventions designed to improve health, not only through appropriate stocking and staffing, and tailored adherence programs, but also through direct patient services. In the Walgreens network alone, there are currently over 2000 retail stores in the continental U.S. located in communities with at least 30% black or Hispanic population. Increasingly, the neighborhood retail pharmacy is being conceptualized as a neighborhood health asset and source of preventive services, for instance serving as a source of healthier foods in food deserts,(49, 50) and of vaccination programs coordinated with local hospitals.(51)

A number of policy and benefit design interventions have also shown value in improving adherence, including policy interventions to reduce copayments, systems interventions to offer case management, and patient-level educational interventions with behavioral support. (52) Cost sharing has been associated with increasing adverse events and the poor and elderly,(53) and elimination of copays has been associated with improved adherence in

numerous studies. (23, 25, 54), without increasing total spending.(55) A greater proportion of patients in our study residing in predominantly black and Hispanic neighborhoods had co-pays under $10 for their statin prescription, and lower annual total copay amounts. Expanding the use of 90-day fills is a testable medication policy change that may hold promise in improving adherence for some chronic medications, as the prevalence of this approach was 30% lower for patients residing in black and Hispanic majority neighborhoods, relative to the full cohort. In our model Medicaid as a payer remained a strong predictor of poorer statin adherence in predominantly black and Hispanic neighborhoods, suggesting that national Medicaid expansion in itself may be insufficient to strongly reduce adherence disparities.

In a time major health care system change, our approach describes a practical and iterative process that can help assess whether the ‘natural experiments’ of state and national policy changes have differential impacts on adherence in predominantly minority communities. Twenty-six states have declined to participate in the Medicaid expansion promulgated under the Affordable Care Act. Commercial pharmacy chains with national reach and a strong presence in minority neighborhoods have the opportunity to evaluate differential trends as state policies shift. As an illustration, in 2000-2002 North Carolina Medicaid policy reduced the days supplied with prescriptions from 100 to 34 days, and significantly hurt adherence, though these results were not published until 2011.(56)

These study findings also have implications for the equity of national quality metrics related to medication adherence. Recent work has shown that the socioeconomic characteristics of enrollees have a significant effect on drug adherence performance measures for Medicare Part D contractors.(57) Moreover, the Centers for Medicare and Medicaid Services Five-Star Quality Rating System specifies that for health plans to achieve 5 stars, at least 75% of covered patients will need to obtain at least 80% of medication prescribed to them in the 3 classes of statins, anti-hypertensive medications, and hypoglycemic medications.(58) Clinical practices, networks, and health plans most involved in the care for vulnerable racial and ethnic populations may face real disadvantages as they are held accountable for coordinated care, which typically carry an expectation of better patient adherence to medication care plans.

Limitations

The socioeconomic variables are inferred from the individual patient’s home address, and may not completely capture the extent of neighborhood social disadvantage, or other unmeasured confounders. Prescriptions obtained from other sources were not available for analysis, and some ‘new-to-therapy’ prescriptions may represent chronic therapy transferred from another pharmacy source. While some patients may have filled prescriptions at other pharmacies, we believe our findings are representative of all large pharmacy chains which account for the majority of prescriptions dispensed in the U.S. Indeed, the use of data from a national chain may underestimate disparities in adherence, as state-level analysis suggests that the costs of retail prescriptions are highest for independent pharmacies in poorer neighborhoods.(59)

Adherence was inferred from prescription refill behavior derived from a single national pharmacy chain, though chain pharmacies provide the majority of U.S. prescriptions, this chain has strong presence in minority block groups, and prior research has suggested little affect in statin adherence between different types of community pharmacies.(60) While some patients may fill prescriptions at multiple pharmacies, in a large nationally representative sample 90% of patients filled statin and ACE/ARB prescriptions at a single pharmacy(61), and about 80% of our patients continued to fill prescriptions with the chain during the following year. While copays may vary by state, the consistency of these findings in a national sample is an important contribution to the literature. The correspondence between locally defined neighborhood and census block group is not precise, but permits a national analysis such as ours. The small area size of block group, relative to census tracts and zip codes, appears to reduce the risk of misclassification.(62) Finally other unmeasured neighborhood characteristics, such as resident-perceived social cohesion, may affect adherence and have been shown to ameliorate the risk of myocardial infarction.(63)

Conclusions

Clinically important disparities in statin adherence are found for individuals residing in predominantly black and Hispanic neighborhoods, even after controlling for age, co-pay, payer, and basic neighborhood socioeconomic factors. This process can also inform and assess programs targeted at the neighborhood level to improve adherence, and potentially reduce cardiovascular mortality. Local retail pharmacies in minority neighborhoods may be fruitful vehicles for disparity reduction interventions. Awareness and monitoring of national and local adherence patterns and exploration of their relation to various neighborhood characteristics can help assess the effects of national and state coverage and policy changes, in a relatively rapid and iterative manner. Expanding Medicaid coverage and co-pay policy changes alone will be insufficient to eliminate adherence differentials in predominantly black and Hispanic neighborhoods. These adherence differentials also call attention to the equity of national quality metrics for medication adherence, for clinicians and groups providing care in these settings.

References

1. Ward BW, Schiller JS. Prevalence of multiple chronic conditions among US adults: estimates from the National Health Interview Survey, 2010. Preventing chronic disease. 2013; 10:E65. PubMed PMID: 23618545. Pubmed Central PMCID: 3652717. [PubMed: 23618545]
2. Kung HCHD, Xu JQ, Murphy SL. Deaths: final data for 2005. National Vital Statistics Reports. 2008; 56(10) Deaths: final data for 2005. National Vital Statistics Reports. 2008;56(10).
3. Steiner CA, Friedman B. Hospital utilization, costs, and mortality for adults with multiple chronic conditions, Nationwide Inpatient Sample, 2009. Preventing chronic disease. 2013; 10:E62. PubMed PMID: 23618542. Pubmed Central PMCID: 3652722. [PubMed: 23618542]
4. Osterberg L, Blaschke T. Adherence to medication. N Engl J Med. Aug 4; 2005 353(5):487–97. PubMed PMID: 16079372. [PubMed: 16079372]
5. Baroletti S, Dell'Orfano H. Medication adherence in cardiovascular disease. Circulation. Mar 30; 2010 121(12):1455–8. PubMed PMID: 20351303. Epub 2010/03/31. eng. [PubMed: 20351303]
6. Pittman DG, Chen W, Bowlin SJ, Foody JM. Adherence to statins, subsequent healthcare costs, and cardiovascular hospitalizations. The American journal of cardiology. Jun 1.2011 2011. Epub 2011 Mar;107(11).

7. Wei L, Wang J, Thompson P, Wong S, Struthers AD, MacDonald TM. Adherence to statin treatment and readmission of patients after myocardial infarction: a six year follow up study. Heart. Sep; 2002 88(3):229–33. PubMed PMID: 12181210. Pubmed Central PMCID: 1767352. [PubMed: 12181210]
8. Shi L, Ye X, Lu M, Wu EQ, Sharma H, Thomason D, et al. Clinical and Economic Benefits Associated With the Achievement of Both HbA1c and LDL Cholesterol Goals in Veterans With Type 2 Diabetes. Diabetes care. Oct; 2013 36(10):3297–304. PubMed PMID: 23801723. Pubmed Central PMCID: 3781519. [PubMed: 23801723]
9. Bitton A, Choudhry NK, Matlin OS, Swanton K, Shrank WH. The impact of medication adherence on coronary artery disease costs and outcomes: a systematic review. Am J Med. Apr; 2013 126(4): 357 e7–e27. PubMed PMID: 23507208.
10. Wu J, Seiber E, Lacombe VA, Nahata MC, Balkrishnan R. Medical utilization and costs associated with statin adherence in Medicaid enrollees with type 2 diabetes. Ann Pharmacother. Mar; 2011 45(3):342–9. PubMed PMID: 21325098. [PubMed: 21325098]
11. Aubert RE, Yao J, Xia F, Garavaglia SB. Is there a relationship between early statin compliance and a reduction in healthcare utilization? The American journal of managed care. 2010; 16(6) 2010.
12. Gellad WF, Haas JS, Safran DG. Race/ethnicity and nonadherence to prescription medications among seniors: results of a national study. Journal of general internal medicine. Nov; 2007 22(11): 1572–8. PubMed PMID: 17882499. Pubmed Central PMCID: 2219813. [PubMed: 17882499]
13. Gerber BS, Cho YI, Arozullah AM, Lee SY. Racial differences in medication adherence: A cross-sectional study of Medicare enrollees. Am J Geriatr Pharmacother. Apr; 2010 8(2):136–45. PubMed PMID: 20439063. [PubMed: 20439063]
14. Qato DM, Lindau ST, Conti RM, Schumm LP, Alexander GC. Racial and ethnic disparities in cardiovascular medication use among older adults in the United States. Pharmacoepidemiology and drug safety. Aug; 2010 19(8):834–42. PubMed PMID: 20681002. [PubMed: 20681002]
15. Lewey J, Shrank WH, Bowry AD, Kilabuk E, Brennan TA, Choudhry NK. Gender and racial disparities in adherence to statin therapy: a meta-analysis. Am Heart J. May; 2013 165(5):665–78. 78 e1. PubMed PMID: 23622903. [PubMed: 23622903]
16. Kochanek, KD., Arias, E., Anderson, RN. How Did Cause of Death Contribute to Racial Differences in Life Expectancy in the United States in 2010?. Hyattsville, MD: 2013.
17. Arias, E. United States Life Tables, 2009. In: NCHS. , editor. National Center for Health Statistics; Hyattsville, MD: 2014.
18. Beohar NSV, Davis AM, Srinivas VS, Helmy T, Althouse AT, Thomas SB, Brooks MM, the BARI 2D Study Group. Race/Ethnic Disparities in Risk Factor Control and Survival in the Bypass Angioplasty Revascularization Investigation 2 Diabetes (BARI 2D) Trial. The American journal of cardiology. Nov.2013
19. Davis AM, Vinci LM, Okwuosa TM, Chase AR, Huang ES. Cardiovascular health disparities: a systematic review of health care interventions. Medical care research and review : MCRR. Oct; 2007 64(5 Suppl):29S–100S. PubMed PMID: 17881625. Pubmed Central PMCID: 2367222. [PubMed: 17881625]
20. Doggrell SA. Adherence to medicines in the older-aged with chronic conditions: does intervention by an allied health professional help? Drugs & aging. Mar 1; 2010 27(3):239–54. PubMed PMID: 20210369. [PubMed: 20210369]
21. Sokol MC, McGuigan KA, Verbrugge RR, Epstein RS. Impact of medication adherence on hospitalization risk and healthcare cost. Med Care. Jun; 2005 43(6):521–30. PubMed PMID: 15908846. [PubMed: 15908846]
22. Ho PM, Bryson CL, Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation. Jun 16; 2009 119(23):3028–35. PubMed PMID: 19528344. [PubMed: 19528344]
23. Schneeweiss S, Patrick AR, Maclure M, Dormuth CR, Glynn RJ. Adherence to statin therapy under drug cost sharing in patients with and without acute myocardial infarction: a population-based natural experiment. Circulation. Apr 24.2007 2007. (Epub 2007 Apr;115(16).

24. Stecker EC, Riles EM, Fendrick AM. Value-based insurance design in cardiology: using “clinical nuance” to improve quality of care and contain costs. Journal of the American College of Cardiology. Oct 30; 2012 60(18):1825–7. PubMed PMID: 23040579. [PubMed: 23040579]
25. Choudhry NK, Fischer MA, Avorn JL, Lee JL, Schneeweiss S, Solomon DH, et al. The impact of reducing cardiovascular medication copayments on health spending and resource utilization. Journal of the American College of Cardiology. Oct 30; 2012 60(18):1817–24. PubMed PMID: 23040581. [PubMed: 23040581]
26. Steiner JF. Can we identify clinical predictors of medication adherence… and should we? Med Care. Mar; 2010 48(3):193–5. PubMed PMID: 20182266. Epub 2010/02/26. eng. [PubMed: 20182266]
27. Wong MCS, Wang HHX, Liu KSD. Non-adherence to lipid-lowering therapies: a need for more studies to evaluate reasons for medication non-adherence. International journal of clinical practice. 2011; 65(12) 2011.
28. Goldman DP, Joyce GF, Karaca-Mandic P. Varying pharmacy benefits with clinical status: the case of cholesterol-lowering therapy. Am J Manag Care. Jan; 2006 12(1):21–8. PubMed PMID: 16402885. [PubMed: 16402885]
29. AlGhurair SA, Hughes CA, Simpson SH, Guirguis LM. A systematic review of patient self-reported barriers of adherence to antihypertensive medications using the world health organization multidimensional adherence model. Journal of clinical hypertension. Dec; 2012 14(12):877–86. PubMed PMID: 23205755. [PubMed: 23205755]
30. Bach PB, Pham HH, Schrag D, Tate RC, Hargraves JL. Primary care physicians who treat blacks and whites. N Engl J Med. Aug 5; 2004 351(6):575–84. PubMed PMID: 15295050. [PubMed: 15295050]
31. Jha AK, Orav EJ, Zheng J, Epstein AM. The characteristics and performance of hospitals that care for elderly Hispanic Americans. Health affairs. Mar-Apr;2008 27(2):528–37. PubMed PMID: 18332511. [PubMed: 18332511]
32. Kershaw KN, Osypuk TL, Do DP, De Chavez PJ, Diez Roux AV. Neighborhood-level racial/ethnic residential segregation and incident cardiovascular disease: the multi-ethnic study of atherosclerosis. Circulation. Jan 13; 2015 131(2):141–8. PubMed PMID: 25447044. Pubmed Central PMCID: 4293329. [PubMed: 25447044]
33. Choo PW, Rand CS, Inui TS, Lee ML, Cain E, Cordeiro-Breault M, et al. Validation of patient reports, automated pharmacy records, and pill counts with electronic monitoring of adherence to antihypertensive therapy. Med Care. Sep; 1999 37(9):846–57. PubMed PMID: 10493464. [PubMed: 10493464]
34. Cramer JA, Roy A, Burrell A, Fairchild CJ, Fuldeore MJ, Ollendorf DA, et al. Medication compliance and persistence: terminology and definitions. Value in health : the journal of the International Society for Pharmacoeconomics and Outcomes Research. Jan-Feb;2008 11(1):44–7. PubMed PMID: 18237359. [PubMed: 18237359]
35. Hoang C, Kolenic G, Kline-Rogers E, Eagle KA, Erickson SR. Mapping geographic areas of high and low drug adherence in patients prescribed continuing treatment for acute coronary syndrome after discharge. Pharmacotherapy. 2011; 31(10) 2011. PubMed PMID: MEDLINE:21950639.
36. Qato DM, Daviglus ML, Wilder J, Lee T, Qato D, Lambert B. ‘Pharmacy Deserts’ Are Prevalent In Chicago’s Predominantly Minority Communities, Raising Medication Access Concerns. Health affairs. Nov 1; 2014 33(11):1958–65. PubMed PMID: 25367990. [PubMed: 25367990]
37. Correa A, Greer S, Sims M. Assessing neighborhood-level effects on disparities in cardiovascular diseases. Circulation. Jan 13; 2015 131(2):124–7. PubMed PMID: 25447043. Pubmed Central PMCID: 4445825. [PubMed: 25447043]
38. Subherwal S, Patel MR, Tang F, Smolderen KG, Jones WS, Tsai TT, et al. Socioeconomic Disparities in the Use of Cardioprotective Medications Among Patients With Peripheral Artery Disease: An Analysis of the American College of Cardiology’s NCDR PINNACLE Registry. Journal of the American College of Cardiology. Jul 2; 2013 62(1):51–7. PubMed PMID: 23643497. [PubMed: 23643497]
39. Chan DC, Shrank WH, Cutler D, Jan S, Fischer MA, Liu J, et al. Patient, physician, and payment predictors of statin adherence. Medical care. 2010; 48(3) 2010.

40. Koch CG, Li L, Kaplan GA, Wachterman J, Shishehbor MH, Sabik J, et al. Socioeconomic position, not race, is linked to death after cardiac surgery. Circulation Cardiovascular quality and outcomes. May; 2010 3(3):267–76. PubMed PMID: 20371761. [PubMed: 20371761]
41. Morrison RS, Wallenstein S, Natale DK, Senzel RS, Huang LL. "We don't carry that"--failure of pharmacies in predominantly nonwhite neighborhoods to stock opioid analgesics. N Engl J Med. Apr 6; 2000 342(14):1023–6. PubMed PMID: 10749965. [PubMed: 10749965]
42. Bernstein SL, Cabral L, Maantay J, Peprah D, Lounsbury D, Maroko A, et al. Disparities in access to over-the-counter nicotine replacement products in New York City pharmacies. American journal of public health. Sep; 2009 99(9):1699–704. PubMed PMID: 19638596. Pubmed Central PMCID: 2724461. [PubMed: 19638596]
43. Taitel M, Jiang J, Rudkin K, Ewing S, Duncan I. The impact of pharmacist face-to-face counseling to improve medication adherence among patients initiating statin therapy. Patient preference and adherence. 2012; 6:323–9. PubMed PMID: 22563240. Pubmed Central PMCID: 3340117. [PubMed: 22563240]
44. Ho PM, Lambert-Kerzner A, Carey EP, Fahdi IE, Bryson CL, Melnyk SD, et al. Multifaceted intervention to improve medication adherence and secondary prevention measures after acute coronary syndrome hospital discharge: a randomized clinical trial. JAMA internal medicine. Feb 1; 2014 174(2):186–93. PubMed PMID: 24247275. [PubMed: 24247275]
45. Zillich AJ, Jaynes HA, Snyder ME, Harrison J, Hudmon KS, de Moor C, et al. Evaluation of specialized medication packaging combined with medication therapy management: adherence, outcomes, and costs among Medicaid patients. Med Care. Jun; 2012 50(6):485–93. PubMed PMID: 22498687. [PubMed: 22498687]
46. Brennan TA, Dollear TJ, Hu M, Matlin OS, Shrank WH, Choudhry NK, et al. An integrated pharmacy-based program improved medication prescription and adherence rates in diabetes patients. Health affairs. Jan; 2012 31(1):120–9. PubMed PMID: 22232102. [PubMed: 22232102]
47. Gerber BS, Cano AI, Caceres ML, Smith DE, Wilken LA, Michaud JB, et al. A pharmacist and health promoter team to improve medication adherence among Latinos with diabetes. Ann Pharmacother. Jan; 2010 44(1):70–9. PubMed PMID: 20028957. [PubMed: 20028957]
48. Akinbosoye OE, Taitel MS, Grana J, Hill J, Wade RL. Improving Medication Adherence and Health Care Outcomes in a Commercial Population Through a Community Pharmacy. Population health management. Apr 1.2016 PubMed PMID: 27035728.
49. Larson C, Haushalter A, Buck T, Campbell D, Henderson T, Schlundt D. Development of a Community-Sensitive Strategy to Increase Availability of Fresh Fruits and Vegetables in Nashville's Urban Food Deserts, 2010-2012. Preventing chronic disease. 2013; 10:E125. PubMed PMID: 23886044. Pubmed Central PMCID: 3725846. [PubMed: 23886044]
50. Goddu AP, Roberson TS, Raffel KE, Chin MH, Peek ME. Food Rx: a community-university partnership to prescribe healthy eating on the South Side of Chicago. Journal of prevention & intervention in the community. 2015; 43(2):148–62. PubMed PMID: 25898221. Pubmed Central PMCID: 4416784. [PubMed: 25898221]
51. Mills B, Fensterheim L, Taitel M, Cannon A. Pharmacist-led Tdap vaccination of close contacts of neonates in a women's hospital. Vaccine. Jan 16; 2014 32(4):521–5. PubMed PMID: 24269619. [PubMed: 24269619]
52. Viswanathan M, Golin CE, Jones CD, Ashok M, Blalock SJ, Wines RC, et al. Interventions to improve adherence to self-administered medications for chronic diseases in the United States: a systematic review. Ann Intern Med. Dec 4; 2012 157(11):785–95. PubMed PMID: 22964778. [PubMed: 22964778]
53. Tamblyn R, Laprise R, Hanley JA, Abrahamowicz M, Scott S, Mayo N, et al. Adverse events associated with prescription drug cost-sharing among poor and elderly persons. JAMA. Jan 24-31; 2001 285(4):421–9. PubMed PMID: 11242426. [PubMed: 11242426]
54. Ye X, Gross CR, Schommer J, Cline R, St Peter WL. Association between copayment and adherence to statin treatment initiated after coronary heart disease hospitalization: a longitudinal, retrospective, cohort study. Clinical therapeutics. 2007; 29(12) 2007.
55. Choudhry NK, Avorn J, Glynn RJ, Antman EM, Schneeweiss S, Toscano M, et al. Full coverage for preventive medications after myocardial infarction. The New England journal of medicine. Dec 1.2011 2011 Epub 2011 Nov;365(22).

56. Domino ME, Martin BC, Wiley-Exley E, Richards S, Henson A, Carey TS, et al. Increasing time costs and copayments for prescription drugs: an analysis of policy changes in a complex environment. Health services research. Jun; 2011 46(3):900–19. PubMed PMID: 21306363. Pubmed Central PMCID: 3087836. [PubMed: 21306363]
57. Young GJ, Rickles NM, Chou CH, Raver E. Socioeconomic characteristics of enrollees appear to influence performance scores for medicare part d contractors. Health affairs. Jan; 2014 33(1):140–6. PubMed PMID: 24395946. [PubMed: 24395946]
58. Marcum ZA, Sevick MA, Handler SM. Medication nonadherence: a diagnosable and treatable medical condition. JAMA. May 22; 2013 309(20):2105–6. PubMed PMID: 23695479. [PubMed: 23695479]
59. Gellad WF, Choudhry NK, Friedberg MW, Brookhart MA, Haas JS, Shrank WH. Variation in drug prices at pharmacies: are prices higher in poorer areas? Health services research. Apr; 2009 44(2 Pt 1):606–17. PubMed PMID: 19178584. Pubmed Central PMCID: 2677057. [PubMed: 19178584]
60. Evans CD, Eurich DT, Lamb DA, Taylor JG, Jorgenson DJ, Semchuk WM, et al. Retrospective observational assessment of statin adherence among subjects patronizing different types of community pharmacies in Canada. J Manag Care Pharm. Jul-Aug;2009 15(6):476–84. PubMed PMID: 19610680. [PubMed: 19610680]
61. Choudhry NK, Fischer MA, Avorn J, Liberman JN, Schneeweiss S, Pakes J, et al. The implications of therapeutic complexity on adherence to cardiovascular medications. Arch Intern Med. May 9; 2011 171(9):814–22. PubMed PMID: 21555659. [PubMed: 21555659]
62. Duncan DT, Kawachi I, Subramanian SV, Aldstadt J, Melly SJ, Williams DR. Examination of How Neighborhood Definition Influences Measurements of Youths' Access to Tobacco Retailers: A Methodological Note on Spatial Misclassification. American journal of epidemiology. Oct 22.2013 PubMed PMID: 24148710.
63. Kim ES, Hawes AM, Smith J. Perceived neighbourhood social cohesion and myocardial infarction. J Epidemiol Community Health. Aug 18.2014 PubMed PMID: 25135074.

Table 1

Demographic Characteristics, Grouped by Census Characteristics in Block Group of Patient Residence

	*Under 50% Black (n=300,315)	*>=50% Black (n=25,856)	*Under 50% Hispanic (n=293,867)	*>=50% Hispanic (n=32,304)	*Under 50% Asian (n=323,493)	*>=50% Asian (n=2,678)
Female %	48.73	58.45	49.25	51.78	49.53	46.27
Age (Y), mean	60.36	58.63	60.45	58.22	60.35	60.22
No. of Therapeutic classes, mean	3.31	3.73	3.33	3.40	3.34	3.04
initial fill copay group% (adjusted to 30-day)						
0	21.19	22.68	20.87	25.36	21.28	24.91
>0 to 5	30.61	38.65	30.75	35.78	31.20	36.74
>5 to 10	22.26	19.01	22.49	17.52	22.04	17.10
>10 to 15	6.90	6.41	6.85	6.99	6.87	6.20
>15	19.04	13.25	19.04	14.36	18.61	15.05
Annual Total Copay,mean	49.71	29.82	50.0	31.23	48.23	36.75
Primary Insurance%						
Medicaid	3.94	10.42	4.12	7.50	4.46	3.81
Medicare	31.90	32.14	32.00	31.32	31.97	26.44
Private	57.14	50.32	57.20	51.09	56.56	60.83
Self pay/uninsured	7.02	7.12	6.70	10.08	7.01	8.92
Language preference as English%	97.02	99.08	98.90	81.49	97.23	91.85
90-day as initial fill%	30.03	18.53	29.82	22.72	29.1	30.77
24h pharmacy Store for initial fill%	30.66	32.03	30.20	35.92	30.80	27.00
Distance(miles) between home to pharmacy%						
<=0.5	15.96	20.61	15.29	25.84	16.14	39.21
>0.5 to<2	54.24	63.47	54.30	61.06	54.99	52.24
>=2 to <5	17.03	12.24	17.51	8.83	16.73	7.65
>=5	12.77	3.68	12.90	4.27	12.14	0.90
*Annual Household Income ($), mean	62,207	38,109	62,369	41,446	60,154	77,579
*Poverty-Yes%	0.82	6.01	0.73	5.80	1.24	0.41
*some college%	58.3	44.44	59.42	37.07	57.17	61.84
*Urbanicity						
Urban	94.60	97.79	94.43	98.92	94.81	100.00
Other	5.30	2.20	5.56	1.07	5.19	0.00

* Data fields are inferred by GIS block groupdata

Table 2

Patient Days on Therapy (PDOT) by proportion of Black or Hispanic or Asian population in block group

	Under 50%		*>=50%*		*p**
	N	***PDOT (95% confidence Interval***	***N***	***PDOT (95% confidence Interval***	
Black Unadjusted	300,315	203.4(202.9-203.8)	25,856	167.6(166.1-169.1)	<.01
Black Adjusted	300,315	184.9(167.9-201.9)	25,856	161.0(144.0-178.0)	<.01
Hispanic Unadjusted	293,867	203.8(203.3-204.3)	32,304	170.7(169.3-172.0)	<.01
Hispanic Adjusted	293,867	180.7(163.8-197.7)	32,304	165.2(148.2-182.2)	<.01
Asian Unadjusted	323,493	200.5(200.1-201.0)	2,678	199.5(194.9-204.6)	0.75
Asian Adjusted	323,493	173.2(156.3-190.0)	2,678	172.8(155.4-190.1)	0.84

p value shows the significance of difference between means

Table 3

Predictors for Adherent Patients residing in majority Black census block group (N=25,856)

Predictors of Adherence>=80%	Odds Ratio	95% Wald Confidence Limits		P-Value
Age (Y), mean	1.021	1.019	1.024	<.0001
Gender				
Male(reference)				
Female	0.932	0.871	0.996	0.0376
Initial fill copay group %				
0 (reference)				
>0 to 5	0.835	0.769	0.906	<.0001
>5 to 10	0.558	0.501	0.622	<.0001
>10 to 15	0.359	0.301	0.427	0.0295
>15	0.072	0.058	0.088	<.0001
Annual Total Copay, mean	1.014	1.014	1.015	<.0001
No. of Therapeutic classes, mean	1.185	1.166	1.204	<.0001
Primary Insurance %				
Private (reference)				
Medicaid	0.764	0.669	0.872	0.015
Medicare	1.268	1.17	1.375	<.0001
Self pay/uninsured	0.583	0.496	0.684	<.0001
Language preference				
English (reference)				
Other than English	0.895	0.619	1.292	0.5532
90-day as initial fill %				
Yes (reference)				
No	0.464	0.43	0.501	<.0001
Distance(miles) between home to pharmacy %				
<=0.5 (reference)				
>0.5 to<2	1.13	1.006	1.27	0.7998
>=2 to <5	1.028	0.945	1.118	0.0008
>=5	1.465	1.209	1.775	0.0003
24h pharmacy Store for initial fill %				
Yes (reference)				
No	1.011	0.942	1.085	0.756
*Annual Household Income ($)	0.999	0.997	1.001	0.4465
*Poverty				
No (reference)				
Yes	1.061	0.921	1.224	0.1854

Predictors of Adherence>=80%		Odds Ratio	95% Wald Confidence Limits		P-Value
*Education: some college %		1.487	1.154	1.916	0.0021
*Urbanicity					
	Urban				
	Other	0.679	0.543	0.851	0.9326

* Data fields are inferred by GIS block group data

Table 4

Predictors for Adherent Patients residing in majority Hispanic census block groups (N=32,304)

Predictors of Adherence>=80%	Odds Ratio	95% Wald Confidence Limits		P-Value
Age (Y), mean	1.015	1.012	1.017	<.0001
Gender				
Male (reference)				
Female	0.916	0.864	0.971	0.0031
initial fill copay group%				
0 (reference)				
>0 to 5	0.784	0.729	0.843	<.0001
>5 to 10	0.604	0.549	0.666	<.0001
>10 to 15	0.307	0.261	0.36	<.0001
>15	0.068	0.057	0.082	<.0001
Annual Total Copay, mean	1.013	1.012	1.014	<.0001
No. of Therapeutic classes, mean	1.237	1.219	1.256	<.0001
Primary Insurance%				
Private (reference)				
Medicaid	0.685	0.602	0.78	0.0003
Medicare	1.156	1.073	1.245	<.0001
Self pay/uninsured	0.571	0.503	0.648	<.0001
Language preference				
English (reference)				
Other than English	0.755	0.692	0.824	<.0001
90-day as initial fill%				
Yes (reference)				
No	0.508	0.475	0.542	<.0001
Distance (miles) between home to pharmacy%				
<=0.5 (reference)				
>0.5 to<2	1.013	0.946	1.085	0.2635
>=2 to <5	1.005	0.898	1.125	0.3553
>=5	1.173	0.997	1.378	0.0538
24h pharmacy Store for initial fill%				
Yes (reference)				
No	1.181	1.11	1.255	<.0001
*Annual Household Income ($)	1.003	1.001	1.006	0.0011
*Poverty				
No (reference)				
Yes	0.874	0.753	1.015	0.2685

Predictors of Adherence>=80%		Odds Ratio	95% Wald Confidence Limits		P-Value
*some college%		1.19	0.964	1.469	0.1051
*Urbanicity					
	Urban				
	Other	1.014	0.746	1.378	0.0473