



# Influence of Practice Characteristics on the Adoption of Electronic Dental Records in Jeddah, Saudi Arabia

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**Objectives:** The adoption of electronic dental records (EDRs) is less extensively studied than electronic medical records (EMRs) in Saudi Arabia. Therefore, a multivariate analysis was conducted to calculate the adoption of EDRs and determine the practice characteristics that influence adoption. **Methods:** An online survey was conducted with 220 dental practices in Jeddah from August to December 2021. The questionnaire contained 10 items that measured the adoption of EDRs and identified the region, district, practice characteristics, and practice size. A regression analysis was used to ascertain the relationships between EDR adoption and the predictor variables. **Results:** About 93% of the dental practices, we surveyed in Jeddah had adopted EDRs. Public dental practices and large practices were associated with higher rates of adoption (respectively, 97.0%,  $p = 0.016$ ; 97.8%,  $p = 0.009$ ). The logistic regression model showed statistically significant results regarding practice characteristics, practice size, and the acceptance of insurance patients. EDR adoption was 89% less likely for private dental practices, 99% less likely for smaller dental practices ( $\geq 2$  dentists), and 98% less likely in dental practices that did not treat patients with insurance. **Conclusions:** Our study sample showed a high rate of EDR adoption. Among the participants, public practices, large practices, and practices that treat patients with insurance were the most positively inclined toward EDR adoption.

**Keywords:** Dental Informatics, Medical Informatics, Electronic Health Records, Telemedicine, Saudi Arabia

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## 1. Introduction

The National Alliance for Health Information Technology (NAHIT) defined an electronic health record (EHR) as “the aggregate electronic record of health-related information on an individual that is created and gathered cumulatively across more than one healthcare organization and is managed and consulted by licensed clinicians and staff involved in the individual’s health and care” [1]. EHRs are known by several synonyms in the literature, such as electronic medical records (EMRs) and computer-based patient records [2]. Among these, EMR is most often used synonymously; how-

ever, NAHIT recognized the difference and defined an EMR as “the electronic record of health-related information on an individual that is created, gathered, managed, and consulted by licensed clinicians and staff from a single organization who are involved in the individual’s health and care” [1].

When designed for dental practices, an EHR is called an electronic dental record (EDR) [3] or electronic oral health record (EOHR) and is used “with a greater focus in oral and maxillofacial region with the ability to store, manage the patient details, and follow the progress of treatment in dental care” [4,5]. The EDR concept includes the electronic dental record application, imaging, prescription management, appointment schedule, and so forth [4]. Hence, EDRs can be considered a dental information technology (DIT) tool that serves the purpose of EHRs in dental practice context [5].

An EHR is a form of health information system or health information technology (HIT) that supports comprehensive and efficient healthcare management by integrating healthcare information and communication technology (ICT) that improves hospital efficiency and the quality of patient care [6]. An integrated medical-dental record (IMDR) allows both medical and dental healthcare providers to view full patient information, which supports well-informed care and treatment planning. Not only does it allow comprehensive analysis of patient data, but the data may also be used for quality-improvement processes and population health. An IMDR enables coordination of the scheduling and billing of patient visits at the national level, and cross-border patient information sharing is possible, as demonstrated by several EU member states [7]. Studies have reported that patient data in dental school EDRs not only facilitates high-quality patient care, it also improves students’ professionalism and is a rich source of research data [8]. Policy-makers in developed countries have recommended the adoption of EHRs, which has led to the implementation of such initiatives as Health Information Technology for Economic and Clinical Health (USA), Smart Open Services (EU), and the Community eHealth Action Plan (EU) as a recommendation for cross-border interoperability [7].

Consequent to major progress in the healthcare infrastructure of the Kingdom of Saudi Arabia (SA), EHR adoption was undertaken to improve the quality of its citizens’ healthcare. A task team was formed in 2002 to build a national EHR program. To strengthen ICT in the healthcare sector, King Saud bin Abdul Aziz University for Health Sciences was founded in 2004. In 2005, the Saudi Association for Health Informatics was established to facilitate the implementation of health informatics training and education

across SA [9]. In 2010, the SA Ministry of Health (MOH), inspired by the Vision 2030 plan, launched several initiatives to enhance citizens’ care outcomes, decrease medication errors, boost healthcare efficiency, and reduce unnecessary costs. One such initiative is the national eHealth strategy [10]. As part of this strategy, the MOH developed a “digital health journey” framework, which is intended to measure the digital capabilities of SA [11]. Although progress has been impeded, the MOH recognizes the importance of adopting an information system that will ultimately link all hospitals within SA [12]. In early 2011, the MOH launched the 2010–2020 national eHealth strategy roadmap in two 5-year phases [10,11], which led to the implementation of a medical records improvement program, a referral system (Ehalty), a unified portal of health services, a health electronic surveillance network, a poison control system (Awatar), a neonatal protection system, a registration system for hospitals’ serious incidents, and a premarital screening system [10]. Standards for manual and electronic medical records and patient information management were developed by the Central Board for Accreditation of Healthcare Institutions (CBAHI), a national accrediting authority in SA [13].

The prioritization of eHealth development and ICT implementation by the MOH made the transition from paper-based health records to EHRs imminent to achieve the mission of “a safe quality healthcare system based on patient-centric care guided by standards, enabled by eHealth.” The MOH’s national efforts towards eHealth initiatives have played an important role in how HIT use has developed, and EHR adoption has gained tremendous momentum in SA during the last decade. Among the diverse eHealth applications, EMRs have been increasingly adopted by SA organizations [14]. Despite the prioritization of eHealth and efforts over recent decades to encourage EHR adoption, EHR adoption in SA has encountered a variety of challenges to organizational and technical implementation [15,16], and paper-based medical record systems are still widely used in the healthcare industry. Whereas studies have reported an EHR adoption rate of 81% by US hospitals [17], only 50% of hospitals in Riyadh had fully functioning EHR systems; 36% had EHR systems in the development stage, and 14% were still using paper-based records [14]. Though EHR is considered a significant HIT innovation with substantial improvements in the effectiveness and efficiency of healthcare delivery, the EHR adoption rate still remains slow in many countries, as is evident from the few studies reporting the adoption rates of EHR at the national level not only in SA, but also globally [18]. Published research also discusses oth-

er aspects of EHRs in medical practice [19]. Furthermore, dental practitioners and researchers agree that DIT adoption in dental practices has been sluggish compared to the medical field, and the adoption of EDRs in dental office settings has received relatively little attention in studies, with insufficient research focusing on aspects that may contribute to adoption [5,20,21]. Because there have been no clear studies in SA that provide credible estimates of adoption by dentists, this study aimed to record the EDR adoption rate in dental offices in Jeddah and to investigate the organizational and environmental aspects related to adoption.

## II. Methods

### 1. Study Design and Sample

We designed a cross-sectional analytical study that used a sample of 220 subjects, calculated using G\*Power with  $\alpha = 0.05$ ,  $\beta = 0.95$ , an effect size of 0.3, and 5 degrees of freedom. We targeted dental practice offices within the city of Jeddah, not individual dentists, since our study question is related to EDR adoption at the practice level. We collected one response per practice from anyone in that office (dentists, dental assistants, and hygienists) who could answer the study questions knowledgeably. We considered any knowledgeable individual representing the practice as eligible to participate because other recent cross-sectional studies have suggested that dental office personnel, rather than dentists, are the key users of DIT, from scheduling appointments to entering treatment and prescription data [22]. We included all licensed dental practice offices in city of Jeddah with a representative who voluntarily consented to participate in the study, and excluded unlicensed dental offices and dental professionals.

### 2. Survey Design

A pretested and validated questionnaire was adapted to suit the current study requirement. The adapted questionnaire was pilot-tested on a total of 25 dental offices, five from each of the five regions (north, south, east, west, and central) of the proposed study area. The feedback from the pilot test led to additional modifications to suit our study. The final study questionnaire was estimated to take 3 to 5 minutes to answer and was divided into two sections. Section 1 contained an opening statement regarding the study and the consent to participate, followed by questions relating to the participant's demographic features (Supplementary Table S1). Section 2 contained 10 questions related to the adoption of EHR in the dental practice. The questionnaire was distributed elec-

tronically as a Google Form to dental practices in Jeddah after formal approval from an Institutional Research Review Board of Ibn Sina National College for Medical Studies (No. H-20-19102021). We redistributed the questionnaire several times to practices that had not responded initially until we reached the minimum sample size calculated.

### 3. Outcomes Measured

The study's independent variables were region, district, and dental practice characteristics, namely practice type, practice size, and whether the practice accepted patients with insurance. Previous medical and dental studies have indicated that these factors were associated with adoption [5]. The region and district were determined from the practice's geographical location in the north, south, east, west, or central part of Jeddah. The practice type was divided into two sub-categories: general or specialty practice and private or public (government) practice. Practice specialties were based upon the guidance of the Saudi Commission for Health Specialties: oral medicine, oral radiology, oral surgery, oral and maxillofacial surgery, removable and fixed prosthodontist, conservative dentist and endodontist, orthodontist, pediatric dentist, and implant dentist. Practice size had two sub-categories: size 1 indicated the number of practicing dentists at the office (1 dentist or  $\geq 2$  dentists), and size 2 indicated the number of patients visiting the dental office per day (small, up to 50/day, or large,  $\geq 50$ /day).

Dependent variables included the EHR, EMR, or EDR as described earlier. Since our study did not aim to differentiate between EHR and EMR, we used these terms interchangeably to refer to EDRs, which are defined as DIT programs that can store and archive patient-related data electronically, ranging from practice management systems with clinical tools to fully certified EHRs [5]. We included any type of IT-based product that could be categorized as an EDR.

### 4. Statistical Analysis

While descriptive statistics was used to calculate the numbers and percentages of the study sample. Chi-square test was used to infer the associations between adoption and practice characteristics and binomial logistic regression analysis was used to ascertain the relationships between adoption and predictor characteristics. The results were reported as odds ratios (OR).

### III. Results

#### 1. Descriptive Statistics

We received 221 responses from the 273 dental practices that we surveyed, at a response rate of 81%. Table 1 shows the participating dental practices' regional location, type, and size. The sample's distribution was nearly uniform across the regions of Jeddah, which consists of 137 districts. A majority of dental practices surveyed were general practices, and most practices were managed by  $\geq 2$  dentists.

#### 2. Inferential Statistics

Adoption rates and environmental factors influencing the adoption are the following.

Table 2 shows the adoption rates and the association of practice characteristics with EDR adoption. Approximately 93% of the clinics surveyed had adopted EDRs. Though adoption rates were nearly the same among different geographic locations of the city, the northern districts of the city showed the highest adoption rate, while the practices of southern districts had the least adoption; however, no statistically significant association was found between geographic location and adoption rate ( $p = 0.712$ ). Public dental practices had a higher adoption rate compared to private practices ( $p = 0.016$ ), as did large dental practices compared to small ones ( $p = 0.009$ ).

Binomial logistic regression analysis of predictor variables, shown in Table 3, showed that multiple variables had statisti-

cally significant relationships with the likelihood of adopting an EDR. Public dental practices (adjusted OR = 10.870,  $p = 0.002$ ), large practices (adjusted OR = 1.722,  $p = 0.011$ ) and practices treating insurance patients (adjusted OR = 0.121,  $p = 0.002$ ) were more likely to adopt an EDR. In contrast, the practice's geographic location did not influence EDR adoption.

### IV. Discussion

This study explored the rate of EDR adoption by dental clinics and the organizational factors associated with its adoption. We investigated the relationships between the adoption of an EDR as a DIT tool and region, practice size, and practice type [5]. Our study attempted to identify the practice characteristics that predict EDR adoption; because the concept of EHRs is relatively new in SA [14,23] our findings could add valuable insights into developing effective strate-

**Table 2. Associations between EDR adoption and dental characteristics**

Variable	EDR adoption		<i>p</i> -value
	Yes (n = 204)	No (n = 17)	
Practice type 1			0.692
General	122 (91.7)	11 (8.3)	
Specialty	82 (93.2)	6 (6.8)	
Practice type 2			0.016*
Public	98 (97.0)	3 (3.0)	
Private	106 (88.3)	14 (11.7)	
Location of practice			0.712
North	48 (97.96)	1 (2.04)	
South	35 (89.74)	4 (10.26)	
East	41 (95.34)	2 (4.66)	
West	43 (93.47)	3 (6.53)	
Central	41 (93.18)	3 (6.82)	
Practice size 1			0.570
1 Dentist	16 (88.9)	2 (11.1)	
$\geq 2$ Dentists	188 (92.6)	15 (7.4)	
Practice size 2			0.009*
Small (up to 50/day)	114 (88.4)	15 (11.6)	
Large ( $\geq 50$ /day)	90 (97.8)	2 (2.2)	
Patients with insurance	153 (93.3)	10 (6.1)	0.145
Overall adoption (%)	93	7	

Values are presented as number (%).

EDR: electronic dental record.

\* $p \leq 0.05$ .

**Table 1. Descriptive statistics of participants**

Variable	n (%)
Geographical location (region)	
North Jeddah	49 (22.17)
South Jeddah	39 (17.64)
East Jeddah	43 (19.45)
West Jeddah	46 (20.81)
Central Jeddah	44 (19.90)
Overall sample	221 (100)
Practice type	
General	133 (60.18)
Specialty	88 (39.81)
Overall sample	221 (100)
Practice size	
1 Dentist	18 (8.14)
$\geq 2$ Dentists	203 (91.85)
Overall sample	221 (100)

Table 3. Logistic regression of EDR adoption

Variable	OR (95% CI)	p-value
Practice type 1 (specialty)	0.523 (0.166–1.648)	0.268
Practice type 2 (public)	10.870 (2.371–49.832)	0.002*
Location of practice (North Jeddah)	0.423 (0.155–1.811)	0.298
Practice size 1 ( $\geq 2$ dentists)	1.722 (0.296–10.026)	0.545
Practice size 2 large ( $\geq 50$ /day)	0.011 (1.631–41.869)	0.011*
Patients with insurance	0.121 (0.031–0.465)	0.002*
Pseudo-R <sup>2</sup>	0.115	
Number of observations	221	

Values are presented as number (%).

EDR: electronic dental record.

\* $p \leq 0.05$ .

gies to encourage healthcare providers to adopt EDRs.

Based on earlier studies, we hypothesized that EDR adoption, region, practice size, and practice type would be associated [5]. Not only did our study reveal a high rate of EDR adoption among the dental practices we surveyed, but we also discovered that adoption rates in different regions of Jeddah were comparable, thus limiting the impact of region as a driving factor in EDR adoption decisions. Our findings are similar to those of other studies [5], that is, contrary to a study originating from the Gulf Cooperation Council (GCC), which reported that technical, social, managerial, and financial barriers inhibited EHR implementation and development [24] and a study of SA that reported low eHealth adoption rates nationally and described cultural, bureaucratic, and human resource issues as barriers to SA eHealth implementation [25]. This does not seem to be the case in our study, since we found a high rate (93%) of EDR/EHR adoption, which is consistent with other reported studies both within and outside SA [5,19,20]. This outcome could be attributed to the unbiased implementation of MOH regulations across the board with regard to patient data records and CBAHI's requirement that institutional healthcare providers obtain accreditation [13].

Dental specialty-related workflow and information needs are said to drive the adoption of EDR [26]. This was not established in our study, and unlike other studies, ours did not find a statistically significant difference in EDR adoption between general and specialty practices [5,26]. We also found that large practices were more likely to adopt EDRs, an important predictor consistently found in earlier EDR/EHR adoption studies [21,27]. Additionally, we found that dental practices receiving patients with insurance coverage were more likely to adopt EDRs. These findings are in line

with other published studies [5,27].

The odds of EDR adoption rate varied for three among the six dental practice predictors, namely public versus private, practice size regarding the number of patients seen per day, and whether the practice received patients with insurance. Other dental practice variables, namely general versus specialty practice and practice size regarding number of dentists, showed comparable odds. Public dental practices were more likely to adopt EDR was a significant finding in our study, consistent with other studies on EHR adoption in SA. This may be attributed to inherent characteristics of public dental practices, such as funding, management policies, and the IT landscape, which may constrain their ability to adopt EDRs [5].

The dental practices we surveyed used widely varied types of EDRs (not reported explicitly due to being out of scope). While some were capable of recording patients' medical and dental information interoperably, others could record dental components only. These findings are consistent with other studies [5,12]. Both the oral and general health of an individual are vital components of optimum health. Therefore, EDR-EMR integration (IMDR) at the national level is important, because a DIT tool should be able to integrate with the HIT ecosystem to effectively implement eHealth in SA [28]. The potential of IMDR in SA extends beyond holistic care of patients within SA to cross-border data sharing with other GCC countries, similar to the European Commission initiative [7].

Our study's findings indicate a high level of EDR adoption in the sample surveyed. Practice characteristics such as being public, being large, and receiving patients with insurance coverage have positively influenced EDR adoption among the participants. Based on our study findings, we deduce



that the support of the MOH of SA and the mandatory EHR requirement by CBAHI have laid the foundation for the adoption of EHR/EDR systems by dental offices in Jeddah. However, because we studied only one city in SA, the results cannot be extrapolated to the entire Kingdom. We did not include educational institutions, though it may not impact our findings, since the number of educational institutions in the city of Jeddah is minimal compared to the number of dental practices we surveyed. Neither did we ascertain whether the EDRs currently in use were capable of communicating with EHRs and being integrated nationally, nor did we explore barriers such as IT readiness and availability of trained personnel. These shortcomings do not play a significant role in our findings because the high rate of adoption we observed suggests that the aforementioned barriers have been overcome by our study's participants.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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## Supplementary Materials

Supplementary materials can be found via <https://doi.org/10.4258/hir.2023.29.3.239>.

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