11-1-2017

Prevalence and Geographic Variations of Polypharmacy Among West Virginia Medicaid Beneficiaries

Xue Feng
West Virginia University

Xi Tan
West Virginia University

Brittany Riley
Marshall University

Tianyu Zheng
West Virginia University

Thomas K. Bias
West Virginia University

See next page for additional authors

HHS Public Access

Author manuscript

Ann Pharmacother. Author manuscript; available in PMC 2018 November 01.

Published in final edited form as:

Ann Pharmacother. 2017 November ; 51(11): 981–989. doi:10.1177/1060028017717017.

Prevalence and Geographic Variations of Polypharmacy Among West Virginia Medicaid Beneficiaries

Xue Feng, MPH[1], **Xi Tan, PhD,PharmD**[1], **Brittany Riley, PharmD,MS**[2], **Tianyu Zheng, MS**[1], **Thomas K. Bias, PhD**[1], **James B. Becker, MD**[2,3], and **Usha Sambamoorthi, PhD**[1]

[1]West Virginia University, Morgantown, WV, USA

[2]Marshall University, Huntington, WV, USA

[3]West Virginia Department of Health and Human Resources, Charleston, WV, USA

Abstract

Background—West Virginia (WV) residents are at high risk for polypharmacy given its considerable chronic disease burdens. Objective: To evaluate the prevalence, correlates, outcomes, and geographic variations of polypharmacy among WV Medicaid beneficiaries.

Methods—In this cross-sectional study, we analyzed 2009–2010 WV Medicaid fee-for-service (FFS) claims data for adults aged 18–64 (N=37,570). We defined polypharmacy as simultaneous use of drugs from five or more different drug classes on a daily basis for at least 60 consecutive days in one year. Multilevel logistic regression was used to explore the individual- and county-level factors associated with polypharmacy. Its relationship with healthcare utilization was assessed using negative binomial regression and logistic regression. The univariate local indicators of spatial association method was applied to explore spatial patterns of polypharmacy in WV.

Results—The prevalence of polypharmacy among WV Medicaid beneficiaries was 44.6%. High-high clusters of polypharmacy were identified in southern WV, indicating counties with above-average prevalence surrounded by counties with above-average prevalence. Polypharmacy was associated with being older, female, eligible for Medicaid due to cash assistance or medical eligibility, having any chronic conditions or more chronic conditions, and living in a county with lower levels of education. Polypharmacy was associated with more hospitalizations, emergency department visits, and outpatient visits, as well as higher non-drug medical expenditures.

Conclusions—Polypharmacy was prevalent among WV Medicaid beneficiaries and was associated with substantial healthcare utilization and expenditures. The clustering of high prevalence of polypharmacy in southern WV may suggest targeted strategies to reduce polypharmacy burden in these areas.

Corresponding Author: Xi Tan, Department of Pharmaceutical Systems and Policy, Robert C. Byrd Health Sciences Center, West Virginia University School of Pharmacy, P O Box 9510, Morgantown, WV 26505, USA. xntan@hsc.wvu.edu.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Keywords

polypharmacy; Medicaid; health care utilization; expenditure; geography

Introduction

Polypharmacy is conventionally regarded as the concurrent use of multiple medications. It is associated with negative health outcomes, including drug-drug interactions, adverse drug events, decreased medication adherence, increased risk of mortality, and increased health care use and costs.[1,2] Polypharmacy research has primarily focused on the elderly population, whereas knowledge about the prevalence of polypharmacy and related issues in the general adult population is still limited. However, recent studies have suggested that multimorbidity and polypharmacy are no longer merely issues for the elderly. The prevalence of multimorbidity among those who were 45 to 64 years old and participated in the National Health Interview Survey increased from 24.5% in 2004 to 28.1% in 2010.[3] Another study examining the 2009 Medical Expenditure Panel Survey found that the prevalence of multimorbidity was similar in those aged 50 to 64 years (8.2%) and those ≥65 years old (9%). There was a relationship between multimorbidity and polypharmacy in both age groups.[4] Kanto et al[5] also found that 15% of those who were 40 to 64 years old in 2011–2012 had polypharmacy which was a significant increase from the 1999–2000 period (10%).[5]

On the other hand, there is no firm consensus on the definition of polypharmacy. A narrative review of polypharmacy among elderly individuals identified 24 distinct definitions.[6] These definitions range from concurrent use of 5 or more drugs, to use of at least 1 inappropriate drug, to use of medications that do not match a patient's diagnosis.[6] Even when studies used a certain number of drugs to define polypharmacy, the numbers varied from 2 drugs[7] to more than 1 SD above the average number of drugs in a specific population.[8] In addition, the duration of concomitant drug use also varied ranging from 30 days to 90 days.[9,10] This inconsistency in the definition results in challenges for the measurement of polypharmacy.

In addition, West Virginia (WV) residents are at particularly high risk for polypharmacy because it has one of the highest chronic disease burdens in the United States.[11,12] Yet, to our knowledge, there has been no systematic examination of this critical issue in WV, including in the Medicaid population of WV. Medicaid is a joint federal-state, public health insurance program in the United States that mainly covers low-income individuals with limited resources. Therefore, the purpose of this study was to estimate the prevalence of polypharmacy by integrating the definitions used in the literature and establishing a feasible approach for addressing this issue using administrative claims data. We also aimed to explore the factors associated with poly-pharmacy and to evaluate the health care use, health expenditures, and geographic variations of polypharmacy among WV Medicaid beneficiaries.

Methods

Study Design, Study Population, and Data Source

In this cross-sectional study, we analyzed WV Medicaid fee-for-service (FFS) claims data in 2009–2010. We included adults who were between 18 and 64 years old, alive during the study time, and continuously enrolled in WV Medicaid's FFS program in both 2009 and 2010. Those with dual Medicaid and Medicare eligibility and with private insurance were excluded from the study. Appendix A shows the flowchart for obtaining the final study population.

The main data source was the Medicaid Analytic eXtract (MAX) data system, which contains extensive person-level data on Medicaid beneficiaries and Medicaid health services. We extracted data for WV Medicaid FFS enrollees from the following MAX files: person summary file, which contains demographic and enrollment data; inpatient file, including hospital claims; prescription drug file with pharmacy claims; and other services file, which involves all types of services not included in the other 4 files. To assess county-level factors, we linked the county code of each Medicaid beneficiary with the Area Health Resources File as well as the Appalachian Regional Commission data reports. The study was approved by WV University's Institution Review Board.

Outcome Measures

Polypharmacy—Our definition of polypharmacy incorporated 3 important components of polypharmacy measures: number of drugs, simultaneous use, and duration of use. First, we chose to use a widely accepted, standard cutoff for clinically relevant polypharmacy: the concurrent use of 5 or more drugs from different drug classes.[13–15] Drugs were identified by the National Drug Codes and classified based on the methodology created in a previous study.[16] Second, among the 3 common measures of polypharmacy (cumulative, continuous, and simultaneous), we chose simultaneous polypharmacy because it gives a value in between the values of cumulative and continuous measures and can demonstrate subtle and transient changes in medications.[17] We defined simultaneous use as the sum of all drug classes used by 1 individual daily, which was developed based on the methodology of Fincke et al.[17] Finally, we chose a consecutive interval of at least 60 days in 1 year as 1 criterion for polypharmacy definition. To summarize, by our definition, polypharmacy was defined as simultaneous use of 5 or more drugs from different drug classes for a consecutive interval of at least 60 days in 1 year. To allow for an 80% medication adherence rate, we also allowed for a gap of 12 days within this interval. In other words, the individual with polypharmacy took 5 or more drugs from different drug classes per day for at least 60 days in 72 consecutive days in 2010.

Health Care Use and Expenditures—We examined 3 types of health care use in each individual in 2010: inpatient hospitalization, outpatient visits, and emergency department (ED) visits. Nondrug health care expenditures were assessed by summing up the expenditures from inpatient services, outpatient services, home health, laboratory/X-ray, and hospice for each eligible individual in 2010. The cost evaluation was from the payer's perspective.

Measurement of Independent Variables

We examined individual- and county-level factors associated with polypharmacy, which followed the constructs of the conceptual framework in the Andersen's Health Behavioral Model of Health Services Use.[18,19] We measured the individual-level characteristics: (1) predisposing factors: age group and gender; (2) enabling factors: Medicaid pathway-to-eligibility indicators, including medical needs and cash assistance, and having private insurance or not; (3) need factors: number of chronic conditions and types of chronic conditions (physical conditions only, mental conditions only, none, or both). Chronic conditions were identified by the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes in 2009. We utilized the strategic framework adopted by the US Department of Health and Human Services (DHHS) for research, policy, program, and practice[20] and also added some other major mental health conditions. The final list of chronic conditions included hypertension, congestive heart failure, coronary artery disease, cardiac arrhythmias, hyperlipidemia, stroke, arthritis, asthma, cancer, chronic kidney disease, chronic obstructive pulmonary disease (COPD), diabetes, hepatitis, HIV, osteoporosis, dementia, depression, schizophrenia, substance abuse, anxiety or posttraumatic stress disorder, and bipolar disorder (Appendix B). Environmental characteristics were assessed by county-level factors, which included county-level metropolitan status, county-level economic status (distressed counties refer to the lowest 10% of the US counties),[21] county-level percentage of persons with less than a high school education in quartiles, and health professional shortage area for primary care doctors.

Statistical Analysis

We calculated polypharmacy rates for the entire final study population and for individuals with different types of chronic conditions. Descriptive statistics of other dependent and independent variables were calculated using means for continuous variables and frequencies and percentages for categorical variables. We assessed bivariate associations of polypharmacy and each factor using χ^2 tests for binary and categorical variables as well as the 2-tailed *t*-tests for continuous variables. To take into consideration potential clustering effects at the county level, we used a multilevel logistic regression model to assess the factors associated with polypharmacy. The association of polypharmacy with outpatient visits was evaluated using a negative binomial model. We utilized logistic regressions to assess the relationships between polypharmacy with inpatient visits and ED visits. The impact of polypharmacy on nondrug medical expenditures was assessed using a generalized linear model with log-link function and gamma distribution. We also used recycled predictions to estimate absolute expenditure differences between polypharmacy and nonpolypharmacy.[22] We used STATA 14 (StataCorp LP, College Station, TX) for data analyses.

Spatial Analysis

The aggregated county-level polypharmacy rates were displayed in choropleth maps. The univariate local indicators of spatial association (LISA) method[23] and global Moran's *I* statistics were applied to study the spatial variations of polypharmacy rates across WV. The univariate LISA method can help identify 4 types of spatial patterns: (1) low-low cluster, (2)

high-high cluster, (3) low-high outlier, (4) high-low outlier. A high-high cluster indicates a county with an above-average prevalence surrounded by counties with above-average prevalence, whereas a low-low cluster refers to a county with a below-average rate surrounded by counties with below-average rates. The Queen contiguity weights matrix was used to define counties sharing a border or vertex/corner with a county's neighbors. For the univariate LISA statistics for each observation and cluster/outlier, the significance level was set at $P < 0.05$. We used ArcGIS 10.4 (ESRI, Redlands, CA) for geo-mapping and GeoDa 1.8 software for the LISA method.

Results

Our analyses included a total of 37 570 WV Medicaid beneficiaries, whose characteristics are presented in Table 1. The majority of participants were female (58.4%), middle-aged (45–64 years old, 60.4%), eligible for Medicaid as a result of cash assistance (91.1%), and with 1 or more chronic conditions assessed in our study (79.8%). About half of them (51.5%) lived in nonmetropolitan areas, and 77.4% lived in primary care doctor shortage areas. The average number of drug classes taken per person per day was 3.9.

Based on our definition, 44.6% of adult Medicaid FFS beneficiaries in WV were classified as having polypharmacy. Among those with polypharmacy, the average number of drug classes taken per day was 6.7. The prevalence of polypharmacy varied among different chronic conditions, ranging from 43.3% to 85.4%. The top 10 conditions with the highest prevalence of polypharmacy were chronic kidney disease (85.4%), congestive heart failure (85.1%), coronary artery disease (80.5%), diabetes (74.9%), dementia (74.4%), stroke (73.1%), osteoporosis (71.5%), hyperlipidemia (69.8%), cardiac arrhythmias (69.2%), and COPD (69.1%). With the exception of dementia, these conditions were also highly prevalent generally among this nonelderly population. Patients with chronic kidney disease, congestive heart failure, coronary artery disease, diabetes, and stroke took at least 6 drug classes on average per day. The most prescribed drug classes at the individual level were analgesics (74.8%) and antibiotics (68.7%), followed, in descending order, by anticonvulsants (48.8%), antidepressants (48.4%), proton pump inhibitors (44.3%), bronchodilators (35.4%), statins (34.5%), anxiolytics (31.9%), antihistamines (29.5%), and angiotensin-converting enzyme inhibitors/angiotensin-receptor blockers (26.8%). Among those with polypharmacy, 85.3% and 76.9% were prescribed analgesics and antibiotics, respectively.

The county-level polypharmacy rates ranged from 31.2% to 54.4% (Figure 1A). The global Moran's I of the county-level polypharmacy rates in WV was 0.43 ($P < 0.01$), indicating a positive spatial autocorrelation (clustering patterns) of polypharmacy in WV. Accordingly, in the univariate LISA, a large and clear high-high cluster of polypharmacy was observed in southern WV (Figure 1B), which includes the counties of Boone, Fayette, Greenbrier, Lincoln, Logan, Monroe, Mingo, Nicholas, Summers, Raleigh, and Wyoming. These counties had above-average polypharmacy rates and were also surrounded by other counties with above-average polypharmacy rates. On the other hand, 2 smaller low-low clusters were found in northeastern W V, including Morgan and Berkeley counties.

Table 2 displays the results of the multilevel logistic regression of polypharmacy. We found that being older, female, eligible for Medicaid as a result of cash assistance or medical eligibility, having any chronic condition or more chronic conditions, and living in a county with lower levels of education were associated with a higher likelihood of polypharmacy. Also, patients with physical conditions were more likely to have polypharmacy than those with mental conditions (adjusted odds ratio [AOR] = 1.98; 95% CI = 1.84, 2.14). Table 3 presents the relationships between polypharmacy, health care use, and nondrug expenditures. Those people with polypharmacy had 69% more outpatient visits than those without polypharmacy ($P < 0.01$). In addition, patients with polypharmacy were more likely to have ED visits (AOR = 1.18; 95% CI = 1.13–1.24) and inpatient visits (AOR = 1.78; 95% CI = 1.67–1.90) compared with those without polypharmacy. Polypharmacy was associated with $4494.36 more in nondrug medical expenditures than nonpolypharmacy (coefficient = 0.69; 95% CI = 0.64–0.74; $P < 0.01$).

Discussion

The current study made a unique contribution to the limited literature of polypharmacy research among adults younger than 65 years by estimating the prevalence of polypharmacy among Medicaid beneficiaries in WV. By integrating various measures of prescription drugs use—duration of use, simultaneous use, and number of drug classes, we observed that polypharmacy was highly prevalent (44.6%) among those <65 years old, which was even higher than the US average rate among adults >21 years of age in 2009 (25.5%) and among the elderly population in 2010 (39.0%). Despite our strict definition, we still found such a high prevalence in this population, suggesting a substantial burden of polypharmacy and related issues in WV. Because this is the first study of its kind in WV, we cannot suggest whether our study findings are consistent with those from the other literature. However, a previous study examining the region-level variations of polypharmacy in the United States also found that WV was located in the region with the highest prevalence of polypharmacy.[25]

Not surprisingly, we found that adults with selected chronic conditions were more likely to have polypharmacy compared with those without these selected chronic conditions. WV also ranks among the top 10 states with the highest prevalence of many chronic conditions, such as cardiovascular diseases, diabetes, stroke, hypertension, cancer, COPD, arthritis, and kidney disease, as well as risk factors such as obesity, tobacco use, and physical inactivity,[11,12] which may partially explain the high burden of polypharmacy in W V. Furthermore, given the trend of increasing polypharmacy rates among American adults over the past 2 decades,[5,24] it may be expected that the burden of polypharmacy in the WV Medicaid population has continued to increase following the period of our study.

Consistent with the previous literature,[16,26] our study showed that polypharmacy was associated with substantial economic burden, including increased health care use and expenditures. Based on our results in 2010, on average, 1 Medicaid beneficiary with polypharmacy had $4494.36 more in nondrug medical expenditures. Since 2014, Medicaid coverage in WV has been expanded to include individuals aged between 19 and 65 years old with income limit at 133% of the federal poverty level.[27] Given the chronic disease burdens

and high polypharmacy rates in this state, it is reasonable to expect more Medicaid beneficiaries with polypharmacy and multimorbidity, which may lead to an increase in health care use and expenditures. Therefore, actions to control the increasing trend of these issues are warranted in order to contain costs in the Medicaid program, which has limited resources and a tight budget.

To more deeply understand this issue in WV, our study further explored the county-level geographic variations of polypharmacy prevalence and identified a high-high cluster of polypharmacy in southern WV that included 11 counties. Almost all these 11 counties also had higher poverty rates and lower education levels than the state as a whole.[28] These counties also had significantly higher prevalence than the WV and US averages of the following health-related indicators: reported fair or poor general health, no leisure-time physical activity or exercise, obesity, hypertension, cardiovascular disease, diabetes, arthritis, and disability.[11] Also, we found that the most prescribed drug classes for West Virginians were analgesics and antibiotics. This is not surprising because WV has one of the highest prescription rates of opioids and outpatient antibiotics in the United States.[29,30] These drugs require particular attention because of the high risk for inappropriate use and adverse drug events leading to harms.[31] Overall, our findings may be helpful for WV Medicaid policy makers to target “hot-spot” areas and “high-risk” drugs requiring close monitoring and regulations and to collaborate with local communities to develop and implement interventions to reduce the risk of polypharmacy and other relevant medication-related issues in the Medicaid population.

We also found that individual characteristics such as being older, being female, and having more chronic conditions were significantly correlated with polypharmacy, consistent with the previous literature.[2,4,5,25] In particular, we found that polypharmacy was not only related to the number of chronic conditions, but also associated with different types of chronic conditions. We found that patients with physical conditions were more likely to have polypharmacy than those with mental conditions. This finding may be partially a result of our measurement of polypharmacy, which only assessed different drug classes but not within drug classes. Within-drug-class polypharmacy is not uncommon in mental condition management; therefore, our definition may to some extent underestimate polypharmacy burden in this population. Nevertheless, it is worthwhile for future research to further investigate the impacts of different types and combinations of chronic conditions on polypharmacy, inappropriate medication use, and medication regimen complexity. It is also interesting in our results that about 5% of the individuals without any chronic disease included in our study had polypharmacy, which may represent the population who used medications for chronic diseases not included in this study, acute diseases, disease prevention purposes, and/or unclear indications.

Additionally, for county-level characteristics, we found that lower educational level was associated with polypharmacy, which was also reflected in the “hot spots” of polypharmacy identified in our spatial analysis. Further research may need to confirm the influence of individual educational level, patient knowledge about medications, and health literacy on polypharmacy, which may also suggest important targets for developing interventions to address these issues.

Several limitations to this study should be noted. First, the cross-sectional design of this study in 1 year made it difficult to infer causality. We did not measure the temporal relationship between polypharmacy and health care use or nondrug medical expenditures in this study, which warrants further research. Second, by our new definition, we only assessed polypharmacy from different drug classes but not within-drug-class polypharmacy. For instance, patients may take multiple antipsychotic drugs, but according to our definition, they are only considered to be taking 1 drug class. Third, our approach may not fully capture early refill issues or patients' real medication-taking behaviors. Fourth, because the data did not contain the accurate indications for the drug used or detailed clinical information, we cannot differentiate between appropriate and inappropriate polypharmacy. Therefore, the next step for this research will be to further explore inappropriate polypharmacy in this population. Finally, caution is required when generalizing the study findings. In particular, the impact of moving from FFS to managed care in WV Medicaid on polypharmacy is still not clear and warrants further research. But the approach for assessing the prevalence and geographic variations of polypharmacy established in this study may be applied to other populations or geographic regions by using claims data.

Conclusions

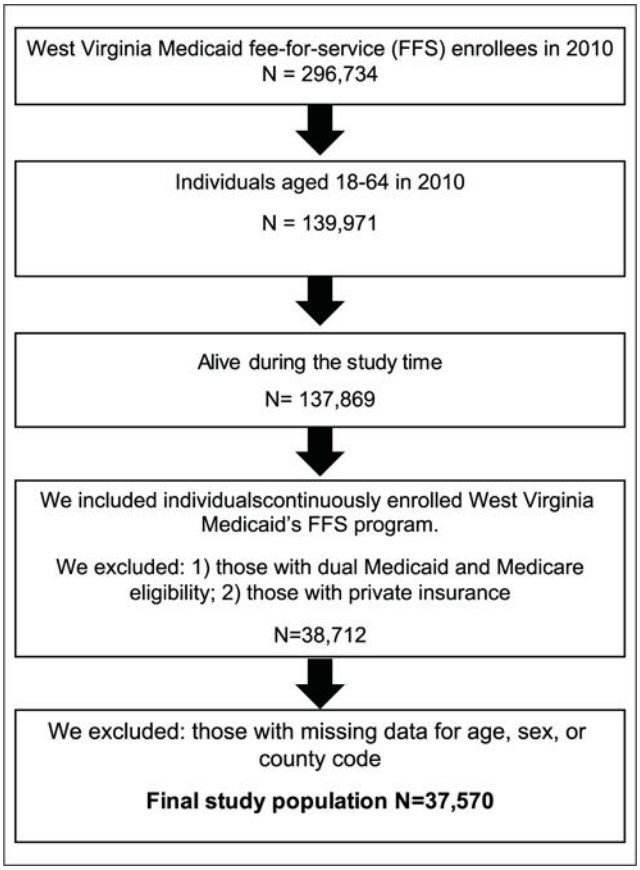
Polypharmacy was highly prevalent among WV Medicaid FFS beneficiaries and was associated with substantial health care use and expenditures. Future research is warranted to explore inappropriate polypharmacy as well as these issues in the WV Medicaid managed care population. The clustering of high prevalence of polypharmacy in southern WV may suggest targeted strategies to improve medication use and reduce polypharmacy burden and the risks of iatrogenesis in these areas.

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The project described was supported by the West Virginia University—Marshall University Health Grants Partnership. The content is solely the responsibility of the authors and does not necessarily represent the official views of West Virginia University or Marshall University.

Appendix A



Flowchart for obtaining the final study population.

Appendix B

List of Chronic Conditions.

Physical condition	Hypertension, congestive heart failure, coronary artery disease, cardiac arrhythmias, hyperlipidemia, stroke, arthritis, asthma, cancer, chronic kidney disease, chronic obstructive pulmonary disease, diabetes, hepatitis, HIV, osteoporosis
Mental condition	Depression, schizophrenia, substance abuse, anxiety or posttraumatic stress disorder, and bipolar disorder
Physical and mental condition	Dementia

References

1. Cooper JA, Cadogan CA, Patterson SM, et al. Interventions to improve the appropriate use of polypharmacy in older people: a Cochrane systematic review. BMJ Open. 2015; 5:e009235.doi: 10.1136/bmjopen-2015-009235
2. Hajjar ER, Cafiero AC, Hanlon JT. Polypharmacy in elderly patients. Am J Geriatr Pharmacother. 2007; 5:345–351. DOI: 10.1016/j.amjopharm.2007.12.002 [PubMed: 18179993]

3. Ward BW, Schiller JS. Prevalence of multiple chronic conditions among US adults: estimates from the National Health Interview Survey, 2010. Prev Chronic Dis. 2013; 10:E65.doi: 10.5888/pcd10.120203 [PubMed: 23618545]
4. Vyas A, Pan X, Sambamoorthi U. Chronic condition clusters and polypharmacy among adults. Int J Family Med. 2012; 2012:193168.doi: 10.1155/2012/193168 [PubMed: 22900173]
5. Kantor ED, Rehm CD, Haas JS, Chan AT, Giovannucci EL. Trends in prescription drug use among adults in the United States from 1999–2012. JAMA. 2015; 314:1818–1830. DOI: 10.1001/jama.2015.13766 [PubMed: 26529160]
6. Bushardt RL, Massey EB, Simpson TW, Ariail JC, Simpson KN. Polypharmacy: misleading, but manageable. Clin Interv Aging. 2008; 3:383–389. DOI: 10.2147/CIA.S2468. [PubMed: 18686760]
7. Jörgensen T, Johansson S, Kennerfalk A, Wallander M, Svärdsudd K. Prescription drug use, diagnoses, and healthcare utilization among the elderly. Ann Pharmacother. 2001; 35:1004–1009. [PubMed: 11573845]
8. Goldberg JF, Brooks JO, Kurita K, et al. Depressive illness burden associated with complex polypharmacy in patients with bipolar disorder: findings from the STEP-BD. J Clin Psychiatry. 2009; 70:155–162. DOI: 10.4088/JCP.08m04301 [PubMed: 19210946]
9. Feinstein JA, Feudtner C, Valuck RJ, Kempe A. The depth, duration, and degree of outpatient pediatric polypharmacy in Colorado fee-for-service Medicaid patients. Pharmacoepidemiol Drug Saf. 2015; 24:1049–1057. DOI: 10.1002/pds [PubMed: 26248529]
10. Bhattacharya R, Zhou S, Wei W, Ajmera M, Sambamoorthi U. A real-world study of the effect of timing of insulin initiation on outcomes in older Medicare beneficiaries with type 2 diabetes mellitus. J Am Geriatr Soc. 2015; 63:893–901. DOI: 10.1111/jgs.13388 [PubMed: 25955280]
11. West Virginia Health Statistics Center. West Virginia behavioral risk factor surveillance system report, 2013. 2015. http://www.wvdhhr.org/bph/hsc/pubs/brfss/2013/BRFSS2013.pdf. Accessed February 25, 2017
12. United Health Foundation. America's Health Rankings®: West Virginia 2016 annual report. http://www.americashealthrankings.org/explore/2015-annual-report/measure/Overall/state/WV. Accessed February 25, 2017
13. Haider SI, Johnell K, Weitoft GR, Thorslund M, Fastbom J. The influence of educational level on polypharmacy and inappropriate drug use: a register-based study of more than 600,000 older people. J Am Geriatr Soc. 2009; 57:62–69. DOI: 10.1111/j.1532-5415.2008.02040.x [PubMed: 19054196]
14. Johnell K, Klarin I. The relationship between number of drugs and potential drug-drug interactions in the elderly: a study of over 600,000 elderly patients from the Swedish Prescribed Drug Register. Drug Saf. 2007; 30:911–918. doi:30109 [pii]. [PubMed: 17867728]
15. Monégat M, Sermet C, Perronnin M, Rococo E. Polypharmacy: definitions, measurement and stakes involved: review of the literature and measurement tests. Quest d'économie la santé. 2014 Dec.204:1–8.
16. Agarwal P, Bias TK, Sambamoorthi U. Longitudinal patterns of emergency department visits: a multistate analysis of Medicaid beneficiaries [published online October 21, 2016]. Health Serv Res.
17. Fincke BG, Snyder K, Cantillon C, et al. Three complementary definitions of polypharmacy: methods, application and comparison of findings in a large prescription database. Pharmacoepidemiol Drug Saf. 2005; 14:121–128. DOI: 10.1002/pds.966 [PubMed: 15386712]
18. Aday LA, Andersen R. A framework for the study of access to medical care. Health Serv Res. 1974; 9:208–220. [PubMed: 4436074]
19. Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? J Health Soc Behav. 1995; 36:1–10. [PubMed: 7738325]
20. Goodman RA, Posner SF, Huang ES, Parekh AK, Koh HK. Defining and measuring chronic conditions: imperatives for research, policy, program, and practice. Prev Chronic Dis. 2013; 10:120239.doi: 10.5888/pcd10.120239
21. Appalachian Regional Commission (ARC). Distressed designation and county economic status classification system, FY 2007-FY. 2017. https://www.arc.gov/research/SourceandMethodologyCountyEconomicStatusFY2007FY2017.asp. Accessed February 25, 2017

22. Menn P, Heinrich J, Huber RM, Jörres RA, John J, Karrasch S, KORA Study Group. Direct medical costs of COPD—an excess cost approach based on two population-based studies. Respir Med. 2012; 106:540–548. [PubMed: 22100535]
23. Anselin L. Local indicators of spatial association—LISA. Geogr Anal. 1995; 27:93–115.
24. Charlesworth CJ, Smit E, Lee DS, Alramadhan F, Odden MC. Polypharmacy among adults aged 65 years and older in the United States: 1988–2010. J Gerontol A Biol Sci Med Sci. 2015; 70:989–995. DOI: 10.1093/gerona/glv013 [PubMed: 25733718]
25. Cashion W, McClellan W, Howard G, et al. Geographic region and racial variations in polypharmacy in the United States. Ann Epidemiol. 2015; 25:433–438.e1. DOI: 10.1016/j.annepidem.2015.01.018 [PubMed: 25908300]
26. Franchi C, Cartabia M, Risso P, et al. Geographical differences in the prevalence of chronic polypharmacy in older people: eleven years of the EPIFARM-Elderly Project. Eur J Clin Pharmacol. 2013; 69:1477–1483. DOI: 10.1007/s00228-013-1495-7 [PubMed: 23535883]
27. West Virginia Department of Health and Human Recource. Medicaid. http://www.dhhr.wv.gov/bcf/Services/familyassistance/Pages/Medicaid.aspx. Accessed February 25, 2017
28. West Virginia Department of Health and Human Resources Bureau for Behavioral Health and Health Facilities. County profiles. 2014. http://www.dhhr.wv.gov/bhhf/Sections/programs/ProgramsPartnerships/AlcoholismandDrugAbuse/Research/Pages/2014-County-Profiles.aspx. Accessed February 25, 2017
29. Centers for Disease Control and Prevention (CDC). Measuring outpatient antibiotic prescribing. https://www.cdc.gov/getsmart/community/programs-measurement/measuring-antibiotic-prescribing.html. Accessed February 25, 2017
30. Paulozzi LJ, Mack KA, Hockenberry JM, Division of Unintentional Injury Prevention, National Center for Injury Prevention and Control CDC. Vital signs: variation among states in prescribing of opioid pain relievers and benzodiazepines—United States, 2012. MMWR Morb Mortal Wkly Rep. 2014; 63:563–568. [PubMed: 24990489]
31. Shehab N, Lovegrove MC, Geller AI, Rose KO, Weidle NJ, Budnitz DS. US emergency department visits for outpatient adverse drug events, 2013-2014. JAMA. 2016; 316:2115–2125. DOI: 10.1001/jama.2016.16201 [PubMed: 27893129]

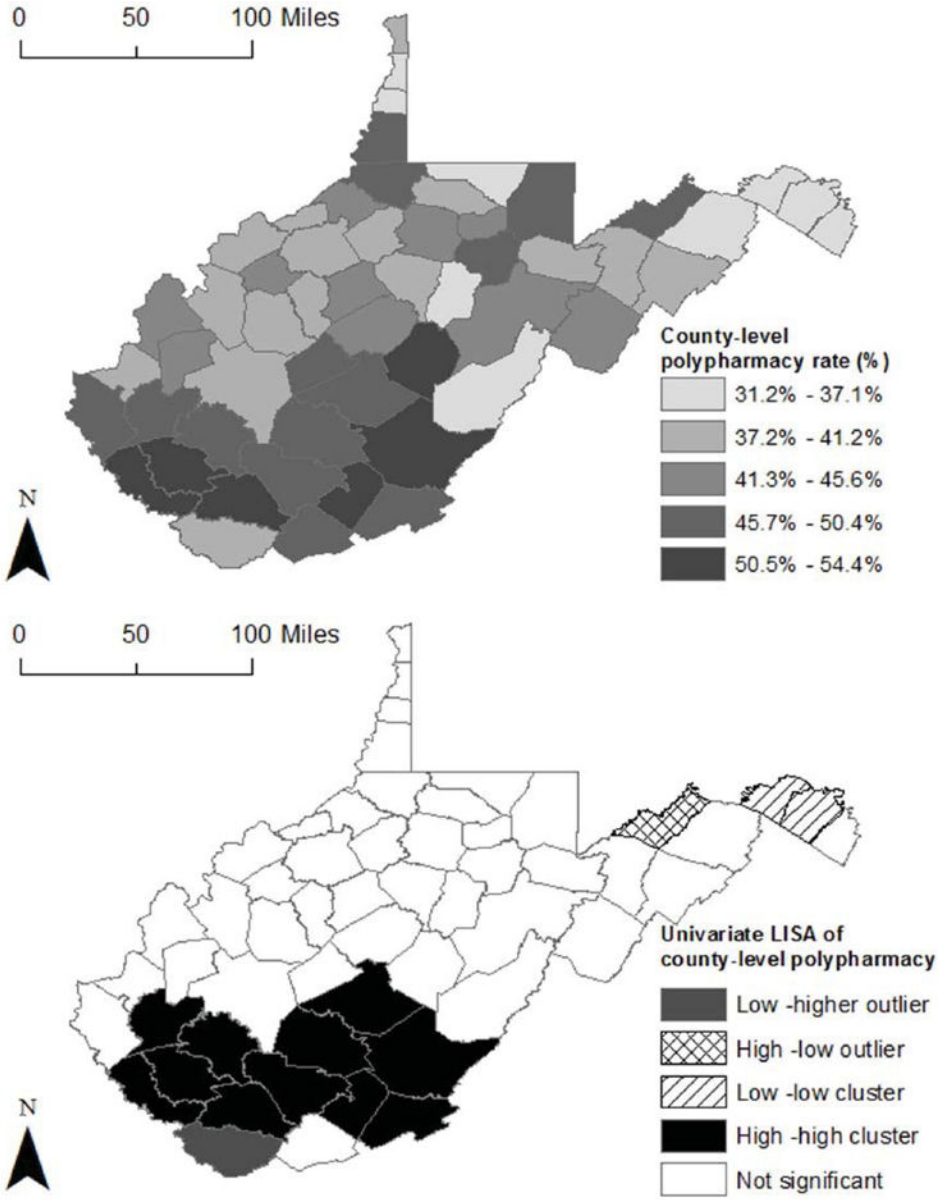


Figure 1.

County-level polypharmacy rate and geographic variations among West Virginia Medicaid beneficiaries. A. The choropleth map displays the aggregated county-level of polypharmacy rates in WV. The county-level polypharmacy rates ranged from 31.2% to 54.4%. B. The univariate local indicators of spatial association (LISA) method was used to help identify 4 types of spatial patterns: (1) low-low cluster (blue); (2) high-high cluster (red); (3) low-high outlier (purple); and (4) high-low outlier (pink). A high-high cluster indicates a county with an above-average prevalence surrounded by counties with above-average prevalence, whereas a low-low cluster refers to a county with a below-average rate surrounded by counties with below-average rates. As shown in the figure, we identified a large and clear high-high cluster of polypharmacy in southern WV, which included 11 counties.

Table 1

Description of the Study Population (18–64 Years Old) With Fee-for-Service Medicaid, Linked 2010 WV Medicaid Claim Database, Area Health Resources Files, and ARC Data Reports: Comparison Between Those With Polypharmacy and Those Without Polypharmacy.[a]

	All		With Poly pharmacy		No Polypharmacy		
	n	Percentage	n	Percentage	n	Percentage	*P* Value
WV Medicaid enrollee	37570		16770	44.6%	20800	55.4%	
Age in years							<0.001
18–24 years	2569	6.8%	248	1.5%	2321	11.2%	
25–34 years	5024	13.4%	901	5.4%	4123	19.8%	
35–44 years	7307	19.4%	2620	15.6%	4687	22.5%	
45–54 years	12167	32.4%	6326	37.7%	5841	28.1%	
55–64 years	10503	28.0%	6675	39.8%	3828	18.4%	
Sex							<0.001
Female	21943	58.4%	11033	65.8%	10910	52.5%	
Male	15627	41.6%	5737	34.2%	9890	47.5%	
Medicaid eligibility pathway							0.40
Cash assistance	34245	91.1%	15296	91.2%	18 949	91.1%	
Medical need	2125	5.7%	960	5.7%	1165	5.6%	
Other	1200	3.2%	514	3.1%	686	3.3%	
Chronic conditions							<0.001
Physical only	12206	32.5%	6796	40.5%	5410	26.0%	
Mental only	6297	16.8%	1508	9.0%	4789	23.0%	
Physical + Mental	11468	30.5%	7604	45.3%	3864	18.6%	
None	7599	20.2%	862	5.2%	6737	32.4%	
Metropolitan area (county level)							<0.001
Metro	18208	48.5%	7834	46.7%	10374	49.9%	
Nonmetro	19362	51.5%	8936	53.3%	10426	50.1%	
County economic status							0.86
Distressed	3880	10.3%	1737	10.4%	2143	10.3%	
Not distressed	33690	89.7%	15033	89.6%	18657	89.7%	
Health professional shortage area for primary care doctors							<0.001

	All		With Poly pharmacy		No Polypharmacy		
	n	**Percentage**	**n**	**Percentage**	**n**	**Percentage**	***P* Value**
Whole county	10039	26.7%	4818	28.7%	5221	25.1%	
Partial	19058	50.7%	8396	50.1%	10 662	51.3%	
None	8473	22.6%	3556	21.2%	4917	23.6%	
The percentage of residents aged 25 years and older with less than a high school diploma (at the county level)							<0.001
Quartile 1 [8.9%, 13.2%][b]	9638	25.7%	3865	23.1%	5773	27.8%	
Quartile 2 [13.3%, 19.1%]	9763	26.0%	4177	24.9%	5586	26.9%	
Quartile 3 [19.2%, 21.6%]	8581	22.8%	4017	23.9%	4564	21.9%	
Quartile 4 [21.7%, 38.1%]	9588	25.5%	4711	28.1%	4877	23.4%	
	Mean	SD	Mean	SD	Mean	SD	
Number of chronic conditions	2.2	1.8	3.1	1.9	1.38	1.4	<0.001
Number of inpatient visits	0.3	0.9	0.4	1.1	0.2	0.6	<0.001
Number of outpatient visits	27.3	36.4	36.4	40.0	20	31.4	<0.001
Number of ED visits	2.1	4.4	2.4	5	1.8	3.9	<0.001
Nondrug medical costs (dollars)	8071.4	18028.6	10886.5	20742.3	5801.7	15122.0	<0.001

Abbreviations: ARC, Appalachian Regional Commission; ED, emergency department; WV, West Virginia.

[a]Based on 37570 adults (aged 18–64 years) who were continuously enrolled in fee-for-service Medicaid in both 2009 and 2010 and used either inpatient or outpatient services paid by Medicaid. Chronic conditions and the number of chronic conditions were identified in the year 2009. The number of visits to ED, inpatient visits, and outpatient visits as well as the nondrug medical costs were measured in 2010 only. *P* values were based on χ^2 tests for categorical variables and *t*-tests for the continuous variables.

[b]Quartile 1 has the highest education level as compared with other quartiles.

Table 2

Factors Associated With Polypharmacy Among West Virginia Medicaid Beneficiaries: Using Multilevel Logistic Regression (n = 37570).

Variables	Odds Ratio (95% CI)[a]
Age group	
18–24	Reference
25–34	1.33 (1.14, 1.56) **
35–44	2.50 (2.16, 2.90) **
45–54	3.90 (3.38, 4.51) **
55–64	5.26 (4.54, 6.09) **
Sex	
Female	1.46 (1.39, 1.54) **
Male	Reference
Medicaid eligibility pathway	
Cash assistance	1.33 (1.16, 1.53) **
Medical need	1.51 (1.27, 1.78) **
Other	Reference
Number of chronic conditions	1.62 (1.58, 1.65) **
Presence of chronic conditions	
Physical conditions only	1.98 (1.84, 2.14) **
Mental conditions only	Reference
Both physical and mental conditions	1.73 (1.59, 1.88) **
Without any chronic conditions included	0.87 (0.79, 0.97) **
County-level metropolitan status	
Yes	1.00 (0.93, 1.32)
No	Reference
County-level economic status	
Distressed	0.91 (0.75, 1.10)
Not distressed	Reference
Health professional shortage area for primary care doctors	
Yes	1.07 (0.93, 1.22)
No	Reference
The percentage of residents 25 years and older with less than a high school diploma (at the county level	
Quantile 1 [8.9%, 13.2%]	Reference
Quantile 2 [13.3%, 19.1%]	1.11 (0.93, 1.32)
Quantile 3 [19.2%, 21.6%]	1.22 (1.02, 1.45) *
Quantile 4 [21.7%, 38.1%]	1.44 (1.16, 1.78) **
Random effect	Estimate
County-level variance	0.024

[a] ** $P < 0.01$;

*0.01 < *P* < 0.05.

Table 3

Health Care Use and Expenditures Among Adults With Fee-for-Service Medicaid, Linked 2010 West Virginia Medicaid Claim Database, the Area Health Resources Files, and the ARC Data Reports (n = 37 570).[a]

	With Polypharmacy Versus No Polypharmacy
Number of emergency room visits	
AOR (95% CI)	1.18 (1.13, 1.24)**
Number of inpatient visits	
AOR (95% CI)	1.78 (1.67, 1.90)**
Number of outpatient visits	
Incidence rate ratio (95% CI)	1.69 (1.66, 1.73)**
Nondrug costs	
Coefficient (95% CI)	0.69 (0.64, 0.74)**

Abbreviations: AOR, adjusted odds ratio; ARC, Appalachian Regional Commission.

[a]The results were adjusted by age groups, Medicaid eligibility pathway, sex, presence of chronic conditions, county-level metropolitan status, and county-level economic status.

** $P < 0.01$;

* $0.01 \leq P < 0.05$.