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# Determining the prevalence and risk factors for prescription drug unaffordability

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ABSTRACT

*Background:* Prescription affordability is a key component of healthcare accessibility and a determinant of health outcomes. Prior studies indicate that up to 1 in 4 Americans report difficulty affording prescriptions.
Objective(s): This study aims to identify factors associated with cost-based prescription refusal.
*Methods:* We identified 17,869 study participants from the 2017 National Health Interview Survey who had been prescribed at least one medication in the past 12 months. The outcome was defined as inability to afford at least one prescription medication. Covariates included demographic data, medical history, and social attitudes. Logistic regression models were constructed to identify predictors of cost-based prescription refusal.
*Results:* Among 8223 study participants, 8.1% reported the inability to afford at least one prescription medication in the past 12 months. Twenty-seven covariates were correlated with prescription unaffordability, and 8 were selected by the LASSO: Income (Odds ratio (OR) 0.55), Concerned About Bills (OR 2.0), Emergency Department Visits past 12 months (OR 1.33), Dissatisfaction with Medical Care (OR 1.3), Seeking Insurance Through the Health Insurance Marketplace (OR 1.26), Feeling Sad Most of the Time (OR 1.24), History of Asthma (OR 1.26) and History of Diabetes (OR 1.24).
*Conclusions:* Prescription unaffordability remains a significant public health problem and is more common among low-income individuals and patients with, chronic medical conditions.

## Introduction

The refusal of medication at the pharmacy counter due to excessive cost constitutes a diagnosable failure of pharmacotherapy.[1] In the United States, 24% of individuals under 65 years of age report difficulty in affording their prescription medicines, according to a 2019 survey conducted by the Kaiser Family Foundation (KFF).[2] Cost-based prescription nonadherence (CBPN) is a significant problem because it has been associated with decreased adherence and poor health outcomes.[3]

While the importance of CBPN has been well documented,[3] it remains unclear what patient factors are associated with cost-based prescription refusal. The National Health Interview Survey (NHIS), an instrument that has been in use since 1957, has provided longitudinal data on prescription affordability and many other aspects of the nation's health.[4] This resource has been used in the past to characterize CBPN, with data from the 2002 NHIS indicating 5.9% of the civilian noninstitutionalized population of the United States refused prescribed medications based on their cost.[5] The passage of the Medicare Prescription Drug Improvement and Modernization Act in 2003 set a precedent for insurance coverage of prescription medications at the Federal level. Medicaid programs administered by individual States and private insurance comprise the patchwork of coverage available today. Private prescription coverage is highly variable with respect to formulary and copayment requirements. The problem of CBPN is similarly complex.

Understanding factors associated with CBPN is necessary to orient health care reform and design interventions aimed at overcoming barriers in access to medications. Using 2013 NHIS data, Patel et al. found major associations between perceived financial stress, financial and food

*Abbreviations:* CBPN, Cost-based prescription nonadherence; CI, Confidence interval; COPD, Chronic obstructive pulmonary disease; HIM, Health insurance marketplace; KFF, Kaiser Family Foundation; LASSO, least absolute shrinkage and selection operator; LGBTQIA+, Lesbian, gay, bisexual, transgender, queer, intersex, asexual, plus; MI, myocardial infarction; NHIS, National Health Interview Survey; OR, Odds ratio; SEP, Socioeconomic position.

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insecurity and CBPN.[7] In the present study, the most recently available NHIS data (2017) were used to address a greater array of potential risk factors in a more general population. Using both univariate statistics, machine learning (LASSO) and multivariate logistic regression, we assessed the effect of income, economic, demographic, clinical and social factors that contribute to, or arise from, CBPN.

## Methods

### *Data sources and sample selection*

Data were retrieved from the 2017 NHIS, which is a biannual questionnaire tracking data on health status, health care access, and progress toward achieving national health objectives.[4] Of the 78,132 patients participating in this survey, 17,869 (22.87%) were selected after constraining sampling to participants who had been prescribed a medication in the past 12 months. Patients with incomplete data were removed as required for subsequent multivariate statistical analysis (Fig. 1). Individuals over the age of 65 were excluded from the analyses because they are eligible for Medicare benefits.

### *Outcomes*

The outcome was CBPN, defined with the survey question "Couldn't afford prescription medicine, past 12 months", coded as a yes or no question with instances of nonresponse coded as incomplete.

### *Potential predictive variables*

Twenty-nine covariates were assessed in univariate testing. These consist of 9 potential medical predictors (history of asthma, cancer, chronic obstructive pulmonary disease (COPD), diabetes, hypercholesterolemia, hypertension, myocardial infarct (MI), renal failure, and stroke) and 16 social dispositions that are well established in health outcomes research.[6,8] These include concern about the payment of bills, history of emergency department admission or physician visit in the past 12 months, feelings of sadness, hopelessness, worthlessness, and poor rest as well as average hours of sleep, attitudes about their patient-physician relationship, lesbian, gay, bisexual, transgender, queer, intersex, asexual, or other non-heterosexual identity (LGBTQIA+). Lastly, 4 demographic variables (sex, age group, racial or ethnic background, and income).

Of 690 questions asked by the NHIS, 29 related to demographic characteristics, disease state history, and social disposition. These were included in the study as potential predictive variables of CBPN (Fig. 2). NHIS responses for categorical variables were recoded as binary. Specifically, questions that were expressed on a 4-point Likert scale were binarized and displayed as "mostly agrees" or "mostly disagrees" (with each respective category consisting of a summation of responses of "always" and "sometimes" or "rarely" and "never"). This recoding applied to "Concerned About Bills", 'Feelings Mostly Interfere with Life", "Feels Mostly Hopeless", "Feels Mostly Poorly Rested", "Feels Mostly Sad", "Feels Mostly Worthless", "Feels Neighborhood is Close Knit", "Feels Physician Shares Culture", "Feels Respected by Physician", and "Dissatisfied with Medical Care". Age was represented as $\leq$25 years or 26–64 years. These categories exist to differentiate individuals eligible to be covered on a parent's health insurance from those who are not. Any measure of non-response, such as "refused", "not ascertained", or "don't know" was coded as missing data.

The variable "income" was comprised of a mixture of self-reported household income and income estimated by multiple imputation according to an algorithm developed by the CDC.[9] Imputation was used only when household income was not explicitly omitted by the respondent. The imputation algorithm used variables from the NHIS

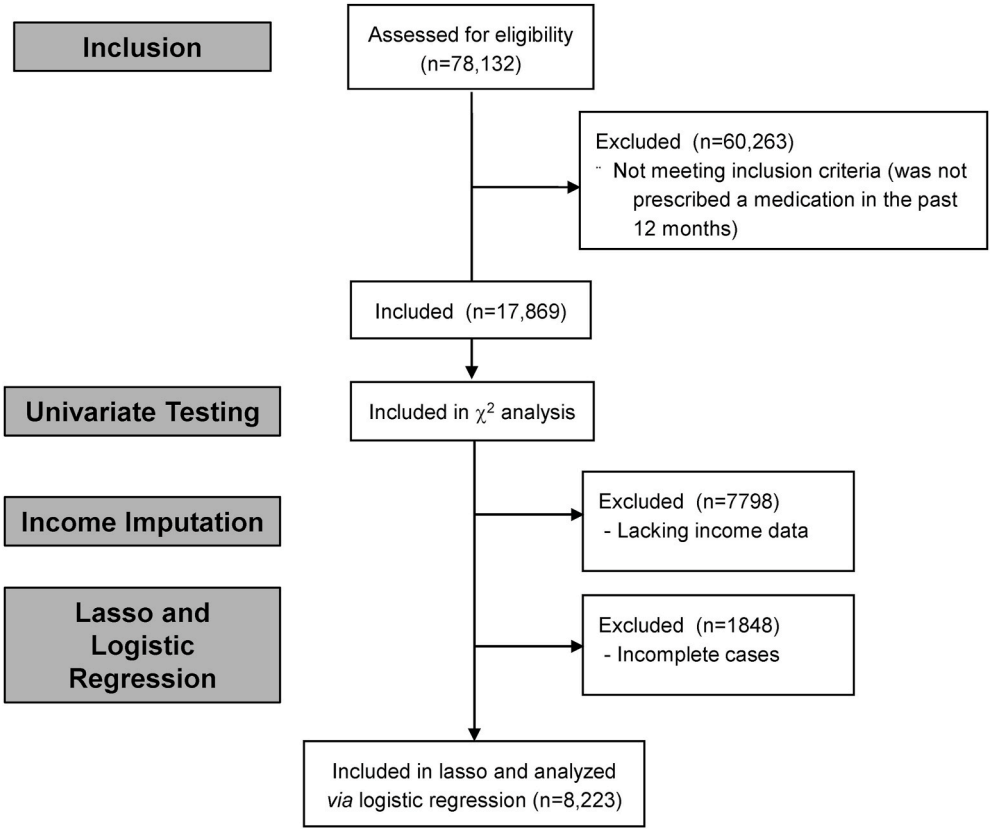


**Figure 1.** Displays the participant cohort size as individuals were excluded in various phases of the study. The figure also details the reasoning behind exclusion and the methodology associated with determining the final cohort.

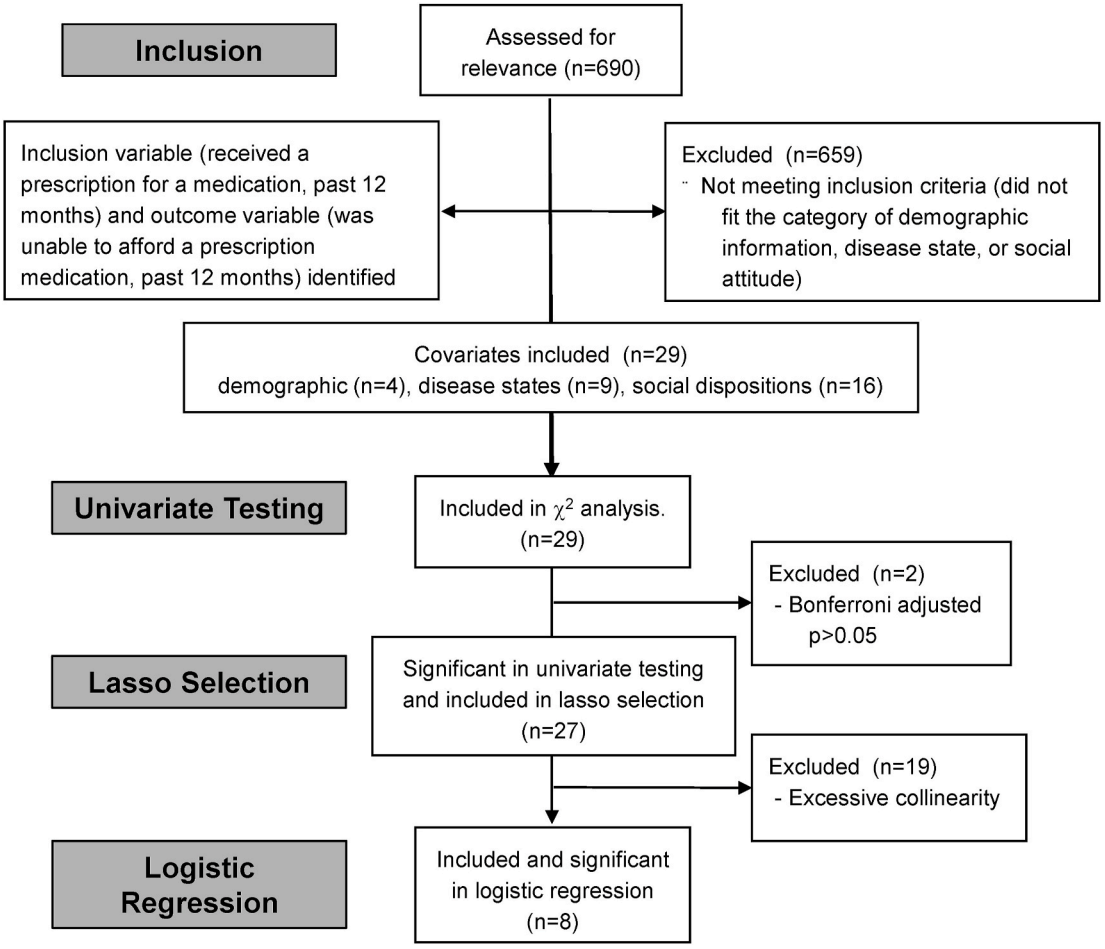


**Figure 2.** Displays the selection of variables for subjection to various statistical testing throughout the study.

"person" and "family" datasets, which had little overlap with the "adult" dataset used for our analysis of CBPN. Aside from explicit omission, income was imputed on the basis of the household, rather than the individual; because of this, respondents in the 'adult' dataset were paired with their household via an identifier specified in the NHIS. If the individual could not be paired with a household, the income data for that individual was considered missing and therefore excluded from the LASSO analysis. In the present study, income was expressed in $10,000 increments in order to gauge the effect of these strata on odds ratios as determined by logistic regression analysis.

*Statistical analysis*

For univariate testing, each covariate was tested against the outcome variable using the Pearson Chi-Squared test. Only covariates with significant Bonferroni-corrected significance values (p-value x 29) were included in the multivariate analyses.

Covariates were selected for logistic regression using the LASSO,[10] which reduced collinearity between covariates. A logistic regression was performed with these variables following z score standardization. Odds ratios (OR), 95% confidence intervals (CI), and Bonferroni-corrected p-values (p-value x 8) are reported. Analyses were performed in R (RStudio: Integrated Development for R. RStudio, PBC, Boston, MA) (Supplement 1).

## Results

In the study cohort 8.1% of respondents reported CBPN, 13.8% of participants were ≤25 years of age, 73.3% were White, 57.3% were female and the median income was $40,000 (Table 1). The most common medical conditions were hypertension and hypercholesterolemia (30.8% and 28.6% respectively), followed by asthma and diabetes (17% and 9.1% respectively). Only two of 29 covariates were excluded in univariate testing (medical history of cancer and hypercholesterolemia). Most participants saw a physician at least annually (85.7%) and felt respected by him or her (93%), however 30% of participants did not feel as though their physician shared their culture.

The LASSO selection algorithm identified 8 covariates from the 27 covariates selected in univariate testing (Fig. 3). Higher income was associated with decreased odds of CBPN (OR 0.55, 95% CI 0.48–0.62 per $10.000 increase in income). Further, study participants who were concerned about bills had 2-fold higher odds of CBPN (OR 2.00, 95% CI, 1.82–2.14). Also positively correlated with CBPN were emergency department visits in the past 12 months (OR 1.33, 95% CI 1.24–1.43), dissatisfaction with medical care (OR 1.3, 95% CI 1.22–1.38), seeking insurance through the health insurance marketplace (HIM, OR 1.26, 95% CI 1.18–1.36), and feeling sad most of the time (OR 1.24, 95% CI 1.17–1.32). Additionally, two clinical characteristics were selected by the LASSO for inclusion in the final regression, both of which increased the odds of CBPN, including history of asthma (OR 1.26, 95% CI 1.17–1.35) and history of diabetes (OR 1.24, 95% CI 1.15–1.33).

## Discussion

To our knowledge, our study is the first to leverage the most recent NHIS data to estimate the rate of CBPN and identify factors associated with CBPN. An affirmative response to the outcome variable, "Couldn't afford prescription medicine, past 12 months" was interpretated as the

**Table 1**
Cohort characteristics.

| Characteristic | N (%) |
|---|---|
| Could not afford a prescription, past 12 months | 665 (8.1) |
| Sex | |
| Female | 4712 (57.3) |
| Male | 3511 (42.7) |
| Age (years) | |
| ≤25 | 1137 (13.8) |
| ≥26 | 7086 (86.2) |
| Ethnicity | |
| American Indian | 86 (1.0) |
| Black American | 770 (9.4) |
| Caucasian | 6026 (73.3) |
| East Asian | 266 (3.2) |
| Hispanic | 1002 (12.2) |
| Indian/South Asian | 73 (0.9) |
| Medical History | |
| History of Asthma | 1394 (17.0) |
| History of Cancer | 608 (7.4) |
| History of Diabetes | 752 (9.1) |
| History of COPD | 152 (1.8) |
| History of Hypercholesterolemia | 2272 (27.6) |
| History of Hypertension | 2533 (30.8) |
| History of MI | 133 (1.6) |
| History of Renal Failure | 98 (1.2) |
| History of Stroke | 120 (1.5) |
| Social History | |
| Concerned About Bills | 237 (28.8) |
| ED Visit in Past 12 Months | 1804 (21.9) |
| Feelings Mostly Interfere with Life | 2042 (24.8) |
| Feels Mostly Hopeless | 601 (7.3) |
| Feels Mostly Poorly Rested | 1550 (18.8) |
| Feels Mostly Sad | 914 (11.1) |
| Feels Mostly Worthless | 460 (5.6) |
| Feels Neighborhood is Close Knit | 5059 (61.5) |
| Feels Physician Shares Culture | 2468 (30.0) |
| Feels Respected by Physician | 7648 (93.0) |
| History of Smoking | 3005 (36.5) |
| Identifies as LGBTQIA+ | 403 (4.9) |
| Mostly Sleeps <7 Hours Per Night | 2990 (36.4) |
| Physician Visit in Past 12 Months | 7046 (85.7) |
| Dissatisfied with Medical Care | 575 (7.0) |
| Sought Insurance Through HIM | 1553 (18.9) |
| Income | Median (IQR) |
| Household Annual Income | 40,000 (20,000–69,000) |

Table 1 displays all variables assessed in this study, along with their prevalence within the study sample. This table characterizes the study group and displays broad trends of response.
Abbreviations: IQR, Interquartile Range; HIM, Health Insurance Marketplace.

inability or refusal to fill a prescription due to the cost of medication. We found that patients with concern about bills or with low income were more likely to report unaffordability of prescribed medications.

In our series, 8.1% of study participants reported CBPN, which is considerably higher than in the 1997 reporting period (4.7%).[5] Our estimate, based on NHIS data, is considerably lower than the findings from a recent KFF survey, which is likely due to the fact that the KFF poll measured difficulty affording prescription, not actual incidents of cost-based refusal.[2]

Our analyses of factors associated with CBPN revealed 8 independently significant predictors. As expected, lower income and concern about bills were associated with increased odds of CBPR. Yet, there were other variables that remained significantly associated with CBPN after adjusting for income. These include chronic diseases that require continuous treatment with costly medications (diabetes, asthma), psychosocial dispositions such as sadness and dissatisfaction with medical care, and health behaviors, such as emergency department use and pursual of health insurance through the federal exchange.

These findings are consistent with the literature.[11,12] The high cost of inhalers has been linked to an increase in medication nonadherence and emergency department admission in children,[11] with a mean annual medication cost of $1,830.[12] This high cost synergizes insidiously with elevated asthma morbidity among low-income individuals.[13] The relationship between diabetes pharmacotherapy and socioeconomics is similarly disquieting, with nonadherence directly linked to income.[14] A recent study showed high prevalence (25.5%) of CBPN among insulin using diabetes outpatients, and associated CBPN with worsened glycemic control.[15]

The evidence that individuals with a medical history of asthma or diabetes are disproportionately unable to afford medications points to the inelastic nature of pharmacotherapy, especially when pertaining to life-sustaining medications. A study conducted by Roebuck et al. on patients enrolled in Medicare (a cohort included in the present study) showed clearly that medication adherence shares an inverse relationship with overall healthcare costs.[16] These findings dovetail with the work of Barron et al. who demonstrated that higher copayment costs were strongly correlated with a decrease in adherence and an increase in treatment failure in diabetic patients receiving prescription insurance.[17] When examined in light of these studies, the rising rate of CBPN suggests a United States healthcare system that generates excess long-term costs because patients face barriers to necessary pharmaceutical care. As Mendoza[18] succinctly put it "prescription drug prices in the US are considered rather extreme", concluding that the high drug prices characteristic of the United States healthcare system discourages preventative care and ultimately burdens the patient. The present study shows that drug pricing for agents treating asthma and diabetes has limited elasticity in the United States, because patients are refusing medicines to treat life-threatening conditions due to excessive cost, where no effective alternative therapies exist.

In addition to medical conditions requiring chronic medication,

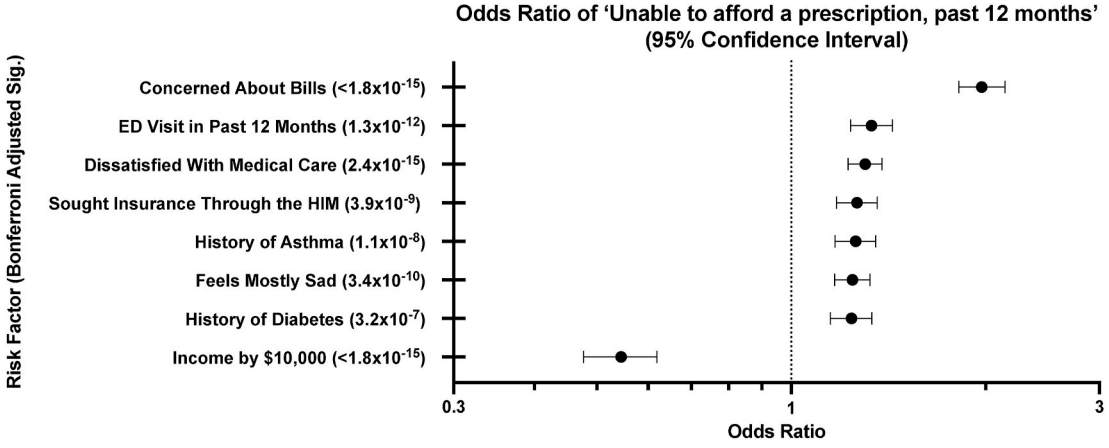


**Figure 3.** Represents graphically via forest plot the odds ratio of covariates selected by lasso for predicting CBPN.

psychosocial dispositions, such as feeling mostly sad, dissatisfaction with medical care, and concerns about finances were also associated with elevated CBPN. These findings are consistent with those of Patel et al. who studied the effects of social determinants of health in diabetes patients.[7] The authors reported on 25 social determinants (including CBPN and concern about paying bills, both of which were the LASSO-selected risk factors in the present study) and demonstrated a correlation between these social determinants and CBPN. The covariates selected by the LASSO algorithm support the findings of Patel et al. and demonstrate that they apply to a broader cohort (all individuals who had been prescribed a medication in the past 12 months).

Our study is subject to the limitation that the White population is overrepresented in the sample.[19] Additionally, more information on health insurance and socioeconomic status would allow the researchers to interrogate the undoubtedly important role of the third-party payer in CBPN.[20] Lastly, the analyses presented in this study are correlative and cannot be used to infer causality.

This study is nevertheless an important contribution to the literature on CBPN. Our use of LASSO variable selection minimized collinearity between predictors, which is a major concern in the study of cost-based barriers to accessing health care. Increasing prescriber awareness of the prevalence and significance of CBPN is essential to optimizing the efficacy of pharmacotherapy and reducing the overall cost burden on the patient and the health care system.

## Conclusion

Increasing rates of CBPN are a matter of public health concern to pharmacists as well as all other medical providers, as noncompliance is associated with poor health outcomes. It is of critical importance that the prevalence of CBPN be reassessed periodically, and the underlying predisposing factors defined so that these outcomes may be improved. This study shows that CBPN is a multifactorial problem that is not limited to simple measures of socioeconomic position. The LASSO variable selection shows that there is sufficient difference in CBPN predictive ability among a diverse subset of correlational covariates to conclude that income is not the sole underlying cause. Only by continuing investigation into these less apparent risk factors can more informed public health and prescribing decisions be made to improve quality of care for all.

## Author statement

**Noah Donnenberg:** Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing, visualization, project administration. **Inmaculada Hernandez:** Formal analysis, investigation, resources, data curation, writing – original draft, supervision. **Daniel Normolle:** Methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, supervision, funding acquisition.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sapharm.2021.06.019.

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