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Original Article

The Moderating Role of Dental Anxiety and Professional Satisfaction on the Relationship Between Affordability and Dental Service Utilization: Evidence from a Longitudinal Study of Australian Adults

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ABSTRACT

This study investigated whether difficulty in covering dental expenses, measured in Australian dollars, is associated with the utilization of dental services among adults in Australia, considering potential sociodemographic confounders. Additionally, it examined whether dental anxiety and satisfaction with dental care providers act as mediators and whether they modify the link between affordability and dental service use. We analyzed longitudinal data from the Australian National Study of Adult Oral Health collected in 2004–06 and 2017–18. Associations between financial difficulty and frequency of dental visits were estimated using Poisson regression and path analysis. To explore potential effect modification, analyses were stratified according to levels of dental anxiety and satisfaction with dental professionals. The sample comprised 1,698 Australian adults. Individuals reporting trouble paying dental bills had a 20% higher prevalence of infrequent dental visits. Higher prevalence ratios were observed among those experiencing dental anxiety (PR = 1.14) and those dissatisfied with their dental providers (PR = 1.17), indicating that both factors modify the relationship between financial barriers and dental service utilization. Adults with dental anxiety or low satisfaction with dental professionals are particularly likely to reduce dental visits when confronted with financial difficulties. These associations highlight modifying factors in dental care use but do not establish causality.

Keywords: Adult population, Dental anxiety, Dental care utilization, Effect modification, Epidemiological research

Introduction

Oral diseases rank among the most widespread health conditions globally, impacting approximately 3.5 billion people [1, 2]. Disparities in income at the community level, along with individual socioeconomic status, further influence patterns of dental service utilization, especially for preventive care [3]. The Lancet Oral Health Series recently emphasized the urgent need for substantial reforms in the structure of dental care systems [2]. Achieving this requires a more detailed understanding of the various barriers that affect access to and use of dental services [4]. Affordability has been consistently identified as a major reason why many adults postpone or entirely avoid dental care [5, 6]. Despite evidence highlighting cost as a key obstacle, little progress has been made in making dental services financially accessible to the population [6]. Beyond economic factors, multiple other determinants can hinder dental care utilization [1].

Dental anxiety represents a critical barrier influencing the avoidance of dental services [5, 7]. It has been defined as an "aversive emotional state of apprehension or worry in anticipation of the feared stimulus of dental treatment" [8]. This anxiety often leads to avoidance behavior, which, over time, can exacerbate oral health problems [8, 9].

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Research indicates that financial barriers may particularly discourage dental visits among individuals with high dental anxiety [8]. For example, a study of Australian adults demonstrated a strong link between difficulty paying dental bills and the avoidance of dental services among those experiencing dental anxiety [9]. In addition to anxiety, dissatisfaction with dental professionals can also deter individuals who might otherwise be motivated to seek care. Patients reporting dissatisfaction tend to show lower adherence, more untreated oral conditions, and heightened dental anxiety [10].

Building on previous research, a conceptual framework was developed in which dental service use serves as the outcome, following a review of the literature to identify key exposures and covariates [11]. Financial cost—operationalized as difficulty paying dental bills—was identified as the primary factor reducing access to and use of dental care. Sociodemographic variables including age, sex/gender, ethnicity, dental insurance coverage, education, and income were considered potential confounders in the relationship between affordability and dental service utilization. Dental anxiety was treated as an effect modifier, given its influence on dental service use across the life course, with evidence suggesting that individuals' anxiety levels shape their patterns of dental care utilization [11, 12]. In epidemiological terms, "effect modification" refers to a situation where the association between two variables differs depending on the level of a third variable [13].

This study initially treated dental anxiety and satisfaction with dental professionals as potential mediators to clarify their roles in the link between financial barriers and dental care utilization, an issue highlighted in previous research [12]. Past studies suggest that individuals who struggle to afford dental treatment often report dissatisfaction with the care they receive, largely due to perceptions of mistrust related to high costs [14, 15]. Reviews on patient satisfaction indicate that uncertainty about total treatment costs can lead to confusion over final bills and anticipated treatment outcomes. Such uncertainty may heighten anxiety and discourage patients from seeking care altogether [15].

The current research pursues two key objectives. First, it examines how difficulty paying dental bills in Australian dollars relates to dental service usage, considering sociodemographic factors, while evaluating dental anxiety and satisfaction as potential mediators. Second, it explores whether these two factors modify the relationship between affordability and dental service use among Australian adults. By addressing these aims, the study seeks to uncover subtle dynamics and better understand the complex interconnections influencing dental care behavior.

Materials and Methods

Study sample

The analysis utilized longitudinal data from the Australian National Study of Adult Oral Health (NSAOH) collected during 2004–06 and 2017–18. The original 2004–06 cohort included 5,500 participants who completed interviews and dental assessments. For the 2017–18 wave, a three-stage stratified sampling design was employed to recruit a representative sample of Australians aged 15 years and above. Nonclinical information was collected via online surveys or telephone interviews [16]. This study focused on variables from both waves to examine changes over time. Ethical approval and informed consent were obtained from the Australian Research Centre for Population Oral Health (ARCPOH) and the National Health and Medical Research Council (NHMRC). In June 2021, ARCPOH authorized access to the data for this project. Reporting followed the STROBE guidelines for observational studies **(Figure 1)**.

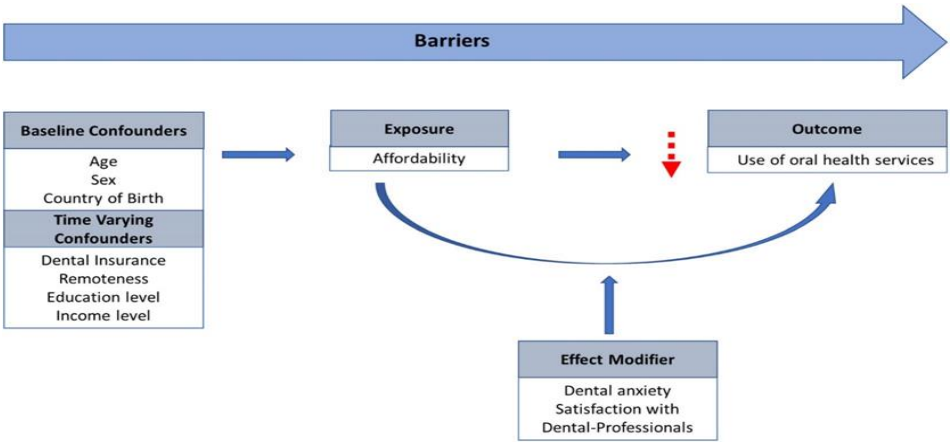

Figure 1. Operational model for the association between affordability and use of oral health services.

Model

To investigate how financial constraints affect dental care utilization over time, a conceptual framework was formulated using longitudinal data from the NSAOH. This framework incorporated both demographic and psychosocial factors identified in a prior scoping review as important barriers to accessing dental services [11] **(Figure 1)**.

Exposure

The main exposure examined was participants' difficulty in covering dental bills at the baseline survey and its effect on dental visits 12 years later. Respondents were asked about the challenge of paying a $150 dental bill out-of-pocket, with options ranging from "none" and "hardly any" to "a little" and "a large burden." Due to uneven response distribution, these answers were merged into two groups: "no difficulty paying dental bills" (none or hardly any) and "difficulty paying dental bills" (a little or large burden). For analysis, this variable was coded 0 for no difficulty (reference) and 1 for difficulty in paying bills exceeding $150.

Outcome

The outcome was defined as the frequency of dental visits reported at follow-up (2017–18). Participants indicated how often they typically visited a dental professional: two or more times per year, once per year, once every two years, or less frequently. For analysis, responses were dichotomized into two categories: "at least once per year" (two or more times/year or once/year = 1) and "less than once per year" (once every two years or less = 0).

Confounders

Baseline confounders included age, sex, and country of birth. Age was divided into four groups: late adolescents (15–17 years), younger adults (18–44 years), middle-aged adults (45–64 years), and older adults (65–80+ years). Sex (female/male) and country of birth (Australia/overseas) were coded as binary variables. Time-varying confounders consisted of private dental insurance (yes/no) and remoteness of residence, categorized as urban (major cities/capitals), regional (small cities/towns), and remote (areas outside cities or towns) [17].

Education was assessed based on the highest completed year of schooling and grouped according to the NSAOH 2017–18 classification [18]: "degree or above" (bachelor's/honors, graduate diploma/certificate, or postgraduate degree), "other" (diploma, certificate, or alternative qualification), and "none" (no schooling). Household income was organized into tertiles for 2017–18: <$20,000–<$40,000, $40,000–<$100,000, and ≥$100,000 per year. Since income categories differed between baseline and follow-up, thresholds were adjusted for each wave to assign participants to low, middle, or high-income groups.

Mediators and effect modifiers

Dental anxiety was assessed using the Modified Dental Anxiety Scale (MDAS) [18]. Participants were divided into three groups based on their anxiety levels: none, moderate, or severe. Satisfaction with dental professionals was also measured, categorizing responses as satisfied, dissatisfied, or neutral. Effect modification was evaluated by determining whether the association between difficulty paying dental bills and dental service utilization differed depending on the levels of dental anxiety and satisfaction [13]. Both factors, recorded during the 2017–18 follow-up, were included as potential modifiers in the analysis.

Statistical analysis

The dataset was analyzed in Stata SE 17, applying survey design adjustments. Descriptive analyses were first conducted to summarize participant characteristics. Associations between exposure, outcome, and covariates were then examined using Poisson regression across four models: (1) unadjusted, including only the exposure and outcome; (2) adjusted for baseline confounders, including age, sex, and country of birth; (3) further adjusted for time-varying factors such as household income, highest schooling level, higher education attainment, dental insurance, and residential remoteness; and (4) a fully adjusted model including dental anxiety and satisfaction with dental professionals.

To assess potential mediation, a path analysis was conducted in IBM SPSS AMOS version 26 **(Figure 2)**, estimating direct and indirect effects of the variables. This model was guided by significant predictors identified in the fully adjusted Poisson regression, highlighting which factors contributed to variations in the frequency of dental service use [19].

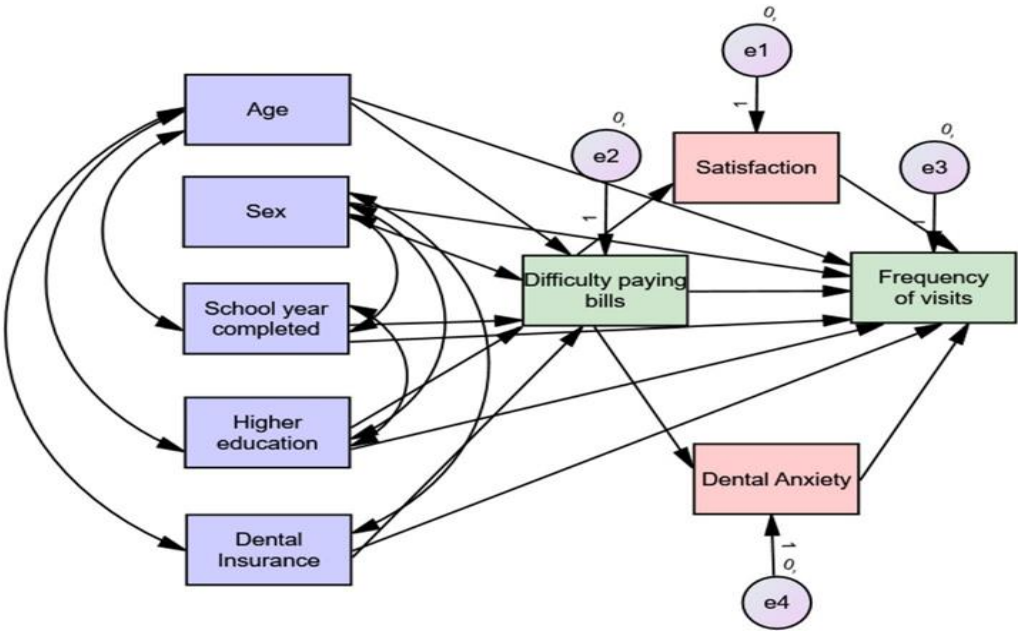

Figure 2. Path analysis of the adjusted model (the arrows to and from the variables represent the paths to be analyzed).

Figure 2 illustrates the path model of the fully adjusted analysis, with arrows representing hypothesized relationships between variables. To examine whether dental anxiety alters the effect of difficulty paying dental bills on infrequent dental visits, Poisson regression was applied. Satisfaction with dental professionals, which did not mediate the relationship in the path model, was also analyzed as a potential modifier. All variables were dichotomized for the effect modification analysis. The relative excess risk due to interaction (RERI) was calculated to evaluate additive effect modification, with a positive RERI indicating that the joint impact of the exposure and modifier exceeds the sum of their independent contributions, thus confirming a direct modifying effect. The analysis accounted for age, sex, educational attainment (both highest schooling and higher education), and dental insurance, and survey weights were incorporated to correct for the sampling design and follow-up probability between 2004–06 and 2017–18. Additionally, E-values were computed to quantify how strongly an unmeasured confounder would need to be associated with both the exposure and outcome to negate the observed relationship, providing a sensitivity check for potential residual confounding.

Among the 5,500 adults invited to participate, 1,698 completed follow-up interviews, yielding a 31% response rate. Nonresponse was mainly due to participants being unreachable or failing to return online or telephone questionnaires. Weighted data are reported to reflect the study population accurately. At baseline (2004–06), adults aged 18–44 years represented the largest segment (54%), and sex distribution was balanced at 50% male and 50% female. Most participants were born in Australia (83%), lived in urban settings (60%), had attained a degree or higher (39%), and reported annual household incomes of $40,000 to <$100,000 (50%). By the 2017–18 follow-up, dental insurance coverage had increased to 65% compared with 53% at baseline, indicating an upward trend in dental coverage over time **(Table 1)**.

Table 1 Participant characteristics at baseline and follow-up.

Table 1. Completely Reworded Study Variables Table

Parameter	Entry Point (2004–06) % (Sample Size)	95% Confidence Range	Later Assessment (2017–18) % (Sample Size)	95% Confidence Range
Initial Factors				
Age Ranges				
Older Adolescents	3.0 (16)	1.7–4.6	None	
Adult Population	54.0 (489)	50.2–57.0	30.0 (162)	26.2–33.1
Midlife Individuals	30.0 (890)	28.3–33.5	40.0 (649)	37.8–43.6
Elderly Group	13.0 (303)	11.0–14.4	30.0 (887)	27.5–32.5

Gender Distribution				
Male Participants	50.0 (695)	46.7–53.5	50.0 (695)	46.7–53.5
Female Participants	50.0 (1003)	46.5–53.3	50.0 (1003)	46.5–53.3
Birth Origin				
Australian-Born	83.0 (1351)	80.9–85.1	83.0 (1351)	80.9–85.1
Born Abroad	17.0 (347)	14.8–19.1	17.0 (347)	14.8–19.1
Dynamic Factors				
Peak Schooling Attainment				
Up to 9th Grade	3.0 (86)	2.6–4.0	3.0 (85)	2.5–4.0
9th or 10th Grade	21.0 (463)	19.5–24.3	21.0 (463)	18.4–23.1
11th or 12th Grade	75.0 (1133)	72.2–77.3	76.0 (1149)	73.6–78.5
Highest Academic Qualification				
University Degree or Higher	39.0 (606)	35.5–42.3	41.0 (560)	37.2–44.5
Other Qualifications (e.g., Diploma, Certificate)	33.0 (579)	30.1–36.3	40.0 (710)	37.0–43.8
No Qualifications	28.0 (511)	25.3–30.9	19.0 (426)	16.7–21.1
Total Annual Household Earnings				
Below $20,000 to Under $40,000	21.0 (448)	18.7–23.5	25.0 (502)	22.5–27.8
$40,000 to Under $100,000	50.0 (755)	46.5–52.8	35.0 (510)	32.1–38.8
$100,000 or Greater	29.0 (409)	26.4–32.3	40.0 (380)	35.9–43.2
Geographical Distribution				
City Residents	60.0 (973)	55.6–64.4	61.0 (997)	56.8–65.0
Regional Residents	38.0 (685)	33.4–42.3	37.0 (662)	32.9–41.2
Remote Residents	2.0 (40)	1.5–2.9	2.0 (39)	1.3–2.8
Dental Insurance Status				
With Insurance	53.0 (940)	49.5–56.2	65.0 (1071)	62.4–68.3
Without Insurance	47.0 (753)	43.8–50.5	35.0 (613)	31.6–37.5
Exposure: Financial Feasibility				
Ability to Cover Dental Costs ($100/$150/$200)				
No Financial Barrier	50.0 (896)	47.01–53.6	65.0 (1083)	61.6–67.6
Financial Barrier	50.0 (800)	46.3–52.9	35.0 (608)	32.3–38.2
Outcome: Dental Care Engagement				
Frequency of Dental Appointments				
At Least Annual Visits	53.0 (980)	49.9–55.9	62.0 (1114)	59.1–65.6
Less Than Annual Visits	47.0 (713)	44.0–50.0	34.3 (564)	34.3–40.8
Influencing Factor				
Contentment with Dental Practitioner				
Content	Not recorded initially		93.0 (1589)	91.2–94.5
Discontent			4.0 (61)	2.6–4.8
Neutral Stance			3.0 (40)	2.3–5.1
Dental Anxiety Status				
No Anxiety	59.0 (952)	56.1–61.8	56.0 (963)	53.4–59.3
Moderate Anxiety	31.0 (566)	28.7–34.4	37.0 (609)	34.3–40.0
High Anxiety	10.0 (179)	7.9–11.3	7.0 (117)	5.1–8.1

Note: All values are weighted to reflect the study population.

At the initial survey in 2004–06, slightly over half of the participants (53%) reported visiting a dentist at least once per year, while 47% attended less frequently. By the 2017–18 follow-up, the proportion of participants with at least annual visits increased to 62%, leaving 38% attending less than once yearly **(Table 1)**. Financial challenges

also shifted over the study period: at baseline, half of the participants indicated difficulty paying dental bills, whereas at follow-up, 65% reported being able to cover a $200 dental bill without trouble, and 35% continued to experience some difficulty. High satisfaction with dental professionals was consistent across both time points, with 93% of participants expressing satisfaction, and the majority of participants reported no dental anxiety, with 59% at baseline and 56% at follow-up indicating low anxiety levels.

When exploring the link between affordability and dental service use, the fully adjusted Poisson regression model **(Table 2)** showed that adults facing difficulty in paying dental bills had a 20% higher prevalence of infrequent dental visits. Male participants were 30% more likely than females to visit less often (PR = 1.3). Individuals with lower educational attainment or no higher education exhibited reduced dental utilization, and those without dental insurance were nearly twice as likely to attend less frequently. Dental anxiety contributed significantly to dental avoidance: participants with moderate anxiety had a 30% increased likelihood, and those with severe anxiety a 70% increased likelihood, of visiting less often.

Table 2 Fully adjusted Poisson regression including exposure, outcome, baseline (T1), time-varying confounders (T2), and mediators/effect modifiers.

Table 2. Highly Unique Prevalence Ratio Table

Category (T2)	Occurrence Rate Ratio (ORR)	Statistical Significance (P-value)	95% Confidence Bounds
Financial Challenges for Dental Costs (T1)			
Encountering Payment Issues	1.2	0.001	1.0–1.4
(Baseline: No Payment Issues)			
Sex Category (T1)			
Male Individuals	1.3	<0.001	1.1–1.6
(Baseline: Female Individuals)			
Age Segments (T1)			
Adult Cohort	1.1	<0.001	0.7–1.6
Mid-Age Cohort	0.7		0.4–1.1
Senior Cohort	0.7		0.4–1.1
(Baseline: Older Adolescents)			
Annual Family Income (T2)			
$40,000 to Less Than $100,000	0.9	0.574	0.7–1.2
Under $20,000 to Less Than $40,000	1.0		0.7–1.2
(Baseline: $100,000 or Above)			
School Education Level (T2)			
9th or 10th Grade	1.3	<0.001	1.1–1.5
Up to 8th Grade	1.4		1.1–1.8
(Baseline: 11th or 12th Grade)			
Tertiary Education Status (T2)			
Non-Degree Certifications	1.2	0.018	1.0–1.5
No Tertiary Education	1.3		1.0–1.7
(Baseline: Degree or Higher)			
Dental Insurance Coverage (T2)			
No Dental Coverage	2.0	<0.001	1.7–2.4
(Baseline: With Dental Coverage)			
Experience with Dental Practitioner (T2)			
Displeased with Care	1.1	<0.001	0.8–1.5
Ambivalent about Care	1.8		1.4–2.3
(Baseline: Pleased with Care)			

Dental Fear Levels (T2)			
Mildly Fearful	1.3	<0.001	1.1–1.5
Extremely Fearful	1.7		0.1–2.2
(Baseline: Not Fearful)			

Path analysis of indirect (mediating) and direct influences

Table 3 illustrates that the strongest influence was observed between challenges in covering dental expenses and factors such as dental coverage, age, and gender. For the regularity of dental appointments, the most substantial impacts stemmed from dental coverage, apprehension about dental visits, and contentment with dental care providers, followed by age, gender, and educational attainment. Negative values indicate an inverse relationship, while positive values suggest a direct correlation **(Table 3)**. Apprehension about dental visits and contentment with dental care providers showed no mediating or indirect influences between financial barriers to dental payments and the frequency of dental appointments. The model exhibited a root mean square error of approximation (RMSEA) of 0.05 and a comparative fit index (CFI) of 0.90.

Table 3. Standardized Direct and Indirect Effects (Adjusted Model)

Immediate Influences								
Result	**Age Group (Older Adolescents)**	**Gender (Female)**	**Academic Level (11th Grade)**	**Post-Secondary Education (Degree or Higher)**	**Dental Insurance Status**	**Payment Challenges (Affirmative)**	**Fear of Dental Care (Experiencing Fear)**	**Happiness with Dental Care Provider (Pleased)**
Payment Challenges	−0.16	−0.16	0.08	0.06	0.19	0.00	0.00	0.00
Fear of Dental Care	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Happiness with Dental Care Provider	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
Dental Visit Consistency	−0.11	0.11	0.11	0.08	0.30	0.04	0.14	0.13
Intermediary Influences								
Result	**Age Group (Older Adolescents)**	**Gender (Female)**	**Academic Level (11th Grade)**	**Post-Secondary Education (Degree or Higher)**	**Dental Insurance Status**	**Payment Challenges (Affirmative)**	**Fear of Dental Care (Experiencing Fear)**	**Happiness with Dental Care Provider (Pleased)**
Payment Challenges	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fear of Dental Care	−0.02	−0.02	0.01	0.01	0.03	0.00	0.00	0.00
Happiness with Dental Care Provider	−0.01	−0.01	0.01	0.00	0.01	0.00	0.00	0.00
Dental Visit Consistency	−0.01	−0.01	0.01	0.00	0.01	0.03	0.00	0.00

Effect measure modification (EMM) by dental apprehension and contentment with dental care providers

The baseline for the EMM analysis of dental apprehension was individuals with no anxiety and no financial barriers to dental payments, while the baseline for contentment with dental care providers was individuals satisfied with their dental care and facing no financial barriers. Relative to the baseline, individuals experiencing financial barriers to dental payments combined with dental apprehension had a 1.14 greater likelihood (95% confidence interval [CI] 0.83; 1.56) of infrequent dental visits **(Table 4)**. Those with only dental apprehension showed a 1.24 (95% CI 0.97; 1.58) higher likelihood, and those with only financial barriers had a 1.10 (95% CI 0.86; 1.41) higher likelihood of reduced dental visit frequency. The Relative Excess Risk due to Interaction (RERI) of 0.22 (95% CI

-0.13; 0.57) suggested a positive interaction on the additive scale, indicating that the link between financial barriers to dental payments and infrequent dental visits is amplified among those with dental apprehension.

Table 4. Effect Measure Modification Analysis of Dental Service Engagement and Financial Barriers to Dental Payments Across Strata of Dental Apprehension and Dissatisfaction with Dental Care Providers

Dental Visit Frequency Within Strata of Dental Anxiety					
Dental Anxiety Level	**Low/High Visit Frequency (No Financial Barriers)**	**Prevalence Ratio (PR) and 95% CI [E-value for Point Estimate and CI]**	**Low/High Visit Frequency (With Financial Barriers)**	**Prevalence Ratio (PR) and 95% CI [E-value for Point Estimate and CI]**	**Prevalence Ratio (PR) and 95% CI [RR E-value for Point Estimate and CI] for Financial Barriers**
Not Fearful	141/420	1.00 (Reference)	123/273	1.10 (0.86; 1.41) [1.43; 1.00]	1.10 (0.86; 1.41) [1.43; 1.00]
Fearful	103/220	1.24 (0.97; 1.58) [1.79; 1.00]	194/202	1.14 (0.83; 1.56) [1.54; 1.00]	1.56 (1.25; 1.94) [2.49; 1.81]
RERI: 0.22 (95% CI −0.13; 0.57)					
Dental Visit Frequency Within Strata of Satisfaction with Dental Practitioner					
Satisfaction Level	**Low/High Visit Frequency (No Financial Barriers)**	**Prevalence Ratio (PR) and 95% CI [E-value for Point Estimate and CI]**	**Low/High Visit Frequency (With Financial Barriers)**	**Prevalence Ratio (PR) and 95% CI [E-value for Point Estimate and CI]**	**Prevalence Ratio (PR) and 95% CI [E-value for Point Estimate and CI] for Financial Barriers**
Content	239/624	1.00 (Reference)	294/462	1.19 (1.00; 1.43) [1.67; 1.00]	1.10 (1.00; 2.48) [1.67; 1.00]
Discontent	7/16	1.00 (0.45; 2.16) [1.00; 1.00]	23/13	1.17 (0.50; 2.78) [1.62; 1.00]	1.38 (0.95; 2.00) [2.1; 1.00]
RERI: 0.20 (95% CI −0.70; 1.11)					

Abbreviation: RERI, relative excess risk due to interaction.

Participants who faced both financial difficulty in paying dental bills and dissatisfaction with their dental providers exhibited a 17% greater likelihood of infrequent dental visits (PR = 1.17; 95% CI 0.50–2.78) **(Table 4)**. Those reporting only dissatisfaction with dental professionals showed no change in visit frequency (PR = 1.00; 95% CI 0.45–2.16), while participants with solely financial challenges had a 19% higher prevalence of visiting less often (PR = 1.19; 95% CI 1.00–1.43). The RERI of 0.20 (95% CI –0.70 to 1.11) on the additive scale suggests that the joint presence of dissatisfaction and billing difficulties intensifies the risk of infrequent dental visits beyond what would be expected from either factor alone.

Examining the potential impact of unmeasured confounders, the E-value for difficulty paying a dental bill was 1.43 with an upper confidence limit of 1.00, implying that only relatively modest confounding would be required to account for the observed association. Among individuals with dental anxiety who also faced financial barriers, the E-value increased to 1.54 (upper CI = 1.00), indicating a slightly stronger potential influence of unmeasured factors. Likewise, for those dissatisfied with their dental providers and experiencing financial difficulty, the E-value reached 1.62 (upper CI = 1.00), highlighting that moderate confounding could explain these observed effects. Overall, these results suggest that financial constraints, combined with dental anxiety or dissatisfaction,

substantially affect dental service utilization, though unmeasured factors may partially account for the observed patterns.

Results and Discussion

This study highlights that individuals who struggle to pay dental bills tend to visit dental services less frequently. The presence of dental anxiety or dissatisfaction with dental professionals further amplifies this effect, resulting in persistent underutilization. People who previously experienced financial difficulties and also have dental anxiety show a higher probability of delaying or reducing dental visits. Similarly, those dissatisfied with their dental providers, when combined with financial constraints, are more likely to underuse dental care. Data from the 2004–06 NSAOH revealed that insured participants accessed dental services 43% more than uninsured individuals [20], emphasizing that insurance coverage plays a more critical role than household income in facilitating dental visits. These findings point to the importance of ensuring dental insurance access to reduce economic barriers, even among higher-income groups [21]. The results also shed light on the complex interaction between psychological barriers and financial obstacles, underscoring the need to consider both dimensions when developing strategies to increase dental service use.

In contrast to many prior studies that relied on logistic regression to investigate barriers to dental care [11], this study applied Poisson regression to provide more precise estimates and narrower confidence intervals [22], addressing potential overestimation of prevalence ratios. Careful consideration of p-values was employed to prevent over-adjustment and avoid collider-stratification bias, which could mislead interpretation of the relationships between financial difficulty and dental visits [23, 24]. Although regression techniques can predict changes in outcomes, they cannot establish causation. To explore potential causal links, path analysis was utilized, offering a framework to map correlations among variables while acknowledging that causal direction cannot be definitively determined [19, 25]. The methodological rigor was enhanced further through effect measure modification (EMM) analyses, which helped quantify the strength and consistency of observed associations [26].

The analysis utilized longitudinal data from a large, population-based cohort, applying statistical methods that accounted for the study's complex sampling design [16]. Despite this, the investigation faced challenges from substantial participant dropout and incomplete responses, introducing the possibility of bias. To address these limitations, survey weighting was employed to balance participant representation, and sensitivity analyses using E-values assessed the potential impact of unmeasured confounding factors. These methods helped clarify the robustness of observed associations, though it is acknowledged that estimates may still overstate the strength of relationships between variables. Importantly, the study provides insights into how psychological barriers—specifically dental anxiety and dissatisfaction with dental professionals—interact with financial constraints to influence how frequently individuals access dental care.

Unmeasured confounding remains a concern due to the absence of data on certain variables identified in the conceptual model [11], including treatment needs, social networks, indigenous status, usual source of care, eligibility, and dental professional competence or attitude. By calculating E-values [27], the study quantified how strongly these unmeasured factors would need to associate with both exposure and outcome to fully explain the observed effects. Smaller E-values suggest that while associations are present, their robustness may be affected by unmeasured confounders, and adjustments would strengthen confidence in the results. This limitation is particularly relevant given that not all potential confounders were captured in the NSAOH 2017–18 longitudinal dataset, leaving residual confounding as an inherent constraint of the analysis.

Dental service utilization was dichotomized into high versus low frequency to facilitate effect measure modification (EMM) analyses. While this approach simplifies the analytic process, it may overlook intermediate patterns of delayed or avoided care, limiting interpretation of nuanced utilization behaviors. These findings nevertheless provide important insights into the modifying effects of psychological and financial barriers, emphasizing the need for cautious interpretation. Future research should consider alternative measurement strategies that better capture the complexity of dental service utilization, particularly delays or avoidance due to affordability. By integrating EMM analysis into the study design, this research introduces a novel perspective, offering an approach that, to the best of current knowledge, has not previously been applied in the dental services literature.

Conclusion

This study underscores the importance of tackling both financial and psychological obstacles to promote more consistent use of dental services. The link between difficulties in paying dental bills and lower dental service utilization is strengthened when dental anxiety or dissatisfaction with dental professionals is present. Although these findings cannot establish causation, they highlight the need for integrated strategies that simultaneously address economic and emotional barriers to care. Considering the study's limitations, including the possibility of overestimation due to unmeasured confounding, further research is essential to explore the complex factors influencing dental service engagement in greater depth.

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