Research Square

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Dental out-of-pocket spending and the measurement of medical financial burden in the United States

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Abstract

Background

Dental payments are included in total medical-service out-of-pocket spending, but their contribution to a threshold-based classification cannot be inferred from spending amounts alone. We estimated how including the dental component changes the same person's two-year medical financial burden state under fixed accounting rules.

Methods

We conducted a descriptive paired accounting analysis of MEPS Panel 27 for 2022–2023. The analytic population comprised 7423 persons with complete observation, valid spending, positive longitudinal weights and positive family income in both years. Annual person-specific medical-service out-of-pocket payments were compared with contemporaneous family income. Total and nondental payments were classified at a primary 10% threshold and a prespecified 20% sensitivity threshold, then combined into four two-year states. Survey-weighted proportions and beta-method 95% confidence intervals incorporated the complex design.

Results

At 10%, 106 of 7423 persons changed two-year states after subtracting dental payments (weighted 1.24%; 95% CI 0.92%–1.63%). Fourteen met the total-spending threshold in both years but had a different nondental state: 0.10% (95% CI 0.05%–0.19%) overall and 20.50% (14/60; 95% CI 8.72%–37.64%) within the rare both-year state. At 20%, any reclassification was 0.46% (46/7423; 95% CI 0.29%–0.69%).

Conclusions

Dental payments changed the fixed two-year classification for a small, measurable proportion of the analytic population. The comparison identifies a spending component's accounting contribution; it does not establish continuous hardship, unmet dental need, or a causal effect of eliminating payments or care.

Background

Dental care affordability matters for oral public health because financial barriers can prevent people from obtaining needed services. US survey research has found higher reported cost barriers for dental care than for several other health services [1]. Such barriers concern access to care, whereas recorded out-of-pocket payments describe care for which payment occurred. A person can have little recorded dental spending because care was affordable, because no service was obtained, or because needed

treatment was deferred. These possibilities make expenditure-based indicators informative but incomplete measures of financial protection.

Financial hardship is also a broader construct than a spending-to-income ratio. A scoping review identified multiple approaches to oral-health financial hardship, including catastrophic expenditure, impoverishment, self-reported burden and negative coping strategies [2]. The choice of spending numerator, resource denominator and threshold determines which observations enter a classification. A threshold crossing is therefore a property of a specified measurement framework, rather than a direct diagnosis of inability to pay or of the value of the care received.

Existing medical financial burden measures already include dental payments. Bernard and colleagues measured family-level burdens using insurance premiums and medical payments inclusive of dental care and prescription drugs, and examined their joint distribution with medical debt and cost-related barriers [3]. The MEPS total medical-service out-of-pocket spending construct also includes dental payments. Our question is not whether an omitted category should be added to that released total. It is how much the dental component contributes to the resulting classification when the same observations are evaluated with and without that component.

Oral-health spending contributions have been studied in other measurement settings. Canadian research quantified oral-health payments' share of out-of-pocket health spending among households incurring catastrophic expenditure, and European research evaluated dental-specific catastrophic payments among older persons using capacity-to-pay denominators [4, 5]. Research among older Americans described changes in dental out-of-pocket payments, while recent pooled MEPS work examined dental access, spending and racial or ethnic welfare disparities [6, 7]. These studies establish the relevance of dental payments, while their reported primary outcomes differ from a paired classification change under otherwise unchanged rules.

Longitudinal burden research provides another relevant comparison. A four-year MEPS study examined the accumulation of burdensome medical spending across repeated observations [8]. Repeated burden and dental-component reclassification are separate questions: the former describes how burden is distributed over time; the latter asks whether the recorded dental component changes a person's state while holding the observed years, income and threshold fixed. Additional observation years by themselves would not resolve that component-specific measurement question.

Using MEPS Panel 27 for 2022–2023, we compared each person's two-year state under total medical-service out-of-pocket spending with the state obtained after subtracting dental payments. The primary estimand was any difference between the paired classifications at a 10% family-income threshold. We also described reclassification among those meeting the total-spending threshold in both years and retained a prespecified 20% sensitivity threshold. The aim was to quantify the population scale of this accounting contribution, while distinguishing it from family catastrophic expenditure, continuous hardship and a policy effect.

Methods

Data Source and Analytic Population

We conducted a secondary observational analysis of the Agency for Healthcare Research and Quality (AHRQ) MEPS HC-252 Panel 27 longitudinal public-use file [9]. MEPS represents the US civilian noninstitutionalized population. HC-252 provides one record per person, combines the 2022 and 2023 annual files, and supplies longitudinal weights for two-year estimates.

The analysis unit was the person, with no age or disease restriction. Structural eligibility required all five rounds, participation in both calendar years, a positive longitudinal weight, and valid annual spending satisfying total ≥ dental ≥ 0 in both years. Of 8292 person records, 7812 met these requirements; 480 did not meet one or more criteria. Positive contemporaneous family income in both years was additionally required for ratio classification, excluding 389 records and leaving 7423 persons. Zero and negative income were retained as observed economic values but were not used as ratio denominators. Missing or inapplicable values were not classified as below threshold.

All eligible persons were included, without a power-based sample-size target or post hoc power calculation. Reporting follows applicable STROBE and OHStat recommendations [10]. The reporting checklists are provided in Additional file 1.

Measures and Paired Classifications

Total spending was annual person-specific medical-service out-of-pocket spending (TOTSLFYt), paid by the person or family for that person's services. Dental spending was its nested component (DVTSLFYt). Nondental spending equaled total minus dental spending. The denominator was contemporaneous Current Population Survey family income (FAMINCYt). Thus, one person's service payments were compared with that person's family resources; spending was not aggregated across family members and excluded insurance premiums. We used released AHRQ constructs without claiming independent measurement validation.

At the primary threshold, an annual indicator equaled 1 when valid spending was at least 10% of family income and 0 when below threshold. Identical rules applied to total and nondental spending. AHRQ has previously reported spending categories exceeding 10% and 20% of family income [11]. Our inclusive threshold operator was specified before outcome analysis and is not attributed to that report. Integer comparisons avoided rounding: 10 × spending ≥ income at 10%, and 5 × spending ≥ income at 20%. No record lay exactly on either total or nondental threshold boundary. The 20% threshold was prespecified for sensitivity analysis.

Within person, the two annual indicators formed four states: 00, below threshold in both years; 10, meeting it in 2022 only; 01, meeting it in 2023 only; and 11, meeting it in both years. Annual observations

were not treated as independent records. State 11 represents two observed annual classifications, not uninterrupted 24-month hardship.

Any reclassification meant that total and nondental two-year states differed. State-11 reclassification meant total state 11 with a nondental state other than 11; the destination could be 00, 10, or 01. Both annual indicators did not have to change. These measures describe observed payments under paired accounting rules.

Baseline age used edited/imputed age at December 31, 2022 (AGEY1X). Sex used released categories. Race and ethnicity used all five categories of AHRQ's edited/imputed combined variable (RACETHX), without merging categories. Age was summarized as a weighted mean and standard deviation; categorical variables used unweighted counts and weighted percentages. Variable-level missingness was assessed. Characteristics were summarized overall, without state-specific or reclassification-specific subgroup analysis. AI-assisted reporting code for these demographic summaries was checked against the fixed analytic population; the question, eligibility rules, estimands, and core analysis code were author specified.

Statistical Analysis

The full survey design was specified before analytic-domain subsetting using the longitudinal person weight (LONGWT), variance strata (VARSTR), and nested primary sampling units (VARPSU). It contained 105 strata, 257 nested primary sampling units, and 152 design degrees of freedom. Taylor linearization supplied standard errors, and survey::svyciprop supplied beta-method 95% confidence intervals (CIs). Analyses used R 4.6.0 and survey version 4.5. Single-primary-sampling-unit strata were set to fail rather than receive an automatic variance adjustment.

Precision was evaluated in each measure's survey subpopulation. The 10% total-state-11 conditional population contained 43 strata and 50 nested primary sampling units (7 df). The corresponding 20% population contained 20 strata and 20 primary sampling units (0 df), making its beta CI unavailable. No alternative interval was selected post hoc. We performed no regression, imputation, bootstrap, hypothesis test, subgroup analysis, threshold optimization, or additional-panel analysis.

AI assistance

OpenAI Codex (OpenAI) was used historically for manuscript drafting and restructuring, reference cross-checking and compilation, reporting and quality control, and drafting code for the reporting-only demographic summary. The historical version was not documented in the approved S8 administrative record. The authors specified the question, design, variables, eligibility criteria, estimands, and interpretation; core analyses used fixed code. Codex did not generate or alter raw data or generate core numerical results. The demographic script produced aggregate results checked against the fixed analytic population. In October 2026, OpenAI Codex in the desktop environment (Codex CLI 0.160.0; workspace

document tools bundle 26.909.12148; accessed October 7, 2026) assisted with manuscript restructuring, language editing, journal adaptation, document production, and quality checks. The underlying model designation could not be independently verified. This later work used existing manuscripts and aggregate outputs without accessing participant records or producing new statistical estimates. Bibliography formatting used a standard CSL reference processor. The authors retain responsibility for final accuracy, integrity, and content. On 8 October 2026, OpenAI Codex (OpenAI; local CLI 0.162.0-alpha.2; document tools 26.1007.11041) assisted final format and administrative checks using existing documents and aggregate results, without new scientific analysis or participant-record access.

On 13 October 2026, OpenAI Codex assisted the bounded literature comparison, narrative revision, BMC Oral Health formatting and document quality checks using existing manuscripts and aggregate outputs, without participant-record access or new statistical analysis.

Results

Analytic Population and State Distributions

The analytic population comprised 7423 persons. Identifiers were complete and unique, and there were no accounting conflicts between total and dental spending in either year. Weighted mean age was 39.87 years (SD, 22.56); women represented 50.51% and men 49.49%. The weighted race and ethnicity distribution was 19.34% Hispanic, 58.69% non-Hispanic White only, 12.19% non-Hispanic Black only, 6.54% non-Hispanic Asian only, and 3.25% non-Hispanic other race or multiple race. These variables had no missing values (Table 1).

Table 1

Characteristics of the analytic population The analytic population comprises 7423 persons meeting the structural and positive-income criteria. Estimates incorporate the Panel 27 longitudinal weight and complex survey design. Age is the survey-weighted mean (SD); categorical estimates are weighted percentages. SD indicates standard deviation. Sex and race/ethnicity retain released AHRQ categories.

Characteristic	Unweighted n	Survey-weighted estimate	Missing, n (%)
Age on December 31, 2022, mean (SD), y	7423	39.87 (22.56)	0 (0.00)
Sex			0 (0.00)
Male	3526	49.49%	
Female	3897	50.51%	
Race/ethnicity			0 (0.00)
Hispanic	1626	19.34%	
Non-Hispanic White only	4032	58.69%	
Non-Hispanic Black only	1048	12.19%	
Non-Hispanic Asian only	467	6.54%	
Non-Hispanic other race or multiple race	250	3.25%	

At 10%, total-accounting counts were 6936 for state 00, 225 for 10, 202 for 01, and 60 for 11. Corresponding nondental counts were 7036, 173, 168, and 46 (Table 2, panel A). Weighted state-00 proportions were 94.83% under total accounting and 96.01% under nondental accounting. At 20%, the corresponding proportions were 97.82% and 98.25%.

Table 2

Two-year burden states and dental-component reclassification A. State distributions

Threshold	Accounting	Two-year state	Unweighted n	Survey-weighted %
10%	Total	00	6936	94.83
10%	Total	10	225	2.50
10%	Total	01	202	2.16
10%	Total	11	60	0.50
10%	Nondental	00	7036	96.01
10%	Nondental	10	173	1.77
10%	Nondental	01	168	1.81
10%	Nondental	11	46	0.40
20%	Total	00	7200	97.82
20%	Total	10	104	1.06
20%	Total	01	97	0.95
20%	Total	11	22	0.18
20%	Nondental	00	7244	98.25
20%	Nondental	10	85	0.84
20%	Nondental	01	79	0.79
20%	Nondental	11	15	0.12
B. Reclassification estimates				

Threshold	Measure	Unweighted n/denominator	Survey-weighted %	95% CI
10%	Any state reclassification	106/7423	1.24	0.92–1.63
10%	Total state 11 reclassified	14/7423	0.10	0.05–0.19
10%	Reclassified within total state 11	14/60	20.50	8.72–37.64
20%	Any state reclassification	46/7423	0.46	0.29–0.69
20%	Total state 11 reclassified	7/7423	0.06	0.02–0.15
20%	Reclassified within total state 11	7/22	35.59	Not available (df=0)

State 00: neither year meets the threshold; 10: 2022 only; 01: 2023 only; 11: both years. Nondental spending is total person-specific medical-service out-of-pocket spending minus dental spending. Any reclassification is a difference between total and nondental states. Total state-11 reclassification is total state 11 with nondental state 00, 10, or 01. CI indicates confidence interval; df, design degrees of freedom. The 20% conditional estimate is precision-limited; no beta CI is available at df=0.

Reclassification

At 10%, states differed for 106 of 7423 persons (weighted, 1.24%; 95% CI, 0.92%–1.63%; Table 2, panel B). Fourteen had total state 11 and a different nondental state, representing 0.10% (95% CI, 0.05%–0.19%) of the weighted analytic population. Their nondental destinations were 00 for eight persons, 10 for three, and 01 for three.

Within the selected total-state-11 population, 14 of 60 persons were reclassified (weighted, 20.50%; 95% CI, 8.72%–37.64%; design df, 7). This conditional estimate applies to that 60-person population, rather than the analytic population overall.

At 20%, any reclassification occurred for 46 of 7423 persons (weighted, 0.46%; 95% CI, 0.29%–0.69%). Seven had total state 11 and a different nondental state, representing 0.06% (95% CI, 0.02%–0.15%) overall. Within the 22-person total-state-11 population, the weighted conditional estimate was 35.59% (7/22). Its beta CI was unavailable at 0 design df. This precision-limited estimate did not guide the primary interpretation.

Discussion

Dental payments changed the fixed two-year burden state for a weighted 1.24% of the analytic population at the primary 10% threshold. This is a small population proportion, estimated with a 95% CI of 0.92%–1.63%. It represents a difference between two classifications of the same observed records, not the prevalence of dental hardship or the fraction of people harmed by dental care. The scale is the principal finding; the conditional estimate among the rare both-year state provides supplementary context.

The scientific value lies in specifying what a spending component changes in a measurement framework. A dental payment can be substantial without changing a person's threshold status if nondental spending already meets the threshold, or if total spending remains below it. Conversely, a smaller dental payment can affect a classification when the combined payment lies on the other side of the fixed threshold. This follows from the accounting definition. The present results quantify how often the paired states differed; they do not estimate the distance of individual observations from the threshold or the magnitude of payments needed to change their classification.

This distinction also explains why marginal spending summaries cannot substitute for a paired comparison. Separate dental expenditure totals, or separate prevalences under total and nondental accounting, do not identify every person whose two-year state changes. The paired indicator retains the identity of the same person across the two accounting rules. Because the dental component is nested within total payments, the comparison isolates one definitional change while keeping each contemporaneous family-income denominator and the threshold unchanged.

The findings fit within a literature that already treats oral-health payments as part of health care financial protection. The Canadian study described service-specific shares among households facing catastrophic expenditure, and the European study defined a dental-specific capacity-to-pay outcome [4, 5]. Those estimands are relevant predecessors rather than interchangeable benchmarks for the present percentage. Bernard and colleagues included dental care in a family-level burden measure and showed that spending burden, debt and barriers capture different financial pressures [3]. Our person-specific service numerator, family-income denominator and paired two-year state comparison address a narrower accounting question.

The difference from prior longitudinal MEPS research is likewise functional. Accumulation of burdensome spending over several years describes repeated exposure to a spending threshold [8]. Here, the observed person and calendar years remain unchanged, and only the inclusion of dental payments varies. The comparison can inform how researchers describe the scope of their burden measure, but neither the separate panel nor the two-year duration establishes methodological novelty by itself. Studies of dental payment transitions and welfare disparities address adjacent spending and access questions [6, 7].

Denominator transparency is particularly important for the both-year state. Reclassification from total state 11 represented 0.10% of the weighted analytic population, while the conditional estimate was 20.50% among 60 persons. Reporting the conditional percentage alone would obscure its limited

population reach and its wide interval. Reporting only the overall percentage would omit the change within that selected state. The two estimates serve different descriptive purposes; the conditional result is not a stable basis for subgroup policy claims. The 20% conditional estimate is still more precision-limited and has no usable beta CI at zero design degrees of freedom.

A spending-based classification should not be interpreted as observed economic difficulty. The threshold does not establish debt, distress financing, inability to meet basic needs, or the clinical necessity of the dental services. Similarly, subtracting payments does not model a world in which dental care is free or prevented. Changes in insurance coverage could alter utilization, provider payments, timing and family resources. None of those responses is represented in this deterministic subtraction. The study therefore cannot estimate the effect of a dental insurance reform or attribute poverty or disease to dental expenditures.

Zero dental spending is also not evidence of zero dental need. Payments observe realized service use and its financing, rather than all potential need. Cost-related nonuse could produce little recorded payment while leaving substantial unmet need. This is why financial-protection research benefits from distinguishing expenditure classifications from access barriers and other hardship indicators [1–3]. The present estimates should be read as an accounting description of recorded payments in the represented domain, not as an assessment of whether dental needs were adequately met.

Several limitations bound interpretation. Only two calendar-year observations were available for this comparison; state 11 does not establish uninterrupted 24-month hardship. Family composition and resources can change, and the numerator is one person's service payments rather than aggregate family payments and excludes premiums. The positive-income domain excludes observed zero or negative income because those values cannot support the chosen ratio classification. Complete observation, valid spending and positive longitudinal weight further define the population represented. Released public-use measures do not independently establish treatment need, benefit or the financial experiences omitted from this analysis.

The analysis did not evaluate heterogeneity among the 106 reclassified persons. Overall demographic description does not justify demographic subgroup conclusions, and the population includes all ages rather than adults alone. Sparse both-year events constrain precision, especially at the sensitivity threshold. No alternative interval, model, threshold search or additional-panel analysis was added to compensate for that limitation. Future work could investigate a different hardship construct or characterize threshold proximity if separately justified, but neither task is required to interpret the current component-specific result.

Conclusions

In MEPS Panel 27, dental out-of-pocket payments changed a fixed two-year medical financial burden classification for a weighted 1.24% of the eligible analytic population. The paired comparison makes the dental component's measurement contribution explicit while preserving the small population scale and

rare-state uncertainty. It does not establish continuous financial hardship or causal effects on affordability, health or policy outcomes.

Abbreviations

AHRQ
Agency for Healthcare Research and Quality
CI
confidence interval
CPS
Current Population Survey
df
design degrees of freedom
MEPS
Medical Expenditure Panel Survey
OOP
out-of-pocket
PSU
primary sampling unit
SD
standard deviation
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology.

Declarations

Ethics approval and consent to participate

The Hospital of Stomatology, Jilin University determined this secondary analysis of public, deidentified MEPS data to be exempt from ethics review. Additional informed consent was not required. An exemption number was not assigned. This determination concerns the present secondary analysis; MEPS data collection was conducted by AHRQ, not by the present investigators.

Consent for publication

Not applicable. No identifiable individual information is reported.

Availability of data and materials

The source data are available from AHRQ as MEPS HC-252 Panel 27 Longitudinal Data Public Use File, 2022–2023 [9], under the MEPS data-use conditions. No new person-level data were generated. Analysis code and aggregate reproducibility materials will be deposited in Zenodo no later than acceptance; the persistent identifier will be added when available.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZZ (Ziqiao Zhuang): Conceptualization; Methodology; Software; Formal analysis; Data curation; Validation; Writing – original draft; Writing – review & editing; Project administration.
SC (Sihao Chen): Validation; Writing – review & editing.
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ZX (Zhaorong Xiao): Validation; Writing – review & editing.
ZL (Zitong Liu): Data curation; Validation; Writing – review & editing.
XX (Xiaoyun Xu): Validation; Writing – review & editing.
SW (Shuo Wang): Data curation; Validation; Writing – review & editing.
EW (Erna Wu): Data curation; Validation; Writing – review & editing.
WL (Weiwei Liu): Conceptualization; Methodology; Supervision; Project administration; Writing – review & editing.

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