



BMJ Open Trends in charges and association with defaults on medical payments in uninsured Americans: a disproportionate burden in ethnic minorities – a retrospective observational study

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ABSTRACT

Objective To evaluate whether medical event charges are associated with uninsured patients' probability of medical payment default and whether there exist racial/ethnic disparity gaps in medical payment defaults.

Design We use logistic regression models to analyse medical payment defaults. Our adjusted estimates further control for a rich set of patient and medical visit characteristics, region and time fixed effects.

Setting Uninsured US adult (non-elderly) population from 2002 to 2017.

Participants We use four nationally representative samples of uninsured patients from the Medical Expenditure Panel Survey across office-based (n=39 967), emergency (n=3269), outpatient (n=1739) and inpatient (n=340) events.

Primary and secondary outcome measures Payment default, medical event charges and medical event payments.

Results Relative to uninsured non-Hispanic white (NHW) patients, uninsured non-Hispanic black (NHB) patients are 142% (p<0.01) more likely to default on medical payments for office-based visits, 27% (p<0.05) more likely to default on emergency department visit payments and 82% (p<0.1) more likely to default on an outpatient visit bill. Hispanic patients are 46% (p<0.01) more likely to default on an office-based visit, but 25% less likely to default on emergency department visit payments than NHW patients. Within our fully adjusted model, we find that racial/ethnic disparities persist for office-based visits. Our results further suggest that the probabilities of payment defaults for office-based, emergency and outpatient visits are all significantly (p<0.01) and positively associated with the medical event charges billed.

Conclusions Medical event charges are found to be broadly associated with payment defaults, and we further note disproportionate payment default disparities among NHB patients.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The study uses four nationally representative samples of uninsured patients from the Medical Expenditure Panel Survey (years 2002–2017) across office-based, emergency, outpatient and inpatient medical events.
- ⇒ The study uses logistic regression models to analyse medical payment defaults and racial/ethnic disparity gaps within these defaults.
- ⇒ Estimates are adjusted for a rich set of patient and medical visit characteristics, as well as region (and year) fixed effects, which are included to adjust for region-specific, time-invariant unobserved confounders.
- ⇒ The study examines charges and does not fully disentangle associations due to the event-specific volume of care received and chargemaster price levels.
- ⇒ Given the observational study design, estimates indicate associations rather than causal effects.

INTRODUCTION

High medical bills have been identified as a primary cause of personal bankruptcies in the USA.^{1–4} While the effect of medical bills on personal bankruptcies is experienced by both insured and uninsured patients,⁵ the risk of medical bills resulting in challenging payment decisions by uninsured patients is potentially higher as these patients do not have a third party with bargaining power to negotiate favourable rates on their behalf, and as such are billed based on providers' chargemaster rates.^{6–8} Chargemaster rates are list prices that providers and health systems assign to each of their medical services, and these list prices are often several factors of magnitude higher than those extended to individuals with either private or public insurance.^{9–11} Furthermore, these prices have been

increasing in relation to underlying provider costs for the past three decades.^{9–12}

While provider policy often allows uninsured patients to negotiate down their chargemaster bills, many patients are unaware of this possibility as information pertaining to financial adjustment practices is hard to access and commonly not volunteered by providers to patients.^{7 13 14} The difficult task of navigating these charge negotiations as an uninsured patient means that many patients may resort to defaulting on their medical bills, which in turn may subject them to debt collection, having their credit tarnished and place them at increased risk of personal bankruptcy. Recent work has highlighted the causal link between default in medical bills from hospitalisations and personal bankruptcies,^{15 16} and while the literature on catastrophic health expenditures has noted vulnerabilities among uninsured patients with hospitalisations^{17–20} it should also be noted that the overall frequency and severity of the financial consequences of healthcare remain at large less settled.^{21 22}

In this study we document trends in medical charge growth across office-based, emergency department, outpatient and inpatient medical events. We further test the hypothesis that medical event charges are associated with patients' decision about defaulting on their medical payment, and we examine the prevalence of payment default disparity gaps across non-Hispanic black (NHB), Hispanic and non-Hispanic white (NHW) patients. We choose to focus on racial/ethnic disparity gaps as it is well established that racial/ethnic minorities are over-represented among the uninsured and because of the historical US context of structural racist policies that restricted African Americans from building intergenerational wealth, something that may cause these individuals to be at elevated risk of medical payment defaults.

METHODS

Data sources and study sample

We use two sets of data and a total of five samples for our study. For the four main samples we pool together the Medical Expenditure Panel Survey (MEPS) consolidated patient condition data files, office-based physician visit event files, emergency department visit event files, outpatient visit event files and inpatient stay event files for the 2002–2017 period.^{23 24}

Our patient inclusion criteria consist of adults under the age of 65 who report being uninsured for the full year during which they are surveyed and who report a race/ethnicity of NHB, NHW or Hispanic in order to ensure sufficient sample sizes. We further ensure our sample is that of fully self-paying (uninsured) patients by excluding any medical event that is recorded with having a payor source other than self-pay.

We restrict our focus to non-flat-fee payments as these may report payments of zero dollars in settings where the services have been prepaid. Lastly, we check the payment data for logical consistencies and exclude events with

payments exceeding the actual charged amount (see online supplemental table S1 for further inclusion restriction details across each of our samples).

Our fifth and final analysis sample is used for the purpose of descriptive trend analyses and this sample consists of the MEPS consolidated patient condition data files alone for the 2002–2017 period. Our inclusion criterion for these data is that of adults (18 years of age and older) with positive medical charges and no missing data on our main covariates (listed in the Covariates section).

Patient and public involvement

Given the retrospective research design of our study, patients and the public were not involved in any way.

Study variables

Outcome variables

Total payment reflects the actual amount paid by the individual in conjunction with the medical visit and is a pure self-pay amount for the uninsured individual.

Beyond our examination of the total payment amount, we also examine the patient's decision of whether or not to default on payment. Here, we code an encounter as a *payment default* if the patient's payment for a visit is equal to zero and the charge is a strictly positive amount. A number of corrections were performed in order to ensure this zero payment is indeed due to the patient failing to pay the provider. First, we check that there is no other payment source for the service (public insurance, private insurance, etc). Second, visits covered under flat-fee agreements are omitted from the analysis since the payment for these are paid in full on the patient's first visit and recorded as zero payments on all events after that. Third, since some follow-up events are sometimes provided free of charge, all these zero charge events are omitted from the analysis. The remaining zero payment events are those used within the analysis. While it is possible that some of the zero events observed may be the result of erroneous billing where a visit was included on another bill, the occurrence of this would likely be random and as such would only work to induce noise into the analysis.

Primary independent variables

Our *charge* variable is the total charge related to the patient's medical event (ie, the charge pertaining to their office-based visit, emergency department visit, outpatient visit or inpatient stay). This charge amount reflects the amount that is billed to the patient for this event in full.

Additionally, we include three sets of race/ethnicity categories: (1) NHB, (2) NHW and (3) Hispanic. Other race categories are excluded from the analysis due to small sample size. NHW is used as the reference category within our main analysis.

Covariates

To account for factors that influence patients' desire to seek medical care, we employ a rich set of controls

that build on the healthcare utilisation framework of Andersen and Newman.²⁵

The Andersen and Newman framework of healthcare utilisation categorises factors that influence utilisation as predisposing, enabling and need based.^{25 26} First, predisposing factors are characteristics that are present before the onset of illness and are associated with different patterns of service utilisation across patients. These factors include race/ethnicity, age, sex, marital status and family size within our analysis. Second, enabling factors capture the degree to which individuals have access to resources that allow them to obtain medical care. In our analysis, we capture the associations of enabling factors by controlling for patients' poverty level/status (across the categories of being poor, near poor, low income, middle income or high income), and we also control for employment status, whether the patient has earned a bachelor's college degree (or higher), and whether the patient reports having had to delay or avoid receipt of care due to anticipated costs. Third, need factors designate the perceived or evaluated presence of an illness that would provide the patient with a reason for seeking medical care. These factors are captured using information on the number of comorbidities that a patient has (measured as a count of whether the patient has a diabetes diagnosis, a diagnosis of high blood pressure, coronary heart disease, stroke, emphysema and/or arthritis). Additionally, we also include indicators of whether the patient reported needing help with activities of daily living and/or instrumental activities of daily living, along with indicators of whether the patient identifies themselves as having either fair or poor health across their physical and mental health.

Lastly, we also include controls for visit-specific contextual factors that we observe for office-based and inpatient stay visits. For office-based visits we control for whether or not the patient reports having seen a doctor, and for the inpatient stays we control for whether the patient had surgery and whether they were in the emergency department prior to being admitted for their inpatient stay.

Statistical analysis

We use multivariate regression methods to estimate the association between charges and our total payment outcome. We use logit regressions in order to measure the association between charges and race/ethnicity on patients' medical payment default decision. In order to mitigate concerns of bias with our observational study design, we take the following two steps. First, we include controls for a broad set of patient and medical event characteristics that we believe are important for explaining payment amounts and final payment decisions by patients using the Anderson model (see Covariates section). Second, we control for census region and year indicators to account for potential confounding from unobserved geographical and time effects.

In terms of our payment regression model specification, this is given by the following:

$$Y_{it} = \alpha + \gamma \text{Charge}_{it} + \tau_1 \text{NHBlack}_i + \tau_2 \text{Hispanic}_i + \beta \mathbf{X} + \phi_r + \lambda_t + \epsilon_{it} \quad (1)$$

In Equation (1), Y_{it} represents our patient-level outcome measure of interest (*total payment*), Charge_{it} captures the event-specific total charge, NHBlack_i is an indicator variable for whether the patient is NHB, Hispanic_i is similarly an indicator variable for whether the patient is Hispanic, and the omitted category here is NHW. Additionally, \mathbf{X} is a vector of control variables (defined within Covariates section). Lastly, ϕ_r controls for census region fixed effects, while λ_t captures the year fixed effects.

Our second set of analyses examines whether charges are associated with patients' medical default decision and whether there are racial/ethnic disparity gaps in the risk of medical payment default. This is evaluated using a logistic model specification:

$$\log_b \text{PaymentDefault}_{it} = \alpha + \gamma \text{Charge}_{it} + \tau_1 \text{NHBlack}_i + \tau_2 \text{Hispanic}_i + \beta \mathbf{X} + \phi_r + \lambda_t + \epsilon_{it} \quad (2)$$

In Equation (2) $\text{PaymentDefault}_{it}$ is an indicator variable for whether patient i defaulted on payment for the visit. The other variables are defined as in Equation (1).

Both sets of analyses are performed using Stata V.16, and in particular the built-in survey commands for mean estimates and logistic regression analysis that accounts for survey weights and provides nationally representative estimates. Statistical significance is noted at the level of $p < 0.01$, $p < 0.05$ and $p < 0.1$ throughout the analyses.

RESULTS

Time trends and sample descriptives

Figure 1 provides time trends in inflation-adjusted (in 2017 US dollars) aggregate annual (per capita) charges and expenditures (figure 1A) and information on the growth trends by the setting within which medical care is received (office-based, emergency department, outpatient and inpatient) (figure 1B).²⁷ This figure is based on the fully consolidated MEPS data files and is included in order to provide context for the main analysis that will follow. These trends show us that total charges (on a per capita basis) have been steadily growing since 2002, and further that this growth is seen across all types of medical settings (office-based, emergency department, outpatient and inpatient); however, we also see that charges have been growing (relatively) the most within office-based and emergency department settings (with that said, we also note that there are significant level differences in terms of charges across these four event types; these level differences can be seen in online supplemental figure S1).

Given these trends, we next examine the summary statistics of our main study samples. Table 1 provides survey-weighted mean estimates for our four sets of samples that span office-based, emergency department, outpatient and inpatient medical events. Each of these samples is further stratified by race/ethnicity in order to facilitate mean

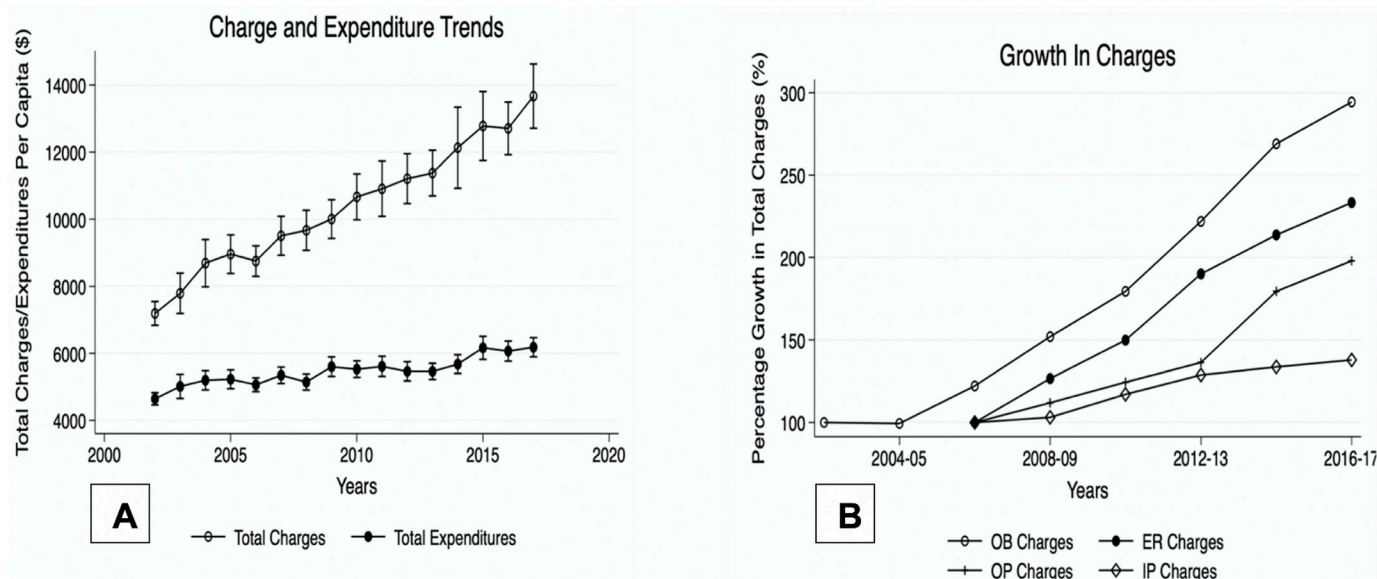


Figure 1 Trends in inflation-adjusted (in 2017 US dollars) charges and expenditures, 2002–2017. (A) Growth in inflation-adjusted charges, along with trend in expenditures, on a per capita basis. The bars around the mean estimates indicate 95% CI. (B) Growth in total charges per capita by type of care. ER, emergency room visit; IP, inpatient stays; OB, office-based visits; OP, outpatient department visits.

comparisons. Looking across the office-based, emergency department and outpatient visit samples, we see a consistent disparity gap between NHB and NHW patients. These mean differences yield significantly higher risk of payment default for NHB patients for office-based visits ($p<0.0001$ relative to NHW, $p<0.001$ relative to Hispanic), emergency department visits ($p=0.03$ relative to NHW, $p<0.0001$ relative to Hispanic) and outpatient visits ($p=0.04$ relative to NHW, $p=0.07$ relative to Hispanic). Here we further note that our inpatient results yield the opposite trend; however, given the very limited sample size within our inpatient sample, we recommend against drawing any strong conclusions from this set of results. (Additional payment default time trends across race/ethnicity are provided in online supplemental figure S2).

In order to explore these racial/ethnic disparity gaps further, [table 2](#) provides disparity gap OR estimates that have been adjusted for census region and year fixed effects. Here we note qualitatively similar trends to those in [table 1](#). That is, relative to uninsured NHW patients, uninsured NHB patients are associated with a 142% ($p<0.01$) higher likelihood of experiencing a medical payment default for office-based visits, a 27% ($p<0.05$) higher likelihood of experiencing one for emergency department visits and a 82% ($p<0.01$) higher likelihood of default on an outpatient visit bill.

Association of medical event charges and final payment amounts

[Table 3](#) examines the association between charges (by the provider) and the resulting payment by patients. Column 1 indicates that a marginal increase in the chargemaster rate (by \$100) for office-based visits is associated with an increase within the average total payment of about \$13.6

($p<0.001$). Column 2 presents the results for emergency department visits. Here we see that a \$100 increase in charges is associated with an increase within the average payment amount by \$17.1 ($p<0.01$). Similarly, in column 3, we note that a \$100 increase in charges for outpatient services results in a \$7.7 ($p<0.01$) increase in average payment. Lastly, in column 4, we see that a \$100 increase in inpatient stay charges is associated with an increase within the average payment amount by \$2.3 ($p<0.01$) on average (note: additional robustness check results that use an alternative generalised linear model, with a gamma distribution and log link, can be found in online supplemental table S2; a robustness check that pools office-based and outpatient visits can be seen in online supplemental table S3; and additional partial payment decision descriptives are provided in online supplemental table S4).

Default rates, charges and the racial/ethnic disparity gap

[Table 4](#) provides our logistic regression OR estimation results across all four of our medical event samples. These fully adjusted models indicate two important sets of results. The first pertains to the association between medical event-specific charges and the probability of payment default. For office-based visits, we observe that a \$100 increase in charges is associated with a 4.1% ($p<0.01$) increase in the odds of the patient having to default on payment. For emergency department and outpatient visits, a \$100 increase in charges is instead associated with a 1.2% ($p<0.01$ and $p<0.01$) increase in the odds of a payment default. The same is not noted within our inpatient stays sample (within column 4); however, in online supplemental table S5, we show that restricting the charge distribution to lower inpatient charge events yields statistically significant ($p<0.01$) associations on par

Table 1 Sample demographics by medical event and race/ethnicity among uninsured US adults, 2002–2017

	OB visits			ER visits			OP visits			IP stays		
	NHW	NHB	Hispanic	NHW	NHB	Hispanic	NHW	NHB	Hispanic	NHW	NHB	Hispanic
Payment action												
Default (%)	20.3	38.4	25.4	68.6	74.2	60.9	40.2	57.6	44.1	80.7	76.3	60.9
Charge (\$100)	1.5	2.2	2.1	17.0	17.5	22.9	8.8	8.4	7.3	156.1	162.2	187.4
Predisposing factors												
Age	42.1	40.7	39.5	35.3	36.5	35.6	45.9	47.1	40.4	39.8	39.7	38.3
Female (%)	57.6	58.9	60.3	52.2	52.6	56.2	52.1	58.0	68.5	58.0	56.3	60.5
Married (%)	42.3	25.3	52.7	31.5	17.5	40.9	40.1	23.2	44.1	38.1	21.9	62.3
Family size	2.5	2.5	3.3	2.5	2.6	3.5	2.3	2.1	3.6	2.6	2.5	3.6
Enabling factors												
Bachelor's degree (%)	21.6	11.6	7.3	5.8	4.7	3.5	14.9	7.3	4.0	7.1	10.9	3.8
Employed (%)	62.8	55.5	62.4	58.7	54.9	61.1	64.5	43.3	56.4	41.6	44.7	52.0
Poverty level (%)												
Poor	17.8	31.0	23.8	39.6	45.3	34.5	18.7	37.3	29.7	36.5	40.2	41.5
Near poor	5.6	9.9	8.4	8.2	8.8	11.4	3.7	5.9	8.7	7.2	3.2	11.0
Low income	18.8	20.9	26.2	19.3	20.3	23.7	17.2	22.1	26.7	25.8	18.1	24.0
Middle income	32.5	24.0	29.7	22.1	19.4	24.0	26.9	28.8	25.6	20.9	30.4	23.5
High income	25.3	14.1	11.9	10.8	6.2	6.5	33.5	6.0	9.4	9.7	8.2	0.0
Delayed care	19.5	12.9	8.1	23.7	17.1	12.3	17.7	5.8	20.5	33.8	7.6	8.6
Unable to get care	18.7	13.6	9.8	28.4	19.2	16.0	15.5	7.6	10.7	34.4	8.4	9.1
Need factors												
Number of comorbidities	0.7	0.9	0.6	0.6	0.7	0.5	1.0	1.2	0.6	1.2	1.0	0.7
ADL help needed (%)	0.9	2.4	1.3	1.1	0.4	0.2	1.7	1.2	0.4	4.1	1.0	3.4
IADL help needed (%)	3.3	3.2	1.7	2.9	1.9	1.4	7.9	6.9	3.0	7.6	5.5	3.4
Self-health (poor/fair) (%)	22.3	26.6	28.0	28.0	33.1	32.4	28.2	36.0	32.3	43.7	43.4	38.8
Self-mental (poor/fair) (%)	12.9	11.8	11.0	18.1	17.1	10.0	14.1	10.9	13.5	29.0	16.3	9.6
Visit factors												
Saw doctor at visit (%)	47.3	64.2	71.1	–	–	–	–	–	–	–	–	–
Had operation (%)	–	–	–	–	–	–	–	–	–	28.4	28.3	32.4
In ER prior to stay (%)	–	–	–	–	–	–	–	–	–	78.1	88.0	63.9
n	20008	5170	14524	1353	879	1018	716	372	608	133	75	126
Population size	15.6 million	1.9 million	4.5 million	0.9 million	0.3 million	0.3 million	0.6 million	0.1 million	0.2 million	85 000	32 000	32 000
ADL, activities of daily living; ER, emergency room; IADL, instrumental activities of daily living; IP, inpatient; NHB, non-Hispanic black; NHW, non-Hispanic white; OB, office-based; OP, outpatient department.												

Table 2 Racial/ethnic disparity gaps in payment default rates among uninsured US adults, 2002–2017

Sample	OB visits	ER visits	OP visits	IP stays
	(1)	(2)	(3)	(4)
	Pr (default)	Pr (default)	Pr (default)	Pr (default)
NHB	2.42*** (0.36)	1.27** (0.16)	1.82* (0.57)	0.77 (0.24)
Hispanic	1.46*** (0.18)	0.75** (0.09)	1.38 (0.35)	0.43*** (0.08)
Observations	39 711	3257	1702	336
Year FEs	Yes	Yes	Yes	Yes
Region FEs	Yes	Yes	Yes	Yes

ORs are reported relative to NHB (the omitted category). SEs are reported within parentheses.

Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

*P<0.1, **P<0.05, ***P<0.01.

ER, emergency room; FEs, Fixed Effects; IP, inpatient; MEPS, Medical Expenditure Panel Survey; NHB, non-Hispanic black; NHB, non-Hispanic white; OB, office-based; OP, outpatient department; Pr, Probability.

with those seen for emergency department and outpatient visit events. As such, we note that (overall) charge levels are associated with patients' payment default decision and that this association may importantly depend on payment feasibility of the initial charge.

The second and perhaps more interesting result in [table 4](#) is seen within the office-based visit sample of column 1. Here, we see that relative to NHB, the odds of defaulting are 2.23-fold ($p<0.001$) higher for NHB and 1.49-fold ($p<0.05$) higher for Hispanic patients. It is important to note that the racial/ethnic disparity gap associations within this model persist even though we control for a rich set of predisposing, enabling and need factors, along with visit-specific characteristics, year, region and

visit type fixed effects. Additionally, within columns 2 and 4, we see that Hispanic patients are associated with significantly lower likelihood of default when compared with NHB patients.

Limitations

First, it should be noted that our study design is retrospective, and as such our findings should be interpreted as associations rather than as causal effects. Second, while great effort has been made to ensure zero payments only reflect payment defaults (see the methods section and online supplemental appendix B), it remains possible that some of these zero payments may be confounded with charity care events. We believe the risk of such confounding is

Table 3 Linear regression estimates for total payment among uninsured US adults, 2002–2017

Sample	OB visits	ER visits	OP visits	IP stays
	(1)	(2)	(3)	(4)
	Total payment	Total payment	Total payment	Total payment
Charge (\$100s)	13.61*** (3.22)	17.05** (8.06)	7.67*** (2.12)	2.35*** (0.44)
Observations	39 711	3244	1702	336
R-squared	0.16	0.17	0.15	0.23
Controls included	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Region FEs	Yes	Yes	Yes	Yes

SEs are reported within parentheses.

The control variables included are race/ethnicity, predisposing factors, enabling factors, need factors and the visit contextual factors from [table 1](#).

Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

*P<0.1, **P<0.05, ***P<0.01.

ER, emergency room; FEs, Fixed Effects; IP, inpatient; MEPS, Medical Expenditure Panel Survey; OB, office-based; OP, outpatient department.

Table 4 Logit (OR) regression estimates for payment defaults by race/ethnicity among uninsured US adults, 2002–2017

	OB visits	ER visits	OP visits	IP stays
	(1)	(2)	(3)	(4)
Sample	Pr (default)	Pr (default)	Pr (default)	Pr (default)
Charged amount				
Charge (\$100s)	1.041*** (0.007)	1.012*** (0.005)	1.012*** (0.004)	1.000 (0.001)
Race/ethnicity				
NHB	2.232*** (0.337)	1.147 (0.137)	1.321 (0.392)	0.568 (0.221)
Hispanic	1.488*** (0.212)	0.686*** (0.086)	0.967 (0.213)	0.482*** (0.119)
Predisposing factors				
Age	0.995 (0.005)	1.001 (0.005)	0.993 (0.010)	0.946*** (0.012)
Female	0.902 (0.090)	0.984 (0.099)	0.962 (0.168)	1.187 (0.288)
Married	0.634*** (0.076)	0.990 (0.131)	0.615** (0.144)	0.952 (0.229)
Family size	1.051 (0.041)	0.967 (0.033)	0.959 (0.062)	0.838*** (0.042)
Midwest	0.846 (0.172)	0.810 (0.154)	1.268 (0.421)	4.549*** (1.179)
South	0.665** (0.121)	0.835 (0.150)	0.907 (0.288)	2.034** (0.605)
West	0.614** (0.125)	0.604** (0.119)	0.662 (0.204)	0.652 (0.203)
Enabling factors				
Bachelor's degree	0.851 (0.142)	0.462*** (0.117)	0.842 (0.304)	2.635* (1.462)
Employed	0.848* (0.081)	0.948 (0.119)	1.044 (0.211)	0.815 (0.250)
Near poor	1.150 (0.189)	0.902 (0.156)	0.514* (0.203)	1.466 (0.824)
Low income	1.005 (0.140)	0.750** (0.101)	0.820 (0.214)	0.689 (0.258)
Middle income	0.652*** (0.089)	0.461*** (0.066)	0.524*** (0.120)	0.333*** (0.083)
High income	0.656** (0.132)	0.433*** (0.084)	0.151*** (0.049)	0.698 (0.242)
Delayed care	0.967 (0.174)	0.905 (0.195)	2.627*** (0.739)	0.761 (0.394)
Unable to get care	0.833 (0.177)	1.116 (0.215)	0.725 (0.227)	0.950 (0.528)
Need factors				
Comorbidity count	1.176*** (0.074)	1.061 (0.069)	1.077 (0.122)	1.587*** (0.254)

Continued

Table 4 Continued

	OB visits	ER visits	OP visits	IP stays
	(1)	(2)	(3)	(4)
Sample	Pr (default)	Pr (default)	Pr (default)	Pr (default)
ADL	0.765 (0.308)	0.348** (0.169)	0.428 (0.256)	0.739 (0.388)
IADL	1.584 (0.480)	1.387 (0.495)	1.090 (0.598)	0.431** (0.143)
Self-health (poor or fair)	1.333** (0.169)	1.231 (0.166)	0.978 (0.204)	1.001 (0.346)
Self-mental (poor or fair)	1.291* (0.175)	0.966 (0.158)	1.922** (0.554)	0.625 (0.180)
Visit contextual factors				
Saw doctor	0.704*** (0.076)			
Had surgery				0.263*** (0.102)
At ER before IP stay				2.232*** (0.522)
Observations	39 711	3244	1702	336
Year FEs	Yes	Yes	Yes	Yes
Visit type FEs	Yes	Yes	Yes	No
Reason for visit FEs	No	No	No	Yes

ORs are reported. SEs are reported within parentheses.

NHW is the omitted reference category for race/ethnicity, the northeast census region is the reference category for our geographical categories, and poor is the omitted reference category for the poverty category variable.

Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

* $P < 0.1$, ** $P < 0.05$, *** $P < 0.01$.

ADL, activities of daily living; ER, emergency room; FEs, Fixed Effects; IADL, instrumental activities of daily living; IP, inpatient; MEPS, Medical Expenditure Panel Survey; NHB, non-Hispanic black; NHW, non-Hispanic white; OB, office-based; OP, outpatient department; Pr, Probability.

ameliorated on account of (1) us controlling for a broad set of income and socioeconomic controls that we believe are able to (at large) capture any systematic variation in payment default that may emanate from charity care events (which tend to be given as a direct function of patient income); and (2) additional robustness checks indicating that our default measure is significantly associated with patients reporting difficulty paying their medical bills (see online supplemental table S6). Third, it ought to be recognised that in this study we focus on four sets of patient medical events as our primary unit of observation (across: office-based, emergency department, outpatient and inpatient events). The focus on an event, rather than a specific type of procedure, implies the possibility that we might have some across-event (within a given event type) variation in the type of care provided. While it is possible that such variations could act to influence patients' default decisions and as such should be noted, we also want to highlight that we use a comprehensive set of control variables (based on the Andersen and Newman framework of healthcare utilisation) to adjust for potential differences

in care needs. We also include controls for visit-specific contextual factors to ensure further homogeneity of the visits (note: the results based on the successive addition of these controls can be seen in online supplemental table S7). Additionally, in online supplemental table S8, we show that for a subsample of our office-based visit events (years 2002–2012 for which we have additional service location details), ensuring greater medical visit homogeneity (1) by only looking at visit events that took place at a doctor's office/group practice, (2) where the care received was a diagnosis/treatment, and (3) where the patient report having seen/talked to a doctor still yields qualitatively similar results. Lastly, we note that while we include a broad set of socioeconomic controls, socioeconomic status still remains coarsely measured within this study.

DISCUSSION

As noted in the Results section, this study has two primary findings. The first is that medical event charges

are associated with the final payment outcome of uninsured patients. This is an important association to note given the trends of the past three decades where charges are (year-on-year) outpacing the growth of underlying medical cost.^{10 11} The second and perhaps most significant finding is that NHB patients are associated with significantly increased odds of default on medical payments than are NHW patients (this is seen for three out of the four event types studied). Our results show that this default gap association persists even after we account for patient characteristics, such as employment status and total annual income (along with a host of other patient, health, visit event, region and time controls) in the case of office-based visits. Additionally, we find that these gaps are a persistent phenomenon across the 16 years in our sample, which spans both pre and post Affordable Care Act periods (see online supplemental figure S1). Pertaining to Hispanic patients, however, the findings are importantly more mixed. For office-based visits, we find similar patterns as for NHB; however, for emergency department and inpatient stays, this pattern is reversed, with Hispanic patients being associated with lower odds of default than NHW patients.

We believe that these default gap results highlight an important area of structural inequity within our health-care system, primarily so for African American patients. This structural inequality is important to highlight as it risks perpetuating the harms done by historical structural racist policies such as the practice of redlining, which greatly limited credit access for African Americans, and in turn their ability to become homeowners and thereafter build intergenerational wealth.^{28–32} This perpetuation can be seen via a number of factors. First, growing charges (relative to underlying costs) may disproportionately hurt racial/ethnic minorities as they are over-represented among the uninsured patients that are billed these charges in full and therethrough at increased risk of catastrophic health expenditure events.^{9–11 33} Second, the consequences of historical inequity can further be seen in the racial/ethnic default gaps documented within this study. Third, these default gaps put NHB and Hispanic patients at increased risk of having their credit scores affected, experiencing financial distress and/or having to file for personal bankruptcy. The potential outcome of this is historically familiar—loss of credit access, which restricts the ability to build intergenerational wealth and thus perpetuates the cycle.

Our hope is that this work can help spur further work within this area, and there appears to be a number of avenues for such efforts. First, we believe that it is important to examine the risk of default within the population with inpatient medical events using a longitudinal sample with more variables than are available within this study. Second, it is important to look at this problem within populations that prior work has identified as being at an increased risk of having multiple medical events (eg, patients with chronic conditions) and high medical expenditures.^{34–36} Third, there is a need to target interventions

for individuals at risk of medical payment defaults and personal bankruptcy. Such targeted interventions could benefit from research examining the potentially heterogeneous payment action responses across more detailed (1) patient characteristics, (2) medical event types, (3) sites and geographical locations, as well as (4) at different levels of the overall charge distribution. Lastly, we need to investigate the effect of policies that can help reverse some of these trends. Such investigations may include analysis of how current policies aimed at expanding insurance coverage (via state-level Medicaid expansions and/or Affordable Care Act market-place design tied to individual mandates and premium subsidies) can be used to reduce the prevalence of medical payment defaults. Additionally, analysis pertaining to how state-level (as well as recent federal) chargemaster transparency initiatives may be leveraged to help curb the rapid growth of charges within the US healthcare system also appears warranted.³⁷

Contributors SL and LEE designed the study. SL acquired and analysed the data. SL drafted the manuscript. LEE reviewed and revised the manuscript. Both authors critically revised the manuscript for intellectual content and approved the final manuscript. SL and LEE are guarantors of the work.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval MCW has identified the Medical Expenditure Panel Survey data used in this study as public data sets. Per 45 CFR 46.101, research using these publicly available data sets does not involve human subjects. The data contained within these specific data sets are neither identifiable nor private and thus do not meet the federal definition of 'human subject', as defined in 45 CFR 46.102. Therefore, per MCW policy, these research projects are exempt from review and approval by the Institutional Review Board (IRB).

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Data availability statement Data are available upon reasonable request. Analysis code and data are all available upon reasonable request.

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Supplementary Appendix

A -- Additional Trend Figures

Figure S1 supplement the trends showcased in Figure 1 (within the main text) by reporting charges and expenditure (per capita) mean trends for office-based visits (Figure S1A), emergency room visits (Figure S1B), outpatient department visits (Figure S1C), and hospital inpatient stays (Figure S1D). A clear trend across all of these figures is the steady increase in charges.

Figure S1: Trends in Inflation Adjusted (\$2017) Charges and Expenditures by Type of Health Care Services, 2002 – 2017.

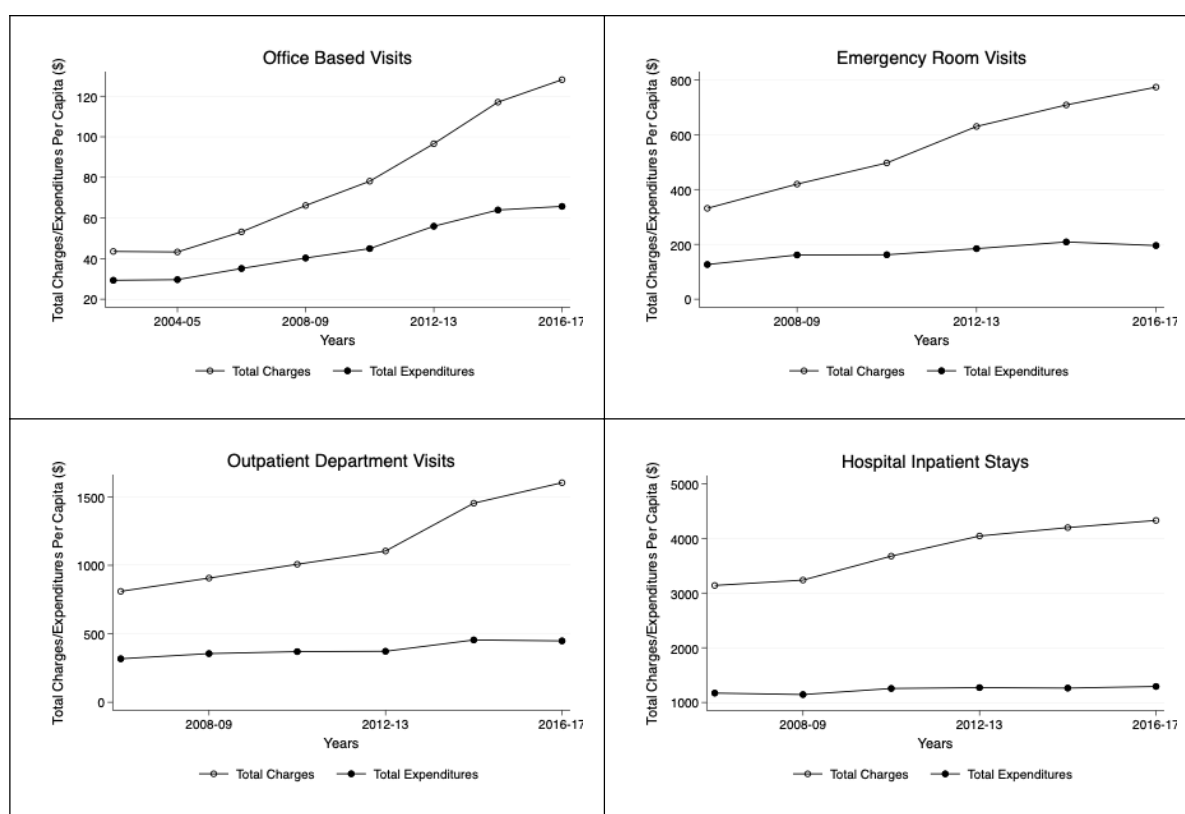
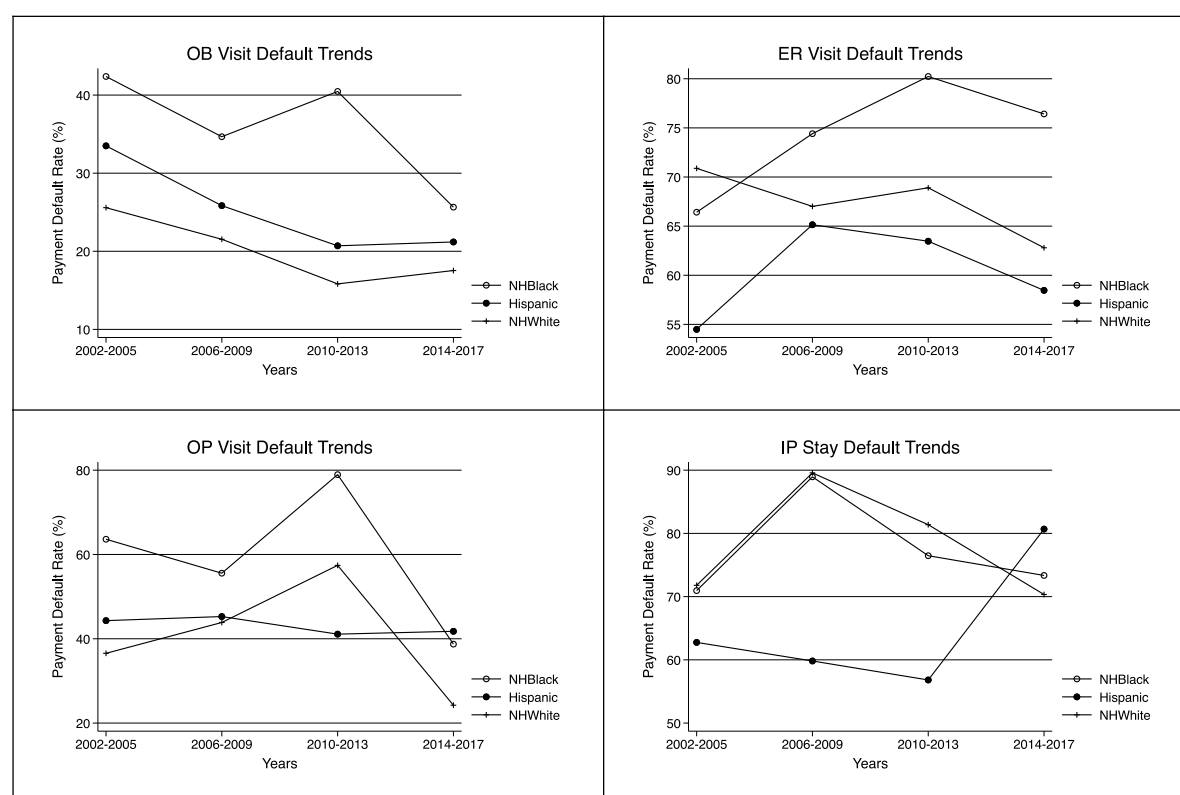


Figure 2S supplements the results within Table 2 (within the main text) by presenting the payment default rates across race/ethnicity. These trends are reported across office-based visits (Figure S2A), emergency room visits (Figure S2B), outpatient department visits (Figure S2C), and hospital inpatient stays (Figure S2D). A clear trend across Figures S2A, S2B and S2C is the elevated default rates among NHB patients.

Figure S2: Trends in Uninsured Patient Payment Default Rates Across Race/Ethnicity and Across the Type of Health Care Services, 2002 – 2017.



B – Additional Details on Sample Selection

Table S1 contains additional details on the sample inclusion restrictions imposed on each of the samples (across office based, ER, outpatient and inpatient events). The numbers reported within each column correspond to the observation drop counts.

Table S1: Sample inclusion restrictions and observation drop count for each set of restrictions.

Inclusion Restrictions:	Observation Drop Count			
	OB Visits	ER Visits	OP Visits	IP Stays
Individuals that are uninsured and aged 18 to 65	2,667,717	521,086	646,690	501,182
Drop if event has missing charge/pay information	45,265	62,293	67,213	68,407
Remove those listing payment source as other than self-paying	58,125	6,833	6,822	2,367
Remove events coded as free, or which are likely to be free (follow-up; post-operative visits); and pre-paid events (if applicable).	8,601	169	392	35
Drop likely entry error: charge < payment	132	3	4	1
Drop if event coded as partial payment, but consolidated file implies full payment.	13	0	2	0
Drop if race/ethnicity other than Non-Hispanic Black, Hispanic or Non-Hispanic white	2,519	133	143	9
Drop if missing values for any of the covariates	6,717	398	192	60
Final Sample	39,711	3,244	1,702	336

C – Robustness Checks

C1 – Generalized Linear Model Estimates

Table S2 provides a robustness check for results reported within Table 2 (of the main text) using a Generalized Linear Model (log-link with gamma distribution). The results within Table S2 are the marginal effects of the Charge (\$100) independent variable, and these are seen to be qualitatively similar to the main results (within Table 2), providing some support for the robustness of these findings.

Table S2: Generalized Linear Model (log-link with gamma distribution) Estimates for Total Payments Among Uninsured US Adults 2002-2017.

Sample:	OB Visits	ER Visits	OP Visits	IP Stays
	(1)	(2)	(3)	(4)
	Total	Total	Total	Total
	Payment	Payment	Payment	Payment
Charge (\$100s)	10.90*** (0.91)	2.66*** (0.50)	3.63*** (0.63)	0.24** (0.10)
Observations	39,711	3,244	1,702	336
Controls Included	YES	YES	YES	Partial
Year FEs	YES	YES	YES	YES
Region FEs	YES	YES	YES	YES

Note: Standard errors are reported within parentheses. Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1. Control variables included for the OB, ER, OP samples: race/ethnicity, predisposing factors, enabling factors, need factors and the visit contextual factors from Table 1. A more limited (partial) set of controls were used for the IP stays sample in order to ensure the model estimation converged. The IP stays controls are: race/ethnicity and the visit contextual factors from Table 1. Associations are given by the marginal effect estimates when other controls are evaluated at their means. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C2 – Joining Office Based and Outpatient Visits

One may be concerned with the separation of office based and outpatient visits as MEPS survey participants may have trouble distinguishing between office based and outpatient visit events. To this end, we here provide a robustness check to see whether our results are dependent upon this visit categorization. This is done by pooling together office based and outpatient visit events and performing the estimation as outlined across Tables 3 – 4 within the main text. The results from this exercise are reported within Table S3. Here we again note qualitatively similar results to those of Tables 3 and 4 of the main text.

Table S3: Estimates Based on Pooling of Office Based and Outpatient Visits.

Specification:	Table 3	Table 4
	Linear	Logit
	Regression	
	(1)	(2)
	Total	Pr(Default)
	Payment	
Charged Amount		
Charge (\$100s)	10.90*** (0.91)	1.04*** (0.00)
Race/Ethnicity		
NHB		2.24*** (0.33)
Hispanic		1.48*** (0.21)
Observations	41,587	41,587
Controls Included	YES	YES
Year FEs	YES	YES
Region FEs	YES	YES

Note: Standard errors are reported within parentheses. Significance is denoted as: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Control variables included are: race/ethnicity, predisposing factors, enabling factors, need factors and the visit contextual factors from Table 1. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C3 – Partial Payments Analysis

To better understand the potential payment decisions by individuals, and how they may vary across different medical events, Table S4 provides details on: (i) the average percentage payment (of total charge) across office based, outpatient, ER and inpatient events. We also provide percentages of medical events with: (i) partial payment; (ii) default; and (iii) full payment. Table S4 indicates that as we move from lower charge events (office based) to higher charge events (ER, inpatient), the percentage of reimbursement decreases. From examination of the individual (event specific) payment decisions/outcomes, we see that this appears to reflect the following dynamics: as charges increase, we see that (1) more people negotiate bills (or in other ways attain discounts off of charges); (2) more people choose to default on payment all together; and (3) fewer individuals are able to pay in full.

Table S4: Payment Decisions/Outcomes by Medical Event.

Sample:	OB Visits	ER Visits	OP Visits	IP Stays
	(1)	(2)	(3)	(4)
Percent Payment (of total charge)	70.7%	17.5%	37.0%	10.9%
	(1.2)	(0.7)	(2.4)	(0.8)
Partial Payment Rate (%)	12.8%	24.1%	31.8%	20.5%
	(0.8)	(1.1)	(4.5)	(1.4)
Default Rate (%)	22.9%	68.5%	43.5%	75.5%
	(1.1)	(1.2)	(3.7)	(1.6)
Payment in Full Rate (%)	64.2%	7.5%	24.7%	4.0%
	(1.3)	(0.5)	(2.2)	(0.4)
Observations	39,711	3,244	1,702	336

Note: Standard errors are reported within parentheses. Reported mean estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C4 – Inpatient Logit Results for Smaller Charge Events

Within Table 4 of the main text we find no significant association between the amount charged and the individual's probability of default. We note that our small sample size for these types of events is a potential problem, however, another might pertain to the level differences across the various medical events. That is, given that inpatient stays tend to be very expensive, small changes in charging for large bills may not cause a notable behavioral response as defaulting patients may be unable to pay in either scenario. However, with that noted, patients may still be responsive to charges at lower levels of inpatient billing. To explore this possibility, we impose three sets of charge cutoffs, which yields three samples: (i) events with charges < 30,000; (ii) events with charges < 20,000; and (iii) events with charges < 10,000. Logit estimation results (in terms of odds ratios) for each of these inpatient event samples are reported within Table S5. Here we note that at lower charge levels the association is significant ($p < 0.01$), with an increasing marginal effect estimate noted with more moderate charges.

Table S5: Logit (Odds Ratio) Regression Estimates for Inpatient Payment Defaults for Smaller Charge Events Among Uninsured US Adults 2002-2017.

Sample:	IP Stays Charge < 30,000	IP Stays Charge < 20,000	IP Stays Charge < 10,000
	(2) Pr(Default)	(3) Pr(Default)	(4) Pr(Default)
Charge (\$100s)	1.006*** (0.002)	1.011*** (0.003)	1.012*** (0.002)
Observations	268	250	184
Controls Included	YES	YES	YES
Year FEs	YES	YES	YES
Region FEs	YES	YES	YES
Reason for Visit FEs	YES	YES	YES

Note: Odds Ratios are reported. Standard errors are reported within

parentheses. Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1. Control variables included were: race/ethnicity, predisposing factors, enabling factors, need factors and the visit contextual factors from Table 1. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C5 – Correlation between default measure and patient reporting difficulty paying medical bills.

For a limited number of years (2014 through 2017) the consolidated datafiles contain individual responses to questions pertaining to their difficulty of paying medical bills. We combine this data with each of our samples across office-based visits, ER visits, outpatient visits, and inpatient stays, in order to explore whether individual reporting of payment difficulties correlate with our default measure.

It should be noted that responses pertaining to payment hardship is only recorded for a limited subset of individuals (as such, we report observation counts below each correlation measure), and this issue is most prominent for our inpatient stay sample where we only have sufficient observations for the second (Family having trouble paying medical bills) variable. With this noted, the results within Table S6 indicate broad qualitative support for there existing a positive association between our default measure and individuals expressing payment hardship.

Table S6: Pairwise correlations between default decision and patients reporting (i) being unable to pay family medical bills and (ii) family having trouble paying medical bills.

Sample:	OB Visits	ER Visits	OP Visits	IP Stays
Unable to pay family medical bills	0.14***	0.40***	0.65***	-
Number of observations	1965	287	167	-
Family having trouble paying medical bills	0.22***	0.22***	0.09*	0.4**
Number of observations:	7087	515	408	36

Note: Significance is denoted as: *** p<0.01, ** p<0.05, * p<0.1. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C6 – Systematic Adding of Controls for Office Based Visit Sample

Table S7 provides the results from successive addition of health care utilization factors pertaining to: (i) predisposing factors; (ii) enabling factors; (iii) need factors; and (iv) visit contextual factors; for office-based visits (the medical event type with the largest sample within our analyses). It should be noted that all specifications adjust for year, region and visit type fixed effects. At large, we note that Race/ethnicity estimates appear to be overstated in specification (1) compared to that in (2) through (4).

Table S7: Office Based Visits -- Logit (Odds Ratio) Regression Estimates for Payment Defaults by Race/Ethnicity Among Uninsured US Adults 2002-2017.

Sample:	(1)	(2)	(3)	(4)	(5)
Office Based Visits	Pr(Default)	Pr(Default)	Pr(Default)	Pr(Default)	Pr(Default)
Charged Amount					
Charge (\$100s)	1.039*** (0.007)	1.040*** (0.007)	1.040*** (0.007)	1.038*** (0.007)	1.041*** (0.007)
Race/Ethnicity					
NHB	2.559*** (0.384)	2.383*** (0.364)	2.180*** (0.320)	2.187*** (0.328)	2.232*** (0.337)
Hispanic	1.537*** (0.192)	1.533*** (0.211)	1.394** (0.203)	1.403** (0.205)	1.488*** (0.212)
Predisposing Factors					
Age		1.002 (0.005)	1.003 (0.005)	0.995 (0.005)	0.995 (0.005)
Female		0.907 (0.096)	0.873 (0.089)	0.898 (0.090)	0.902 (0.090)
Married		0.608*** (0.075)	0.628*** (0.078)	0.635*** (0.075)	0.634*** (0.076)
Family Size		1.060 (0.043)	1.044 (0.042)	1.047 (0.040)	1.051 (0.041)
Midwest	0.891 (0.181)	0.926 (0.188)	0.885 (0.178)	0.872 (0.177)	0.846 (0.172)
South	0.731* (0.133)	0.786 (0.141)	0.684** (0.124)	0.648** (0.118)	0.665** (0.121)
West	0.598** (0.133)	0.647** (0.139)	0.635** (0.136)	0.638** (0.132)	0.614** (0.125)
Enabling Factors					
Bachelor's Degree			0.789 (0.135)	0.860 (0.143)	0.851 (0.142)
Employed			0.756*** (0.071)	0.844* (0.080)	0.848* (0.081)
Near Poor			1.110	1.143	1.150

			(0.187)	(0.188)	(0.189)
Low Income			0.959	1.009	1.005
			(0.139)	(0.140)	(0.140)
Middle Income			0.633***	0.667***	0.652***
			(0.088)	(0.091)	(0.089)
High Income			0.595**	0.665**	0.656**
			(0.120)	(0.132)	(0.132)
Delayed Care			1.047	0.962	0.967
			(0.196)	(0.173)	(0.174)
Unable to Get Care			0.905	0.865	0.833
			(0.193)	(0.181)	(0.177)
Need Factors					
Comorbidity Count				1.163**	1.176***
				(0.071)	(0.074)
ADL				0.799	0.765
				(0.319)	(0.308)
IADL				1.532	1.584
				(0.452)	(0.480)
Self-Health (poor or fair)				1.302**	1.333**
				(0.167)	(0.169)
Self-Mental (poor or fair)				1.269*	1.291*
				(0.173)	(0.175)
Visit Contextual Factors					
Saw Doctor					0.704***
					(0.076)
Observations	39,711	39,711	39,711	39,711	39,711
Year FEs	YES	YES	YES	YES	YES
Visit Type FEs	YES	YES	YES	YES	YES

Note: Odds Ratios are reported. NHW is the omitted reference category for race/ethnicity, the Northeast Census region is the reference category for our geographic categories, and Poor is the omitted reference category for the Poverty Category Variable. Standard errors are reported within parentheses. Significance is denoted as: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.

C7 – Imposing Further Restrictions on the Office Based Visit Sample to Ensure Greater Homogeneity of Visit Type and Costs

To ensure greater homogeneity of visit type, and likely costs, we firstly focus on office-based visits as the medical complexity of these events are the lowest. Second, since care and cost may vary based on facility type, the type of care received, and the type of provider seen during the visit, we further restrict our sample to: (1) only visit events that took place at a doctor's office / group practice, (2) where the care received by the patient was recorded as a diagnosis or treatment, and (3) where patient report having seen/talked to a doctor. It should be noted that information on the kind of place where the patient saw the provider was only collected by the MEPS (Office-Based Medical Provider Visit files) up until 2012, as such our sample is here based on data from 2002 through 2012 only. Table S8 provides logit (odds ratio) regression estimates for this restricted, and more uniform, sample. These results show estimates that are very similar to our main results within Table 4 of the main text – that is, the likelihood of default is positively (and statistically significantly) associated with medical event charges and patient race/ethnicity.

Table S8: Office Based Visits at Doctor's Office / Group Practice where -- Logit (Odds Ratio) Regression Estimates for Payment Defaults by Race/Ethnicity Among Uninsured US Adults 2002-2012.

	(1) Pr(Default)	(2) Pr(Default)	(3) Pr(Default)	(4) Pr(Default)
<i>Charged Amount</i>				
Charge (\$100s)	1.036*** (0.014)	1.037*** (0.014)	1.036*** (0.013)	1.037*** (0.012)
<i>Race/Ethnicity</i>				
NHB	2.542*** (0.711)	2.469*** (0.772)	2.575*** (0.776)	2.898*** (0.862)
Hispanic	2.027** (0.640)	2.034** (0.672)	2.137** (0.709)	2.196** (0.718)

Predisposing Factor Controls	-	YES	YES	YES
Enabling Factor Controls	-	-	YES	YES
Need Factor Controls	-	-	-	YES
Observations	5,863	5,863	5,863	5,863
Year FEs	YES	YES	YES	YES
Region FEs	YES	YES	YES	YES

Note: Odds Ratios are reported. NHW is the omitted reference category for race/ethnicity, the Northeast Census region is the reference category for our geographic categories, and Poor is the omitted reference category for the Poverty Category Variable. Standard errors are reported within parentheses. Significance is denoted as: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Reported estimates are based on using the MEPS sample weights, but the observation counts are based on actual (unweighted) observation counts.