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# Cost-Related Nonadherence to Medications Among US Adults With Chronic Liver Diseases

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## Abstract

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SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at http://www.mayoclinicproceedings.org. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

**Objective:** To estimate the prevalence, risk factors, and consequences of cost-related medication nonadherence (CRN) in individuals with chronic liver diseases (CLDs) in the United States.

**Patients and Methods:** Using the National Health Interview Survey from January 1, 2014, to December 31, 2018, we identified individuals with CLDs. Using complex weighted survey analysis, we obtained national estimates and risk factors for CRN and its association with cost-reducing behaviors and measures of financial toxicity. We evaluated the association of CRN with unplanned health care use, adjusting for age, sex, race/ethnicity, insurance, income, education, and comorbid conditions.

**Results:** Of 3237 respondents (representing 4.6 million) US adults with CLDs, 813 (representing 1.2 million adults, or 25%; 95% CI, 23% to 27%) reported CRN, of whom 68% (n¼554/813) reported maladaptive cost-reducing behaviors. Younger age, female sex, low income, and multimorbidity were associated with a higher prevalence of CRN. Compared with patients without CRN, patients experiencing CRN had 5.1 times higher odds of financial hardship from medical bills (adjusted odds ratio [aOR], 5.05; 95% CI, 3.73 to 6.83) and 2.9 times higher odds of food insecurity (aOR, 2.85; 95% CI, 2.02 to 4.01). The CRN was also associated with 1.5 times higher odds of emergency department visits (aOR, 1.46; 95% CI, 1.11 to 1.94).

**Conclusion:** We observed a high prevalence of CRN and associated consequences such as high financial distress, financial hardship from medical bills, food insecurity, engagement in maladaptive cost-reducing strategies, increased health care use, and work absenteeism among patients with CLD. These financial determinants of health have important implications in the context of value-based care.

Chronic liver diseases (CLDs) account for 2 million deaths per year worldwide.[1] The Centers for Disease Control and Prevention (CDC) estimates that there are 4.5 million (1.8%) adults with CLD and 633,323 (0.27%) adults with cirrhosis in the United States.[2,3] US health care spending in patients with cirrhosis was approximately $32.5 billion in 2016, with inpatient care accounting for 63% of spending.[4] Hospitalized patients with CLDs spend 7 days in the hospital per year; a small subset of high-need high-cost patients with CLDs spend more than 4 days per month in the hospital, with monthly hospital costs of approximately $9000.[5] During the last 2 decades, the burden of hospitalization and readmission in patients with CLDs is increasing at a much higher rate than for other chronic diseases such as congestive heart failure or chronic obstructive pulmonary disease (COPD).[6]

One important factor that contributes to the high frequency of hospitalization in patients with CLDs, particularly those with cirrhosis, is nonadherence to medications. Several factors have been associated with nonadherence, including high pill burden, complex medication regimens, intolerable side effects, and concurrent mental health issues.[7,8] Adherence to medications such as lactulose in patients with hepatic encephalopathy, b-blockers in patients with variceal bleeding, and antiviral therapy for patients with cirrhosis due to viral hepatitis are key metrics for quality of care in patients with cirrhosis.[9,10] One critical factor that has not been well studied is nonadherence to medications due to cost. Recent studies have suggested that approximately 10% to 15% of patients with diabetes or atherosclerotic cardiovascular disease experience cost-related medication nonadherence (CRN).[11,12]

To address this knowledge gap, we assessed the national burden and risk factors for financial hardship from medical bills among individuals with CLDs; evaluated its potential consequences, including maladaptive coping strategy, CRN, personal and/or health care—related financial distress, and food insecurity; and explored downstream effects on unplanned health care use and work productivity. Comprehensive understanding of potentially modifiable factors associated with nonadherence would inform targeted population health management strategies for patients with CLDs.

## PATIENTS AND METHODS

### Data Source

We used data from the National Health Interview Survey (NHIS) from January 1, 2014, to December 31, 2018. The NHIS, compiled annually by the National Center for Health Statistics/CDC, is a cross-sectional national survey that incorporates complex multistage sampling to provide estimates on the noninstitutionalized US population. The NHIS collects data through questionnaires delivered by trained interviewers and collects information on demographic, socioeconomic, and self-reported information on health conditions and access to care for at least 1 randomly selected member adult from each household.[2] We used the Integrated Public Microdata Series[2] tool to generate the pooled data set because it allows multiyear variable extraction and provides integrated survey design variables for the aggregate cohort (eg, strata, weights, and sampling units) that are based on the original NHIS and ensure the integrity of the complex multistage sampling survey structure.[13,14] The NHIS data are publicly available as deidentified data from the National Center for Health Statistics, exempting this study from the institutional review board committee purview.

### Study Population

Patients were identified as having a diagnosis of CLD based on affirmative response to either of the following questions: “Ever had any chronic liver condition?” or “Told had a liver condition, past 12 months?” Our sample consisted of participants 18 years or older. Unweighted sample figures and their respective survey-weighted representative estimates are reported and referenced accordingly.

### Definitions

**Cost-Related Medication Nonadherence.—**The CRN was defined based on affirmative response to any of the following 4 survey questions: (1) “Did you need but could not afford prescription medicines over the past 12 months?”; (2) “Did you take less medication to save money over the past 12 months?”; (3) “Did you skip medication doses to save money over the past 12 months?”; and (4) “Did you delay refilling medications to save money over the past 12 months?”[11,12] Also, we assessed whether patients had pursued cost-reducing strategies for prescription medications based on the following questions: (1) “During the past 12 months, have you asked your doctor for lower-cost medication to save money?”; (2) “During the past 12 months, have you bought prescription drugs from another country to save money?”; and (3) “During the past 12 months, have you used alternative therapies to save money?”

**Financial Hardship Due to Medical Bills.—**Patients were identified as having financial hardships due to medical bills if they (or anyone in their family) reported having problems paying medical bills in the past 12 months and/or currently having medical bills being paid off over time.[15]

**Financial Distress.—**Financial distress was derived from 6 questions regarding the level of worry (4-point Likert scale, ranging from "not worried at all" to "very worried") concerning personal and/or health-related financial matters, including (health-related financial distress): (1) ability to pay medical costs of illness/accident, (2) ability to pay medical costs of usual health care; and (personal financial distress), (3) saving enough for retirement, (4) maintaining standard of living, (5) inability to pay rent/ mortgage/housing costs, and (6) inability to pay monthly bills. Each of these questions was answered using a 4-point "worry" scale (very/moderately/not too/not at all) from which the aggregate financial distress score was generated. Participants within the highest score quartile were considered as having high financial distress.

**Food Insecurity.—**Food insecurity was defined based on the US Department of Agriculture Economic Research Service's 10-item questionnaire, which focuses on being worried about food running out, inability to afford a balanced meal, cutting portions, or skipping meals due to costs, among other aspects.[16] First, a raw score on the 30-day food security scale was constructed. Respondents were then categorized into 3 groups: food secure (raw score, 0–2), low food security (raw score, 3–5), or very low food security (raw score, 6–10). Participants with low and very low food security were deemed "food insecure" for our study.

**Health Care Use and Health-Related Labor Productivity Loss.—**Emergency department (ED) visits were used as surrogate indicators of unplanned health care use and derived from the NHIS survey question: (1) "Were you in an emergency room in the past 12 months?" Illness-related labor productivity loss was derived from the self-reported inability to work due to a health problem, which is defined by NHIS survey documentation "as any condition, physical, mental, or emotional, which causes activity limitation [excluding pregnancy or delivery as a health problem]."

## Study Outcomes

Our primary outcome was to assess the prevalence and trends of CRN among patients with CLDs, overall and by education status, family income, insurance status, and race/ ethnicity. We evaluated risk factors associated with CRN and co-prevalence of other financial toxicity domains—financial hardship from medical bills, financial distress, and food insecurity—and adoption of maladaptive coping behaviors aimed at saving money. We also evaluated the association between CRN and ED visits and work productivity (illness-related work absences).

## Covariates

We also collected data on the following covariates: age, sex, marital status, education, race/ethnicity, family size, family income (high [≥400% of federal poverty limit], middle

[200%-400%], and low income [<200%]), geographic region, health insurance status (private/nonprivate/uninsured), employment, having paid sick leave, receipt of public assistance/welfare, use of alcohol/tobacco, body mass index (calculated as the weight in kilograms divided by the height in meters squared; obese vs nonobese), and self-reported major medical comorbid conditions (coronary artery disease [CAD], COPD, chronic kidney disease, obesity, and diabetes mellitus type 2 [DM2]).

### Statistical Analyses

Because we pooled multiple years of survey data in our cohort, there were 2 particularly important considerations. First, NHIS is a multistage probability sample that incorporates stratification, clustering, and oversampling of some subpopulations, and these change from year to year. Moreover, there was a change in sample design during our chosen period (2005–2015 vs 2016–2018), which means that samples from each period should be treated as statistically independent.[2] To overcome these challenges, we used the Integrated Public Use Microdata Series/NHIS tool to extract our data set variables, along with all relevant stratification, clustering, and weighting variables adjusted to our cohort.[13] Then, as recommended by NHIS, resultant participant-level weights were divided by the number of years included to obtain adjusted sampling weights for use in our multiyear data set.[14]

Survey-weighted proportions were used to describe prevalence throughout the article. Rao-Scott $x^2$ test was used to assess to test for differences in categorical variables prevalence across groups. Multivariable logistic regression models were used to evaluate the association between demographic (age, sex, race/ethnicity, income, insurance, region, and marital status) and clinical factors (tobacco use, alcohol intake, and comorbid conditions) and risk for CRN. Adjusted survey-specific logistic regression models were used to examine the association between CLD status and CRN, as well as the association between CRN and various financial toxicity domains, ED visits, and loss in labor productivity. We evaluated the association between CLDs alone (without major comorbid conditions) and CLDs with varying burden of comorbid conditions and risk for CRN. Logistic regression model results were reported as adjusted odds ratios (aORs) and corresponding 95% CIs. For all statistical analyses, $P<.05$ was considered the level of statistical significance. All statistical analyses were performed with survey-specific tools using Stata, version 15.1 (StataCorp).

## RESULTS

The 2014 to 2018 sample included 152,836 surveyed US adults. Of these, 3676, representing 5.3 million or approximately 2% (95% CI, 2% to 3%) of the US population, self-reported having CLD, similar to the current national prevalence of approximately 2% estimated by the CDC; 3237 respondents (representing 4.6 million US noninstitutionalized adults) with complete data for analysis were included.2 Overall, 57% (95% CI, 55% to 60%; 1,845/3,237) of patients were middle-aged between 40 and 64 years, 48% (1,554/3,237) were men (95% CI, 46% to 50%), 67% (95% CI, 64% to 69%; 2,169/ 3,237) were non-Hispanic white, 40% (95% CI, 38% to 42%; 1,295/3,237) of patients belonged to low-income families, and 7% (95% CI, 6% to 8%; 227/3,237) were uninsured. Approximately 51% (95% CI, 49% to 54%; 1,651/3,237) were obese, 32% (95% CI, 31% to 34%;

1,036/3,237) self-reported DM2, 10% (95% CI, 9% to 11%; 324/3,237) reported CAD, 23% (95% CI, 21% to 25%; 745/3,237) reported current tobacco use, and 55% (95% CI, 53% to 57%; 1,780/ 3,237) reported current alcohol use (Table 1).

## Prevalence and Risk Factors for CRN

Overall, 813 (representing 1.2 million) adults with CLD (survey-weighted proportion, 25%; 95% CI, 23% to 27%) reported CRN. Seventeen percent (n=138; 95% CI, 15% to 19%) were unable to afford medications, 12% (n=98; 95% CI, 10% to 14%) skipped medication doses, 13% (n=105; 95% CI, 11% to 14%) took less medication than recommended, and 16% (n=130; 95% CI, 14% to 18%) delayed refills to save money (Figure 1).

The presence of CLD was independently associated with 40% higher odds (aOR, 1.40; 95% CI, 1.22 to 1.61) of experiencing CRN as compared with adults without CLDs after adjusting for age, sex, race, education, income, comorbid conditions, and insurance status, with similar odds observed after stratification by the presence of concurrent major comorbid conditions (Figure 2).

On multivariable logistic regression modeling, as compared with patients without CRN, patients with CLDs experiencing CRN were younger, more frequently women, more likely to come from a low-income household, uninsured, and more likely to have concomitant COPD and DM2 and lack paid sick leave (Table 1). Patients with a higher burden of comorbid conditions (ie, CAD, COPD, chronic kidney disease, DM2, functionally-limiting mental health condition, and obesity) co-occurring with CLDs reported CRN more frequently, with 33% (n=421/1,275; 95% CI, 29% to 37%) of patients with CLD and 2 to 3 major comorbid conditions, and 43% (n= 83/194; 95% CI, 32% to 54%) of patients with CLD and 4 or more major comorbid conditions reporting CRN (Table 2). On multivariable logistic regression modeling, patients with CLDs with 4 or more major comorbid conditions and those with 2 to 3 major comorbid conditions, respectively, had 3.4 higher odds (aOR, 3.40; 95% CI, 1.93 to 6.01) and 2.3 higher odds (aOR, 2.27; 95% CI, 1.54 to 3.34) of experiencing CRN when compared with patients with CLDs without additional comorbid conditions (Table 2).

In analysis stratified by education level, income, and insurance status, the burden of CRN was highest among uninsured/low-income individuals regardless of education level, with up to 78% (2,524/3,237; 95% CI, 62% to 94%) of patients reporting CRN (Supplemental Figure 1, available online at http://www.mayoclinicproceedings.org). Even among mid-/high-income insured individuals, the prevalence of CRN ranged from 17% (550/3,237) to 19% (615/3,237). Insurance type (private vs nonprivate), race/ ethnicity, and college education were not associated with a significant impact on the prevalence of CRN within categories (Supplemental Figure 1).

## Co-prevalence of CRN and Financial Toxicity Domains

Approximately 70% (569/813; 95% CI, 66% to 74%), 68% (553/813; 95% CI, 63% to 72%), and 41% (333/813; 95% CI, 36% to 45%) of patients experiencing CRN reported financial hardship from medical bills, personal and/or health-related financial distress, and food insecurity, respectively (Figure 3; Supplemental Table 1, available online at

http://www.mayoclinicproceedings.org). The co-prevalence of individual financial toxicity domains (financial hardship from medical bills, financial distress, and food insecurity) and cumulative burden of financial toxicity was higher among patients who reported CRN (Supplemental Figure 2, available online at http://www.mayoclinicproceedings.org). Patients with CLDs who reported CRN had 5.1 times higher odds of experiencing financial hardship from medical bills (aOR, 5.05; 95% CI, 3.73 to 6.83), 4.3 times higher odds of financial distress (aOR, 4.28; 95% CI, 3.19 to 5.76), and 2.9 times higher odds of food insecurity (aOR, 2.85; 95% CI, 2.02 to 4.01), as compared with patients without CRN.

### Cost-Reducing Behaviors and CRN

Approximately 30% (95% CI, 29% to 32%; 971/3,237) of patients with CLDs engaged in at least some kind of cost-reducing strategy, including 27% (95% CI, 25% to 29%; 874/3,237) requesting low-cost medications from health care providers, 8% (95% CI, 7% to 9%; 259/3,237) using alternative therapy, and 2% (95% CI, 2% to 3%; 65/3,237) buying medications from abroad to save money. The CRN was significantly associated with a higher prevalence of cost-reducing behaviors, with up to 68% (95% CI, 64% to 72%; 553/813) of patients experiencing CRN using at least 1 cost-reducing behavior, compared with 19% (95% CI, 17% to 21%; 461/2,424) among patients without CRN (Figure 3, Supplemental Table 2, available online at http://www.mayoclinicproceedings.org).

On multivariable logistic regression modeling, patients experiencing CRN had 9.3 higher odds (aOR, 9.3; 95% CI, 6.9 to 12.7) of engaging in cost-reducing behaviors when compared with patients without CRN. Specifically, CRN was associated with 7.8 higher odds of asking for lower-cost medication from providers (aOR, 7.8; 95% CI, 5.7 to 10.8), 11.1 higher odds of using alternative therapy (aOR, 11.1; 95% CI, 7.0 to 17.8), and 3.0 higher odds of buying medications abroad (aOR, 3.0; 95% CI, 1.7 to 5.7), all to save money, when compared with patients without CRN (Figure 3).

### CRN, Health Care Use, and Work Productivity

More than half the patients experiencing CRN had at least 1 unplanned ED visit in the last 12 months (52.0%; 95% CI, 47.6% to 56.5%; 423/ 813) (Supplemental Figure 3, available online at http://www.mayoclinicproceedings.org). Approximately 14% (95% CI, 10.8% to 17.6%; 114/813) of patients experiencing CRN visited an ED on 4 or more occasions, compared with 7% (95% CI, 5.9% to 8.7%; 170/2,424) of patients without CRN. Patients experiencing CRN had 1.5 times higher odds (aOR, 1.46; 95% CI, 1.11 to 1.94) of ED visits and 1.6 times higher odds of health-related work absenteeism (aOR, 1.62; 95% CI, 1.20 to 2.19) as compared with patients without CRN (Supplemental Figure 4, available online at http://www.mayoclinicproceedings.org).

## DISCUSSION

In this study, using a nationally representative sample of patients with CLDs, we made important observations regarding the prevalence, risk factors, and impact of CRN. First, we observed that 1 in 4 patients with CLDs, representing 1.2 million US adults, experienced cost-related nonadherence to medications, delaying, skipping, or not being able to afford

prescriptions altogether. These estimates are higher than the prevalence of CRN in patients with atherosclerotic cardiovascular diseases and diabetes (ranging from 12%-15%) or those reported in the general population (ranging from 10%-12%).[11,12,17] This suggests that CLDs, independent of other comorbid conditions commonly associated with metabolic syndrome, are associated with increased risk for CRN. Expectedly, the prevalence of CRN was higher in patients with CLDs experiencing multimorbidity, a population particularly susceptible to adverse outcomes with medication nonadherence. A small study of patients with cirrhosis at a referral clinic suggested that approximately 50% of patients with CLD report nonadherence to medications.[7] Our data suggest that cost considerations may be an important factor contributing to nonadherence. Patients unfortunately do not volunteer this information unless directly asked and hence it is imperative that we routinely assess these aspects in the context of assessing health and financial risks of patients.[8]

Second, we observed that although the prevalence of CRN was highest among uninsured patients with a low family income, it was also substantial in privately insured middle-or high-income individuals, a group not generally thought of as being at risk for financial toxicity. This underscores that although insurance coverage is vital to protect against the risk for CRN, current coverage structures are insufficient. A substantial proportion of individuals with CLDs reporting CRN were insured, including 41% with private insurance. This suggests inadequate protection (underinsurance) against the substantial financial impact of out-of-pocket health expenses. With increasing enrollment in high-deductible health plans, the risk for CRN is likely to increase. Notably, neither race/ethnicity, attainment of college-level education, nor having worked during the prior year made a significant impact on CRN prevalence, which is consistent with prior studies showing that rates of medication adherence cannot be predicted by employment status or education level.[8]

Third, CRN was frequently associated with financial hardship from medical bills, financial distress, and food insecurity. Our study highlights the co-existence of financial toxicity across multiple domains, which were frequently overlapping and appear to be strongly linked to each other and CRN. More than one-fourth (220/813) of patients experiencing CRN had co-occurrence of all 3 domains, and more than one-third (285/ 813) had overlap with at least 2 financial toxicity domains. Approximately 70% (569/ 813) of patients with CRN also reported financial hardship from medical bills. This association can be catastrophic because it can catalyze a runaway effect of ever-increasing financial burden, particularly in a vulnerable population. For example, medication nonadherence among the hepatitis C population has been associated with significantly higher inpatient costs.[8]

Finally, we observed that CRN was associated with a higher rate of engaging in cost-reducing strategies that may stand in the way of guideline-directed therapy and may lead to worse outcomes. Similarly, CRN was associated with a higher burden of unplanned health care use, including ED visits, and a decline in work productivity, Approximately 22% to 37% of all 30-day readmissions for decompensated cirrhosis are potentially preventable with improved medication management, with up to 55% and 36% of potentially preventable 30-day admissions driven by diuretic and lactulose nonadherence, respectively.[8,18]

Initiatives to reduce out-of-pocket patient costs such as through vouchers and coupons have been found to improve adherence to chronic disease treatments[19] but may not reduce long-term costs.[20] Drug pricing models lie at the crux of the matter, with less availability of generic drugs, monopolistic pricing in the generic sector, and market consolidation all implicated in the egregious increase in drug spending over recent decades.[20] Population health management strategies for CLDs should also incorporate universal screening for CRN as part of a multicomponent process to identify high-risk patients and deliver high-quality patient-centered care to effectively manage clinical and financial risks.[9,10,21]

Although our findings provide valuable insights into the national estimates of CRN in patients with CLDs, it is not without limitations. First, NHIS relies on self-reported diagnoses of CLDs, without adequate validation. However, it forms the basis for the CDC's official estimates of the burden of CLDs in the United States.

Second, we are not able to evaluate the effect of CLD severity, particularly the presence or absence of cirrhosis and its complications, on CRN and vice versa. It is plausible that these adverse financial determinants of health would be more prevalent in patients with more advanced disease and in turn lead to worse outcomes due to patients' health susceptibility.

Third, due to the cross-sectional nature of our study, we are unable to establish causality between the CRN, its association with other domains of financial toxicity, cost-reducing behaviors, and clinical outcomes such as ED visits.

Finally, the comparison of our results with the hitherto available literature might overstate the association between CLDs and CRN given that our definition of CRN was more expansive by including the inability to afford medications that were otherwise needed, in contrast to prior definitions of CRN by other authors.

## CONCLUSION

We observed a high prevalence of CRN and associated consequences such as high financial distress, financial hardship from medical bills, food insecurity, engagement in maladaptive cost-reducing strategies, increased health care use, and work absenteeism among patients with CLD. Given the impact of these risk factors on maladaptive coping, treatment-related decision making, and unplanned health care use, our study highlights the importance of screening for CRN as standard of care in all patients with CLDs.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Abbreviations and Acronyms:

| | |
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| **aOR** | adjusted odds ratio |
| **CAD** | coronary artery disease |
| **CDC** | Centers for Disease Control and Prevention |
| **CLD** | chronic liver disease |
| **COPD** | chronic obstructive pulmonary disease |
| **CRN** | cost-related medication nonadherence |
| **DM2** | diabetes mellitus type 2 |
| **ED** | emergency department |
| **NHIS** | National Health Interview Survey |

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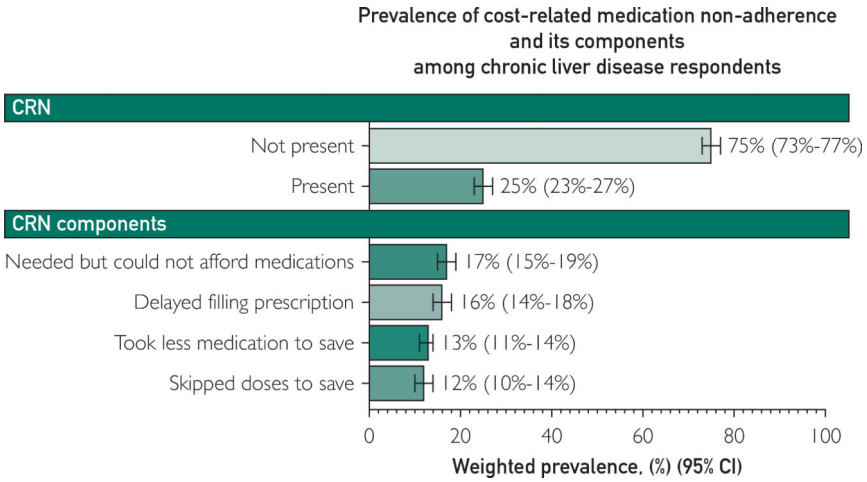


**FIGURE 1.**

Prevalence of cost-related medication nonadherence (CRN) and its components among respondents with chronic liver diseases, based on the National Health Interview Survey 2014 to 2018.

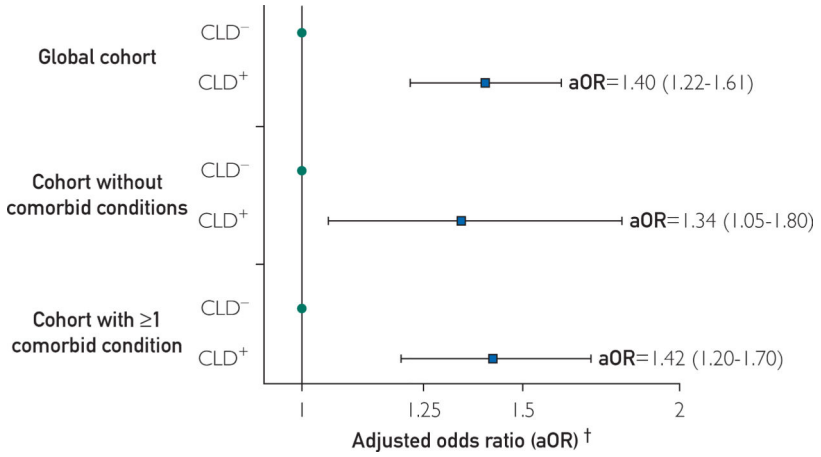


**FIGURE 2.**

Odds of cost-related nonadherence to medications in patients with chronic liver disease ($CLD^+$), in patients with or without other comorbid conditions. [a]Adjusted odds ratio (aOR) and associated 95% confidence interval (CI). All obtained from multivariable logistic regression models adjusted for age, sex, marital status, education, race/ethnicity, family income, region, insurance, alcohol and/or tobacco use, presence of comorbid conditions, employment status, having had paid sick leave from work, and having received welfare. Comorbid conditions included coronary artery disease, chronic kidney disease, chronic obstructive pulmonary disease, functionally limiting mental illness, obesity, and diabetes.

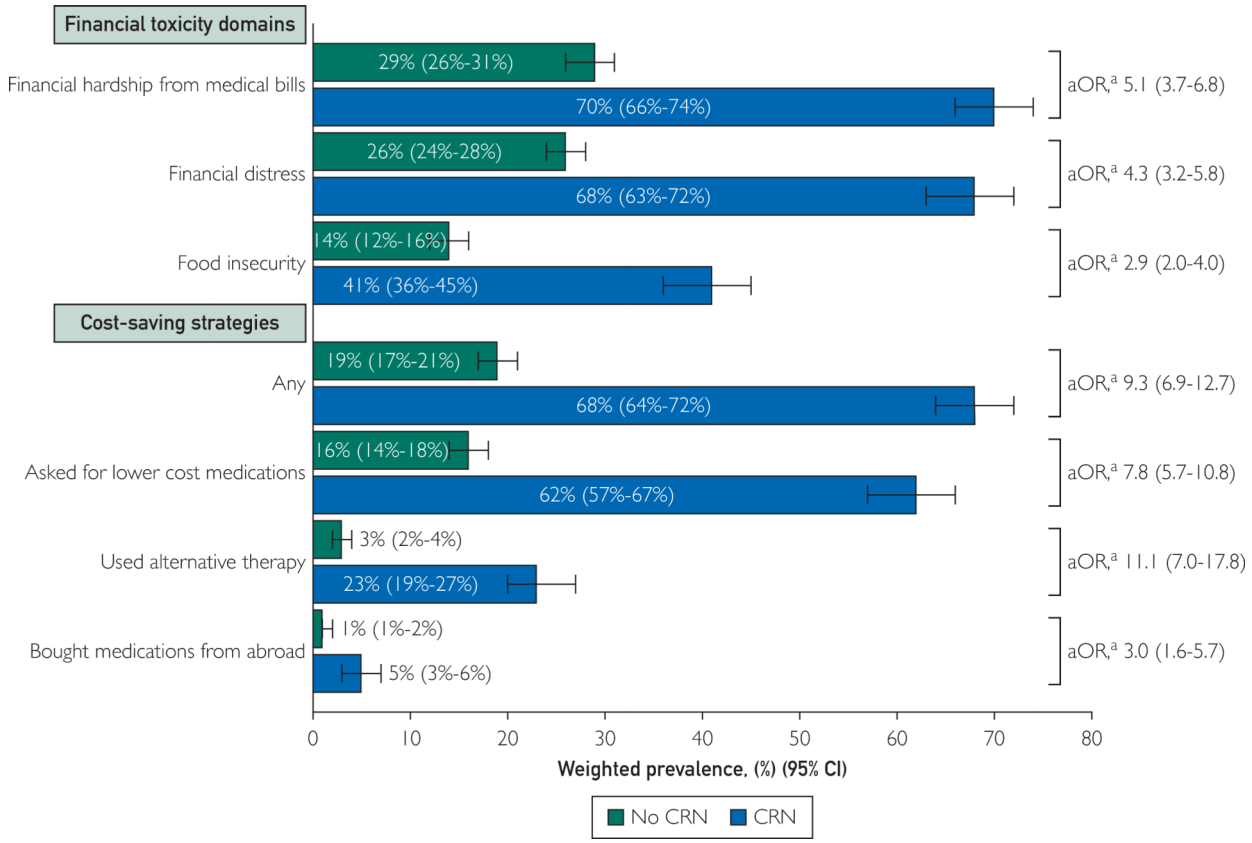


**FIGURE 3.**

Odds and prevalence of concurrent financial toxicity domains and cost-reducing behaviors in patients with chronic liver diseases with or without cost-related nonadherence to medications. aAdjusted odds ratio (aOR) and associated 95% CI were obtained from multivariable logistic regression models adjusted for age, sex, marital status, education, race/ethnicity, family income, region, insurance, alcohol and/or tobacco use, presence of comorbid conditions (coronary artery disease, chronic kidney disease, chronic obstructive pulmonary disease, functionally limiting mental illness, obesity, and diabetes), employment status, having had paid sick leave from work, and having received welfare.

**TABLE 1.**

Distribution and Odds of General Sample Characteristics Among Respondents With Chronic Liver Diseases by Cost-Related Medication Nonadherence Status[a]

| | Cost-Related Medication Nonadherence Status | | | | | |
|---|---|---|---|---|---|---|
| | Absent | Present | Totals | | aOR (95% CI)[b] | *P* |
| Unweighted sample | 2424 | 813 | 3237 | | | |
| Survey sample demographics[c] | | | | | | |
| Weighted sample | 75% (73%–77%) | 25% (23%–27%) | 4,592,679 (100%) | | | |
| Age category | | | | | | |
| ≥65 y | 31% (29%–33%) | 14% (12%–17%) | 1,224,527 | 27% (25%–29%) | 1 (reference) | |
| 40–64 y | 54% (52%–57%) | 66% (61%–70%) | 2,631,780 | 57% (55%–60%) | 1.9 (1.3–2.9) | .002 |
| 18–39 y | 15% (13%–17%) | 20% (16%–24%) | 736,373 | 16% (14%–18%) | 2.6 (1.5–4.7) | .001 |
| Sex | | | | | | |
| Male | 50% (47%–52%) | 43% (38%–47%) | 2,202,982 | 48% (46%–50%) | 1 (reference) | |
| Female | 50% (48%–53%) | 57% (53%–62%) | 2,389,697 | 52% (50%–54%) | 1.5 (1.1–2.0) | .005 |
| Marital status | | | | | | |
| Single | 46% (43%–48%) | 54% (49%–59%) | 2,189,147 | 48% (45%–50%) | 1 (reference) | |
| Married | 54% (52%–57%) | 46% (41%–51%) | 2,388,329 | 52% (50%–55%) | 1.0 (0.7–1.3) | .85 |
| Education | | | | | | |
| ≤High school | 43% (40%–46%) | 47% (43%–52%) | 2,006,586 | 44% (42%–46%) | 1 (reference) | |
| ≥College | 57% (54%–60%) | 53% (48%–57%) | 2,554,599 | 56% (54%–58%) | 0.9 (0.6–1.2) | .30 |
| Race/ethnicity | | | | | | |
| Non-Hispanic White | 67% (64%–70%) | 64% (60%–69%) | 3,050,728 | 67% (64%–69%) | 1 (reference) | |
| Non-Hispanic Black | 8% (7%–9%) | 8% (6%–10%) | 352,600 | 7% (7%–9%) | 0.9 (0.5–1.5) | .64 |
| Non-Hispanic Asian | 6% (5%–7%) | 2% (1%–3%) | 224,702 | 5% (4%–6%) | 0.6 (0.2–1.5) | .23 |
| Hispanic | 17% (14%–19%) | 21% (17%–25%) | 809,829 | 18% (16%–20%) | 1.1 (0.7–1.6) | .67 |
| Other | 2% (2%–3%) | 5% (3%–8%) | 146,783 | 3% (2%–4%) | 1.5 (0.8–2.8) | .26 |
| Income[d] | | | | | | |
| Mid/high | 66% (63%–68%) | 43% (38%–48%) | 2,624,303 | 60% (58%–62%) | 1 (reference) | |
| Poor/low | 34% (32%–37%) | 57% (52%–62%) | 1,757,027 | 40% (38%–42%) | 2.0 (1.4–2.9) | .001 |

| | Cost-Related Medication Nonadherence Status | | | | | | |
|---|---|---|---|---|---|---|---|
| | Absent | Present | Totals | | | aOR (95% CI)[b] | *P* |
| Region | | | | | | | |
| South | 35% (33%–38%) | 42% (37%–47%) | 1,705,540 | • | 37% (35%–40%) | 1 (reference) | |
| Midwest | 20% (18%–22%) | 19% (16%–23%) | 901,541 | • | 20% (18%–22%) | 1.2 (0.9–1.8) | .26 |
| Northeast | 17% (15%–19%) | 13% (10%–17%) | 737,960 | • | 16% (14%–18%) | 0.7 (0.5–1.1) | .18 |
| West | 28% (25%–30%) | 26% (21%–30%) | 1,247,639 | • | 27% (25%–30%) | 1.1 (0.8–1.6) | .56 |
| Insurance status | | | | | | | |
| Nonprivate | 44% (42%–47%) | 43% (39%–48%) | 2,021,663 | • | 44% (42%–46%) | 1 (reference) | |
| Private | 52% (49%–55%) | 41% (36%–46%) | 2,250,357 | • | 49% (47%–52%) | 1.4 (1.0–2.0) | .08 |
| Uninsured | 4% (3%–5%) | 16% (13%–19%) | 311,269 | • | 7% (6%–8%) | 6.4 (3.5–11.5) | <.001 |
| Risk factors and comorbid conditions[c] | | | | | | | |
| Tobacco smoking status | | | | | | | |
| Never | 48% (45%–50%) | 37% (33%–42%) | 2,067,596 | • | 45% (43%–48%) | 1 (reference) | |
| Former | 33% (31%–36%) | 29% (25%–34%) | 1,475,375 | • | 32% (31%–34%) | 1.1 (0.8–1.6) | .43 |
| Current | 19% (17%–21%) | 34% (29%–38%) | 1,041,980 | • | 23% (21%–25%) | 1.4 (0.9–2.0) | .14 |
| Alcohol drinking status | | | | | | | |
| Never | 17% (15%–19%) | 16% (13%–20%) | 773,828 | • | 17% (15%–19%) | 1 (reference) | |
| Former | 29% (26%–31%) | 27% (23%–31%) | 1,287,636 | • | 28% (26%–30%) | 0.9 (0.5–1.5) | .64 |
| Current | 54% (51%–57%) | 57% (53%–62%) | 2,511,610 | • | 55% (53%–57%) | 1.3 (0.8–2.0) | .30 |
| Comorbid conditions | | | | | | | |
| Coronary artery disease | 10% (8%–11%) | 11% (9%–13%) | 453,262 | • | 10% (9%–11%) | 1.0 (0.7–1.5) | .99 |
| Chronic obstructive pulmonary disease | 11% (10%–13%) | 22% (19%–26%) | 649,392 | • | 14% (13%–16%) | 1.8 (1.3–2.5) | <.001 |
| Chronic kidney disease | 13% (12%–15%) | 19% (15%–23%) | 670,400 | • | 15% (13%–16%) | 1.4 (1.0–2.1) | .09 |
| Functionally limiting mental condition | 11% (10%–14%) | 19% (15%–23%) | 444,722 | • | 14% (12%–15%) | 1.3 (0.9–2.0) | .12 |
| Type 2 diabetes mellitus | 31% (28%–33%) | 37% (33%–41%) | 1,481,293 | • | 32% (31%–34%) | 1.4 (1.0–1.9) | .03 |
| Obesity (body mass index ≥30 kg/m$^2$) | 50% (47%–52%) | 56% (52%–61%) | 2,304,745 | • | 51% (49%–54%) | 1.2 (0.9–1.6) | .27 |
| Work and productivity[c] | | | | | | | |
| Employed, past y | | | | | | | |
| No | 55% (52%–58%) | 55% (50%–59%) | 2,522,623 | • | 55% (53%–57%) | 1 (reference) | |
| Yes | 45% (42%–48%) | 45% (41%–50%) | 2,059,767 | • | 45% (43%–47%) | 1.0 (0.7–1.4) | .91 |

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| | Cost-Related Medication Nonadherence Status | | | | | | |
|---|---|---|---|---|---|---|---|
| | Absent | Present | Totals | | | aOR (95% CI)[b] | *P* |
| Paid sick leave, past y | | | | | | | |
| Yes | 55% (52%–58%) | 39% (35%–44%) | 2,192,974 | • | 51% (49%–53%) | 1 (reference) | |
| No | 45% (42%–48%) | 61% (56%–65%) | 2,111,554 | • | 49% (47%–51%) | 1.5 (1.1–2.0) | .01 |
| Welfare, past y | | | | | | | |
| Yes | 1% (1%–2%) | 1% (0%–2%) | 49,790 | • | 1% (1%–2%) | 1 (reference) | |
| No | 99% (98%–99%) | 99% (98%–100%) | 4,539,494 | • | 99% (98%–99%) | 2.4 (0.9–6.5) | .08 |

[a] aOR, adjusted odds ratio.

[b] The aOR, 95% CI, and corresponding *P* value correspond to multivariate logistic regression modeling adjusted forage, sex, marital status, education, race/ethnicity, family income, survey region, insurance status/type, alcohol and/or tobacco use, presence of the specific comorbid conditions listed, employment status, having paid sick leave, and welfare receipt.

[c] Values represent survey-weighted prevalence figures (or percentages); their respective 95% CIs lie within parentheses.

[d] Mid-/high-income category is defined as 200% or greater of the national poverty rate for the survey year; the converse is true for the low/poor category.

**TABLE 2.**

Prevalence and Odds of Cost-Related Medication Nonadherence Among Respondents With Chronic Liver Disease by Incremental Burden of Concurrent Comorbid Conditions

| No. of Major Comorbid Conditions[a] | Survey-Weighted Sample Size | Survey-Weighted Prevalence (95% CI) | Adjusted Odds Ratio (95% CI)[b] | *P* |
|---|---|---|---|---|
| 0 | 112,325 | 19% (14%–24%) | 1 (reference) | — |
| 1 | 281,925 | 25% (21%–29%) | 1.58 (1.06–2.34) | .02 |
| 2–3 | 408,133 | 33% (29%–37%) | 2.27 (1.54–3.34) | <.001 |
| ≥4 | 81,947 | 43% (32%–54%) | 3.40 (1.93–6.01) | <.001 |

[a]Values represent survey-weighted prevalence figures (or percentages); their respective 95% CIs lie within parentheses.

[b]Adjusted odds ratio, 95% CI, and corresponding *P* value correspond to multivariate logistic regression modeling adjusted for age, sex, marital status, education, race/ethnicity, family income (greater or lesser than 200% of national poverty rate for survey year), survey region, insurance status/type, alcohol and/or tobacco use, presence of specific comorbid conditions, employment status, having paid sick leave, and welfare receipt.

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