Ramadan Fasting, Cognitive Strain, and Academic Scheduling in English-Medium Medical Education: Evidence from Saudi Arabia

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Abstract

The practice of fasting during Ramadan through extended daily abstention from eating and drinking water can negatively impact both a university student's learning and overall cognitive performance. In order to gain insight into these issues, this study adopted a quantitative cross-sectional survey methodology to evaluate the perceptions of 94 male undergraduate medical students at a public university in Saudi Arabia—who were studying through the medium of English—regarding their cognitive performance while fasting during Ramadan. The students' feelings and opinions were captured via a structured questionnaire. The questionnaire items included, but were not limited to, the following areas: whether or not the students had eaten prior to dawn (*suhur*); the students' perception of dehydration-related mental fatigue; hours of sleep per night; the students' perception of clarity of mind after breaking the fast (*iftar*) and the students' opinion towards modification of the academic schedule during Ramadan.

The results indicate that many of the students experienced some degree of cognitive strain each day as a result of their fasting periods. They also reported a variety of negative experiences while fasting; these included decreased concentration, significant amounts of dehydration-related mental fatigue, and lack of sleep. Despite most of the students reporting that they ate suhur each day, they continued to report difficulty focusing, suggesting this early sustenance offers little protection for students in an academic setting. Conversely, a large number of the students reported increased cognitive clarity after having broken their fast (iftar), suggesting the possibility of time-dependent recovery. Additionally, an extremely high percent of the students expressed agreement that their academic schedules should be modified during Ramadan.

Overall, the findings suggest that the cognitive strain resulting from fasting may result from a combination of metabolic depletion, dehydration, sleep deprivation, disruption to students' natural circadian rhythms, and the rigid academic schedules faced by these students. As such, the present study emphasises the necessity for context-sensitive, institution wide policies to support student learning while observing Ramadan in universities across Saudi Arabia and other Muslim countries.

Keywords: Ramadan; fasting; medical students; English medium instruction; low-glucose levels; dehydration; circadian rhythm; sleep deprivation

1. Introduction

Every year, Muslims of pubertal age around the world observe the practice of fasting during the month of Ramadan. They abstain from the consumption of food and fluids from dawn to dusk for the entire month. Therefore, fasting individuals tend to modify their eating so that they consume just two meals a day: *iftar* (Arabic *iftār*), pronounced as /ɪfˈtˤaːr/, which is the meal taken after the end of the fasting day at sunset to break the fast and *suhur* (Arabic *suḥūr*)**,** pronounced as /suːˈħuːr/, which is a pre-dawn meal consumed just before the fasting day begins in order to help the individual to sustain enough energy throughout the day (Aziz & Png, 2008).

Since the consumption of food or fluids during the fasting hours is prohibited, fasting in Ramadan has been associated with dehydration during the daylight hours (Leiper et al., 2003) and low glucose levels (Larijani et al., 2003). Moreover, the drastic change in daily routine and lifestyle, such as adjusting mealtimes and physical and social activities to take place during nighttime, leads to a decrease in the quantity and quality of the fasting individual's nighttime sleep throughout the whole month (Roky et al., 2003, 2001; Roky et al., 2012; Roky et al., 2004). As Masismadi et al. (2017) point out, "Such drastic alterations can also affect the individual's daily circadian rhythm that may negatively influence the fasted individual's mood status … which in turn may affect the motivation to learn" (p. 78). Therefore, it appears that students' ability to learn is negatively impacted by four different—yet intertwined—aspects of fasting: low-glucose levels; dehydration; altered sleeping pattern; and circadian rhythm and mood swings. Thus, this study attempts to assess the impact of these four aspects of fasting on male students who are studying via the English language in their preparatory year at a state university in Saudi Arabia.

2. Literature review

This section first discusses the four aspects of fasting i.e., low-glucose levels, dehydration, sleeping pattern, and circadian rhythm and mood swings that affect learners' cognitive abilities and which can impact the achievement of their learning goals before moving on to discuss the body of literature on Ramadan fasting and its impact on learners.

2.1 Low Glucose Levels and Fasting

Medical sciences confirm that to function effectively the brain depends heavily on the glucose supply (Masismadi et al., 2017). Breakfast, which is the earliest meal of the day, is a significant provider of glucose and is beneficial for memory and mental concentration (Mahoney et al., 2007; Muthayya et al., 2007; Wesnes et al., 2003; Widenhorn-Muller et al., 2008). Cooper et al. (2011) found that those who consumed breakfast scored higher in attention tests and visual perception and showed quicker responses in memory tests compared to those who did not. Consequently, fasting students, who rely on the nutrients from the suhur meal that they consume before dawn to sustain their energy throughout the fasting day, could experience a drop in their blood glucose level (Fakhrzadeh et al., 2003; Larijani et al., 2003). However, what makes the matter more challenging is that some students prioritise sleep over food and, therefore, they may not wake up before dawn to consume the suhur meal (Nakhostin-Roohi & Barmaki, 2012). As a result, these students may experience longer fasting hours than necessary (Masismadi et al., 2017), resulting in a drastic drop in their glucose levels (Faye et al., 2005). Therefore, low-glucose levels appear to be a hurdle that impacts learners' cognitive skills and concentration.

2.2 Dehydration

The second aspect that could impact learners' cognitive skills and abilities is dehydration. People who observe Ramadan abstain not only from any food but also from consuming any fluids during the daylight hours, a practice which may produce severe dehydration. Leiper et al. (2003) demonstrated that fasting during the day results in dehydration symptoms. Body weight fluid loss exceeding 2% that typically results from Ramadan fasting has been proven to diminish visual memory and reduce both alertness and concentration as well as working memory performance (Adan, 2012; Masismadi et al., 2017). Dehydration causes young adults to experience increased altered concentration ability, fatigue, drowsiness, and tiredness (Benton et al., 2016; Cian et al., 2000; 2001; D'Anci et al., 2009; Ganio et al., 2011; Patel et al., 2007). According to Benton et al. (2016) and Shirreffs et al. (2004), even a decrease of as little as 1% in one's dehydration could impact cognitive abilities negatively. They argue that mental processes such as memory and focus along with alertness become impaired and motivation levels decrease (Benton et al., 2016; Shirreffs et al., 2004). Benton et al. (2016) further argue that dehydration—at even small percentages—may cause individuals to experience physical distress such as headaches, low energy levels together with concentration difficulties, and increased anxiety or depression.

These physiological and psychological effects are caused by the electrolyte imbalances that occur when the human body consumes less fluid than needed. This imbalance affects brain activity and cognitive ability (D'Anci et al., 2006; Lieberman, 2007; Wilson & Morley, 2003). Duning et al. (2005) go further, arguing that those who do not consume any fluid for many hours—as is the case during fasting Ramadan—experienced a 0.55%, decrease in the brain volume which constitutes a direct hit to the cognitive skills of fasting individuals. As the studies above demonstrate, fasting in the month of Ramadan may negatively impact the learning achievements of students who observe the fasting requirements of Ramadan.

2.3 Sleep Restriction and Sleepiness

The third aspect that could impact learners' cognitive skills and abilities is sleep restriction and sleepiness. Because of the low level of energy and reduced cognitive abilities that result from the dehydration and low-glucose levels they experience during Ramadan, many Muslims modify their daily activities and postpone most of their tasks until the evening after they break their fast at sunset. For example, the *tarawih* ceremony (Arabic *tarāwīḥ*) and pronounced as /ta.raːˈwiːħ/ at the mosque is a specific Ramadan religious service that is widely performed by many Muslims (Muarif, 2022); it starts approximately 2 hours after breaking the fast. As a result, many Muslims adjust their social activities to start in the late evening following the tarawih service. Another example of daily activities modifications is that Muslims need to consume the suhur meal before dawn—the time at which fasting starts—in order to help them manage their fasting throughout the ensuing daylight hours. Thus, they need to get up very early in the morning to eat their suhur meal. The timing of activities such as shopping also needs to be altered as many food businesses change their opening and closing times (Abdul Haris et al., 2025). Thus, the combination of religious activities and social commitments during Ramadan causes individuals to delay their sleep schedules and to diminish their overall rest, an alteration which leads to a reduction in their sleep quantity and quality (BaHammam, 2005; BaHammam et al., 2014; Leiper et al., 2008; Herrera, 2012; Roky et al., 2000, 2003; Zerguini et al., 2007). Research indicates that decreased and disturbed sleep have a detrimental effect on one's cognitive abilities (Alhola & Polo-Kantola, 2007; Curcio et al., 2006) and, consequently, may impact learners' learning skills. The quality and quantity of sleep experienced through Ramadan impact learning outcomes in various ways. According to Hershner and Chervin (2014), sleep plays an essential role in memory consolidation; regular minor sleep losses can also make learners less vigilant and slower in their reactions (Sadeh et al., 2003). Research shows that partial sleep deprivation makes people respond more slowly and decreases their ability to focus, especially during the afternoon (Jarraya et al., 2013). Academic performance decreases when students experience either poor sleep quality or receive less total sleep time (Dewald et al., 2010). All of the studies discussed in this section demonstrate that the decreased sleep quality and quantity that many Muslims students experience during Ramadan may impact their academic performance and learning abilities.

2.4 Changes in Mood Swings and Circadian Rhythm

The effects of low-glucose levels, dehydration, and decreased sleeping quality and quantity noted above lead to the fourth factor that affects learners' cognitive abilities, that is, changes in the body's circadian rhythm and mood swings. The distribution of circadian rhythms may delay or modify the acrophase of specific physiological functions, including core body temperature, the sleep–wake cycle, and hormonal secretion (Bogdan et al., 2001; Reilly & Waterhouse, 2007). Further, these changes result in mood disorders and increased daytime fatigue and lethargy and general malaise (Reilly & Waterhouse, 2007; Roky et al., 2003; Waterhouse, 2010). Therefore, during Ramadan these changes lead to lower concentration abilities compared to the pre-Ramadan period (Leiper et al., 2008). Masismadi et al. (2017) point out that "[t]his decreased ability to concentrate negatively impacts the learning of skills and knowledge, especially those that require higher brain functions and complexity" (p. 81). Moreover, Roky et al. (2000) argue that this decreased concentration is likely to continue throughout Ramadan's daytime fasting period and that full recovery from this reduction occurs only when fasting individuals break their fast in the evening. When it comes to mood swings, Mastor et al. (2019) argue that during the fasting hours in Ramadan, many fasting individuals may experience negative emotions such as irritation and anger. Needless to say, when learners have these negative emotions, their minds are less capable of learning.

In conclusion, it appears that low-glucose levels, dehydration, decreased sleep quantity and quality, changes in their circadian rhythm, and mood swings are all factors that negatively affect learners' cognitive skills and their abilities to learn during the fasting hours of Ramadan. The next section focuses on studies that have investigated the impact of fasting on learning abilities.

2.5 Research on How Ramadan Impacts Learning

A number of studies directly discuss the effect of Ramadan fasting on learners' academic performances. For example, Oosterbeek and van der Klaauw (2013) compared the academic results of Muslim students during Ramadan to those of their non-Muslim (and hence nonfasting) peers in a university in the Netherlands. They employed a difference-in-differences (DiD) design to assess how Ramadan fasting affects the academic performance of Muslim students who study in a non-Muslim country. In their study, identification relies on the fact that the number of Ramadan weeks falling within a course varies across years—from zero to 4 weeks—providing natural variation in exposure. By comparing the grades of Muslim students (treated) with those of their non-Muslim peers (control) across courses with differing Ramadan exposure, the authors were able to isolate the effect of fasting on educational outcomes. Their main result shows that each additional Ramadan week reduces the final grade of Muslim students by roughly 0.10 standard deviations, indicating that fasting in Ramadan had a negative impact on the students' academic performances and that their performance declined progressively with every passing week of the month of Ramadan.

Almutairi et al. (2023) investigated how Ramadan fasting influences medical students' sleep patterns, daytime sleepiness, and academic performance. They used a cross-sectional design with 386 fasting medical students from several colleges in Riyadh. Their study revealed that fasting during Ramadan was linked to a noticeable decline in academic performance among the medical students studied. Over 80 % reported a reduced desire to study and more than 70 % experienced poorer concentration during class sessions. Additionally, three-quarters of participants cut back on the number of hours they spent studying, and 75 % slept fewer hours than on nonfasting days. The rise in daytime sleepiness, shown by a higher Epworth Sleepiness Scale (a short self-assessment to identify how likely you are to fall asleep during the daytime) score during Ramadan (10.70 ± 4.64 vs 9.46 ± 4.41; $p = 0.001$), further supports the deterioration in cognitive functioning. The authors concluded that "There was a relation between Ramadan fasting and students' sleep as well as academic performance. Most of the students have experienced a noticeable reduction in their sleep quality and duration and difficulties in their academic performance during the month of Ramadan" (Almutairi et al., 2023, p. 111).

Similar findings were reported by Abukanna et al. (2022) who investigated the influence of Ramadan fasting on the academic performance of 445 university students at a state university in Saudi Arabia. Participants reported that fasting affected their academic work: 72.6 % said it influenced test performance, with only 17.3 % perceiving a positive effect while 82.7 % perceived a negative one; 82.7 % said it altered their study focus; 17.2 % said it did so positively and 82.8 % reported a negative impact. Common physical complaints during fasting were headaches (73.7 %), sleepiness (73 %), and tiredness/exhaustion (82.5 %). When asked about test results while fasting, 24.7 % indicated improvement, 44.7 % reported a decline, and 30.6 % observed no change. No significant associations were found between gender, age, marital status or academic year, and the reported academic impact. The authors concluded that, despite research suggesting religious practice can foster traits that boost achievement, the physiological discomforts experienced by this cohort outweighed any potential cognitive benefits, leading to predominantly negative self-rated effects on exam performance and concentration.

Nevertheless, other studies have reported the opposite effect of Ramadan fasting on learners' academic performances. For example, Nuryakin et al. (2022) examined the impact of Ramadan fasting on students at the University of Indonesia over two consecutive academic years. The study exploited the overlap of Ramadan with final examination periods in 2018 and 2019 as a natural experiment. Data was obtained from the university's SIAK NG database and included student-level exam scores, demographic characteristics (religion, age, gender, and parental education), and course attributes. Muslim students were defined as the treatment (Ramadan-exposed) group, while non-Muslim students served as the control group. The analysis used a 2×2 difference-in-differences framework with three specifications. The first used a binary Ramadan treatment indicator to estimate the average effect. The second used a nonbinary variable for the *n*-th day of Ramadan to capture cumulative effects. The third included a triple interaction term (Muslim × Ramadan × afternoon exam) to test for morning–afternoon differences. In their findings, they state:

> We find no evidence of Ramadan's negative effects on students' test scores after controlling for semester-course-class fixed effects, student, class, and course characteristics. Consistently, we also find no evidence of morning–afternoon differential effects. We argue that the absence of (or weak) Ramadan's effects is likely because Muslim students had adapted to the fasting environment earlier in the Ramadan period, allowing them to improve their scores as the exam period progresses. The regression results also suggest that the fasting effects are more positive among students with less good academic performance. (Nuryakin et al., 2022, p. 1)

Rachid et al. (2021) offer similar findings. They evaluated the impact of Ramadan fasting on cognitive performance in 41 healthy male medical students in Morocco. Participants completed the CogState computerised battery—assessing psychomotor speed, attention, visual and verbal learning/memory, and working (executive) memory—one week before Ramadan (W1), during the second (W2) and third (W3) weeks of fasting, and 4 weeks after Ramadan (W4). While they found that body weight and BMI decreased significantly after the fasting month, none of the five cognitive domains showed statistically significant differences across the four testing periods (all $P > 0.05$). The authors concluded that, despite reported disturbances in sleep, meals, and working hours, Ramadan fasting did not impair short-term cognitive function in these students. Nevertheless, the authors did voice their concerns regarding the limitation of their study, such as the small, exclusively male sample and the specific academic context, which may affect the study's generalisability.

Therefore, although there is strong evidence to suggest that fasting in Ramadan is likely to affect learners' cognitive abilities—and hence their academic performances—negatively, there is another body of literature—though smaller—that suggests the opposite; i.e., a positive effect may occur. Thus, this study attempts to expand our understanding of the effect of Ramadan fasting on learners' performances by studying a group of medical students at a state university in Saudi Arabia, who are studying medical sciences in English: a language that is not their first. What distinguishes this study from previous studies that investigated the impact of Ramadan fasting on students' performances is that the participants in this study are studying their specialisations (i.e., medical sciences) in another language (i.e., English), which puts extra demands on their cognitive capabilities. Some research has already been done on the demands of L2 academic learning. Roussel et al. (2021), for example, examined a group of French law and political-science students at the Institute of Political Sciences of Bordeaux to determine whether learning academic content in a second language can offset the expected loss in content acquisition. The experiment showed that the students' cognitive processing was constrained by the limited capacity of working memory: when the audio was delivered only in German, the students had to translate while simultaneously trying to understand new legal concepts, which created a high level of extraneous cognitive load and overloaded their working-memory system, leading to poor performance. Therefore, the authors concluded that listening to academic material only in a second language led to substantially lower content scores than any condition that included the native language, indicating that learning in L2 is more difficult.

Thus, these findings demonstrate the cognitive constraints that many university students endure when they study their fields of study in a second language. However, the medical students who participated in the current study experienced not only similar cognitive constraints when they study medical sciences in English but also encountered additional cognitive challenges when they do so during the fasting the month of Ramadan.

The interplay between English medium instruction and Ramadan fasting may also be examined using the cognitive load theory (CLT) model. CLT views learning as a function of the architectural properties of the human mind. More specifically, CLT posits that there are limits to the amount of information that an individual can hold in working memory at any one time and that the working memory interacts with the long-term memory when the individual acquires new knowledge (Evans et al., 2024; Tabatabaee et al., 2024). CLT defines cognitive load as the mental effort required by the learner to process the instructional content (Tabatabaee et al., 2024; Evans et al., 2024). CLT further breaks cognitive load down into three categories: intrinsic cognitive load, which is related to the complexity of the instructional material itself; extraneous cognitive load, which results from how the instructional content is delivered; and germane cognitive load, which represents the mental energy invested in developing and improving the learner's knowledge structure (Tabatabaee et al., 2024; Nordin et al., 2026). Therefore, when the demand placed upon the working memory exceeds the capacity of the working memory, the efficiency of the learning may decrease due to the reduction of the number of cognitive resources available for meaningful processing and integration of new knowledge (Evans et al., 2024). Thus, in the case of the high level of complexity present in many academic environments, and especially in cases where students have to manage several sources of information and are exposed to difficult subjects, cognitive overload can reduce students' ability to process, retain, and apply their knowledge effectively (Surbakti et al., 2024).

To explore this phenomenon more fully, the study posed the following research questions:

1- How does Ramadan fasting affect the daily routine of university medical students studying in English in Saudi Arabia?

2- What impact does fasting during Ramadan have on their cognitive abilities and academic performances?

3- How do students perceive the effects of Ramadan fasting on their concentration and cognitive functioning during English-medium instruction?

3. Methodology

In order to answer these research questions, this study implements a quantitative study. A cross-sectional survey approach employing a five-point Likert scale questionnaire was used to gather responses from a group of undergraduate students studying for a medical sciences degree at the College of Applied Medical Sciences at a state university in Saudi Arabia.

3.1 Data Collection Process

The respondents are the author's students. He teaches them a module called "Writing 1", and one of the topics that arose in classroom discussion was the impact of Ramadan fasting on their academic performances. The author proposed conducting a study to investigate this issue, and the students showed interest in taking part in it. Moreover, using a snowballing technique, the students recruited their peers from other groups. Although not the author's students, these students were studying at the same college; the students distributed the survey to one another.

3.2 The Respondents

Ninety-four male students (aged between 19 and 24) responded to the survey. The reason for not including female students is that female students are only taught by female staff and are segregated from their male peers. They, therefore, could not be approached to participate in the study, although they too study their subjects in English.

3.3 Context of the Study

The study was conducted with students at the college of Applied Medical Sciences. The College consists of four academic departments where students choose a field to study for an undergraduate degree: the Nursing Department, the Public Health Department, the Health Management and Information Technology Department, and the Clinical Nutrition Department. All of the subjects across these departments are taught in English only. However, before enrolling in the College, the students are required to successfully complete an academic year at the Preparatory Year Programme (PYP). The PYP is a one-year preparatory programme designed to equip students for the academic rigour of a full multiyear degree curriculum. The programme functions as a transitional phase between secondary education and university-level study (Aldarmahi et al., 2022). A core objective of the PYP is to enable incoming students to explore university academic disciplines and to become acclimatised to the campus environment. Moreover, they study extensive English courses that prepare them for their enrolment in their colleges of preference where they study their subjects in English (Muhammad, 2020). Therefore, when students at the College of Applied Medical Sciences enrol in one of the College's departments, they already possess the necessary English language skills that enable them to study at one of the College's four departments without any issues related to their mastery of the English language.

3.4 Data Collection Tools

This study adopted a quantitative, descriptive survey design to examine the impact of Ramadan fasting on the academic performance of students at the College of Applied Medical Sciences where instruction is conducted exclusively in English. Data was collected using a structured questionnaire based on a five-point Likert scale to measure students' perceptions of the effects of fasting on their cognitive skills. The initial version of the instrument was reviewed by two senior professors specialising in English language teaching (ELT). Revisions were made in accordance with their feedback. The final version of the questionnaire was developed using Google Forms and distributed to participants via an online link.

3.5 Instrumentation

The questionnaire consists of 30 questions divided into five parts that follow the research's four points of inquiry; the first part contains six questions which address the impact of low-glucose levels on the students' cognitive skills. The second part focuses on the impact of dehydration and consists of five questions. The third part's six questions address the issue of the decreased sleeping hours during Ramadan, while the fourth part focuses on the changes in the circadian rhythm and the mood swings that result from the fasting hours and asks six questions. The final part focuses on the students' perceptions of the current studying schedule during Ramadan and how they would like to have it modified in order to improve their cognitive abilities during Ramadan and, subsequently, improve their academic performances.

3.6 Data Analysis

One advantage of using Google Forms is its capacity to automatically generate descriptive statistics, including frequencies and percentages, and to present them in graphical form, thereby enabling researchers to identify patterns without the need for manual data processing. This automated visualisation enhances efficiency and minimises the risk of human error associated with manual calculations. Consequently, once the participants had submitted their responses, the data was automatically compiled and visualised without direct researcher intervention.

Given that this study involved the surveying of some of his own students, the author sought and obtained ethical approval for the study from the Research Ethics Committee at the Deanship of Scientific Research at King Faisal University, Saudi Arabia.

4. Findings

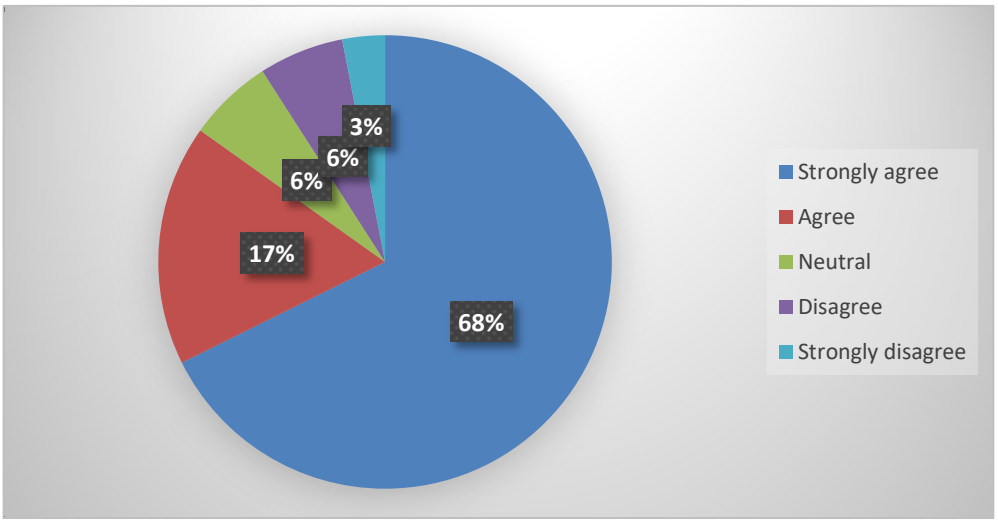

Figure 1. Perceived decline in concentration across fasting hours during Ramadan

As shown in Figure 1, when asked if their concentration declined as the fasting hours progressed, 68% of respondents strongly agreed that their concentration does decline, with a further 17% agreeing that their ability to concentrate weakens during the day. In contrast, 6% were neutral, 6% disagreed, and 3% strongly disagreed that their concentration declined. These results show a very strong overall tendency toward reduced daytime concentration, with 85% agreement in total.

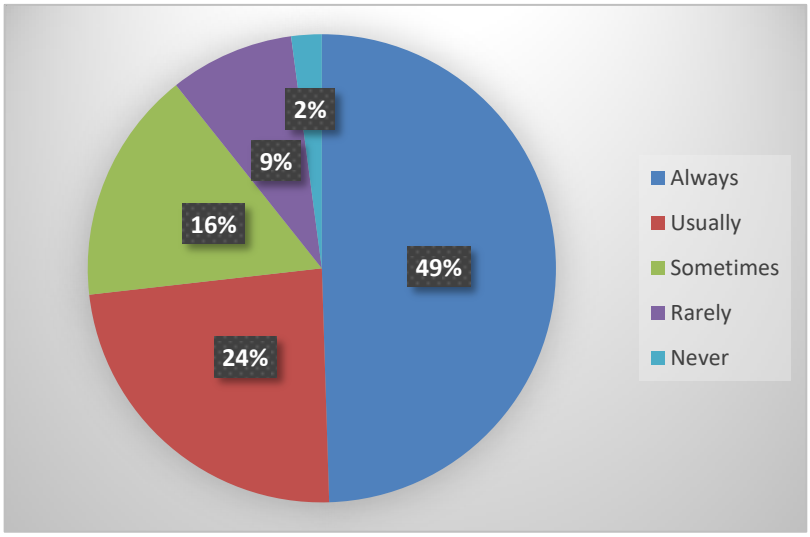

Figure 2. Frequency of suhur consumption among respondents during Ramadan

Figure 2 displays the distribution of suhur consumption frequency. The largest group of students (49%) reported always eating suhur, followed by 24% who usually eat suhur. A further 16% reported eating it sometimes, while 9% rarely and 2% never eat suhur. This finding indicates that although a majority of students maintain regular suhur intake, a nonnegligible minority (11%) rarely or never consume this predawn meal.

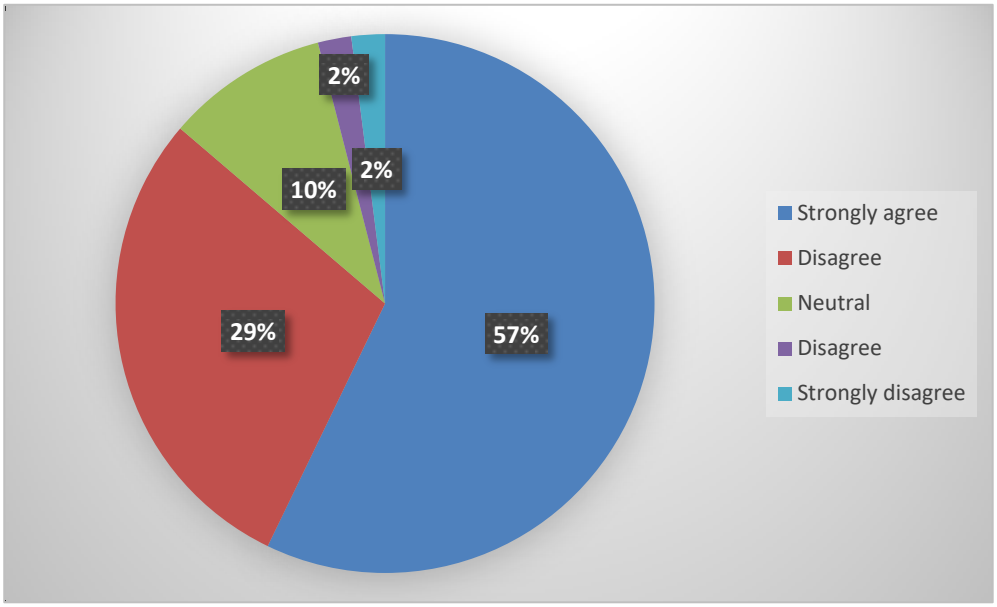

Figure 3. Perceived effect of dehydration on mental fatigue during fasting

As illustrated in Figure 3, dehydration was strongly associated with mental fatigue during lectures. A total of 57% strongly agreed and 29% agreed that dehydration causes them mental exhaustion while studying. However, 10% were neutral, and only 2% disagreed and just 2% strongly disagreed. Overall, 86% of respondents confirmed the negative effect of dehydration on mental fatigue, indicating that hydration is a major perceived constraint on learning during fasting hours.

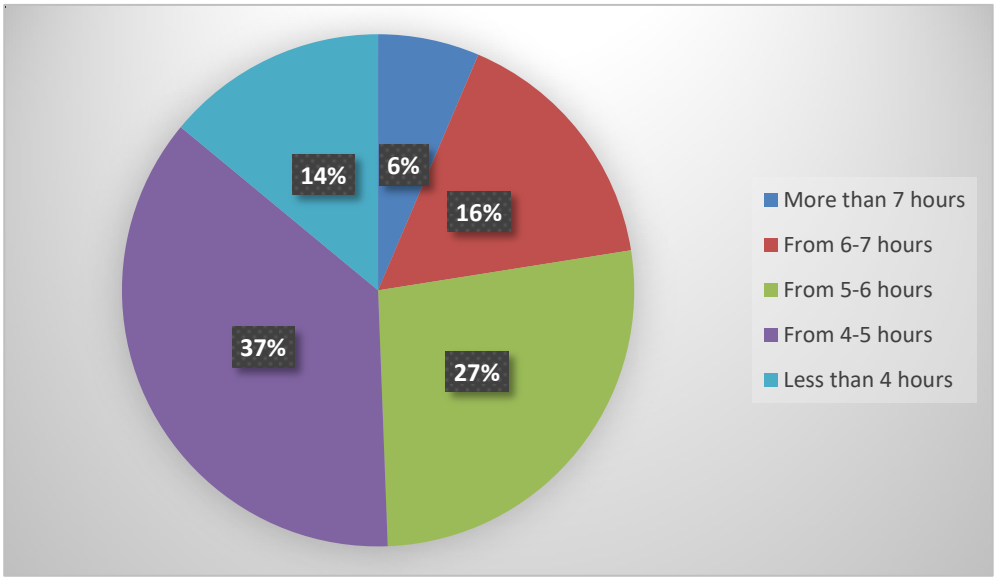

Figure 4. Distribution of daily sleep duration among students during Ramadan

Figure 4 shows a clear trend toward reduced sleep during Ramadan. Only 6% of students slept more than 7 hours, while 16% slept between 6–7 hours. In contrast, 27% slept between 5–6 hours; 37% slept between 4–5 hours; and 14% slept less than 4 hours per day. Thus, 78% of students slept fewer than 6 hours per night, indicating widespread sleep restriction during Ramadan.

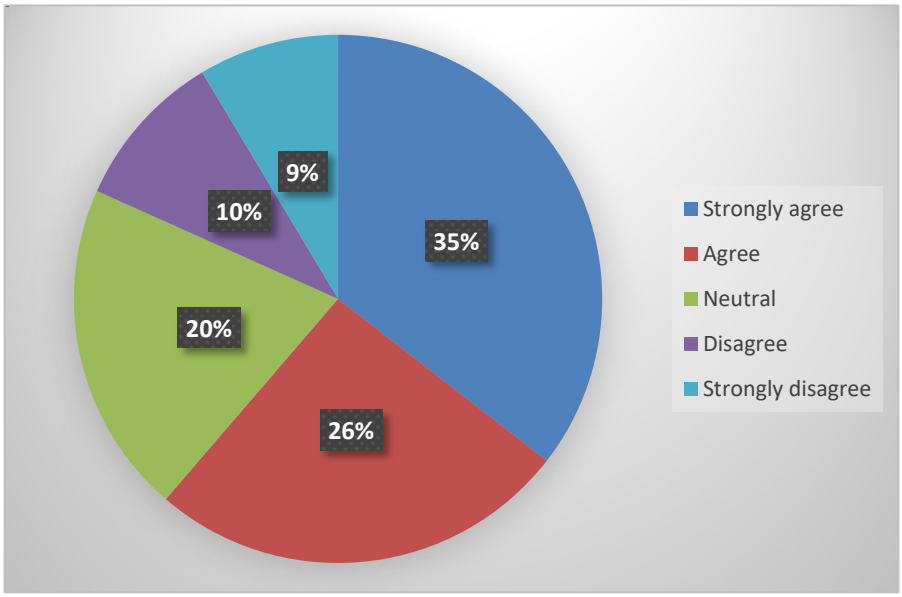

Figure 5. Perceived improvement in cognitive clarity after iftar

As presented in Figure 5, students' responses regarding cognitive clarity after iftar were mixed but generally positive. A total of 35% strongly agreed and 26% agreed that they feel mentally clearer after breaking the fast; 20% were neutral; 10% disagreed; and 9% strongly disagreed. This finding shows that 61% of students perceive a cognitive improvement after iftar, suggesting partial evening recovery of mental performance.

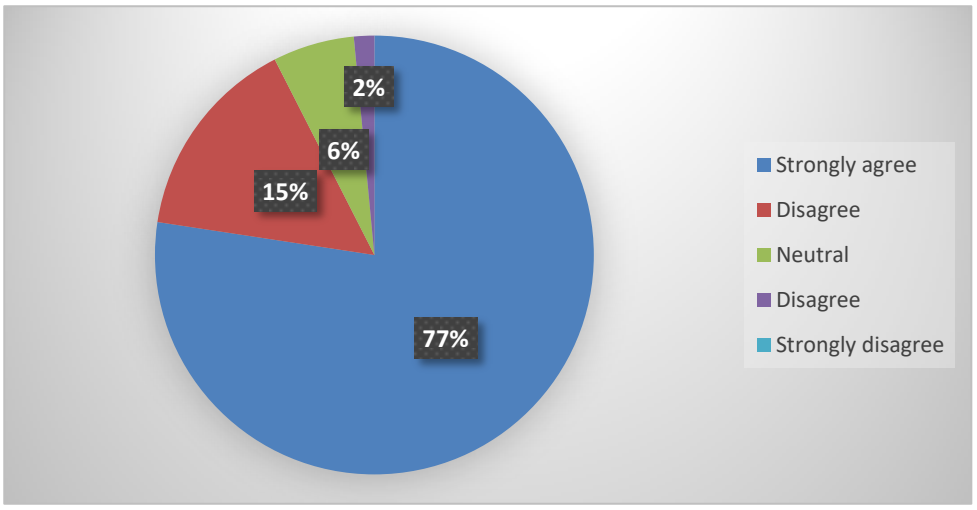

Figure 6. Students' support for academic schedule modification during Ramadan

Figure 6 demonstrates very strong student support for modifying the academic schedule during Ramadan with 77.4% of respondents agreeing and 15.1% strongly agreeing that adjusting the academic timetable would improve their academic performance, giving a total agreement rate of 92.5%. Only a very small minority expressed neutral or negative views. This finding indicates an overwhelming consensus in favour of institutional schedule adjustment during Ramadan.

In addition to providing an overview of the findings from the descriptive analyses, exploratory inferential data analyses were performed to determine if there are statistically significant associations between the selected variables. As these included the measurement of questionnaire response measures on the ordinal Likert scale categories, Spearman's rho correlation coefficient was calculated to evaluate these relationships. Results indicate that sleep duration demonstrates a moderate, negative association with a decrease in concentration (ρ= -0.34). This finding implies that students who slept less during Ramadan encountered increased difficulty in concentrating throughout their daytime lectures. Furthermore, the analysis found a strong, positive association between dehydration-related mental fatigue and a decrease in concentration (ρ= 0.53); thus, it can be inferred that students experiencing more severe dehydration-related fatigue were significantly more likely to experience a decrease in their ability to concentrate. Finally, no association between the frequency of

consuming suhur and a decrease in concentration was detected ($\rho = \sim 0$); therefore, the consumption of suhur at regular intervals is not sufficient by itself to reduce the level of cognitive fatigue experienced during long periods of abstinence from food and water during the college day. Consequently, the exploratory data analysis further supports the descriptive data analysis which identified sleep deprivation and dehydration as two major contributors to students' self-reported perception of decreased cognitive function while attending college during the period of Ramadan.

5. Discussion

This study set out to examine how students perceive the effects of Ramadan fasting on their cognitive functioning and academic experience within an English-medium medical education context. By jointly examining daytime concentration, suhur habits, dehydration-related fatigue, sleep duration, cognitive clarity after iftar, and support for academic schedule modification, the study provides a multi-layered picture of how fasting intersects with learning in demanding academic environments. Rather than pointing to a single cause, the findings indicate that fasting-related cognitive strain arises from the combined and cumulative effects of metabolic, hydration, sleep, and circadian factors, while also being shaped by institutional structures.

5.1 Daytime Concentration and Low Glucose

Respondents' perceptions of their ability to focus throughout the day were influenced by the length of time since they had last consumed food. As demonstrated by the survey data, 85% of respondents reported that their ability to focus was influenced by the amount of time since they had last consumed food. In addition, respondents reported an increase in their inability to focus as the amount of time increased since they had last consumed food. This study's results align with previous research that identified a need for a continuous supply of blood sugar in order for the brain to maintain peak levels of attention and working memory (Mahoney et al., 2007; Masismadi et al., 2017; Muthayya et al., 2007; Wesnes et al., 2003; Widenhorn-Muller et al., 2008). Therefore, the results of this study support the assertion that students' decreased concentration levels are a direct result of prolonged abstinence from nourishment throughout the day.

Even though a significant percentage of the students surveyed for this study reported that they do eat suhur before commencing their academic day, a significant percentage also reported that they experienced a reduction in their ability to focus. The findings of this study have significant theoretical implications, as they refute the idea that consuming suhur will completely eliminate the cognitive loss experienced by students throughout the day. Previous studies have highlighted the importance of consuming suhur to prevent the glucose depletion that occurs as a result of fasting (Fakhrzadeh et al., 2003; Larijani et al., 2003). However, although the results of the present study suggest that suhur may serve as a partial protective measure against some of the cognitive losses experienced by students, eating suhur is unlikely to protect against all cognitive losses experienced by students as a result of prolonged fasting. Additionally, it appears that some students may experience a greater degree of decline in cognitive function than others based upon how often they consume suhur. Furthermore, students that seldom or never consume suhur appear to be at a higher risk of experiencing the negative consequences associated with prolonged fasting. Overall, the findings of the present study demonstrate the complexities associated with the relationship between fasting and cognition and highlight the need for a more refined understanding of the role of suhur and its role in protecting against the negative consequences associated with prolonged fasting.

5.2 Dehydration as a Central Cognitive Stressor

Dehydration was identified as a major barrier to cognitive functioning and academic success among students in this study, with 86% of the respondents stating that they experienced mental fatigue as a result of dehydration. While dehydration has been shown in experimental settings to impair students' attention, alertness, and working memory (Adan, 2012; Masismadi et al., 2017), the results of this study emphasise the importance of dehydration in students' lived experience of academia during Ramadan. The study found that dehydration was not just a source of physical discomfort; it also acted as a direct cognitive obstacle to students' learning and ability to pay attention in class. Thus, the combination of dehydration and glucose depletion likely contributes to the development of students' mental fatigue and reduces their ability to sustain their attention over long periods of instructional time.

5.3 Sleep Restriction as a Cognitive Multiplier

As mentioned previously, a majority of the respondents in this study (78%) reported sleeping fewer than 6 hours per night. Such a restriction represents a critical additional factor in the fasting–cognitive relationship. Numerous studies have documented not only the disrupted sleep patterns experienced by students during Ramadan—often as a result of engaging in late-night social activities and then having to wake up very early to eat suhur (e.g., Alhola & Polo-Kantola, 2007; Curcio et al., 2006)—but also the cognitive effects of students' poor sleep (Alhola & Polo-Kantola, 2007; Curcio et al., 2006). Given this information, it is reasonable to conclude that sleep restriction serves as a cognitive multiplier and increases the adverse effects of low glucose and dehydration rather than being a separate source of cognitive burden for students. From an integrative standpoint, the combination of limited sleep, metabolic strain, and hydration deficiencies creates an environment in which students' cognitive systems operate at below-optimal physiological states during the day.

5.4 After-Iftar Cognitive Recovery as a Metabolic and Motivational Rebound

Sixty-one percent of the respondents reported improvements in cognitive clarity after breaking their fast with iftar, indicating that the cognitive impairment associated with fasting is time-sensitive rather than universal. As discussed previously, the restoration of metabolism and partial alignment of circadian rhythms following food and water consumption explain the cognitive recovery that occurred in the evening (Roky et al., 2000). However, it is likely that the improvement in cognitive clarity that the students report is due

to both physiological and motivational–psychological recoveries. After iftar, students are likely to experience reduced levels of physical discomfort, improved moods, and enhanced alertness, all of which can positively impact students' subjective learning capacities. Therefore, the dual metabolic and motivational explanations for the students' evening cognitive recovery pattern are more comprehensive than the physiological explanations alone.

5.5 Academic Schedule Modification as Structural Mitigation

One of the most striking institutional findings of the study was the almost unanimous support (92.5%) for the modification of students' academic schedules. A finding of this magnitude has the effect of transforming the relationship between fasting-related cognitive strain and the organisational structure of institutions from a matter of individual concern to a structural educational issue. It is clear that the students believe that the institutional design of their academic schedules interacts with their physiological fatigue to produce cognitive difficulties. Moreover, this finding converts what may be seen to be a matter of convenience into a call for the structural alignment of students' biological rhythms with the timing of their instruction. Given that the cognitive load inherent in medical education is so great, the misalignment of students' biological rhythms with the timing of their instruction is especially problematic. Therefore, the current findings offer empirical support from a student-centred perspective for future policy discussion about implementing later start times, reducing the density of instructional time during the day, or adjusting the timing of assessments to accommodate the students' fasting needs.

5.6 Integrated Interpretation

Together, the findings of this study provide evidence for an interactive, dynamic model of fasting-related cognitive functioning. Students' academic experiences during Ramadan are shaped by the interactions of glucose depletion, dehydration, sleep restriction, and disruptions in their circadian rhythms occurring within the framework of structured academic schedules. These interacting factors combine to create significant cognitive difficulties for students during the day, while also creating opportunities for students to partially restore their cognitive functioning following iftar. Finally, the overwhelming support shown by the students for modifying the academic schedule to reduce the cognitive burdens of fasting supports the idea that students see flexibility in their academic schedules as the most effective way to mitigate the cognitive burdens of fasting.

The implications of these findings within the context of CLT provide additional insights into the nature of the cognitive burdens placed upon students who are fasting while undertaking academic studies. According to CLT, the effectiveness of a given learning experience will depend on how well an instructor balances the level of cognitive demand of a particular learning activity with the capacity of the learner's working memory (Evans et al., 2024). Students enrolled in academically intensive programmes such as medical sciences are generally dealing with high levels of intrinsic cognitive load as they attempt to process large volumes of complex discipline-specific knowledge. Furthermore, in addition to the challenges posed by acquiring new knowledge through a second language (e.g., English), students also face a second layer of cognitive demand in terms of processing the lectures, terminology, and academic texts required for academic success. Thus, when students studying medicine or other similar intensive disciplines are also experiencing the physiological limitations caused by fasting (e.g., dehydration, lower blood sugar levels, and restricted sleep) their cognitive resource availability for learning may be even further strained. Research has previously demonstrated that when excessive amounts of cognitive load are imposed upon learners, their ability to effectively process information and develop meaningful knowledge structures can be negatively impacted (Surbakti et al., 2024; Tabatabaee et al., 2024). Therefore, the concentration problems reported by students in this study likely represent the cumulative impact of both physiological impairment and increased cognitive processing demands during the day while engaging in academic work during Ramadan fasting.

6. Contributions to the Literature

This study makes several contributions to the existing body of research concerning Ramadan. First, the study expands the application of fasting–cognition research into an English-medium applied medical sciences context where the students' ability to attend to their studies for extended periods of time and maintain their cognitive endurance while learning through a second language is critical. Second, the study provides empirical support for a cumulative physiological load model of how fasting affects cognition, moving beyond single-factor explanations. Third, the study highlights students' perspectives on institutional mitigation, providing quantitative evidence, albeit rare, that students believe that the scheduling of their academic courses has a major effect on the effectiveness of their learning during the fasting period. By treating fasting-related cognitive strain as both a physiological phenomenon and a structural element of the educational system, the study introduces an educational systems dimension to the predominantly biomedical literature on Ramadan.

7. Conclusion

This study assessed the cognitive and academic effects of Ramadan fasting on university students' perceptions in an English-medium medical education context in Saudi Arabia. Overall, the findings demonstrate that many students experience a considerable amount of cognitive strain during the daytime hours of Ramadan, indicated by the decreased concentration, dehydration-related mental fatigue, and extensive sleep restriction of students. On the other hand, the findings show that the students experience some degree of cognitive recovery after iftar, thus illustrating that the cognitive effects of fasting do not continue uniformly throughout the day, but instead follow a time-dependent course.

More importantly, the study demonstrates that the students' use of individual strategies, such as consuming suhur, may not provide

adequate protection against daytime cognitive impairment under the difficult academic conditions caused by extended fasting hours, restricted fluid intake, and shortened sleep periods. Furthermore, the almost universal support for academic schedule modification found in the study emphasises that students recognise that the fasting-related challenges to their learning capabilities are not solely based on personal or physiological factors but also on structural elements of the academic environment in which they study.

In conclusion, the findings of this study illustrate that fasting during Ramadan interacts with both the students' biologic rhythms and the academic organisation of their programmes to create the students' learning experiences. Therefore, the findings of this study indicate that higher education institutions in Saudi Arabia and other Muslim countries would benefit from developing flexible and responsive academic policies and practices during Ramadan, which would allow them to better align the demands of instruction with the students' physiologic constraints, thereby supporting the students' learning abilities without compromising their institutions' academic standards. Future research could develop and expand on the findings of this study through the use of longitudinal methodologies, the inclusion of female student populations, and the collection of objective measures of students' academic performance to provide a clearer understanding of how fasting affects learning in a variety of higher education settings. Moreover, future research could also examine students' academic writing performance during Ramadan and non-Ramadan academic periods by incorporating formative and/or summative assessments of writing tasks.

A number of recommendations for institutions of higher education can be drawn from this study. First, universities should consider making adjustments to their schedules during Ramadan, so that classes better accommodate the physiological status of the student body during fasting. For example, lectures should be scheduled at later times in the day or after students break their fast (iftar) when their hydration levels are restored and when they will likely be more mentally focused.

Moreover, universities should balance and reduce the number of dense examination periods during Ramadan as doing so could help to alleviate some of the issues around fatigue and concentration that students experience.

Finally, universities should also provide students with greater flexibility in terms of attendance policies and due dates for assignments in order to assist students in achieving high levels of cognitive performance, while still maintaining acceptable levels of academic achievement.

8. Limitations

There are several limitations of the study that should be noted. First, the study used self-reported questionnaire data to collect information from the students, and, therefore, the data collected represent the students' perceptions of their own cognitive and academic experiences; these may, therefore, be influenced by subjective biases, inaccurate recollections, and social desirability. Here, it is important to note that some element of social desirability bias may have played a part in the participants' responses, given that many of them were his students. Furthermore, the findings of this study represent the students' perceptions of the cognitive and academic effects of fasting during Ramadan, rather than an objective measure of their academic performance. Second, the study employed a cross-sectional methodology to collect data from the students at a single point in time during Ramadan, a factor which restricted the researcher's ability to assess changes across the different stages of the fasting month and to establish causality between the observed relationships. Finally, the sample consisted exclusively of male students from a single college at a single Saudi public university, and, therefore, the findings of the study cannot be generalised to students from other colleges or universities, to female students, or to students enrolled in different disciplines, and to those not studying through the medium of English.

Despite these limitations, the study provides valuable insight into students' lived academic experiences during Ramadan and offers a useful foundation for future research that adopts broader samples, longitudinal designs, and objective academic or cognitive measures.

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Authors' contributions

Dr. Muneer Hezam Alqahtani is the sole author of this article and contributed to all aspects of the research, including study design, data collection, data analysis, and manuscript writing.

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Competing interests

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