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Review Article

Investigating Medical and Dental Students' Opinions about the Legibility of Their Handwriting

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Abstract

Objectives: To investigate early medical students' opinions regarding their handwriting illegibility and the possible factors causing it to be illegible. **Methods:** A survey was prepared to collect perceptions regarding handwriting illegibility from the study sample 26.2% (N=489) representing (N=1863) male and female 2nd-year medical and dental students at King Abdulaziz University, Jeddah, KSA during the academic years 2017- 2018, 2018-2019, and 2019-2020. **Results:** Medical students agree more than dental students with handwriting training and awareness do campaigns (P=0.011 and 0.001 respectively). Moreover, males are happier with their handwriting legibility compared to females (P <0.001). Additionally, males underwent more handwriting training programs and agreed more with handwringing training courses compared to females (P=0.015 and P=0.024 respectively). Interestingly, medical students agree more that students' handwriting gets worse when their study advances compared to dental students (P=0.005). On the other hand, male students agree more that rapid computerization and carelessness are the factors contributing to handwriting illegibility compared to females (P=0.003 and 0.002 respectively). However, females agree more than males that lecture notetaking is the factor responsible for handwriting illegibility (P=0.002). Strikingly, Medical students agree more than dental students' illegible handwriting contributes to errors in medical prescriptions, doses, diagnostic and procedural medical terms, patient information, and clinical instructions (P value ranged from 0.02 to less than 0.001). **Conclusions:** The current study highlights the medical and dental students' awareness of the factors which cause their handwriting to be illegible, and that illegible handwriting contributes to errors in healthcare services.

Keywords: Handwriting illegibility; Doctors' handwriting; Handwriting training; Medical education

Background

Doctors' handwriting is the worst among health professionals [1]. Moreover, the illegibility of doctors' handwriting is the cause of most medication errors [1-3]. In detail, the illegibility of doctors' handwriting may affect the quality and safety of health care services causing harm to patients [4], lead to mal performance of nursing and other supporting staff members [3], and produce poor referral letters [1]. Furthermore, poor doctors' handwriting is certainly unhelpful in legal transactions [5].

Medical fields are still dealing with written instructions

It is not yet too late to discuss medical, medicinal, and medication errors caused by doctors' illegible handwriting according to [6], as there are more than 250,000 people die every year in the US due to medical errors which handwritten prescriptions are part of. Likewise, numerous studies investigated medical errors from the viewpoint of poor handwriting of prescriptions such as [2-,4,7,8].

Interestingly, Hsu et al. (2015) [9] reported the increasing dependence of clinical care on computerization claiming that studies have not addressed its adverse effect on physicians' handwriting. They assessed the legibility, accuracy, and completeness of handwritten prescriptions taking advantage of a system crash at a large hospital. Their study found that none of the 1418 prescriptions had all necessary fields filled out where age and dosage details were frequently omitted. Other observations included a small frequency of illegibility and inaccuracies of drug name 11.4%, dose 13.6%, and strength 19.5%.

Literature Review

Lyons et al. [1] used computer technology in a Welsh health district to objectively compare and assess the handwriting of three groups: doctors, nurses and other medical professionals, and administrative staff. They collected a unified form filled by hand by the three mentioned groups, scanned it, analyzed it with computer software, and generated median legibility error scores for the participants. Ultimately, the study found that although doctors were asked to be as neat as possible, their handwriting was the worst among the other professions suggesting that the legibility of doctors' handwriting is remarkably poor. Surprisingly, the study stated that the legibility of doctors' handwriting was restricted to letters rather than numbers, suggesting that they might attach more importance to the legibility of doses.

Consequently, there is a general consensus on the doctors' habit of illegibility. Therefore, individuals, groups, and institutions strive to help others attain self-awareness and synthesize their mind and body to function smoothly as one unit [10] and perform

the sort of writing output that reaches excellent performance rates [2]. In that sense, the illegible handwriting of doctors is considered a finable offence in six American states [11]. Similarly, the court in India also directed doctors to write legibly [5]. [11] Went on thinking aloud and giving suggestions to enhance doctors' handwriting by calling families, schools, and higher education institutions to pay more attention, take poor handwriting seriously, and pose penalties for careless handwriting.

[12] Nevertheless, thinks that the problem begins in the very early stages of the educational system, as although students' handwriting tends to be poor or illegible, they are not making any efforts to be neat. Strikingly, [3] explores an inclination of literature that rejects a great deal of the intimidations of illegibility of doctors' handwriting and proposes a considerable number of justifications. [13] For example, assumes that doctors' handwriting has worsened after writing so much throughout their college years or in their very busy medical environment. [11] Similarly, state that doctors may plan to maintain the secrecy of their prescription contents, appear as not sure about the correct spelling of medicines, and leave it to nurses and pharmacists to decipher illegible words that seem to work as a mutual coding system between doctors and pharmacists.

[10] Names the hints that writers unintendedly leave behind to determine their characteristics and reveal their strengths and weaknesses "Beyond the conscious information contained in the written words, the handwriting also divulges information about you and how you felt unconsciously as you wrote." [14], however, rejects all the attempts that were dominant less than a century ago to equate the mere analysis of handwriting with fortune telling, horoscopes, or pseudoscience. Instead, she calls for understanding handwriting analysis as an invaluable psychological tool that is supported by scientific evidence. Moreover, she states that handwriting analysis as a science dates back to Nero's age when its first book ever was published in 1555 before it reaches its peak in the current century.

In an attempt to analyze first-year medical students' handwriting and label their types of errors, [15] assigned (N=134) medical students from Mahidol University's four medical schools to write an English paragraph on medical ethics guided by three reading passages. For evaluating students' work, they utilized a ten-criterion rubric. Interestingly, most students had errors with a high percentage of eight items out of the ten criteria. The ten criteria were as follows: inability to perform the assigned task because of not understanding the question, no introduction, no conclusion, no main ideas, no topic sentences, and no development of main ideas, no organization, errors in sentence usage and/or structure, no transitional words, and incoherence.

With findings such as that handwriting of doctors from different specializations looks similar, doctors should sidestep

abbreviations to prevent confusion, and that pharmacists are considered the most likely to decipher prescriptions correctly; Cerio et al. [2] conducted a study to evaluate how legible doctors' handwriting is, in the private and public hospitals of Quezon, Philippines. The study collected prescriptions and divided their contents as texts, medicine names, abbreviations, and numbers.

Correspondingly, Mandal et al. [8] went in the same direction of research investigating (N=120) private practitioners' handwritten prescriptions for legibility and accuracy. In light of that, there were no spelling mistakes in medicine names and only 6.6% of the prescriptions were illegible or legible with effort. Ultimately, the study concluded from its survey that private practitioners have the habit of neither maintaining the standard nor ensuring the adequate quality of prescribing. They, however, orient themselves to the situation depending on two significant factors that confuse and affect prescription accuracy: omission of leading zero and use of archaic terms.

Likewise, (Albarrak et al., [4]) assessed and compared the completeness and legibility of (N=199) handwritten and (N=199) electronic prescriptions from different departments in King Khalid University Hospital, Riyadh, Saudi Arabia. The handwritten prescriptions were assessed by two pharmacists using a checklist made according to the design of the hospital. Findings of the study on prescription incompleteness and medication errors on both setups of prescription (handwritten and electronic) support that omitted or incomplete e-information and poor handwriting lead to numerous errors to be in agreement with previous studies such as (Brennan et al., [16] and (Barker et al., [17].

Similarly, Van Drempt et al. [7] assumed that the handwriting performance of healthy adults is influenced by factors that should be unveiled through a review of the literature up to 2010. Interestingly, they concluded that young adults write faster and more legibly compared to older ones, women's writing is faster and more legible than men's, and that nontraditional pen grips can consume an acceptable time to produce legible texts. Additionally, the study found that pen pressure varies across a page of text with a different speed, text size, words, and letters. Furthermore, mixed writing style and error corrections occurred in the samples.

Van Drempt et al. [7] emphasized the importance of assessment accuracy of handwriting performance as an essential factor in evaluating performance and outcomes and developing appropriate remedial programs. Nevertheless, they argued that research to update information about the advancements in the assessment and retaining programs or to guide practice is still limited and that there is not enough to know about unimpaired adults' handwriting to suggest benchmarks for therapists.

Al-Johany et al. [18] as well conducted a study on 2nd-year dental students at the College of Dentistry of King Saud University (N = 71) using a three-part test: a handwritten answer to a question composed of four lines, drawing a picture, and preparing a plastic molar tooth from an amalgam. Interestingly, their results showed a significant correlation between the three parts of the test p<0.001.

It has referentially been found that junior doctors make more errors as compared to other prescribers according to Leape et al. [19] and later to Classen et al. [20]. This fact appears as a remarkable point to be considered in our study because it deals with a similar community - male and female second-year medical and dental students.

Objectives/Aims

The current study aims at addressing the following questions:

1.	To what extent are medical and dental students aware of the errors caused by illegible handwriting?

2.	What are the factors leading to illegible handwriting from the students' point of view?

3.	To what extent do medical and dental students agree to undergo handwriting training?

4.	To what extent are medical and dental students aware of the contribution of illegible handwriting to errors in patient health care?

Methodology

Study Design and Settings

This is a cross-sectional study held at King Abdulaziz University in Jeddah, Saudi Arabia to investigate 2nd-year medical and dental students' opinions regarding the importance of neat handwriting in the current healthcare settings. The study considers the ongoing development in computerization and automation of medical services and other factors that may negatively affect the features of students' handwriting.

Survey

The survey used in the current study was specially developed by its authors in an online form to investigate the 2nd-year medical and dental students' opinions about the characteristics of their handwriting. The items of the survey (22 items) varied between Likert scale items (14), Yes/No items (3), and MCQs (5).

The domains of the survey include the characteristics and demographic data of the sample, their willingness to receive handwriting remedial training, their perceptions regarding the factors contributing to handwriting illegibility, and their perceptions regarding the contribution of illegible handwriting to medical errors.

Ethics and consent

The study was approved by the Unit of Biomedical Ethics of the Faculty of Medicine, King Abdulaziz University, KSA (Reference No. 700-20). The study was also approved by the Research Ethics Committee, Faculty of Dentistry, King Abdulaziz University (Proposal No. 170-12-20). The purpose of the study was mentioned at the beginning of the survey.

Subjects

The samples of this study were collected after the 2nd-year male and female students got the hang of their medical studies at the medical and dental colleges of KAU during the academic years 2017/2018, 2018/2019, and 2019/2020. It is worth mentioning here that medical and dental students at KAU normally begin their medical studies with basic medical sciences after a complete preparatory year so far.

Inclusion criteria:

The participation in the questionnaire of this study was based on that the participant must be a 2nd-year medical or dental male or female student studying at the Faculty of Medicine or Dentistry of King Abdulaziz University during the academic years 2017/2018, 2018/2019, and 2019/2020.

Exclusion Criteria:

All survey questions were required, and no links were sent to individuals in disagreement with the inclusion criteria so there were no invalid responses received.

Sample Size

Snowball sampling - a non-probability sampling technique - was used to hire the most possible proportion of the medical and dental students' population as a sample for the study. All the responses of the students who met the inclusive criteria were accepted to represent the three-batch population of the study.

Data Collection

This study used the website: https://app.surveyplanet.com/ as an online tool for the spreading of the questionnaires through common social media (WhatsApp, Telegram, etc.) as well as the preparation, collection, and export of the sample's data. Another paper-based version of the survey was used to collect data from the students who do not prefer the electronic form. Data collectors were the leaders of each batch during the academic years 2017/2018, 2018/2019, and 2019/2020 for both medical and dental male and female students. It is to be mentioned here that participation in the present study was voluntary and no incentives were given to students to participate.

Data Analysis

The collected data was exported in Excel file format, prepared for statistical analysis using MS Excel, and analyzed using the IBM Statistical Packages of Social Sciences software (IBM SPSS Statistics v 22). The breakdown of population and sample data was done using Wondershare MindMaster software v 8.5.1. The statistical tests used for correlation examinations are specified in the Results section.

Results

Breakdown of Study Population and Sample

Figure 1 below illustrates the breakdown of our study population (N=1863) and sample (N=489). Our study population is composed of three 2nd-year medical and dental batches through the academic years 2017-2018, 2018-2019, and 2019-2022. As shown in (Figure 1), the respondents to the study survey made up 26.2% (N=489) distributed as 23.6% (N=153) of (N=649), 32.1% (N=220) of (N=686), and 22.0% (N=116) of (N=528) 2nd-year male and female medical and dental students in 2017-2018, 2018-2019, and 2019-2020, respectively.

Medical participants made up 62.6% (N=306) while dental participants formed 37.4% (N=183) of the total sample (N=489).

The gender characteristics of the study sample (N= 89) were summarized as 40.5% (N=198) male medical students, 22.1% (N=108) female medical students, 18.0% (N=88) male dental students, and 19.4% (N=95) female dental students.
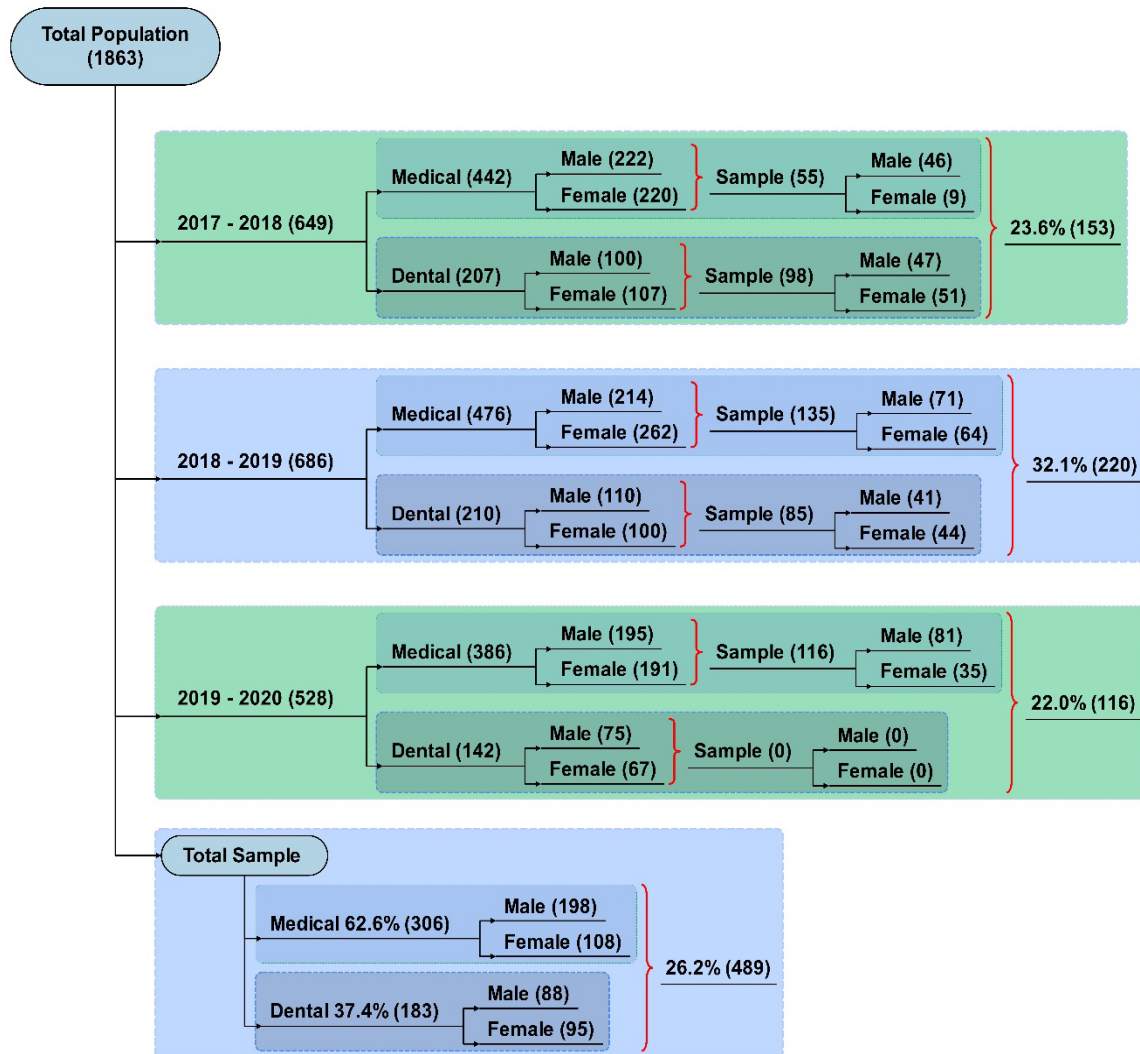
Figure 1: A concept map showing the breakdown of population and sample.

Table 1 shows the characteristics of the study sample where 56.6% (N=277) students come from public high schools, 27.8% (N=136) come from private schools, 7% (N=34) come from international schools, and 8.6% (N=42) come from other types of school such as a different Saudi school or a school in an Arab or a foreign country. Most students use their right hand in writing 91% (N=445) against 9% (N=44) left-handed students. Finally, in Table 1, the students with vision problems make up 44% (N=215).

VARIABLES		N (%)
HIGH SCHOOL	Public	56.6% (277)
	Private	27.8% (136)
	International	7% (34)
	Other	8.6% (42)
HAND DOMAIN	Right	91% (445)
	Left	9% (44)
VISION PROBLEM	Yes	44% (215)
	No	56% (274)

Table 1: Sample Characteristics.

Table 2 shows the distribution of the sample according to students' willingness to receive handwriting training and both their institution and gender. Medical students statistically significantly agreed more with handwriting training courses and awareness campaigns compared to dental students (P=0.011 and 0.001 respectively). Male students statistically significantly were happier with the legibility of their handwriting compared to females (P <0.001). In addition, male students statistically significantly tried more handwriting training programs and agreed more with handwriting training courses compared to female students (P=0.015 and 0.024 respectively).

Willingness to receive Handwriting Training	Institution	Mean ±Std. Deviation	P value	Gender	Mean ±Std. Deviation	P value
Handwriting Legibility	Medicine	2.13 ±1.005	0.712	Male	2.25±1.015	<0.001*
	Dentistry	2.09±0.998		Female	1.92±0.95	
Tried a handwriting training program	Medicine	1.87±0.341	0.935	Male	1.84±0.37	0.024*
	Dentistry	1.86±0.344		Female	1.91±0.29	
Agree with handwriting training courses	Medicine	2.68±1.284	0.011*	Male	2.67±1.32	0.015*
	Dentistry	2.99±1.313		Female	2.97±1.27	
Agree with handwriting awareness campaigns	Medicine	1.97±0.991	0.001*	Male	2.02±0.96	0.082
	Dentistry	2.30±1.119		Female	2.19±1.17	
Likert scale boundaries ranged from 1: strongly agreed or very good and 5: strongly disagreed or very bad. The level of significance is at 0.05.						

Table 2: Distribution of the sample according to their willingness to receive handwriting training and agreement to handwriting campaigns along with their gender and institution.

Table 3 shows students' perceptions regarding factors contributing to handwriting illegibility in relation to their institution and gender. Medical students statistically significantly agreed more that handwriting gets worse when students advance in their academic level compared to dental students (P=0.005). Male students statistically significantly agreed more that rapid computerization and carelessness were the factors contributing to handwriting illegibility compared to female students (P=0.003 and 0.002 respectively). On the other hand, females statistically significantly agreed more that lecture notetaking is the factor contributing to handwriting illegibility compared to male students (P=002).

Factors contributing to handwriting illegibility	Institution	Mean ±Std. Deviation	P value	Gender	Mean ±Std. Deviation	P value
Rapid computerization	Medicine	2.68±1.146	0.942	Male	2.55±1.08	0.003*
	Dentistry	2.67±1.075		Female	2.85±1.15	
Lecture notetaking	Medicine	1.75±0.88	0.416	Male	1.86±0.92	<0.001*
	Dentistry	1.68±0.89		Female	1.53±0.8	
No-time for handwriting enhancement	Medicine	2.19±1.128	0.290	Male	2.30±1.15	0.121
	Dentistry	2.30±1.196		Female	2.13±1.16	
English language standard	Medicine	3.31±1.17	0.711	Male	3.28±1.24	0.67
	Dentistry	3.27±1.17		Female	3.33±1.06	
Carelessness	Medicine	2.38±1.01	0.301	Male	2.29±1.01	0.002*
	Dentistry	2.48±1.06		Female	2.58±1.04	
Handwriting gets worse when students advance	Medicine	2.92±0.83	0.005*	Male	2.86±1.11	0.230
	Dentistry	2.64±1.33		Female	2.74±0.97	
Likert scale boundaries range from 1: strongly agree and 5: strongly disagree. The level of significance is at 0.05.						

Table 3: Students' perceptions regarding factors contributing to handwriting illegibility in relation to their institution and gender.

Table 4 shows the students' perceptions regarding the contribution of illegible handwriting to errors in patient health care in relation to their institution and gender. Medical students statistically significantly agreed more that illegible handwriting contributes to errors in medical prescriptions, doses, diagnostic and procedural medical terms, patients' information, and clinical instruction compared to dental students (P value ranged from 0.02 to less than 0.001).

Affected Procedures	Institution	Mean ±Std. Deviation	P value	Gender	Mean ±Std. Deviation	P value
Medical prescriptions	Medicine	1.65±0.9	<0.001*	Male	1.75±0.94	0.469
	Dentistry	1.99±1.1		Female	1.82±1.07	
Doses	Medicine	1.75±0.94	0.002*	Male	1.85±0.93	0.934
	Dentistry	2.03±1.04		Female	1.86±1.06	
Diagnostic and procedural medical terms	Medicine	1.85±0.88	<0.001*	Male	1.97±0.95	0.898
	Dentistry	2.17±1.08		Female	1.96±1.	
Patients' information	Medicine	2.02±0.98	0.02*	Male	2.17±1.03	0.075
	Dentistry	2.24±1.06		Female	2±1	
Clinical instruction	Medicine	1.94±0.88	0.001*	Male	2.04±0.92	0.729
	Dentistry	2.23±0.05		Female	2.07±1.01	

The Likert scale boundaries range from 1: strongly agree and 5: strongly disagree. The level of significance is at 0.05.

Table 4: Students' perceptions regarding the contribution of illegible handwriting to errors in patient health care and both their institution and gender.

Discussion

The issue of the illegibility of physicians' handwriting has been enormously addressed, arousing discussions from various points of view. Numerous studies were to be content with disclosing the fact that doctors' handwriting is poor or illegible. Nevertheless, the current study moves beyond this fact and addresses the problem from the onset of medical education aiming at accompanying future physicians earlier in exploring the factors to affect their handwriting, the desire to get their handwriting legible, and the problems possible to be caused when their handwriting gets illegible.

In the current study, it has been found that 215 (44%) of the sample have different vision problems, insofar as new studies could be suggested to address the prevalence issue. Similarly, R. Li et al. [21] studied computer vision syndrome (CVS) among school children during the COVID-19 pandemic. Their study defined (CVS) as symptoms related to the eye thanks to extra use and exposure to smartphones, computers, tablets, and other digital devices. Exposure to the devices of digital display nature has a relatively adverse effect on vision stability and functioning (Jaiswal et al., [22]; Mowatt et al., [23]; Qasim et al., [24]; Seresirikachorn et al., [25]. It has been reported by many studies that medical schools have integrated smartphones, tablets, and iPads into their learning environment (Pyörälä et al., [26].

Interestingly, the male participants in our study were more satisfied with their handwriting legibility than the females. Previous studies tried to guess the gender of participants from their handwriting features such as neatness [27] and other personality traits [28]. It appears as a hard job when thinking of a link between writing legibly and neatly and the gender of the writer according to [27]. They concluded that it was not useful to identify the gender of the writer based on the assumption that girls' handwriting is neat, and boys' handwriting is messy.

The findings of the current study show that medical students are more likely to welcome handwriting training and awareness campaigns than dental students. Medical students are aware of the importance of written communication skills and that there is still more room for improvement according to Melvin et al. [29]. Our study comes in line with Melvin's work in suggesting suitable handwriting training for medical students to enhance their written communication skills. Consequently, medical students build their agreement with handwriting training on their statistically significant belief that handwriting worsens over time while advancing in their medical education. An assumption stated earlier [30] is that handwriting stability is a condition known as graphic maturity, which continues until the writer experiences some disturbing factors including the level of education.

Factors contributing to handwriting illegibility were controversial for the male and female participants of the current study. As males consider rapid computerization and carelessness contribute more than other factors to the eligibility of their handwriting. Females, on the other hand, think that lecture notetaking contributes more to the illegibility of their handwriting. Correspondingly, it has been reported by Pyörälä et al. [26] that notetaking with iPads was used frequently and constantly during study years.

The contribution of illegible handwriting to medical errors affecting patient safety has been proved by numerous studies (Sendlhofer et al., [31]. In the current study, medical students agree more than dental students that illegible handwriting contributes to errors in medical prescriptions, doses, diagnostic and procedural medical terms, patient information, and clinical instructions. Similarly, Hsu et al. [9] reported the failure of 114 physicians in writing a flawless prescription during a crash of a long-running computerized physician order entry system (CPOE system). Moreover, [32] reported a considerable number of prescriptions missing patient information and/or dose units, illegible prescriptions, or legible with difficulty.

[33] For high quality patient care is the direct result of high-quality medical education. In that sense, early observation and care for details bring consideration of satisfactory outcomes. Since 2nd-year medical and dental students are still foundation medical learners, attention to the quality of their handwriting is a value-added to quality medical education. Amar et al. [34] highlight the role of medical schools all over the world in the selection of the best medical candidates of numerous qualified applicants. They all target quality health care services.

Limitations

The present study has some limitations from our point of view. First, 489 respondents (26.2%) of 1863 male and female medical and dental students have only represented the relatively small sample size as the study population. Second, the study took place at KAU Medical and Dental faculties only, whereas the issue needs to be addressed in a wider manner. It could have included other KAU departments such as the Faculty of Pharmacy and the Faculty of Nursing and even other local universities.

Conclusion

The current study could be regarded as a wake-up call for future physicians and dentists to determine the extent to which their illegible handwriting can contribute to medical errors. In addition, the study reflects the students' awareness that despite the widespread use of computerization and digitization in the medical field, neat, legible, and flawless handwriting is necessary and needs to be preserved and developed.

The present study reveals the participants' awareness that illegible handwriting and failure to produce faultless medical prescriptions, doses, patient information, or clinical instruction may cluster around affecting the quality and safety of healthcare services.

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