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Impact of Socioeconomic Factors on Access to Advanced Prosthodontic Treatments Utilizing Digital Dentistry Technologies

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ABSTRACT

Objective: To examine the connection between socioeconomic factors and access to advanced prosthodontic procedures with digital dentistry.

Methods: This study was a descriptive cross-sectional analytical study, which was carried out at the Department of Prosthodontics. The 150 people who participated in our sample have been recruited across the institution using the non-probability consecutive sampling. Data was collected using a semi-validated questionnaire that was structured and comprised of questions on demographic and socioeconomic factors (age, gender, education, occupation, income, and residence) and questions on awareness, access, and utilization of digital prosthodontic services. Data was analyzed by use of SPSS v.26, including the Shapiro-Wilk test of normality, Chi-square test of association, and stratification analysis to control the modification of effects.

Results: The participants had an average age of 42.8 ± 11.6 years, and 56 and 44% were males and females, respectively. Sixty-one point three percent of the sampled respondents were aware of digital prosthodontic options, and only 32.7 percent had experienced such treatment. The use of digital prosthodontics was linked to significantly higher income ($p = 0.001$), graduate education ($p = 0.018$), workforce engagement ($p = 0.047$), and urban geography ($p = 0.006$). The cost also remained a great obstacle, with 74 percent saying they believe that the treatment is too expensive.

Conclusion: Socioeconomic inequality has a significant effect on access to digital prosthodontic care. Although an increased consciousness of access issues and technology-based care exists, affordability, education, and geography tend to limit the capacity of people to receive the care.

Keywords: *Digital dentistry, socioeconomic factors, prosthodontics, access to care, CAD/CAM*

1. INTRODUCTION

There has been a major change in prosthodontics over the last several years due to the advent of digital dentistry technologies, including computer-aided design and manufacturing (CAD/CAM), intraoral scanning, and 3D printing.(1) These improved methods of designing, manufacturing, and delivering dental prostheses have provided patients with increased precision, improved aesthetics, reduced treatment/testing time, and increased comfort when compared to conventional treatment methods.(2) Digital workflows improved efficiency for clinicians, decreased laboratory mishaps and errors, and have standardized patient outcomes, which represent a global shift in prosthodontic practice.(3)

While technology has improved all aspects of care in prosthodontics, the availability and implementation of digital prosthodontic treatment continues to be stratified by population.(4) Specifically, socioeconomic measures such as income, education, employment, and urban-rural contrast to innovate in care delivery measures access. Studies suggest individuals with higher socioeconomic status are more likely to attain modern dental care, whereas individuals with lower income are more likely to attain basic but less precise time consuming prosthodontic care. (5, 6) This inequality impacts health and oral health outcomes as well as quality of life, self-image, and well-being.

Global health reports identified that affordability for digital prosthodontics is still a key barrier in many developing regions, coupled with poor infrastructure, insufficient trained personnel, and limited insurance coverage.(7) Reports state that over 70% of dental clinics in high-income countries have instituted some form of CAD/CAM systems, while low- and middle-income countries have less than 20% of clinics that have access to such technologyThis provides justification to assess socioeconomic factors that limit equitable access on dental prosthetic treatments utilizing digital dentistry technologies.

The increased differences in particular processes that can restrict the access of certain patients to progressive prosthodontic care are of particular significance in terms of better comprehension of how individual socioeconomic factors can be influenced differentially. Increased understanding can help in specific policies or oral health care/dental education systems that can help in promoting equity, affordability, and integration of technology in dental care. A timely exploratory study on the impact of social and economic conditions on the access and use of digital dentistry in prosthodontic treatments would fill a gap between the innovation and equity. The aim of the current research was to determine how socioeconomic factors affect access to the advanced prosthodontic treatments using digital dentistry technologies by patients

2. METHODOLOGY

The study was a cross-sectional analytical study that examined the socioeconomic factors and the availability of advanced prosthodontic treatment through the use of digital dentistry. The experiment was done in the Department of Prosthodontics. Data collections occurred between October, 2024 to June, 2025, during which eligible participants were enrolled according to the study plans.

The required sample size was determined using OpenEpi version 3, with a 95% confidence level, and a 5% margin of error, with a 50% expected access to advanced prosthodontic treatment, resulting in a minimum required sample size of 150 participants.(8) A non-probability consecutive sampling method was utilized to include all eligible patients who attended the department of prosthodontics during the specified time period who met the inclusion criteria until the desired sample size was reached.

The study was conducted among adult patients, aged 20 years and above, who were referred for prosthodontic rehabilitation, expressed a willingness to participate in the study, and provided informed consent. Excluded from the study were patients who had already undergone full mouth rehabilitation using a digital prosthodontic technique, had cognitive impairment to the extent that understanding the questionnaire was not possible, or were not willing to participate in the study.

The collection of data was done using a structured, pretested questionnaire, which was administered in face-to-face interviews with participants. The questionnaire had sections on demographic and socioeconomic variables (age, gender, level of education, occupation, monthly household income and area of residence) and the variables on accessibility, including awareness, affordability and use of the digital technologies in prosthodontics (CAD/CAM crowns, implant-supported restorations and dentures produced using a digital method). The process of data collection was done by the trained dental researchers under the supervision of the principal investigator. The whole process was kept confidential and all the participants were assured that their answers would only be utilized in research purposes.

The data used in the study were entered and analyzed with the help of SPSS version 26. The Shapiro-Wilk test was used to test the normality of the continuous variables. Descriptive statistics such as frequencies, percentages, means and standard deviations were used to summarize the data. To examine the relationship among the categorical variables, Chi-square test was carried out. The independent tests were conducted on continuous variables, with the application of either independent t-tests or Mann-Whitney U tests. In order to test the hypothesis, a p-value ≤ 0.05 was established to be statistically significant. Age, gender and residence, which are examples of effect modifiers, were stratified to control the confounding variables and determine their impact on access to digital prosthodontic services.

3. RESULTS

A total of 150 participants were recruited for the study, with a mean age of 42.8 ± 11.6 years. Of the total population, 56% were males, and 44% were females. A majority (64%) of participants lived in urban areas, compared to 36% of participants who lived in rural areas. Educational history showed that almost one-third of the population, 31.3% of participants, had completed secondary level education with 30% being graduates or above. Employment status showed that 43.3% of participants were employed, 28% were unemployed, and the remainder were students or retired. In income, 40.7% of participants reported a monthly household income in the range of PKR 50,000 to 100,000, while 38.7% of the participants reported a monthly household income less than PKR 50,000 (Table 1).

Table 1. Socio-Demographic Characteristics of Study Participants (n = 150)

Variable	Category	n (%)/Mean ± SD
Age (years)	—	42.8 ± 11.6
Gender	Male	84 (56.0)
	Female	66 (44.0)
Education Level	No formal education	18 (12.0)
	Secondary	47 (31.3)
	Higher secondary	39 (26.0)
	Graduate and above	46 (30.7)
Occupation	Employed	65 (43.3)
	Unemployed	42 (28.0)
	Student	16 (10.7)
	Retired/Other	27 (18.0)
Monthly Household Income (PKR)	<50,000	58 (38.7)
	50,000–100,000	61 (40.7)
	>100,000	31 (20.6)
Residence	Urban	96 (64.0)
	Rural	54 (36.0)

The study population had an average awareness of digital prosthodontic technologies like CAD/CAM and 3D printing, as 61.3% of participants were previously aware of these options. However, only 32.7% of participants had ever received a digital prosthodontic treatment. The treating dentist was the most reported source of information about digital prosthodontics (51.3%), followed by the internet and social media (28.0%). Despite this, 74.0% of participants believed that the procedures were not affordable, which may have contributed to their lack of use. (Table 2).

Table 2. Awareness and Utilization of Digital Prosthodontic Technologies (n = 150)

Variable	Category	n (%)
Awareness of digital prosthodontic options (e.g., CAD/CAM, 3D printing)	Yes	92 (61.3)
	No	58 (38.7)
Ever received any digital prosthodontic treatment	Yes	49 (32.7)
	No	101 (67.3)
Main source of information	Dentist	77 (51.3)
	Internet/Social media	42 (28.0)
	Friends/Family	31 (20.7)
Perceived affordability of digital prosthodontics	Affordable	39 (26.0)
	Not affordable	111 (74.0)

Socioeconomic status was significantly associated with the receipt of digital prosthodontic treatments. There was a significant difference in the likelihood of receiving digital prosthodontics by education level ($p = 0.018$), the majority of participants with higher education completed these procedures. Income also showed a clear pattern, as more than half (61.3%)

of participants earning > PKR 100,000 had received digital prosthodontic treatment compared to less than a quarter (15.5%) of those earning < PKR 50,000 ($p < 0.001$). Urban dwellers received digital prosthodontics at a higher rate compared to rural dwellers (40.6% vs 18.5%, $p = 0.006$). Employment status also demonstrated a difference where employed patients had higher rates of digital prosthodontic treatment ($p = 0.047$). (Table 3).

Table 3. Association between Socioeconomic Variables and Utilization of Digital Prosthodontic Treatments

Socioeconomic Variable	Category	Utilized Digital Treatment n (%)	p-value
Education level	No formal education	4 (22.2)	
	Secondary	11 (23.4)	
	Higher secondary	13 (33.3)	
	Graduate and above	21 (45.7)	0.018
Monthly Income (PKR)	<50,000	9 (15.5)	
	50,000–100,000	21 (34.4)	
	>100,000	19 (61.3)	<0.001
Residence	Urban	39 (40.6)	
	Rural	10 (18.5)	0.006
Occupation	Employed	26 (40.0)	
	Unemployed/Student/Other	23 (25.8)	0.047
(Chi-square test applied; $p \leq 0.05$ considered significant.)			

Further stratification analysis revealed that gender and age did not significantly influence the uptake of digital prosthodontic services ($p > 0.05$). However, the disparity between urban and rural participants remained statistically significant even after stratification, reinforcing the role of geographical and infrastructural accessibility as an effect modifier (Table 4).

Table 4. Stratification Analysis for Effect Modifiers

Variable	Category	Mean Age ± SD	Utilized Digital Prosthodontics n (%)	p-value
Gender	Male	43.1 ± 10.8	29 (34.5)	
	Female	42.3 ± 12.7	20 (30.3)	0.57
Age Group (years)	20–39	—	25 (36.8)	
	≥40	—	24 (28.9)	0.29
Residence	Urban	—	39 (40.6)	
	Rural	—	10 (18.5)	0.006

4. DISCUSSION

The present study found that higher education and greater monthly household income were significantly associated with utilization of digital prosthodontic treatments, while urban residence and employment status also favored uptake. These relationships were consistent with the broader pattern reported in reviews and empirical studies that described a socioeconomic gradient in adoption of digital dentistry: wealthier, better-educated patients and those treated in better-resourced urban centres tended to have greater access to CAD/CAM and other digital workflows. Several reviews and country/region studies attributed this pattern primarily to cost, infrastructure, and workforce distribution, arguing that digital equipment investment and running costs concentrate in private and urban clinics and thereby limit access for lower-income and rural populations.(9, 10)

Awareness in our sample was moderate (61.3%) but actual utilization was substantially lower (32.7%), and a large majority perceived digital prosthodontics as unaffordable. This gap between awareness and use paralleled findings from cross-sectional surveys in clinical and educational settings where knowledge or positive attitudes toward digital technologies did not automatically translate into patient access or routine clinical use, cost and availability were repeatedly named as the principal barriers. For example, a regional cross-sectional study in Kerala showed growing integration of 3D scanning and CAD/CAM in routine practice but noted limited penetration outside tertiary and private clinics; similarly, surveys of dentists and trainees highlighted that willingness to adopt often exceeded real uptake because of financial and logistical constraints. These reports supported our interpretation that awareness alone is an insufficient driver of access without concurrent reductions in price and expansion of infrastructure.(11, 12)

Income showed a steep gradient in our results: participants earning >PKR 100,000/month had markedly higher utilization than lower-income groups. This income effect has been observed in several settings and was emphasized in analyses of digitization in low- and middle-income countries (LMICs), which argued that patient ability to pay (out-of-pocket expenditure) and the private-sector orientation of digital services create affordability barriers for disadvantaged groups. Our finding therefore aligned with studies that suggested policy interventions (subsidies, insurance coverage, tiered pricing, or public investment in digital equipment) would be necessary to reduce income-related disparities.(10, 13)

Urban–rural disparity remained statistically significant after stratification in our data, indicating that geographic factors and local infrastructure strongly modified access. This echoed country-level and multicentre reports that showed higher rates of digital adoption in urban tertiary centres and private practices, while rural clinics lagged because of limited equipment, fewer trained staff, and weaker maintenance and supply chains. A study examining availability and perceptions of simulation and digital training among prosthodontic trainees in Pakistan similarly documented uneven access across training sites, reinforcing how workforce training and site resources influence patient access. Our results therefore supported the call for decentralization of digital capabilities and targeted capacity building in peripheral areas.(10, 14)

Education and employment were both associated with higher utilization in our cohort; this likely reflected multiple mechanisms: more educated patients had greater health literacy and were more likely to seek advanced options, while employed persons were more able to afford or prioritize esthetic/advanced care. Comparable associations between higher education or professional status and CAD/CAM acceptance were reported in practitioner- and patient-focused studies, which noted that education influenced patients' preferences and dentists' treatment recommendations. At the same time, some studies cautioned that clinician availability and clinic-level adoption often determined whether an informed and willing patient could actually receive digital care, highlighting that patient factors and system factors interact.(15, 16)

Gender and age were not significant determinants of utilization in our analysis, a pattern that several recent surveys also reported, where socioeconomic and structural variables outweighed demographic ones in predicting access to digital prosthodontics. However, a few practice-level studies have reported gender or age differences in attitudes among dentists or in specific procedures, suggesting that context and the particular technology under study can yield heterogeneous results; nonetheless, our nonsignificant findings aligned with the majority view that income, education, and geography are the dominant predictors.(12, 17)

The present study findings and the literature together pointed to several practical implications. First, increasing patient awareness must be paired with affordability strategies like insurance coverage, subsidized services to convert knowledge into equitable uptake. Second, investments in public clinics, mobile digital units, and training programs could reduce urban–rural gaps and extend access beyond tertiary centres. Third, promoting cost-efficient digital solutions like shared lab services, pooled procurement, low-cost scanners, and incentivizing public–private partnerships were recommended in multiple studies and were supported by our results as plausible ways to bridge the equity divide.

Limitations of our study mirrored those commonly acknowledged in the comparative literature: the single-centre, cross-sectional design limited causal inference and generalizability; nonprobability consecutive sampling could have introduced selection bias; and reliance on self-reported measures (awareness, perceived affordability) may have produced measurement bias. Several studies we reviewed used multi-centre samples or mixed-methods approaches (qualitative interviews with practitioners and patients) to unpack barriers in richer detail, a strategy that future research on this topic could adopt to validate and extend our findings.

The present study findings were largely consistent with the emerging literature; socioeconomic status, income, education, and urban residence were key determinants of access to digital prosthodontic treatments, while affordability and infrastructure constraints limited the translation of awareness into utilization. Addressing these structural barriers through policy, financing, and targeted capacity building was emphasized both by our data and by recent studies, and should be prioritized to ensure that the benefits of digital dentistry are distributed more equitably.

5. CONCLUSION

The current research demonstrates that the availability of progressive prosthodontic therapy with the aid of digital technologies in dentistry is greatly dependent on the socioeconomic inequalities, higher income, education, employment, and living in the city provide a high probability of being used. Affordability and infrastructural constraints in spite of increased

awareness are still considered to be significant barriers to large scale adoption especially among lower income and rural populations. These results highlight that the technology will not be able to guarantee equitable oral healthcare without specific socioeconomic measures. To bridge this gap, it is necessary to strengthen or reinforce the public-private collaboration, subsidize digital prosthodontics treatment, increase training in the peripheral centers, and introduce cheaper digital workflows. These socioeconomic determinants are the true targets that dentistry can use digital innovation to attain inclusive, patient-centered, and sustainable oral health outcomes in every individual.

REFERENCES

[1] Alaoffey AS, Asiri MA, Alhazmi TAA, Alshetaiwi AA, Almobarak AM, Alqasir YH, et al. Digital dentistry: transforming diagnosis and treatment planning through CAD/CAM and 3D printing. Egyptian Journal of Chemistry. 2024.

[2] Biswas P, Lahori M. DIGITAL DENTISTRY IN PROSTHODONTICS:" TRANSFORMING PRECISION AND EFFICIENCY IN RESTORATIVE DENTISTRY". Guident. 2024;17(6).

[3] Smith Z. From Analog to Digital: Transforming Traditional Prosthodontic Techniques with Digital Workflows. Journal of Dental Care. 2024;1(2):79-85.

[4] Joda T, Balmer M, Jung RE, Ioannidis A. Clinical use of digital applications for diagnostic and treatment planning in prosthodontics: A scoping review. Clinical Oral Implants Research. 2024;35(8):782-92.

[5] Smith M. The Relationship Between Income and Race With the Utilization of Oral Health Services Among Older Adults: Walden University; 2025.

[6] Taylor H, Holmes AM, Blackburn J. Prevalence of and factors associated with unmet dental need among the US adult population in 2016. Community dentistry and oral epidemiology. 2021;49(4):346-53.

[7] Sulashvili N, Lominadze K, Egnatievi I, Gabunia L, Gorgaslidze N, Alavidze N, et al. THE SCIENTIFIC DISCOURSE ON INNOVATIVE PERSPECTIVES REGARDING THE ROLE OF FAMILY DENTISTS IN PRIMARY DENTAL CARE AND PUBLIC HEALTH: CHALLENGES, EVIDENCE AND FUTURE DIRECTIONS GLOBALLY. Junior Researchers. 2025;3(5):105-40.

[8] Beaven A, Marshman Z. Barriers and facilitators to accessing oral healthcare for older people in the UK: a scoping review. British Dental Journal. 2024:1-7.

[9] Patil M, Kambale S, Patil A, Mujawar K. Digitalization in dentistry: CAD/CAM-a review. Acta Scientific Dental Sciences. 2018;2(1):12-6.

[10] Mikayelyan H. Digitization in Dentistry and Dental Implantology in Low-and Middle-Income Countries. Digitalization of Medicine in Low-and Middle-Income Countries: Paradigm Changes in Healthcare and Biomedical Research: Springer International Publishing Cham; 2024. p. 161-9.

[11] Usman J, Latha N, Saraswathy A, Thachanath HM. Integration of Three-Dimensional Scanning and Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) Technology in Routine Prosthodontic Practice: A Cross-Sectional Study in Kerala. Cureus. 2024;16(12).

[12] Al-Ibrahim IK, Alshammari FA, Alanazi SM, Madfa AA. The attitude of Saudi dentists towards CAD/CAM in Restorative Dentistry. The Open Dentistry Journal. 2023;17(1).

[13] Adnan S, Lal A, Naved N, Umer F. A bibliometric analysis of scientific literature in digital dentistry from low- and lower-middle income countries. BDJ open. 2024;10(1):38.

[14] Khalid T, Yaqoob H, Syed FA, Kazmi SMR. Assessing availability and trainees' perceptions of simulation and augmented reality in prosthodontics postgraduate education in Pakistan: a cross-sectional study. BMC Medical Education. 2024;24(1):1541.

[15] Ardila CM, González-Arroyave D. Efficacy of CAD/CAM technology in dental procedures performed by students: a systematic scoping review of randomized clinical trials. Heliyon. 2023;9(4).

[16] ELKHYATT YMA. Attitude, perception, and knowledge toward artificial intelligence among dental hygiene students and alumni: a cross-sectional based survey study: Manara-Qatar Research Repository; 2025.

[17] Tahani B, Manesh SS. Knowledge, attitude and practice of dentists toward providing care to the geriatric patients. BMC geriatrics. 2021;21(1):399.

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