

Trends and Regional Differences in U.S. Dental Caries Burden and Preventive Service Utilization

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Date: December 2025

(1) Motivation

Dental service utilization is a key indicator of population oral health and access to care.

Understanding long-term patterns in utilization helps identify disparities across age groups, service types, and geographic areas.

California Medi-Cal administrative records provide an opportunity to examine system-level trends over time, while national NHANES oral health estimates offer broader context on disease burden and prevention gaps.

Our project aims to integrate these two data sources to understand: **How has dental service use changed over time in California, and how do these trends compare to national oral health patterns?**

(2) Background & Related Work

Prior research has documented persistent disparities in oral health across age, socioeconomic status, and race/ethnicity. National surveillance summaries show long-standing gaps in untreated caries prevalence and access to preventive services (National Institute of Dental and Craniofacial Research, 2022).

Preventive interventions—especially dental sealants—are well established as effective strategies for reducing childhood caries risk and remain a core component of pediatric oral health policy (Ng et al., 2023).

These studies motivate our investigation by highlighting the importance of preventive care and the need to understand how service utilization evolves across different populations.

(3) Initial Questions

Our project began with the following questions:

1. **How has overall dental service utilization in California changed from 2013 to 2023?**

Has utilization increased, decreased, or remained stable?

2. **Do age-based disparities exist, and have they widened or narrowed over time?**

Are certain age groups consistently under-utilizing services?

- 3. How do different service categories (preventive, diagnostic, restorative, sealants, treatment) vary in their trends over time?**
- 4. Did COVID-19 cause measurable disruptions in utilization patterns?**

We explored this using an interrupted time-series framework.

- 5. How do California trends relate to national oral health data from NHANES?**

Are patterns in preventive service use aligned with trends in untreated caries?

(4) Data Sources

1. California Medi-Cal Dental Utilization (2013–2023)

- Source: California Department of Health Care Services
- Contains: annual counts of users, denominators, and utilization rates across age groups and service categories
- Citation: *California Department of Health Care Services (2023)*

2. NHANES Oral Health Prevalence Estimates (1999–2018)

- Source: Centers for Disease Control and Prevention

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- Contains: age-, sex-, and race-specific prevalence of total caries and untreated caries
 - Citation: *Centers for Disease Control and Prevention (2025)*

These two datasets allow comparison of service use patterns (CA) and disease burden (NHANES) over time.

(5) Exploratory Analysis

This section summarizes descriptive findings from both the California administrative dataset (2013–2023) and national NHANES oral health prevalence data. Together, these analyses illustrate statewide utilization patterns, disparities by age, variation across service types, the impact of COVID-19, and how California trends compare to national disease burden.

5.1 California statewide utilization trends (2013–2023)

Statewide weighted dental service utilization in California shows:

- A gradual **increase** from 2013 to 2019, reaching a peak of **26.6%**.
- A sharp **decline in 2020**, consistent with COVID-19 disruptions.
- A steady **recovery** from 2021 to 2023, with rates stabilizing around **24–25%**.

Overall, the mean utilization rate during this period was **22.8%**, and the total enrolled population grew by over **110%**, indicating expanded program reach over time.

5.2 Age-group disparities in utilization

Across all years, utilization rates vary substantially by age:

- **Children (ages <10)** consistently show higher utilization of preventive and diagnostic services.
- **Adults (30–59)** show moderate but stable patterns, with slight declines during COVID-19.
- **Older adults (≥ 65)** show the lowest but steadily increasing utilization, reflecting improving access.

Time-series plots reveal persistent **age gradients**, with younger groups accessing services more frequently than adults.

5.3 Trends by service type

Eight service categories were evaluated from 2013–2023:

- **Dental visits** showed the highest utilization and a consistent upward trend (from ~25.6% to ~34.9%).
- **Preventive services** and **Exam/Evaluation** also increased steadily, reaching nearly 30% by 2023.
- **Restorative** and **Diagnostic services** remained low (~10–12%) but stable.
- **Sealant use** fluctuated but generally increased prior to COVID-19.
- Nearly all categories show a **2020 decline**, followed by recovery.

These patterns suggest sustained improvements in preventive care access over the decade.

5.4 Interrupted Time-Series (ITS) analysis of the COVID-19 impact

An ITS model was used to estimate the effect of COVID-19 on statewide utilization:

- The regression slope for the time trend was **+0.0061 per year** ($p < 0.001$), indicating a significant long-term upward trend.
- A clear **interruption** occurred in 2020, consistent with statewide shutdowns and reduced access to in-person care.
- Post-interruption recovery demonstrates a partial return toward pre-COVID levels, but some services remain below projected trajectories.

Model fit metrics ($R^2 \approx 0.18$, AIC ≈ -882) indicate a reasonable model capturing long-term patterns despite variability.

5.5 National oral health trends from NHANES

To contextualize California utilization patterns, national NHANES data were examined for total and untreated caries in permanent teeth.

5.5.1 Trends in total and untreated caries (ages 12–19, 20–29, 30–39)

NHANES trends show:

- **High but slowly declining total caries prevalence**, particularly after 2015.
- **Untreated caries decreases more noticeably**, especially among adolescents.
- Adults continue to have **substantially higher caries prevalence**, often exceeding 80–90%.

These findings indicate persistent national disease burden despite gradual improvement.

5.5.2 Broader age-group comparisons

Across all NHANES age groups:

- Total caries prevalence rises sharply with age and approaches **100%** in older adults.
- Untreated cavities are highest in adolescents and working-age adults, with modest declines in recent cycles.
- Wide confidence intervals in some groups indicate population variability.

These results mirror California's age-based gradients.

5.5.3 National regression slopes

Based on NHANES slope estimates:

- Total caries shows **slightly negative slopes** for most age groups (-0.31 to -0.43 percentage points per year).
- Untreated caries generally show **stronger decreases**, especially among adolescents (e.g., -0.45 per year for ages 12–19).
- Some middle-aged groups show minimal or slightly positive trends.

This reflects slow national improvement.

5.5.4 Sex differences in caries prevalence

The sex-difference heat map indicates:

- Modest fluctuations in male–female gaps across time.
- No consistent advantage; some cycles show **higher prevalence in males**, others in females.
- Differences generally remain within ± 8 percentage points.

Overall, sex disparities are present but not dominant.

5.5.5 Race/ethnicity disparities

NHANES data show persistent disparities:

- **Mexican American** and **Non-Hispanic Black** children exhibit higher total caries prevalence than **Non-Hispanic White** children.
- These differences appear consistent across survey cycles.
- Slight narrowing is observed in recent years but disparities remain significant.

This aligns with national reports of unequal access to preventive services.

Summary of national context

NHANES findings indicate:

- High national prevalence of dental disease.
- Gradual improvements in untreated caries.
- Strong age gradients, moderate sex differences, and persistent racial/ethnic disparities.

These national trends serve as an important benchmark for interpreting California's utilization data and highlight the broader context of oral health inequities.

(6) Comparison: California vs NHANES

This section synthesizes findings from California's administrative utilization data and NHANES national oral health prevalence data. Together, they help assess whether California's service utilization patterns are aligned with national disease burden and preventive care needs.

6.1 Alignment between CA utilization trends and national caries burden

California shows increasing preventive utilization, while NHANES shows decreasing untreated caries.

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- NHANES national data indicate a **decline in untreated caries**, especially among adolescents and young adults.
 - California preventive utilization (e.g., visits, exams, preventive services) shows **consistent increases** over 2013–2023.
 - These parallel trends suggest potential alignment:
greater access to preventive services may correspond with reduced disease burden at the national level.

Although the datasets cover different populations and years, the directionality is broadly consistent.

6.2 Age patterns: High utilization in children vs high disease burden in youth

- California data show **highest service utilization among children**, especially ages **3–5, 6–9, and 10–14**.
- NHANES shows **highest untreated caries prevalence among adolescents**, especially **ages 12–19**.

Taken together:

California appears to be allocating more preventive and diagnostic care to age groups with higher national caries risk.

This suggests the state's utilization patterns are reasonably targeted according to epidemiologic needs.

6.3 COVID-19 impacts: Similar national and state-level disruptions

Both datasets reflect COVID-related effects:

- California shows a **sharp drop in utilization rates in 2020** across nearly all service categories.

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- NHANES prevalence trends (e.g., 2015–2016 to 2017–2018) similarly show **disrupted patterns**, with slower improvements in untreated caries.

While NHANES is not collected during 2020 lockdowns, the slowing or plateauing before 2020 mirrors California's service disruptions.

6.4 Disparities: Consistent patterns across state and national data

Age disparities

- California: Younger children consistently use more dental services.
- NHANES: Younger children have lower permanent-tooth caries but **higher primary-tooth caries**; adolescents show rising disease burden.

Both datasets exhibit **pronounced age gradients**.

Sex disparities

- California's dataset lacks sex-specific utilization.
- NHANES shows **small but persistent sex differences**, with some cycles favoring females and others males.

Although data structures differ, sex differences appear modest in both contexts.

Race/ethnicity disparities

- NHANES shows **substantial disparities**: Mexican American and Black youth have higher caries prevalence.
- California utilization data does not include race/ethnicity, preventing direct comparison.

However, NHANES disparities underscore the importance of evaluating equity in service delivery — a limitation for the California dataset.

6.5 Trend direction and intensity: Utilization rises faster than national disease declines

- California's linear model shows **a significant upward trend** ($\beta \approx 0.0061$ per year).
- NHANES trends for untreated caries show **negative slopes** (up to -0.45 per year in youth).
- Total caries declines slowly (- 0.3 to - 0.4 per year for many adult groups).

This suggests:

California's increase in preventive service utilization is occurring at a faster rate than national reductions in dental disease.

While not implying causality, these patterns are consistent with preventive effectiveness reported in national reviews (e.g., sealants and prevention strategies).

6.6 Overall synthesis

Across major domains—time trends, disparities, service patterns, and COVID-19—California's utilization trends are **broadly aligned with national oral health needs**, but reflect:

- **Higher emphasis on preventive care,**
- **Stronger recovery after COVID-19, and**
- **Data limitations** (e.g., missing race/ethnicity) that restrict deeper equity analysis.

These comparisons highlight that California is moving in a direction consistent with national disease reduction goals, particularly in pediatric populations.

(7) Discussion

Our analysis provides a comprehensive view of dental service utilization patterns in California (2013–2023) and situates these findings within the broader context of national oral health trends reported by NHANES. Several key themes emerge when synthesizing results across datasets.

1. Long-term improvements alongside persistent disparities

California shows a clear upward trend in preventive and overall dental service utilization, suggesting expanded access and growing engagement with preventive dental care. This pattern aligns with national declines in untreated caries observed in NHANES, particularly among children and adolescents. Together, these findings point to gradually improving oral health behaviors over the past decade.

However, disparities remain substantial.

- In California, utilization varies sharply across age groups, with young children consistently demonstrating the highest engagement with dental services and older adults showing much lower rates.
- NHANES reveals complementary disparities: adolescents and older adults carry a disproportionate caries burden, and racial/ethnic gaps (e.g., higher prevalence among Mexican American and Non-Hispanic Black youth) remain evident.

Although the two datasets capture different aspects of the dental care continuum (service use vs. disease burden), both highlight the need for targeted interventions in groups that remain underserved.

2. COVID-19 introduced measurable disruptions

Both datasets reflect evidence—direct or indirect—of pandemic-related disruption:

- California shows a pronounced drop in 2020 utilization across nearly all service categories, followed by a gradual recovery.

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- NHANES does not include 2020, but temporal patterns before and after 2015–2018 indicate instability and slower declines in untreated caries prevalence, consistent with national reports of limited access during the pandemic period.

These findings reinforce broader literature documenting COVID-19's impact on preventive dental care, with potential implications for long-term oral health outcomes.

3. Service type patterns highlight preventive demand but uneven use

Our service-specific analyses in California demonstrate:

- **Preventive, exam/evaluation, and dental visit** services show the strongest, most consistent growth.
- **Restorative and sealant** services remain used at far lower levels.
- Age-specific utilization heatmaps reveal that high-use service categories are concentrated among children, while adults—especially older adults—engage primarily in restorative treatment rather than preventive care.

This suggests that preventive care uptake improves mainly in populations already engaged with the dental system (e.g., children), while adults may continue to use dental services reactively.

4. Trends suggest alignment between utilization and disease burden

When comparing California and NHANES:

- Groups with higher disease burden nationally (e.g., school-aged children, adolescents, older adults) correspond to the groups where California's utilization patterns show either high engagement (younger children) or persistent under-engagement (older adults).

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- The parallel between rising preventive utilization in CA and declining untreated caries nationally suggests that preventive strategies—including sealants, cleanings, and diagnostic visits—remain central to population-level improvements in oral health.

Yet the disconnect in adult preventive utilization indicates an opportunity for more targeted outreach and policy intervention.

5. Implications for policy and practice

The findings collectively highlight:

- **Successful expansion of preventive dental access for children**, consistent with national goals.
- **Ongoing gaps for adolescents and older adults**, both in utilization and disease burden.
- **Need for recovery planning post-COVID**, especially for vulnerable age groups.
- **Importance of preventive interventions**, such as sealants, whose low utilization contrasts with their documented effectiveness (Ng et al., 2023).

These patterns underscore the need for age-tailored strategies and potentially enhanced coverage or outreach programs to reduce disparities and sustain long-term improvements.

(8) Limitations

Several limitations should be considered when interpreting the findings from this project. These limitations arise from both the structure of the datasets used and the analytic constraints associated with aggregated data.

1. Use of aggregated administrative data in California

The California dataset is fully aggregated at the year \times age group \times service type level. As a result:

- Individual-level variation cannot be analyzed.
- We cannot examine behavioral predictors (e.g., socioeconomic factors, insurance continuity, comorbidities).
- Standard statistical adjustments such as weighting, clustering, or modeling individual heterogeneity are not possible.
- Equity analyses are limited because **race/ethnicity and sex variables are not available** in the CA administrative dataset.

Therefore, observed patterns reflect population averages and may mask within-group disparities.

2. Limited time-series resolution and ITS model power

The interrupted time-series analysis uses **annual data**, which reduces the sensitivity of the model to detect rapid changes:

- Only **one data point represents the COVID-19 disruption year (2020)**.
- The short series (11 years) limits power to detect slope changes or interaction effects.
- The ITS model estimates directionality but should not be interpreted as causal due to the absence of control groups or monthly/quarterly temporal structure.

Thus, COVID-related effects may be underestimated or imprecisely measured.

3. NHANES summary tables restrict analytic flexibility

NHANES data were used in **pre-aggregated form**, which prevents:

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- Reapplying survey sampling weights
 - Conducting statistical hypothesis tests
 - Accounting for stratified sampling
 - Adjusting for covariates that influence disease prevalence

Additionally, NHANES summary tables only include selected age groups, preventing full comparability across all life stages.

4. Temporal misalignment between datasets

The two datasets cover different time periods:

- California utilization spans **2013–2023**.
- NHANES carries data available to us spanning **1999–2018**.

Because of this mismatch:

- Trends cannot be aligned year-by-year.
- COVID-19 effects cannot be examined in NHANES.
- Comparisons rely on **pattern similarity**, not direct temporal correspondence.

This limits the strength of cross-dataset inferences.

5. Utilization does not equate to disease burden

California data measure **service use**, not **oral health outcomes**.

NHANES measures **caries prevalence**, not utilization or access.

Thus:

- High utilization does not necessarily imply improved oral health.
- Low disease burden does not necessarily imply adequate access.

Interpretations linking utilization and disease burden must therefore be made cautiously and contextually.

(9) Conclusion

This project examined statewide dental service utilization patterns in California from 2013 to 2023 and compared these trends with national oral health indicators from NHANES. Our findings highlight both meaningful progress and persistent challenges in achieving equitable access to dental care.

California demonstrated **steady long-term increases in overall and preventive dental service utilization**, particularly among children. Preventive and diagnostic services drove much of this growth, suggesting improvements in early detection and routine care. Despite the pronounced drop in utilization during the COVID-19 pandemic, recovery patterns indicate a return toward the pre-existing upward trajectory.

However, **substantial disparities remain**. Young children exhibit the highest utilization, while infants and older adults consistently have the lowest engagement with dental services. These age-based differences align with national NHANES patterns showing elevated caries burden in adolescents and adults, emphasizing the need for targeted preventive interventions across the life course. NHANES data also reveal persistent racial and ethnic disparities in caries prevalence, underscoring gaps that cannot be directly evaluated in the California dataset due to missing demographic information.

The comparison of utilization and disease burden suggests that improvements in preventive service use may be contributing to broader positive trends in oral health, although the relationship cannot be assessed causally with the available data. The lack of individual-level information and temporal misalignment between datasets further limits the strength of

cross-dataset inferences. Nevertheless, taken together, the findings support the conclusion that California’s dental system has expanded access to preventive care in a manner consistent with national oral health needs.

Continued progress will require sustained investment in preventive services, focused efforts to reach underserved age groups, and more comprehensive data collection to evaluate disparities in greater depth. These results provide a foundation for future work aimed at understanding patterns of care, addressing inequities, and improving population oral health outcomes.

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