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SEARCH STRATEGY

A database search was performed by a library specialist using the databases OVID Medline and Ebsco CINAHL to collect articles related to Medicaid beneficiaries and chronic disease status, healthcare costs, or utilization. The search strategy was limited to articles written in English and published since 2000. Appendix Table 1 outlines the search strategy and specific syntax that was employed by the library specialist to identify these articles in both databases.

Appendix Table 1. Database Search Strategy and Syntax

| Database	Search syntax	Run date
Medline (OVID) 1946– Limit English; 2000–	*Medicaid/sn OR (Medicaid and (enrollee* OR beneficiar* OR population OR patient* OR member* OR enrollment)).ti AND *Health Status/ or *Health Care Costs/ or *Healthcare Disparities/ *"Health Services Needs and Demand"/ or *"Patient Acceptance of Health Care"/ or *Health Services Accessibility/	August 3, 2016
CINAHL (Ebsco) 1982- Limit English; 2000-	(MJ Medicaid/SN) OR (Medicaid N2 (enrollee* OR beneficiar* OR population OR patient* OR member* OR enrollment)) AND (MJ "Health Status") or (MJ *Health Care Costs) or (MJ *Healthcare Disparities) or (MJ "Health Services Needs and Demand") or (MJ "Patient Acceptance of Health Care") or (MJ *Health Services Accessibility)	August 3, 2016

* = "wildcard"/truncation character

Search results were returned to the authors in an EndNote database. The EndNote database automatically eliminated duplicates by matching title, author, and year, which left 349 articles in the database returned to the authors. The authors identified and removed 25 additional duplicates not automatically removed by the EndNote program.

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The authors supplemented this search by using Google Scholar and checking the references of relevant articles. The supplemental Google Scholar search used the keywords *Medicaid* combined with *cost, chronic condition, hypertension, heart disease, diabetes, asthma,* or *cancer.* Thirty-five additional potentially relevant articles were identified and included for further screening.

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Appendix Figure 1. Distribution of number of articles examining particular chronic conditions.
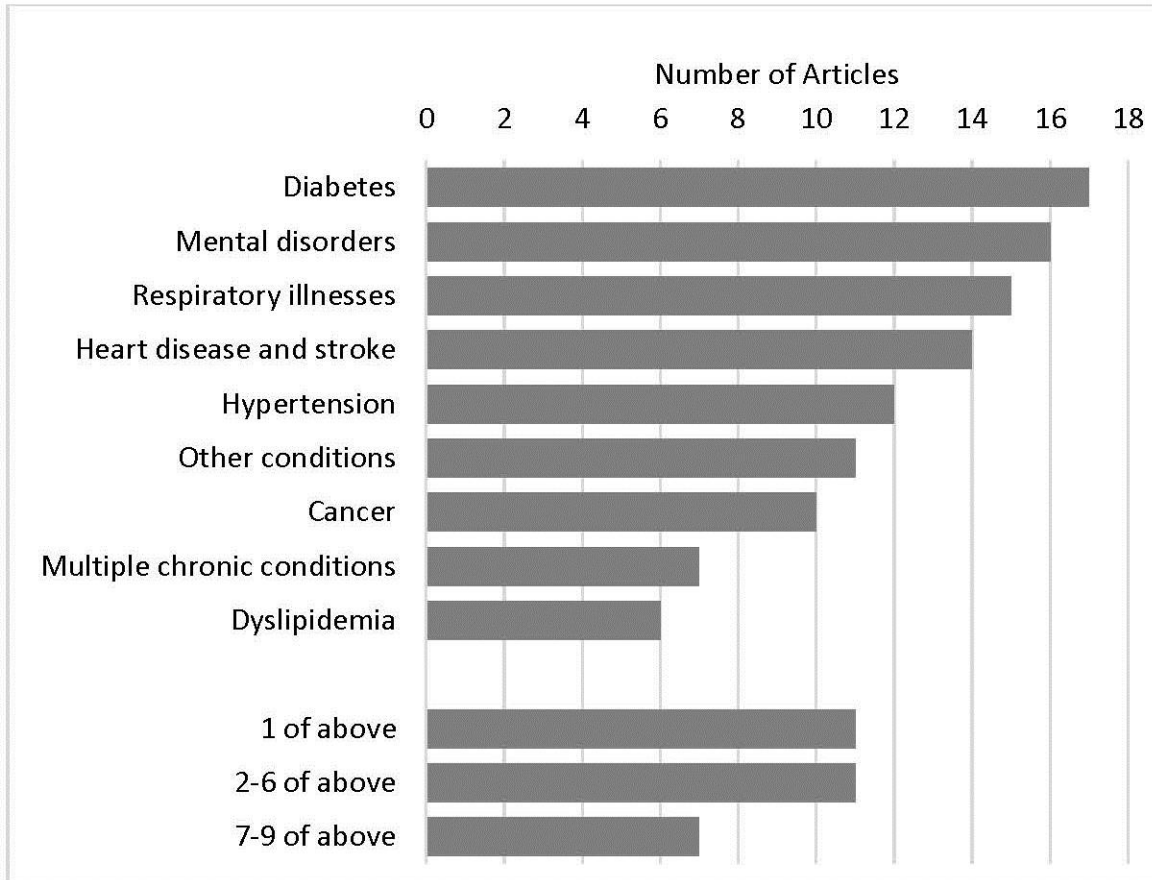
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Appendix Table 2. Estimated Prevalence of Non-Communicable Chronic Diseases Among Medicaid Beneficiaries (2000−2016, N=19)

Author (Year)	Heart disease and stroke	Hypertension	Dyslipidemia	Diabetes	Cancer	Respiratory illnesses	Mental disorders	Other chronic conditions	Multiple chronic conditions
Buescher (2010)[13]				15.7%					
Chang (2013)[14,a]		9.9%[c]		7.5%			Depression: 22.3%	Obesity: 42.9%	
Cheung (2012)[15]	CHD: 11.1%; Stroke: 6.2%	31.8%		14.3%	7.8%	Asthma: 18.1%		Obesity: 33.5%	
Christopher (2015)[16,a]									≥1 conditions: 55.7%
Decker (2013)[18,a]	Any heart disease: 11.8%; Stroke: 5.5%	27.4%	Hyperlipidemia: 23.2%	12.7%	9.5%	Asthma: 19.3%; Emphysema: 4.8%	Depression: 5.0%	Obesity: 45.2%	≥1 conditions: 56.8%; ≥2 conditions: 29.3%
Hill (2014)[27,a]	Any heart disease: 8.8%; Stroke: 1.5%	17.2%	Hyperlipidemia: 16.8%	7.7%		Active asthma: 7.8%; Emphysema: 1.6%	Depression: 16.5%; Serious psychological distress: 9.7%	Arthritis: 27.7%; Obesity: 35.3%	≥1 conditions: 62.1%
Khoury (2013)[28,b]	CHF: 6.7%	32.8%		15.7%	Breast: 0.9%; Lung: 0.2%	Asthma: 2.9%; COPD: 13.2%	Depression: 19.5%	End-stage renal disease: 2.6%	
Piecoro (2001)[32]						Asthma: 4.6%			
Priest (2011)[33]	CHD: 1%; HF: 1%	4%[d]	Hyperlipidemia: [e] 4%	3%		Asthma: 4%; COPD:[f] 1%	New depression: 0.3%		
Wildmer (2015)[38,a]	CHD: 5%; Angina: 2%	18%				Asthma: 15%			
The following studies examined only those with a specific disease, n=9									
Bagchi (2007)[12,g]	CHD: 26.1%			27.5%					
Clemans-Cope (2013)[17]									≥2 conditions: 68.0% (in patients with ≥1 conditions); 76.9% (in patients with ≥1

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									mental disorders)
Downie (2011)[19,h]	CVD: 18.4%		Hyperlipidemia: 43.9%	38.8%		Asthma or COPD: 19.9%		Chronic kidney disease: 26.5%; Obesity: 62.5%	
D'Souza (2014)[20,i]	CVD: 64.2%; MI: 6.5%; CHF: 32.5%; Stroke: 17.1%			33.5%	Presence of any cancer: 18.3%; Malignant cancer tumors: 6.6%	Asthma: 16.3%; Respiratory diagnosis (exclude COPD): 27.5%	Depression: 27.9%; Dementia: 7.9%	Renal: 5.4%; Peptic ulcer disease: 2.9%	
Esposito (2009)[22,j]	CHD: 29.1%			29.8%					
Guo (2007)[25,k]	CHD: 2.2%; Stroke: 1.7%	13%		7.1%	0.4%	COPD: 4%	Anxiety: 36.2%	Arthritis: 1.6%; Obesity: 7.9%	
Lin (2010)[29,l]	MI: 3.75%; CHF: 17.94%; Pulmonary heart disease: 0.22%; Stroke: 10.73%	63.40%		27.74%	Any malignancy: 5.98%			Renal: 0%; Peptic ulcer disease: 3.39%	Comorbidities in addition to COPD: 1–2: 50.58%; 3–4:28.46%; ≥5: 8.42%
McCombs (2000)[30,m]							Bipolar: 15.4%; Anxiety: 13.2%; Major depression: 21.0%; Dementia: 4.9%		
Yang (2016)[40,n]	Pulmonary vascular disease: 2.9%; Preexisting heart condition:[o] 8.5%		Dyslipidemia: 14.6%	20.7%		Chronic respiratory disease: 19.5%	Depression: 11.0%	Chronic kidney disease: 8.4%	

[a] Study examined beneficiaries aged 18/19 years to 64 years using nationally representative data. Prevalence estimates included in the range presented in the text.
[b] Prevalence estimates among female beneficiaries only.
[c] The extreme low prevalence was treated as an outlier and excluded from the range presented in the text.
[d] Excludes those with evidence of HF or MI.

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[e] Excludes patients with evidence of CHD.

[f] Includes only those aged ≥40 years.

[g] Prevalence estimates among beneficiaries diagnosed with CHF.

[h] Prevalence estimates among beneficiaries diagnosed with hypertension.

[i] Prevalence estimates among beneficiaries diagnosed with COPD. Study also includes prevalence estimates for ten other chronic conditions not listed in the table due to space limitations and the fact that two or more articles reported on those conditions.

[j] Prevalence estimates among beneficiaries diagnosed with CHF.

[k] Prevalence estimates among beneficiaries diagnosed with bipolar disorder, excluding those with schizophrenia. Study also includes prevalence estimates for three other mental disorders not listed in the table due to space limitations and the fact that two or more articles reported on those conditions.

[l] Prevalence estimates among beneficiaries diagnosed with COPD. Study also includes prevalence estimates for ten other chronic conditions not listed in the table due to space limitations and the fact that two or more articles reported on those conditions.

[m] Prevalence estimates among beneficiaries diagnosed with schizophrenia. Study also includes prevalence estimates for nine other mental disorders not listed in the table due to space limitations and the fact that two or more articles reported on those conditions.

[n] Prevalence estimates among beneficiaries diagnosed with hypertension. Also includes range of prevalence estimates by adherence level for antihypertensive medication not shown here due to space limitations.

[o] Emergency department visits or hospitalization related to stroke, HF, MI, or CHD.

CHD, coronary heart disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; HF, heart failure; MI, myocardial infarction.

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Appendix Table 3. Estimated Medical Costs by Non-Communicable Chronic Disease Among Medicaid Beneficiaries (2000−2016, n=20)

Author (year)	Definition of costs	Estimation methods	Chronic disease(s)	Medical cost (adjusted to 2015 $)[a]
Clemans-Cope (2013)[17]	Average annual healthcare spending (out-of-pocket spending presented separately) per patient with one or more chronic conditions and one or more mental health conditions, in 2003−2009 (2013 $US). Included cost components: inpatient, outpatient ED, office/outpatient (general practitioner or specialist), and prescription drug spending.	Descriptive statistics used to calculate mean annual costs for both disease groups.	≥1 chronic conditions (including mental health conditions)	$8,881 (additional out-of-pocket spending=$392)
			≥1 mental health conditions	$10,645 (additional out-of-pocket spending=$475)
D'Souza[20]	Mean annual healthcare costs per patient with COPD (and excess cost), from the 1 year following first occurring date of maintenance medication claim during 2004−2006 (2007 $US). Included cost components: medical, pharmacy, and long-term care costs (including deductibles/copayments)	Costs estimated as the mean cost per patient with COPD from a generalized linear model (adjusting for comorbidities) compared to a matched non-COPD cohort. Excess (incremental) cost calculated by subtracting total healthcare costs of the non-COPD matched cohort from the COPD cohort.	COPD	$20,900 (excess compared to non-COPD cohort=$2,478)
Epstein (2008)[21]	Median annual healthcare costs per patient in 12 months following initiation of treatment during 1995−2003 (2002 $US). Included cost components: inpatient, outpatient/physician, nursing facility/intermediate care (long-term care), and prescription costs.	Nonparametric statistics described the median total cost per patient.	Cancer (oral or pharyngeal)	$34,882

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Esposito (2009)[b, 22]	Mean annual total healthcare costs per patient with CHF, by medication adherence (adherent or nonadherent), in 1999 (1999 $US). Included cost components: inpatient, outpatient, drug, ED, skilled nursing facility, hospice, and durable medical equipment costs.	Costs estimated from a generalized linear model (adjusting for demographic characteristics and comorbidities) to compare adherent to nonadherent beneficiaries.	CHF	Adherent to nonadherent: $29,271−$38,187
Garis (2002)[c, 23]	Average annual total healthcare costs per patient with just one major chronic condition alone (i.e., without other major chronic conditions) in 1995 (1995 $US). Included cost components: home/medical supply, physician, pharmacy, hospital, and "other" costs	Patients with evidence of the disease by claim diagnosis and related drug claim, with no evidence of other chronic diseases, were included in the disease groups. Unadjusted annual means calculated for each disease group.	Hypertension; CHF; CVD (excluding CHF and HTN); Diabetes; Respiratory/ asthma; Psychosis; Depression; Anxiety; Acid peptic disease; One of above	$2,220; $3,810; $3,813; $3,475; $2,686; $11,446; $9,048; $2,193; $2,977; $4,857
Gilmer (2004)[24]	Mean annual healthcare costs per patient with schizophrenia, by level of medication adherence (nonadherent, partially adherent, adherent, excess filler), in 1998−2000 (2000 $US). Included cost components: inpatient hospital, outpatient (physician, other clinic care, laboratory and radiological services, and other	Costs estimated using gamma regression for the four medication adherence groups.	Schizophrenia	(Range from non- adherent to excess filler) $11,972−$20,585

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	noninpatient acute care), and pharmacy costs.			
Guo (2007)[25]	Mean total healthcare costs per patient year of a bipolar patient (and percent of total costs related bipolar disorder) in 1998−2002 (2002 $US). Included cost components: inpatient, ER, outpatient, mental health services, physician visit, laboratory tests, other medical services (for example surgical procedures and transportation), and prescriptions costs.	Bipolar-related costs were the percent of total costs that were from medical claims with any ICD-9 codes for bipolar disorder, selected laboratory tests considered directly relevant for treating bipolar disorder, and pharmacy claims for bipolar related drugs. Mean cost per patient-year calculated as [(total cost of all patients/number of patients)/mean enrollment months]x12.	Bipolar disorder	$16,038 (30% related to bipolar disorder)
Hankin (2011)[26]	2-year mean (and median) healthcare costs per patient with pure-OCD (OCD without other major mental disorders) or pure-depression for 2 years following first claim with diagnosis in 1997−2006 (costs not adjusted for inflation in study, 2006 used to adjust costs to 2015 $US). Included cost components: inpatient, outpatient, and pharmacy costs, (medical and psychiatric).	Patients with pure-OCD matched with at least one patient with pure-depression. Nonparametric statistics used to compare median 2-year costs of the two groups.	Obsessive-compulsive disorder;	$26,622 ($7,961);
			Depression	$11,446 ($6,461)
Lin (2010)[d, 29]	Mean annual medical cost per patient with COPD (and excess cost of COPD patients compared to non-COPD patients) in 2001−2003 (year of study costs not specified, 2003 used to adjust to 2015).	Costs estimated as the mean cost per patient with COPD from a generalized linear model (adjusting for comorbidities) compared to a matched non-COPD cohort. Excess (incremental) cost calculated by	COPD	$10,114 (excess compared to non-COPD cohort=$2,489)

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	Included cost components: physician office, inpatient, and outpatient costs.	subtracting total healthcare costs of the non-COPD matched cohort from the COPD cohort.		
McCombs (2000)[30]	Total 2-year healthcare costs per patient diagnosed with schizophrenia for the 2-year period following initiation of treatment in 1987−1996 (1996 $US). Included cost components: outpatient, psychologist, prescriptions, community mental health center, dental, other, acute hospital, psychiatric hospital, and nursing home costs.	Descriptive statistics used to calculate unadjusted mean total costs per patient for the 2-year period.	Schizophrenia	$76,679
Piecoro (2001)[32]	Average annual healthcare costs and asthma-related costs per patient with asthma (and total cost of patient population and total asthma-related costs to Kentucky Medicaid) in 1996 (1996 $US). Included cost components: pharmaceuticals and medical and institutional claims, including ER, inpatient, outpatient, medical services, and other.	Asthma-related costs defined as medical claims with asthma as the primary diagnosis and drug claims for a list of asthma related drug classes. Average annual costs calculated as unadjusted means.	Asthma	$5,724; asthma-related: $989 (total patient population cost: $139,487,832; asthma-related: $24,110,420)
Priest (2011)[33]	Mean annual all-cause (and disease-related) healthcare costs per patient with condition in 2007 (2007 $US). Included cost components: inpatient, ER, outpatient, and pharmacy costs.	Medical claims with a primary diagnosis for the condition and pharmacy claims with National Drug Codes mapped to disease classes specified for each condition considered disease-related. Unadjusted annualized means calculated for the total	Asthma; COPD; CHD; HF; Diabetes; Depression; Hypertension; Hyperlipidemia	$9,127 ($1,185); $31,753 ($3,968); $35,548 ($5,835); $51,937 ($7,031); $27,888 ($3,219); $11,231 ($1,545); $19,821 ($687); $18,785 ($560)

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	costs per patient with the disease and the disease related costs.			
Subramanian (2011)[35]	6-month medical costs per patient in the months following diagnosis in 1999−2004 (2004 $US). Included cost components: physician office visits, outpatient visits, hospital admissions, prescription drugs, home health care, and stays at long-term facilities.	Descriptive statistics used to calculate unadjusted baseline mean costs for each state before and after changes in copayment policies.	Cancer	$29,384−$41,705 (depending on state and differences in copayment policy)
Subramanian (2013)[e, 36]	6-month medical costs per patient for the months following initiation of treatment during 2000−2003 (2003 $US). Included cost components: hospital, long-term care, ambulatory care services, and prescription costs.	Unadjusted mean 6-month baseline cost calculated for the sample.	Cancer	$46,194
Svarstad (2001)[37]	12-month hospital costs per patient (and range by medication adherence level, from "regular user" to "irregular user") in a 12 month period in 1989−1990 (1990 $US). Included cost components: hospital.	Descriptive statistics used to calculate the mean 12-month cost for each disease group and medication adherence subgroup.	Schizophrenia;	$2,268 ($3,831−$7,285);
			Bipolar disorder;	$9,151 ($3,529−$20,659);
			Other severe mental illness	$3,398 ($1,320−$6,440)
Wu (2011)[39]	Average annual healthcare costs (and hyperlipidemia related costs) per patient with diabetes and hyperlipidemia by adherence level (adherent, nonadherent) during 2004−2006 (study costs year not specified, 2006 used to adjust to 2015). Included cost components: outpatient, ED, inpatient, and drug costs.	Hyperlipidemia-related costs defined as drug claims for statins and primary ICD-9 codes in medical claims based on cardiovascular codes such as MI, angina, CHF, and stroke. Unadjusted means calculated for total costs and hyperlipidemia-related costs.	Diabetes + Hyperlipidemia	Adherent to nonadherent: $17,515−$21,518 (hyperlipidemia related $2,756−$3,370)

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Yang (2016)[40]	Mean annual all-cause Medicaid costs (and CVD-related costs) per patient with hypertension by adherence level (low, moderate, high) for those enrolled at least 36 months beginning in 2007 (2011 $US). Included cost components: ED visits, hospitalizations, and medication costs, and excluding outpatient costs, copayments/deductibles, and payments by other payers.	CVD-related costs include claims with CVD-related principle diagnosis and antihypertensive medications. Costs calculated as the least square means by adherence group from a generalized linear model, adjusted for age, race, sex, comorbidities, and preexisting heart conditions	Hypertension	High to low adherence: $5,458−$6,038 (CVD-related $1,067−$1,156)
The following studies examined disease-related costs only, n=3				
Buescher (2010)[13]	Average annual cost of diabetes-related care per patient with diabetes (and total diabetes related medical costs to the North Carolina state Medicaid program) during fiscal year 2007–2008 (2008 $US). Included cost components: skilled and intermediate nursing care, physician and other medical, hospital, outpatient clinic, prescription drugs, and home healthcare costs.	Diabetes-related costs identified as claims with diabetes as the primary or contributing diagnosis and pharmacy claims for drugs used almost exclusively for diabetes treatment (various antihyperglycemic medications). Per patient diabetes related costs calculated as total diabetes related expenditures divided by the unduplicated number of persons with diabetes-related claims.	Diabetes	$4,674 (Total Medicaid cost: $598,332,389)
Mullins (2004)[31]	Average annual cancer-related ambulatory treatment costs in 2000 (2000 $US). Included cost components: outpatient therapies, physician visits, and pharmacy costs.	Ambulatory cancer treatment costs included outpatient chemotherapy, antiemetic, analgesic, hematopoetic and radiation therapy; all physician visits; and pharmacy costs for cancer treatment related drugs,	Prostate cancer; Breast cancer; Colorectal cancer	$1,755−$1,775; $1,662−$1,672; $1,381−$1,391

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		such as oral chemotherapy drugs and antiemetics. Treatment costs and recipient enrollment time used to calculate mean annualized costs.		
Shaya (2009)[34]	Mean annual healthcare costs per patient with asthma (without COPD), COPD (without asthma), and COPD with asthma during 2001−2003 (study costs year not specified, 2003 $US used to adjust to 2015). Included cost components: office visits, outpatient services, inpatient services.	Asthma or COPD related costs defined as claims with asthma or COPD as primary, secondary, or tertiary diagnosis. Medicaid fee schedules used to impute costs of all procedures, costs, and services performed by point of service (inpatient, outpatient, and physician). Annualized means calculated for each disease group.	Asthma; COPD; Asthma+COPD	$3,069; $6,491; $19,840

[a] Costs adjusted to 2015 U.S. dollars using the Personal Consumption Expenditures health component price index.

[b] Also includes cost estimates by medication adherence modeled as a 3-level and 5-level variable.

[c] Estimates for physical conditions treated as outliers and excluded from the ranges presented in the text. Also includes cost figures per patient with concurrent conditions for 28 combinations of two of the studied conditions (not presented in table because of space limitations).

[d] Also includes incremental cost figures per COPD patient with 13 individual comorbidities studied. Due to space limitations, these figures are not included in the table.

[e] Includes cost figures per cancer patient with comorbid cardiac conditions, respiratory conditions, diabetes, or mental health conditions and a total of one, two, three, or four chronic conditions. Due to space limitations, these figures are not presented in the table.

CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; ED, emergency department; ER, emergency room; HTN, hypertension; OCD, obsessive-compulsive disorder; HF, heart failure.