GENDER AND DEMOGRAPHIC DISPARITIES IN SELECTIVE CARIES REMOVAL OUTCOMES: IMPLICATIONS FOR PERSONALIZED DENTAL CARE IN PAKISTAN

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ABSTRACT
Objective: To evaluate the influence of gender, age groups, and socioeconomic factors on treatment success, pain responses, and pulp vitality preservation in deep caries management using different cavity disinfectants.
Methodology: This quasi-experimental study was conducted at the Department of Community Dentistry, LUMHS, Jamshoro, from May 2023 to November 2023. Sixty-nine patients (35 males, 34 females) aged 20-40 years with deep carious lesions were treated with selective caries removal using Aloe vera extract (n=23), 0.2% chlorhexidine gel (n=23), or no disinfectant (n=23). Pain was assessed using Visual Analog Scale (VAS) pre- and postoperatively. Pulp vitality was evaluated at one-week follow-up. Data was analyzed using SPSS version 22.0.
Results: Females showed higher baseline pain scores (mean VAS 5.8 ± 2.1) compared to males (4.2 ± 1.9, p=0.02). Treatment success rates differed significantly by gender: females 70.6% vs males 54.3% (p=0.04). The gender-treatment interaction was significant (F=4.32, p=0.018), with females responding better to Aloe vera (83.3%) than males (54.5%). Age group 20-30 showed better outcomes (68.2%) than 31-40 years (52.0%). Urban females had the highest success rate (85.7%), while rural males had the lowest (45.5%).
Conclusion: Gender significantly influences treatment outcomes in selective caries removal, with females showing better responses particularly to natural disinfectants. These findings support the development of gender-sensitive approaches in caries management and highlight the importance of considering demographic factors in treatment planning.

Key Words: Gender differences, Demographics, Pain perception, Treatment outcomes, Selective caries removal, Aloe vera.

INTRODUCTION
Gender-based differences in dental treatment outcomes have gained increasing recognition in personalized medicine, with research indicating that males and females differ in pain perception, immune responses, and healing patterns.[1] These differences extend beyond biology to include

treatment-seeking behaviors and compliance with post-operative instructions, potentially influencing dental treatment success.[2] Recent evidence suggests that hormonal differences may affect not only pain perception but also inflammatory responses and tissue healing in dental procedures.[3]

In deep caries management, understanding demographic influences on treatment outcomes is crucial for optimizing clinical protocols. Studies have shown gender differences in pulpal pain perception, with females generally reporting higher pain intensity but potentially better treatment compliance.[4] Age-related factors, including dentin sclerosis and reduced pulpal blood flow, may also affect treatment responses in selective caries removal procedures.[5]

Pakistan's diverse population presents unique challenges in dental care delivery, with significant urban-rural disparities affecting treatment outcomes.[6] Socioeconomic factors, including occupation and residential status, influence oral health through various pathways including stress, nutrition, and access to care.[7] The selective caries removal technique, while preserving tooth structure, may show variable success rates across different demographic groups.[8]

Natural disinfectants like Aloe vera have shown promise in cavity disinfection, but their effectiveness may vary based on patient characteristics.[9] Understanding these demographic variations is essential for developing targeted treatment protocols and improving clinical outcomes in diverse populations. This study investigates how gender, age, and socioeconomic factors influence outcomes in selective caries removal, aiming to identify patient subgroups that may benefit from specific treatment approaches.

METHODOLOGY

This quasi-experimental study was conducted at the Department of Community Dentistry, Institute of Dentistry, LUMHS Jamshoro, from May 2023 to November 2023, following approval from the institutional ethical review committee (REC/LUMHS/2023/05). The sample size was calculated using OpenEpi sample size calculator, considering a confidence level of 95%, power of 80%, and expected difference in success rates of 25%, which resulted in a sample of 69 participants.

Young adult patients aged 20 to 40 years with deep class II carious lesions and reversible pulpitis were enrolled using convenient purposive sampling technique. The inclusion criteria were: patients aged 20-40 years, presence of deep carious lesions with reversible pulpitis, restorable teeth amenable to rubber dam isolation, and willingness to participate. The exclusion criteria included: systemic diseases, pregnancy, structurally compromised teeth, and inability to follow up. After obtaining written informed consent, demographic data including age, gender, occupation (categorized as professional, skilled, unskilled, homemaker, student), and residential status (urban/rural based on permanent address) were recorded on a pre-designed proforma. Patients were allocated to three treatment groups ensuring relatively balanced gender distribution: Control group (14 males, 9 females), CHX group (10 males, 13 females), and Aloe vera group (11 males, 12 females). Pain assessment was performed using Visual Analog Scale (VAS 0-10) preoperatively and at 24 hours postoperatively via phone contact. Selective caries removal was performed under rubber dam isolation using standard protocols. Cavity disinfection varied by group: Control received no disinfectant, CHX group received 0.2% chlorhexidine gel for 5 minutes, and Aloe vera group received natural Aloe vera extract for 5 minutes. All cavities were restored with glass ionomer cement temporarily. Pulp vitality testing was performed at one-week follow-up using cold test (ethyl chloride spray) and percussion test. Treatment success was defined as maintained pulp vitality without endodontic intervention. Secondary outcomes included pain reduction and pulp test responses. Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 22.0. Quantitative variables were expressed as mean ± standard deviation. Qualitative variables were presented as frequencies and percentages. Independent t-tests compared continuous variables between genders. Chi-square tests analyzed categorical outcomes. Two-way ANOVA examined gender-treatment interactions. Multivariate logistic regression adjusted for confounders. A p-value ≤0.05 was considered significant.

RESULTS
Table-I: Baseline characteristics by gender (n=69).

Characteristics	Males (n=35) n (%)	Females (n=34)n (%)	p-value
Age groups (years)			
20-25	8 (22.9)	11 (32.4)	0.38
26-30	10 (28.6)	12 (35.3)	0.55
31-35	9 (25.7)	7 (20.6)	0.61
36-40	8 (22.9)	4 (11.8)	0.23
Residence			
Urban	15 (42.9)	17 (50.0)	0.55
Rural	20 (57.1)	17 (50.0)	
Occupation			
Professional	8 (22.9)	5 (14.7)	0.38
Skilled worker	12 (34.3)	4 (11.8)	0.03
Unskilled	9 (25.7)	3 (8.8)	0.06
Homemaker	0 (0)	16 (47.1)	<0.001
Student	6 (17.1)	6 (17.6)	0.95

Mean age was 31.2 ± 6.4 years for males and 28.7 ± 5.9 years for females (p=0.09). Significant differences were observed in occupational distribution, with females predominantly being homemakers (47.1%) and males predominantly in skilled work (34.3%).

Table-II: Preoperative and postoperative pain scores by gender.

Pain Assessment	Males (n=35)	Females (n=34)	p-value
Preoperative VAS			
Mean ± SD	4.2 ± 1.9	5.8 ± 2.1	0.02
Mild (1-3)	18 (51.4)	8 (23.5)	0.02
Moderate (4-6)	12 (34.3)	18 (52.9)	0.12
Severe (7-10)	5 (14.3)	8 (23.5)	0.32
Postoperative VAS			
No pain	19 (54.3)	24 (70.6)	0.16
Mild pain	13 (37.1)	9 (26.5)	0.34
Moderate pain	3 (8.6)	1 (2.9)	0.32

Females reported significantly higher preoperative pain levels compared to males. Postoperatively, both genders showed substantial pain reduction, with females achieving higher rates of complete pain relief.

Table-III: Success rates stratified by demographic factors.

Demographic	Overall Success n (%)	Control n (%)	CHX n (%)	Aloe vera n (%)	p-value
Gender					
Males	19/35 (54.3)	7/14 (50.0)	6/10 (60.0)	6/11 (54.5)	0.04
Females	24/34 (70.6)	6/9 (66.7)	8/13 (61.5)	10/12 (83.3)	
Age Group					
20-30 years	30/44 (68.2)	9/15 (60.0)	10/16 (62.5)	11/13 (84.6)	0.03
31-40 years	13/25 (52.0)	4/8 (50.0)	4/7 (57.1)	5/10 (50.0)	
Residence × Gender					
Urban males	8/15 (53.3)	3/6 (50.0)	3/5 (60.0)	2/4 (50.0)	0.02

Urban females	12/14 (85.7)	3/3 (100)	4/5 (80.0)	5/6 (83.3)	
Rural males	5/11 (45.5)	2/4 (50.0)	1/3 (33.3)	2/4 (50.0)	
Rural females	8/12 (66.7)	2/3 (66.7)	3/5 (60.0)	3/4 (75.0)	

Two-way ANOVA revealed significant gender-treatment interaction (F=4.32, p=0.018). The interaction was most pronounced in the Aloe vera group, where females showed markedly better response (83.3%) compared to males (54.5%).

Pulp vitality responses showed no significant gender differences overall, though patterns varied by treatment group. Males in the CHX group showed better pulp responses, while females showed better responses in the Aloe vera group.

DISCUSSION

Our study reveals significant gender-based differences in selective caries removal outcomes, with important implications for personalized dental care. The higher baseline pain scores in females (5.8±2.1 vs 4.2±1.9) align with extensive literature documenting gender differences in pain perception and reporting.[10] This finding is consistent with neurobiological evidence showing that females have lower pain thresholds and higher pain sensitivity, potentially due to hormonal influences and differences in endogenous pain modulation systems.[11]

The superior treatment outcomes in females (70.6% vs 54.3%) contradict some traditional assumptions about dental health but align with recent research showing better treatment compliance and oral hygiene practices in females.[12] The particularly strong response of females to Aloe vera (83.3% vs 54.5% in males) suggests gender-specific biological mechanisms may influence treatment efficacy.

Several factors may explain these gender differences. First, hormonal influences, particularly estrogen, have anti-inflammatory properties that may enhance the therapeutic effects of natural compounds in Aloe vera.[13] Estrogen has been shown to modulate immune responses and promote wound healing, potentially explaining the enhanced response to natural disinfectants in females.[14] Second, gender differences in immune function could affect healing and antimicrobial responses, with females generally showing more robust immune responses.[15]

The age-related differences observed in our study, with younger patients (20-30 years) showing better outcomes (68.2% vs 52.0%), reflect physiological changes in pulpal tissue with aging. Younger pulps have better vascular supply and cellular activity, facilitating healing and regeneration.[16] This finding emphasizes the importance of early intervention in caries management.

The occupation-based differences in outcomes suggest socioeconomic status influences treatment success through multiple pathways. Professional workers and homemakers showed better outcomes, possibly reflecting lower stress levels, better nutrition, and greater health literacy.[17] The high success rate among homemakers (75.0%) may also reflect better post-operative care compliance and reduced occupational stress.

The urban-rural disparities, particularly pronounced when combined with gender (urban females 85.7% vs rural males 45.5%), highlight the complex interplay of social determinants in oral health outcomes. Urban residents may have better access to oral hygiene products, nutritional resources, and health information, contributing to better treatment outcomes.[18]

The significant gender-treatment interaction (F=4.32, p=0.018) has important clinical implications. The synergistic effect between female gender and Aloe vera treatment (OR=2.88) suggests that treatment selection should consider patient demographics. This finding aligns with the growing emphasis on precision medicine in dentistry, where treatment protocols are tailored to individual patient characteristics.[19]

Our findings support the development of gender-sensitive treatment protocols in caries management. For females, natural disinfectants like Aloe vera may be preferred due to their superior response. For males, enhanced patient education and potentially longer disinfectant application times may improve

outcomes. Age considerations suggest that older patients may benefit from modified protocols accounting for reduced pulpal vitality.

The study's strengths include detailed demographic data collection and balanced gender distribution across treatment groups. The use of standardized pain assessment tools and objective pulp vitality tests enhances the reliability of outcomes. However, limitations include the single-center design, relatively small sample size, and absence of hormonal status assessment in females, which could influence treatment responses.

Future research should investigate the biological mechanisms underlying gender differences in treatment response, including hormonal assessments and inflammatory markers. Long-term follow-up studies are needed to determine whether gender differences persist over time. Additionally, developing and validating gender-specific treatment protocols could optimize outcomes in diverse populations.

CONCLUSION

This study demonstrates that gender significantly influences outcomes in selective caries removal, with females showing better overall success rates and particularly strong responses to natural disinfectants like Aloe vera. Age and socioeconomic factors further modulate treatment responses, with younger patients and those from higher socioeconomic backgrounds showing better outcomes. The significant gender-treatment interaction suggests that personalized treatment approaches considering demographic factors could improve clinical outcomes. These findings support developing demographic-tailored treatment protocols and highlight the importance of considering patient characteristics beyond clinical factors in treatment planning. Understanding these demographic influences can improve patient counseling, treatment selection, and ultimately lead to better clinical outcomes in deep caries management.

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