The circadian preference to operate electively among surgeons: A cross-sectional study

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Abstract

Background: The circadian rhythm is unique to each individual. The time of the day when an individual is most productive is determined by several factors associated with circadian rhythm. Some evidence suggests that late-night surgeries are associated with a better prognosis and a lower rate of complications than those performed at other times of the day. However, the impact of surgeons’ preferred operating time on patients remains unclear. Objective: The present study is the first to examine at what time of the day surgeons prefer to operate. Methods: This cross-sectional, questionnaire-based study involved 15 items designed to interrogate surgeons’ preferred time of day to operate. The questionnaire was distributed electronically to the consultants of different surgical specialties after explaining the purpose of the study and obtaining their consent to participate. Results: A total of 226 surgeons participated in this study, of which 192 (85%) were men. Most (25.2%) consultants were general surgeons. The weekly workload for most (66.4%) surgeons was 41–60 h. The surgeons indicated their preference to operate in the early (11.9%) or late morning (71.2%), early (15.0%) and late (1.3%) afternoon, and evening (0.4%). The key determinant of their preference was the availability of hospital resources (36.3%). Men and women tended to prefer operating in the early morning and afternoon and late afternoon, respectively. Conclusions: In the present study, most surgeons preferred to operate between 8 am and 12 noon (late morning), and their preference was determined by the availability of hospital resources.

Keywords: Circadian rhythm, operating time, surgeons, survey

Introduction

A circadian rhythm is a natural process that controls the sleep-wake cycle in a human being and repeats with each rotation of Earth, approximately every 24 h. It is unique to each individual. The time of day when an individual is most alert and productive is determined by several factors associated with circadian rhythm.[1] These factors include the timing of social interactions (work schedules), exposure to light, temperature changes, exercise schedules, and eating and drinking patterns.[2] Previous studies have examined the impact of surgery time on patient outcomes. For instance, Zafar et al.[3] reported no difference in the mortality rates between daytime and nighttime trauma surgeries, on the other hand, some recent papers revealed that nighttime surgeries were associated with increased mortality.[4,5] Meanwhile, Lehmann et al.[6] have shown that a reduced number of sleeping hours the night before did not affect the performance of the surgeons participating in a study involving a virtual surgery.
simulator. Similar findings were reported by studies with fatigued and rested surgeons.\(^7\)

In a separate retrospective cohort study, among 330 cases of trauma intervention surgery, over half (53.15\%) of the surgeries were performed in the morning, while 73 (25.5\%) and 61 (21.3\%) surgeries were performed in the evening and late at night, respectively. However, surgeries performed late at night were associated with a rate of complications lower than those associated with surgeries performed in the morning or evening (1.6\% vs. 2.7\%).\(^9\) Meanwhile, the incidence of intraoperative complications arising from video-assisted thoracoscopic surgery for pulmonary resection was higher among the surgeons performed at nighttime than among those performed during the daytime.\(^9\)

A study of short-term outcomes after appendectomy to the time of surgery revealed that 38, 31, 18, and 13\% of these surgeries were performed in the afternoon, evening, morning, and at night, respectively. The patients who underwent surgery at night had slightly lower scores set by the American Society of Anesthesiologists and were more likely to be managed as emergency cases (98\%). The overall complication rate was 4.7\%, ranging from 3.5\% in the nighttime group to 5.0\% in the afternoon group.\(^9\)

A few previous studies have examined surgeons’ preferred time to operate. Chin-Quee et al.\(^1\) have shown that among the surgeons, surgical residents of varied specializations showed a greater tendency to choose morning shifts. Moreover, Yamaguchi et al.\(^2\) used questionnaires and urine sample analysis to assess the levels of stress among Japanese surgeons performing nighttime surgery, showing that surgery duration and the associated blood loss corresponded to increased stress levels among the surgeons. It has also shown a decrease in sleeping time during the night following a night shift and a decreased arousal in the morning and evening.

Although several studies have evaluated the outcomes of surgeries performed at different times of the day, no similar studies have examined the surgeons’ preferences for the timing of surgery. The current study is the first to evaluate surgeons’ preferred time of the day to operate as well as the factors that lead to such a choice for elective surgeries.

**Methods**

Study was initiated after obtaining approval from the institutional review board (IRB) at King Saud University Medical City (KSUMC). Ref. No. 21/0199/IRB. All the surgeons participated voluntarily and provided their informed consent to participate before completing the questionnaire. The study has been reported in line with the strengthening the reporting of cohort, cross-sectional and case-control studies in surgery (STROCSS) criteria.\(^3\)

**Study design and data collection**

This cross-sectional, questionnaire-based study was conducted between November 2020 and January 2021 to assess the surgeons’ preferences for the timing of the surgery. The questionnaire was delivered electronically to the surgeons of different surgical specializations after obtaining informed consent. Thirteen major hospitals participated in this study, allowing access to their surgical staff. Additionally, the questionnaires were distributed via social media. The authors handled all the queries regarding the questionnaires. All surgical consultants working in Saudi Arabia were eligible for this study, regardless of their place of employment.

**Study variables**

The questionnaire included 15 items and was prepared using Google Forms. It consisted of three sections. The first section collected data on the demographic characteristics and training details; the second interrogated the preferred time to operate; the third examined factors that affected the surgeons’ preferred time of day to operate. The questionnaires were randomly distributed to the hospitals to minimize the risk of bias.

**Statistical analysis**

All data were categorical, and therefore, reported as frequencies and percentages. The Chi-square test was performed to assess the relationship between the surgeons’ demographic characteristics and operating time preference, and that between the surgeons’ operating time preference and the associated determinants. The analysis was performed at 95\% confidence intervals using the SPSS (version 25.0; IBM, Armonk, NY, USA).

**Results**

The details of the demographic characteristics of the surgeons participating in this study are shown in Table 1.

| Table 1: Participants’ demographic characteristics (n=226) |
|---------------------------------|----------|-----|
| Characteristics                  | Attributes | n  | %   |
| Age, years                       | 30-39     | 94  | 41.6|
|                                 | 40-50     | 89  | 39.4|
|                                 | 51-60     | 24  | 10.6|
|                                 | >60       | 19  | 8.4 |
| Gender                          | Male      | 192 | 85.0|
|                                 | Female    | 34  | 15.0|
| Nationality                     | Saudi     | 200 | 88.5|
|                                 | Non-Saudi | 26  | 11.5|
| Marital status                  | Married   | 208 | 92.0|
|                                 | Single    | 16  | 7.1 |
|                                 | Divorced  | 2   | 0.9 |
| Number of children              | 1         | 33  | 14.6|
|                                 | 2-3       | 112 | 49.6|
|                                 | >3        | 61  | 27.0|
|                                 | N/A       | 20  | 8.8 |
| Diagnoses                       | Hypertension | 25 | 11.1|
|                                 | Hyperlipidemia | 9 | 4.0 |
|                                 | Diabetes  | 4   | 1.8 |
|                                 | Other     | 18  | 8.0 |
|                                 | N/A       | 170 | 75.2|
| Smoking status                  | Yes       | 72  | 31.9|
|                                 | No        | 141 | 62.4|
|                                 | Ex-smoker | 13  | 5.8 |
Most (25.2%) participants were general and plastic surgeons (24.8%) [Figure 1]. The maxillofacial surgeons accounted for the smallest proportion of the present sample (0.9%). Of the total, 48.7% of them were trained in Saudi Arabia and 31.9%, in Canada [Figure 2].

The survey questions and the corresponding answers given by the surgeons are shown in [Table 2].

Age \( (P = 0.004) \), nationality \( (P = 0.034) \), the number of children \( (P = .023) \), medical diagnoses \( (P = .011) \), and smoking status \( (P = .009) \) were factors significantly associated with the operative time preferences. Meanwhile, it was found that gender \( (P = .115) \) and marital status \( (P = .485) \) were not associated with the operative time preference. However, men tended to prefer operating in the early morning and early afternoon and women in the late afternoon. Overall, in the present study, the surgeons preferred early and late morning hours for surgery [Table 3].

The key determinant of the operating time preferences for early and late mornings was the availability of hospital resources (44.4 and 36.6%, respectively). Meanwhile, the key determinants of the operating time preferences for early and late afternoon were personal (61.8%) and social (66.7%) factors. Finally, patient-related factors determined the preference for operating in the evening (100%; \( P < .001 \)) [Table 4].

**Discussion**

The previous studies investigated the surgical outcomes based on the time of the day when the surgery was performed.\[^{8,10}\]

![Figure 1: Surgical specialties included in the present study.](image1.png)

![Figure 2: Countries in which the participating surgeons received their training.](image2.png)

### Table 2: Survey questions and surgeons’ answers

| Questions                                                                 | Answers                      | N   | %  |
|---------------------------------------------------------------------------|------------------------------|-----|----|
| How long have you been practicing since completing training (years)?      | <5                           | 81  | 35.8|
|                                                                            | 6-10                         | 62  | 27.4|
|                                                                            | 11-20                        | 49  | 21.7|
|                                                                            | >20                          | 34  | 15.0|
| What type of sector do you work for?                                      | Government                   | 55  | 24.3|
|                                                                            | Private                      | 35  | 15.5|
|                                                                            | Private and government       | 136 | 60.2|
| How long is your working week (hours)?                                   | <40 h                        | 28  | 12.4|
|                                                                            | 41-60 h                      | 150 | 66.4|
|                                                                            | >60                          | 48  | 21.2|
| How many surgeries do you perform per week?                              | 1-2 weekly                   | 49  | 21.7|
|                                                                            | 3-5 weekly                   | 91  | 40.3|
|                                                                            | ≥6 weekly                    | 86  | 38.1|
| At what time do you prefer to perform surgery?                            | Early morning (5-8 am)       | 27  | 11.9|
|                                                                            | Late morning (8 am-12 pm)    | 161 | 71.2|
|                                                                            | Early afternoon (12-3 pm)    | 34  | 15.0|
|                                                                            | Late afternoon (3-6 pm)      | 3   | 1.3 |
|                                                                            | Evening (6-11:59 pm)         | 1   | 0.4 |
| What determines your choice of operative time for elective surgeries?     | Social factors (e.g., family)| 8   | 3.5 |
|                                                                            | Psychological factors (e.g., motivation and beliefs)| 33 | 14.6|
|                                                                            | Personal factors (e.g., demographics, lifestyle, traffic)| 76 | 33.6|
|                                                                            | Patient factors (e.g., patient preference, surgical equipment’s availability)| 27 | 11.9|
|                                                                            | Hospital schedule and resource availability| 82 | 36.3|
However, these studies disregarded the impact of the surgeons’ circadian rhythm, which may affect their alertness at certain times of the day, thus, affecting patient outcomes.

In the present study, most respondents declared a preference for operating in the late morning, with the availability of hospital resources being a significant determinant of this preference. Surgical scheduling is associated with high variability, which may be determined by the availability of hospital resources. The previous studies have examined the sources and impact of the operating time variability.\[14-16\] For example, Van Eijk et al.\[17\] have shown that the operative time variability may be associated with the surgeons’ age, workload, and experience. Considering these factors alongside the surgeons’ operative time preferences may improve the operative time use and overall surgeon satisfaction.

Some participants of the present study preferred to operate in the evening, which may have been due to the negative effects of night shifts on the surgeons.\[18,19\] Yamaguchi et al.\[12\] have shown that night shifts impaired sleep quantity and quality and decreased daytime arousal in the following days. In addition, sleep deprivation has been shown to have a detrimental effect on surgical performance.\[20,21\] Similarly, a 2021 study revealed that surgeons preserve focus better while working a 12-h shift rather than a 24-h shift.\[22\] Understanding the surgeons’ operating time preferences may help support their physical and mental health, thereby, improving patient outcomes.

### Table 3: Impact of surgeons’ demographic characteristics on their preferred time to operate

| Characteristics | Early morning (n=27) % | Late morning (n=161) % | Early afternoon (n=34) % | Late afternoon (n=3) % | Evening (n=1) % |
|-----------------|------------------------|------------------------|-------------------------|------------------------|----------------|
| Age, years      |                        |                        |                         |                        |                |
| 30-39           | 25.9                   | 39.1                   | 64.7                    | 33.3                   | 100.0         |
| 40-50           | 29.6                   | 45.3                   | 23.5                    | 0.0                    | 0.0            |
| 51-60           | 25.9                   | 9.3                    | 5.9                     | 0.0                    | 0.0            |
| >60             | 18.5                   | 6.2                    | 5.9                     | 66.7                   | 0.0            |
| Gender          |                        |                        |                         |                        |                |
| Male            | 92.6                   | 83.2                   | 91.2                    | 33.3                   | 100.0         |
| Female          | 7.4                    | 16.8                   | 8.8                     | 66.7                   | 0.0            |
| Nationality     |                        |                        |                         |                        |                |
| Saudi           | 88.9                   | 85.7                   | 100                     | 100                    | 100.0         |
| Non-Saudi       | 11.1                   | 14.3                   | 0.0                     | 0.0                    | 0.0            |
| Marital status  |                        |                        |                         |                        |                |
| Married         | 81.5                   | 94.4                   | 88.2                    | 100                    | 100.0         |
| Single          | 18.5                   | 5.0                    | 8.8                     | 0.0                    | 0.0            |
| Divorced        | 0.0                    | 0.6                    | 2.9                     | 0.0                    | 0.0            |
| Number of children |                |                        |                         |                        |                |
| 1               | 0.0                    | 16.8                   | 17.6                    | 0.0                    | 0.0            |
| 2-3             | 33.3                   | 52.2                   | 50.0                    | 33.3                   | 100.0         |
| >3              | 44.4                   | 24.8                   | 20.6                    | 66.7                   | 0.0            |
| N/A             | 22.2                   | 6.2                    | 11.8                    | 0.0                    | 0.0            |
| Diagnoses       |                        |                        |                         |                        |                |
| Hypertension    | 3.7                    | 8.1                    | 23.5                    | 66.7                   | 100.0         |
| Hyperlipidemia  | 11.1                   | 3.7                    | 0.0                     | 0.0                    | 0.0            |
| Diabetes        | 0.0                    | 2.5                    | 0.0                     | 0.0                    | 0.0            |
| Other           | 0.0                    | 8.1                    | 14.7                    | 0.0                    | 0.0            |
| N/A             | 85.2                   | 77.6                   | 61.8                    | 33.3                   | 0.0            |
| Smoking status  |                        |                        |                         |                        |                |
| Yes             | 33.3                   | 27.3                   | 55.9                    | 0.0                    | 0.0            |
| No              | 66.7                   | 64.6                   | 44.1                    | 100                    | 100.0         |
| Ex-smoker       | 0.0                    | 8.1                    | 0.0                     | 0.0                    | 0.0            |

### Table 4: Relationship between surgeon’s preferred time to operate and factors influencing the decision to choose a particular time for the operation

| Characteristics | Early morning (n=27) % | Late morning (n=161) % | Early afternoon (n=34) % | Late afternoon (n=3) % | Evening (n=1) % |
|-----------------|------------------------|------------------------|-------------------------|------------------------|----------------|
| The most important factor that influences the decision to choose an operative time | 0.0                    | 3.7                    | 0.0                     | 66.7                   | 0.0            |
| Social factors  |                        |                        |                         |                        |                |
| Psychological factors | 11.1                   | 18.6                   | 0.0                     | 0.0                    | 0.0            |
| Personal factors | 25.9                   | 29.2                   | 61.8                    | 33.3                   | 0.0            |
| Patient factors | 18.5                   | 11.8                   | 5.9                     | 0.0                    | 100.0         |
| Availability of OR time at the hospital | 44.4                   | 36.6                   | 32.4                    | 0.0                    | 0.0            |

However, these studies disregarded the impact of the surgeons’ circadian rhythm, which may affect their alertness at certain times of the day, thus, affecting patient outcomes.
Limitations

The present study had some limitations. First, this study was cross-sectional and covered a short period, which may have led to bias. In addition, the current sample may not have been representative of all surgeons in Saudi Arabia. Second, we were unable to determine the response rate, as it was impossible to determine the overall number of eligible participants who received the online survey. As a result, the present study findings may have limited generalizability. Future studies should involve validated tools and account for surgeons’ mental and physical health. Another important limitation is that this study’s questionnaire was distributed during the coronavirus (COVID-19) pandemic period. Thus, the findings of our study are limited to a certain time under the circumstances of COVID-19 restrictions. As a result, it cannot be applied to the times before the COVID-19 pandemic. Once surgical operations and clinical duties have resumed their normal routines, more research should be done, especially regarding extending the research into the primary care field, in the hope to inspire further evaluation of the preferred time to perform based on each individual’s circadian rhythm and preference. Moreover, tailoring a suitable schedule to each individual could lead to better productivity and satisfaction.

Conclusions

In conclusion, most surgeons in Saudi Arabia prefer to operate in the late morning (8 am to 12 noon). This preference is essentially determined by the availability of hospital resources. The present findings suggest that hospitals may benefit from a scheduling approach that accounts for the surgeons’ preferences. Finally, it was found that the surgeons’ age, nationality, number of children, medical diagnoses, and smoking status also affect their operating time preferences.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.
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