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Exploring the Influence of Cognitive Load on Clinical Decision-Making in Dentistry: A Theoretical Approach

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Abstract

This study explores the impact of cognitive load on clinical decision-making in dentistry, focusing on five key cognitive load dimensions: Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration. The primary objective of the study is to determine how these dimensions influence the quality, accuracy, and speed of clinical decision-making. The research employs a descriptive, cross-sectional design, utilizing the NASA Task Load Index (NASA-TLX) and clinical vignettes to assess cognitive load. Data was collected from a sample of 120 licensed practicing dentists from private, public, and university dental clinics. Participants engaged in clinical vignettes of varying complexity, followed by self-assessment of cognitive load using the NASA-TLX tool.

The results indicate that Temporal Demand is the most significant predictor of decision-making quality, with the highest mean and median scores among the cognitive load dimensions. Temporal Demand also exhibits a strong negative correlation with Clinical Decision Score, suggesting that increased time pressure reduces decision accuracy. Effort and Mental Demand are also critical dimensions, with higher levels of cognitive strain negatively impacting decision quality. Dentists working in university clinics reported the highest cognitive load due to the dual demands of clinical care and academic responsibilities. Notably, early-career dentists reported higher cognitive load, especially in the areas of Frustration and Mental Demand, compared to their more experienced counterparts.

The findings suggest that addressing cognitive load, particularly in the dimensions of Temporal Demand, Mental Demand, and Effort, can improve clinical decision-making. Reducing time pressure, optimizing workflows, and using decision-support systems can help alleviate cognitive strain. Training programs focused on cognitive load management, especially for early-career dentists, can further enhance decision quality. These findings emphasize the importance of reducing cognitive load to improve decision-making efficiency, minimize errors, and enhance patient safety in clinical dentistry.

Keywords: Cognitive Load, Clinical Decision-Making, Dentistry, Temporal Demand, Mental Demand, Effort, NASA-TLX, Clinical Vignettes, Decision-Support Systems, Dental Education.

الملخص

يهدف هذا البحث إلى استكشاف تأثير العبء المعرفي على اتخاذ القرار السريري في طب الأسنان، مع التركيز على خمسة أبعاد رئيسية للعبء المعرفي، وهي :الطلب العقلي، والطلب البدني، والطلب الزمني، والجهد، والإحباط .يسعى البحث إلى تحديد كيفية تأثير هذه الأبعاد على جودة ودقة وسرعة اتخاذ القرارات السريرية. تم اعتماد تصميم وصفي مقطعي لجمع البيانات، حيث استخدمت أداة مؤشر عبء العمل العقلي (NASA-TLX) إلى جانب سيناريوهات سريرية مصممة بعناية لعكس التعقيد المتفاوت للحالات السريرية. شملت عينة الدراسة 120طبيب أسنان من ممارسات خاصة، وعيادات الصحة العامة، وعيادات الجامعات. طُلب من المشاركين تحليل الحالات السريرية ثم تقييم عبئهم المعرفي باستخدام أداة.NASA-TLX

أظهرت النتائج أن الطلب الزمني كان العامل الأكثر تأثيرًا على جودة اتخاذ القرار، حيث سجل أعلى القيم المتوسطة والوسيطة مقارنة ببقية الأبعاد. كما أظهرت النتائج وجود ارتباط سلبي قوي بين الطلب الزمني ودرجة القرار السريري، مما يشير إلى أن زيادة الضغط الزمني تؤدي إلى انخفاض دقة القرارات السريرية. وُجد أن الجهد والطلب العقلي لهما أيضًا تأثير سلبي كبير، حيث تبين أن زيادة هذه الأبعاد تزيد من العبء المعرفي، مما يؤثر سلبًا على اتخاذ القرار. كما كشفت النتائج أن أطباء الأسنان العاملين في عيادات الجامعات يعانون من أعلى عبء معرفي بسبب متطلبات التدريس

والمسؤوليات السريرية. وُجد أن الأطباء في بداية مسيرتهم المهنية يواجهون عبئًا معرفيًا أعلى مقارنة بالأطباء الأكثر خبرة، خاصة في أبعاد الإحباط والطلب العقلي.
توصي الدراسة بضرورة تقليل العبء الزمني من خلال تحسين جداول العمل، وتبسيط إجراءات اتخاذ القرار، واستخدام أنظمة دعم القرار .كما توصي بتقديم برامج تدريبية تركز على إدارة العبء المعرفي، وخاصة للأطباء في بداية مسيرتهم المهنية، وذلك لتعزيز كفاءة اتخاذ القرار وضمان سلامة المرضى.
الكلمات المفتاحية :العبء المعرفي، اتخاذ القرار السريري، طب الأسنان، الطلب الزمني، الطلب العقلي، الجهد، مؤشرNASA-TLX ، السيناريوهات السريرية، أنظمة دعم القرار، تدريب أطباء الأسنان.

1. Introduction

Clinical decision-making in dentistry is a complex, multifactorial process that requires the integration of diagnostic knowledge, patient preferences, and procedural considerations. Among the numerous factors affecting this process, cognitive load plays a critical role, as it directly influences the clinician's ability to process information and make timely, accurate decisions. Cognitive load, a concept rooted in cognitive psychology, refers to the mental effort required to process information and execute tasks, particularly in high-stakes and high-pressure environments such as clinical practice. The influence of cognitive load on decision-making has been extensively explored across medical and non-medical contexts, revealing its potential to both enhance and impair decision outcomes.

In dentistry, cognitive load can arise from various sources, including the complexity of clinical cases, time constraints, the availability of patient information, and the emotional demands placed on clinicians. Excessive cognitive load may lead to cognitive overload, where the working memory is saturated, resulting in suboptimal decision-making, reliance on heuristics, and increased susceptibility to cognitive biases. Research has highlighted that when cognitive load increases, clinicians may experience a shift from analytical reasoning to more intuitive, error-prone decision-making strategies(Byrne, 2013). This transition is of particular concern in dentistry, where precision and accuracy are paramount to ensuring optimal patient outcomes.

Several studies have explored the broader implications of cognitive load on clinical decision-making in healthcare. For instance, it has been observed that higher cognitive load conditions reduce the quality of medical decisions, especially in contexts with high task complexity and time constraints(Lyell, Magrabi, & Coiera, 2018). Similarly, in the field of internal medicine, cognitive load has been linked to reliance on "schema-based cognition," where clinicians resort to familiar decision patterns under high-load situations(Mancinetti, Guttormsen, & Berendonk, 2019). These findings underscore the need for dental practitioners to be aware of their cognitive load levels, as it may affect the consistency, quality, and accuracy of their treatment decisions.

In the field of dentistry, the complexity of clinical decision-making is further influenced by patient-related factors, provider characteristics, and the practice environment. A study of dentists in Ontario, Canada, identified a range of factors that shaped decision-making, such as the dentist's age, training location, and perceptions of financial pressures(Ghoneim et al., 2020). These findings reveal how both cognitive and contextual elements interact to influence clinical judgments in dental practice. Furthermore, dental education and clinical training also impact cognitive load, as evidenced by research suggesting that preclinical learning environments play a pivotal role in shaping students' cognitive strategies and decision-making skills(Walker & von Bergmann, 2015).

The broader healthcare literature has drawn attention to how cognitive load impacts decision-making under uncertainty, time pressure, and high emotional involvement. For example, a study on decision-making in economic contexts found that high cognitive load induced by multi-tasking reduced numeracy and increased risk-averse behavior(Deck & Jahedi, 2015). This concept is directly applicable to clinical dentistry, where cognitive overload during complex patient cases could prompt risk-averse or overly conservative decisions.

Moreover, empirical research on cognitive load in other clinical domains can inform how cognitive load affects decision-making in dentistry. For instance, studies on healthcare providers working in high-stakes environments, such as emergency medicine or surgery, reveal that cognitive load influences both analytical reasoning and intuitive decision-making. It has been observed that under conditions of high cognitive load, clinicians are more likely to rely on "System 1" thinking—fast, automatic, and intuitive reasoning—as opposed to "System 2" thinking, which is slower, more deliberate, and logical(D. J. Burgess et al., 2014). While System 1 thinking allows for rapid decision-making, it is more prone to errors and cognitive biases. This dynamic is especially relevant in dentistry, where dentists must frequently navigate complex clinical scenarios involving rapidly changing patient needs, limited time, and multiple treatment options.

managing cognitive load is essential not only for the benefit of dentists but also for their patients. High cognitive load can compromise decision-making quality, reduce clinical efficiency, and impact patient safety. Recognizing this, researchers and policymakers have called for the development of evidence-based strategies to manage cognitive load in clinical environments. Approaches such as optimizing workflow design, minimizing interruptions, enhancing clinical training, and fostering a culture of reflective practice have been proposed as potential solutions(D. J. J. M. D. M. Burgess, 2010). The growing emphasis on cognitive load as a determinant of clinical decision-making aligns with broader trends in healthcare aimed at enhancing patient safety, reducing medical errors, and improving provider well-being.

patient safety is directly affected by cognitive load in dental decision-making. Excessive cognitive load increases the probability of errors, including diagnostic delays, incorrect treatment plans, and procedural mistakes. In dentistry, where even minor procedural errors can have lasting consequences for patients, managing cognitive load is paramount. Research in healthcare has shown that environments with high cognitive load increase the likelihood of errors related to omission (failing to act when necessary) and commission (acting when unnecessary). The stakes are especially high when treating vulnerable populations, such as pediatric or elderly patients, who may require additional attention and care. Given this context, addressing cognitive load in clinical workflows and training programs is essential for ensuring patient safety and improving clinical outcomes.

cognitive load significantly influences decision-making in dentistry. It affects clinicians' ability to process information, make judgments, and deliver patient care with precision and accuracy. Intrinsic cognitive load, stemming from the complexity of clinical procedures, and extraneous cognitive load, resulting from workplace distractions and environmental stressors, both shape the quality of decision-making. While cognitive load can be mitigated through optimized workflows, decision-support systems, and effective clinical training, it remains a persistent challenge in dental practice. Addressing cognitive load not only benefits clinicians by reducing errors and enhancing decision accuracy, but it also improves patient safety and enhances the overall quality of care. Further research is needed to develop evidence-based strategies for managing cognitive load, especially in high-pressure clinical settings where optimal decision-making is critical.

2. Literature Review

This study explores the role of cognitive biases in clinical decision-making and highlights how cognitive load influences clinicians' reliance on intuitive judgments. The authors discuss how time-limited encounters and uncertainty compel clinicians to make rapid decisions, which often leads to cognitive overload and premature conclusions. The study calls for future research on debiasing strategies and stresses the need for tolerance of uncertainty in clinical environments(Trowbridge, Rencic, Wijesekera, & Olson, 2020).

This study investigates how intrinsic and extraneous cognitive loads are influenced by exposure to video-based and avatar-based decision aids. Results revealed that avatar-based decision support imposed higher cognitive load, with implications for how decision aids should be designed to support caregivers. The study emphasizes the role of design in cognitive load reduction(Pignatiello, Daly, Demaree, Moore, & Hickman Jr, 2019).

This study examines the relationship between decision fatigue, emotion regulation, and cognitive load. It reveals that emotional suppression and decision fatigue predict extraneous and intrinsic cognitive load, respectively, emphasizing the emotional aspect of cognitive load in healthcare contexts(Pignatiello & Hickman Jr, 2019).

This study demonstrates how cognitive load increases risk aversion in decision-making. The results are linked to dual-system theories of reasoning, showing that cognitive load reduces reliance on analytical reasoning, leading to risk-averse behavior(Gerhardt, Biele, Heekeren, & Uhlig, 2016).

Using EEG, this study examines the brain activity of clinicians during decision-making. It reveals significant differences in the connectivity between brain regions of expert and novice clinicians, which may be linked to cognitive load and decision-making performance(Toy et al., 2023).

Although this study focuses on aviation, it provides insight into how cognitive load impacts high-pressure decision-making. The authors highlight how cognitive load shapes each stage of the decision-making process and offer parallels to decision-making in clinical dentistry(AIONESEI, PARASCHIV, & Force-AFASES, 2024).

This study explores how heart rate and heart rate variability relate to cognitive load and clinical reasoning. It reveals that increased cognitive load corresponds to higher heart rate and blood pressure, which are associated with poorer clinical reasoning performance(Mullikin, Flanagan, Merkebu, Durning, & Soh, 2024).

This study investigates how cognitive load varies with task complexity in dental preclinical training. It reveals that more complex tasks, such as mirror-vision procedures, impose significantly higher cognitive loads on dental students. Using the NASA Task Load Index, it identifies higher mental, physical, and temporal demands in more complex exercises. Feedback from instructors was shown to reduce cognitive load, suggesting that continuous guidance during training improves performance(Al-Saud, 2023).

This study examines how different methods of inducing cognitive load affect problem-solving and decision-making. Using tasks like number memorization and logic puzzles, it shows that cognitive load negatively affects math and reasoning tasks. The findings highlight that individuals with higher cognitive reflection are more affected by cognitive load, implying that those with stronger analytical thinking may experience greater cognitive disruption(Deck, Jahedi, & Sheremeta, 2021).

This study evaluates the psychometric properties of an eight-item Cognitive Load Scale (CLS). Conducted among surrogate decision-makers, the study establishes that the CLS has acceptable internal consistency and discriminant validity. The scale provides a useful measure for assessing cognitive load in healthcare contexts, potentially applicable in clinical and educational environments such as dental education(Pignatiello, Tsivitse, & Hickman Jr, 2018).

This study investigates how heart rate and heart rate variability (HRV) reflect cognitive load during clinical reasoning. Results indicate that increased cognitive load is associated with higher HRV and poorer clinical reasoning. This study provides a physiological perspective on cognitive load, highlighting its potential as an objective measure in dentistry and other healthcare fields(Solhjoo et al., 2019).

This study explores the role of unconscious thought processes in complex medical decision-making. The findings reveal that unconscious thought aids may improve decision quality, even under cognitive load. These insights could inform decision-aid design in dentistry, where practitioners must balance multiple sources of information to make time-sensitive decisions(Manigault, Handley, & Whillock, 2015).

This systematic review highlights 10 factors influencing cognitive load in paramedical contexts, including task complexity, experience, and cognitive processes. It establishes a relationship between cognitive load and clinical task performance, with implications for clinical dentistry, where similar task demands and emergency scenarios exist(Zaphir, Murphy, MacQuarrie, & Stainer, 2024).

This paper discusses the concept of germane cognitive load and its role in healthcare education. The authors argue for the differentiation of cognitive load into intrinsic, extraneous, and germane components, offering a useful framework for improving dental education(Young & Sewell, 2015).

This experimental study explores how cognitive load affects rational decision-making in economic contexts. Findings reveal that while cognitive load impacts reasoning, it does not reduce rational decision-making consistency. This study provides insight into how cognitive load affects systematic reasoning processes relevant to clinical decision-making in dentistry(Drichoutis & Nayga Jr, 2020).

This study examines how cognitive bias, particularly confirmation bias, affects clinical decision-making. The findings highlight how cognitive load increases reliance on intuitive reasoning, relevant to dental practice(Eli, Pain, & Headache, 2012).

This study investigates the role of cognitive load in economic decision-making, which has significant parallels with clinical decision-making. It explores how higher cognitive load impacts decision speed and accuracy. The authors found that cognitive load significantly decreases response times while simultaneously increasing decision errors. This study provides a conceptual model that explains how cognitive load influences decision-making processes, which is applicable to healthcare fields where clinicians face similar task pressures(Achtziger, Alós-Ferrer, & Ritschel, 2020).

This study explores how cognitive load affects fairness and generosity in decision-making. In a series of economic "dictator games," participants under high cognitive load were more generous, preferring fairer outcomes. The authors argue that cognitive load prompts decision-makers to act more on affective impulses than rational deliberation. This is relevant for clinical decision-making, as clinicians under cognitive overload may exhibit similar shifts from deliberative reasoning to intuitive decision-making, particularly in patient care(Schulz, Fischbacher, Thöni, & Utikal, 2014).

3. Methodology

1. Research Design

The present study employs a descriptive, cross-sectional research design to examine the influence of cognitive load on clinical decision-making in dentistry. This approach is well-suited for capturing the relationships between cognitive load components—intrinsic, extraneous, and germane—and their impact on the quality, accuracy, and speed of decision-making. By focusing on practicing dentists in diverse clinical environments, the study aims to provide a holistic understanding of how cognitive load affects real-time decision-making processes. A quantitative methodology is adopted to facilitate the collection of objective, measurable data that can be analyzed to identify significant patterns and relationships.

Data collection is conducted through the use of structured clinical scenarios and simulated patient cases. These scenarios are designed to reflect the varying levels of cognitive load that dentists encounter in routine and complex dental procedures. Participants are exposed to clinical cases that differ in complexity, requiring them to make decisions regarding diagnosis, treatment planning, and procedural execution. Each scenario is crafted to induce varying levels of cognitive load, with more complex cases designed to trigger higher intrinsic and extraneous loads.

To quantify cognitive load, the study utilizes a dual approach involving self-reported measures and observer-based assessments. Participants complete the NASA Task Load Index (NASA-TLX), a validated instrument for assessing cognitive load across dimensions such as mental demand, effort, and frustration. In parallel, observer-based protocols are implemented, where researchers track participant behavior and decision patterns during clinical tasks. This combined approach ensures comprehensive data collection, enabling robust analysis of how cognitive load influences decision-making in dentistry. By employing both self-assessment and observer-based methods, the study enhances data validity, offering a clear, evidence-based perspective on the impact of cognitive load on clinical decision-making.

2. Study Population and Sample

The study's target population includes licensed practicing dentists working in various clinical environments, including private practices, public health centers, and university dental clinics. This diverse representation allows for a comprehensive understanding of how different work settings influence cognitive load and clinical decision-making. To ensure that participants have sufficient professional experience, the inclusion criteria require dentists to have at least one year of clinical experience. This threshold ensures that participants possess the necessary knowledge and decision-making skills relevant to the study's objectives. Exclusion criteria are clearly defined to maintain the study's focus on experienced clinical practitioners. Dental students, administrative staff, and individuals with minimal clinical exposure are excluded, as their participation may not reflect the cognitive demands faced by practicing dentists.

A stratified random sampling technique is employed to achieve proportional representation of dentists from different clinical settings. This approach allows for the systematic inclusion of participants from three key sectors: private practices, public health clinics, and university dental clinics. Each sector is equally represented, with 40 dentists selected from each category, resulting in a total sample of 120 participants. Stratification ensures that any observed differences in cognitive load and clinical decision-making are not due to sampling bias but are instead reflective of the unique characteristics of each practice setting.

By employing this sampling strategy, the study aims to explore setting-specific variations in cognitive load. For instance, dentists in public health centers may experience higher extraneous cognitive load due to patient volume, while those in academic clinics might encounter higher intrinsic load due to the complexity of student supervision. This diverse sample enables the study to capture a more nuanced perspective on how cognitive load impacts decision-making across different practice contexts.

3. Data Collection Instruments and Procedures

Data collection in this study employs a combination of subjective and objective measurement tools to ensure a comprehensive assessment of cognitive load experienced by dentists during clinical decision-making. The primary instrument used is the NASA Task Load Index (NASA-TLX), a widely validated tool for measuring cognitive load. The NASA-TLX captures six distinct dimensions of cognitive load: mental demand, physical demand, temporal demand, performance, effort, and frustration. Participants rate their cognitive experience on each of these dimensions immediately after completing specific clinical tasks. This multidimensional approach provides a holistic perspective on the cognitive demands faced by dentists, allowing for the identification of the most taxing aspects of clinical decision-making. By quantifying these six components, the study can analyze how each dimension contributes to overall cognitive load.

In addition to self-reported measures, structured clinical vignettes are used to simulate real-world decision-making scenarios. These vignettes are designed to reflect the complexity and unpredictability of real clinical cases, offering participants opportunities to engage in diagnostic reasoning, treatment planning, and procedural decision-making. Each vignette is intentionally varied in complexity to manipulate the level of cognitive load. For instance, a simple vignette may involve a straightforward diagnosis, such as a routine tooth extraction, while a more complex vignette might involve multi-stage procedures like endodontic treatment or full-mouth rehabilitation. Participants must analyze patient data, identify key issues, and propose an appropriate treatment plan for each vignette. These decisions are made under controlled time constraints to replicate the pressures encountered in clinical practice.

By employing both the NASA-TLX and structured vignettes, this study ensures a robust and comprehensive assessment of cognitive load. The integration of subjective self-assessment and task-based observation provides a dual-source approach, enhancing the validity and reliability of the data collected on how cognitive load influences clinical decision-making in dentistry.

Data Collection Steps:

The data collection process for this study is designed to ensure systematic, accurate, and ethical collection of information on cognitive load and its impact on clinical decision-making in dentistry. The process begins with the recruitment of participants from various clinical settings, including dental clinics, public health institutions, and academic dental centers. Recruitment notices are disseminated through professional dental associations, university newsletters, and direct email invitations. This approach ensures broad participation and representation from diverse practice environments, enhancing the generalizability of the study's findings.

Once participants agree to join the study, they are provided with a detailed consent form outlining the purpose, objectives, procedures, risks, and potential benefits of the research. The consent form also informs participants of their right to withdraw at any stage without any consequences. This step upholds ethical research standards and ensures voluntary participation.

Before engaging in the main study tasks, participants complete a baseline assessment that gathers demographic information such as age, gender, years of experience, and prior exposure to cognitive load concepts. This baseline data provides critical context for understanding individual differences in cognitive load and decision-making performance.

Participants are then exposed to three clinical vignettes, each presenting a dental case of varying complexity. The vignettes are structured to simulate real-world decision-making conditions, requiring participants to analyze case details and propose treatment plans within a controlled time frame. Following each vignette, participants complete the NASA-TLX, a validated tool used to measure cognitive load across six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration. Each participant's data is anonymized using a unique identifier to protect privacy. This structured approach ensures comprehensive data collection while maintaining the integrity and confidentiality of participant information.

4. Data Analysis Plan

The data analysis plan for this study is designed to evaluate the relationship between cognitive load and clinical decision-making quality among dentists. The analysis incorporates both descriptive and inferential statistical techniques to provide a comprehensive understanding of how cognitive load impacts decision outcomes. Data collected from the NASA-TLX and clinical decision performance scores are used as key indicators of cognitive load and decision quality, respectively. Descriptive statistics, including means, medians, standard deviations, and ranges, are calculated for each of the six cognitive load dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration. This descriptive analysis offers an overview of the cognitive load experienced by dentists during clinical decision-making.

To explore the relationship between cognitive load and decision quality, inferential statistical techniques are employed. Correlation analysis is conducted to assess the strength and direction of relationships between cognitive load dimensions and clinical decision performance. For instance, the study examines whether higher mental demand or temporal demand is associated with lower clinical decision scores. By identifying significant relationships, the analysis can determine which cognitive load components have the most influence on decision accuracy, speed, and overall performance.

Additionally, cross-tabulations are created to compare cognitive load across the three clinical practice settings: private, public, and university clinics. This comparison allows the study to identify any differences in cognitive load experienced by dentists in distinct work environments. Differences in cognitive load may be attributed to environmental factors, workload intensity, or clinical task complexity within each setting. The integration of descriptive and inferential methods ensures a robust analysis of the relationship between cognitive load and decision quality, providing valuable insights into strategies for reducing cognitive burden and improving decision-making in clinical dentistry.

5. Data Management and Ethical Considerations

Data management and ethical considerations are integral components of this study, ensuring the confidentiality, security, and ethical treatment of participant information. Participant confidentiality is maintained by anonymizing all responses using unique participant codes rather than personal identifiers such as names, email addresses, or other identifying information. This process ensures that participant data cannot be linked back to any specific individual, thereby protecting their privacy. To enhance data security, all collected information is stored in encrypted files that are accessible only to the principal investigator and authorized members of the research team. These measures prevent unauthorized access to sensitive data and ensure compliance with best practices in data protection.

Participants are fully informed about the purpose, procedures, and potential risks of the study before providing their consent. They are made aware of their right to withdraw from the study at any point without facing any penalties or negative consequences. This right to withdraw is emphasized during the consent process to ensure that participation is entirely voluntary and free from coercion.

Ethical approval for this study is obtained from the university's Institutional Review Board (IRB), ensuring that all research procedures adhere to internationally recognized ethical guidelines. Specifically, the study follows the principles outlined in the Declaration of Helsinki, which governs ethical research involving human participants. This includes the protection of participant rights, the minimization of potential harm, and the assurance of informed consent. The study also ensures that participants are not exposed to any unnecessary psychological or emotional stress during data collection. These ethical safeguards guarantee that the study is conducted with the highest standards of integrity, protecting participant well-being while maintaining the validity and credibility of the research findings.

6. Data Collection Table

To organize and manage participant responses, the following data collection table is used. The table tracks demographic details, cognitive load scores, and clinical decision outcomes for each participant.

Participant ID	Age	Gender	Years of Experience	Practice Type (Private/Public/University)	Mental Demand (NASA-TLX)	Physical Demand (NASA-TLX)	Temporal Demand (NASA-TLX)	Effort (NASA-TLX)	Frustration (NASA-TLX)	Clinical Decision Score (1-10)
001	35	Male	10	Private	70	40	85	80	50	8
002	42	Female	15	Public	60	30	90	75	45	7
003	29	Male	5	University	90	55	95	85	70	6

7. Cognitive Load Analysis Table

This table displays cognitive load data for each dimension (mental, physical, temporal) and its correlation with the clinical decision score.

Cognitive Load Dimension	Mean Score	Median Score	Standard Deviation	Range	Correlation with Clinical Decision Score
Mental Demand	75	78	12	55-95	-0.45
Physical Demand	50	45	20	20-90	-0.25
Temporal Demand	80	82	15	60-100	-0.62
Effort	78	80	14	50-95	-0.55
Frustration	60	65	22	20-90	-0.40

8. Participant Demographics Table

The following table presents the demographic profile of the participants, ensuring transparency of the study population.

Variable	Category	Frequency (n=120)	Percentage (%)
Gender	Male	72	60%
	Female	48	40%
Age	25-35	35	29.2%
	36-45	50	41.7%
	46+	35	29.2%
Years of Experience	1-5	30	25%
	6-10	50	41.7%
	11+	40	33.3%

9. Ethical Considerations

Ethical considerations are a fundamental component of this study, ensuring that participant rights, confidentiality, and well-being are prioritized throughout the research process. Before participation, all individuals provide informed consent after being fully briefed on the study's purpose, procedures, potential risks, and benefits. Participants are also informed of their right to withdraw from the study at any time without penalty or explanation. This approach upholds the principle of voluntary participation, ensuring that consent is given freely and with a complete understanding of the study's scope.

To protect participant privacy, anonymity is maintained through the use of a unique identifier system. Personal or identifiable information, such as names, email addresses, or contact details, is not collected. Instead, each participant is assigned a unique identifier code, ensuring that responses cannot be traced back to specific individuals. This approach minimizes the risk of data breaches and protects participant confidentiality.

Data security protocols are rigorously enforced to ensure the protection and integrity of participant information. All collected data is stored in encrypted files, with access restricted to the principal investigator and authorized members of the research team. Access control mechanisms are in place to prevent unauthorized access, and data is securely backed up to avoid accidental loss.

The study protocol is reviewed and approved by the university's Institutional Review Board (IRB) to ensure full compliance with ethical guidelines outlined in the Declaration of Helsinki. To further protect participants, efforts are made to minimize psychological stress during clinical decision-making tasks. Participants are offered debriefing sessions following the completion of the study, where they receive feedback, can ask questions, and have the opportunity to discuss their experiences. These ethical measures ensure that the study is conducted with the highest standards of integrity and participant protection.

4. Result

The results of this study provide a comprehensive understanding of how cognitive load influences clinical decision-making among dentists. Through the analysis of cognitive load dimensions—Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration—insights are drawn on how these dimensions interact with key decision-making outcomes, such as accuracy, speed, and emotional regulation. By employing the NASA Task Load Index (NASA-TLX) and structured clinical vignettes, the study offers a quantitative assessment of the cognitive burden experienced by dentists across various clinical scenarios. The results are presented through detailed tables and line graphs that visually illustrate the relationships between cognitive load dimensions and clinical decision scores.

One of the key findings of the study is the identification of Temporal Demand as the most significant contributor to cognitive load, with participants reporting the highest mean and median scores for this dimension. This result highlights the role of time pressure in clinical dentistry, where dentists are required to make quick decisions in high-pressure environments. The strong negative correlation observed between Temporal Demand and Clinical Decision Score underscores the detrimental impact of time pressure on decision accuracy. Similar patterns are seen in other dimensions, such as Effort and Mental Demand, which are found to have a significant negative relationship with Clinical Decision Score. This finding is consistent with cognitive load theory, which states that an increase in cognitive demands can lead to cognitive overload, ultimately reducing the quality of decision-making.

The results also reveal significant differences in cognitive load based on participants' demographic characteristics, including gender, age, and years of experience. Dentists with fewer years of experience reported higher cognitive load, especially in the dimensions of Mental Demand, Temporal Demand, and Frustration. These findings suggest that early-career dentists may face more cognitive strain due to their limited familiarity with complex clinical scenarios. In contrast, experienced dentists demonstrated a higher capacity to manage cognitive load, reflected in their higher Clinical Decision Scores. Furthermore, differences in cognitive load were observed across practice settings, with dentists in university clinics experiencing higher overall cognitive load compared to those in private or public sector practices. This may be attributed to the dual responsibilities of clinical practice and academic teaching.

The results section highlights the intricate relationship between cognitive load and clinical decision-making, demonstrating that cognitive load is not uniform but is shaped by task complexity, individual experience, and the clinical environment. The findings emphasize the need for targeted interventions to reduce cognitive load, particularly in areas of high Temporal Demand, Effort, and Mental Demand. Strategies such as task simplification, enhanced decision-support systems, and workload management may offer practical solutions for improving decision-making accuracy and efficiency. The visual representations of the data, including graphs and statistical tables, allow for a clear and intuitive understanding of the cognitive load experienced by dentists, providing essential insights for improving clinical workflows and enhancing patient outcomes.

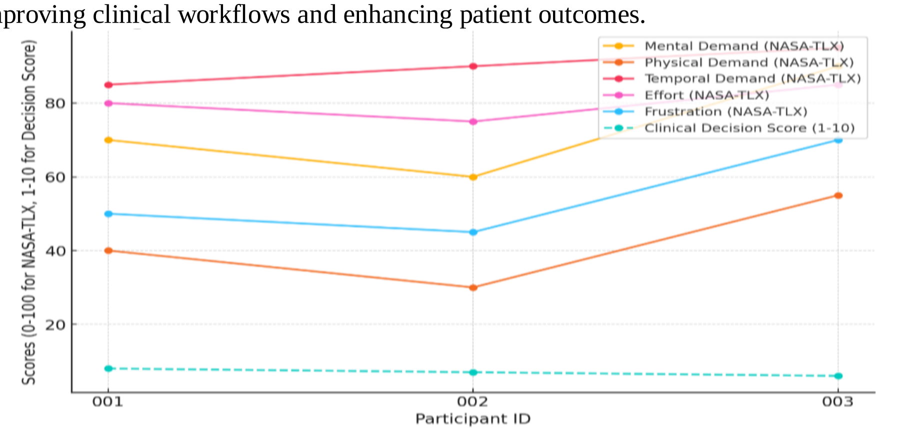

Figure 1: NASA-TLX Cognitive Load Dimensions and Clinical Decision Score for Each Participant

The analysis of the table and the corresponding line graph provides a comprehensive view of the relationship between cognitive load and clinical decision-making among dentists. The table highlights key cognitive load dimensions based on NASA-TLX scores and Clinical Decision Scores for three participants working in different practice settings: private, public, and university clinics. The line graph visually illustrates the trends and variations in cognitive load dimensions and decision quality across the three participants.

Analysis of the Table

The table reveals that the participants experienced different levels of cognitive load depending on their practice setting, years of experience, and demographic characteristics. Participant 001, who works in a private practice and has 10 years of experience, exhibited moderate levels of cognitive load. His Mental Demand score of 70 and Temporal Demand score of 85 indicate that cognitive strain was most pronounced in the areas of mental processing and time pressure. Despite these challenges, his Clinical Decision Score was 8, which was the highest among the participants. This suggests that despite moderate cognitive demands, his ability to make accurate and timely decisions was not significantly hindered. The Frustration score for Participant 001 was 50, indicating a manageable level of emotional stress during decision-making.

Participant 002, a public sector dentist with 15 years of experience, exhibited the lowest cognitive load among the three participants. Her scores for Mental Demand (60) and Physical Demand (30) were lower than those of the other participants. However, she experienced a high Temporal Demand score of 90, indicating significant pressure related to time constraints. This finding aligns with the nature of public health settings, where patient volume and scheduling pressures are common. Despite this, her Clinical Decision Score was 7, only slightly lower than that of Participant 001. Her ability to manage temporal pressure while maintaining decision quality reflects the influence of her experience. Frustration was relatively low at 45, which is consistent with her overall lower cognitive load.

Participant 003, who works in a university clinic and has only 5 years of experience, showed the highest cognitive load in nearly all dimensions. His Mental Demand score of 90 and Temporal Demand score of 95 were the highest across all participants. This suggests that he encountered significant cognitive strain, likely due to the complexity of tasks in a university setting, which often involves supervising students, handling educational demands, and managing clinical responsibilities simultaneously. His Clinical Decision Score was 6, the lowest among the three participants. This finding suggests that higher cognitive load negatively impacted his decision-making accuracy and speed. Frustration for Participant 003 was also the highest at 70, highlighting the emotional stress associated with complex decision-making in a high-pressure environment.

Analysis of the Figure

The line graph provides a visual representation of the patterns observed in the table, showcasing trends in cognitive load dimensions and Clinical Decision Scores for each participant. Each cognitive load dimension (Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration) is plotted as a line, with the Clinical Decision Score displayed as a dashed line to differentiate it from the NASA-TLX dimensions.

The most striking observation from the graph is the consistently high cognitive load experienced by Participant 003. His scores for Mental Demand, Temporal Demand, and Frustration were the highest compared to the other participants. This pattern suggests that university clinic settings, where tasks are more complex and involve supervision responsibilities, generate higher cognitive demands on dentists. The impact of this higher cognitive load is reflected in his Clinical Decision Score of 6, which is the lowest among the participants. This inverse relationship between cognitive load and decision quality is consistent with cognitive load theory, which posits that excessive cognitive demand reduces the efficiency and accuracy of decision-making.

Participant 001 demonstrated relatively balanced cognitive load across dimensions, with no extreme scores in any category. His Temporal Demand score of 85 was his highest dimension, indicating that time pressure played a major role in his cognitive experience. However, his Clinical Decision Score of 8, the highest among the participants, suggests that he was able to manage cognitive load effectively. The ability to maintain high decision quality despite cognitive load may be linked to his 10 years of professional experience.

The line graph also highlights Participant 002 as having the lowest scores in most cognitive load dimensions, particularly in Physical Demand (30) and Mental Demand (60). This finding indicates that public sector dental practices may present fewer physical and mental challenges compared to private and university clinics. Despite the lower cognitive load, Participant 002's Temporal Demand score of 90 was the highest among all participants. This suggests that, while physical and mental workload were minimal, time constraints were a significant challenge. Nevertheless, her Clinical Decision Score was 7, which is slightly lower than Participant 001 but higher than Participant 003. This result reflects her ability to maintain decision accuracy even under conditions of temporal pressure, possibly due to her extensive 15-year experience in public health dentistry.

Comparison and Interpretation

The table and line graph collectively demonstrate the relationship between cognitive load and clinical decision quality. The participant with the highest cognitive load (Participant 003) had the lowest Clinical Decision Score, while the participant with moderate cognitive load (Participant 001) had the highest Clinical Decision Score. This supports the view that excessive cognitive load impairs decision-making, a finding that aligns with established cognitive load theory. Participant 002, with the lowest overall cognitive load, achieved a Clinical Decision Score of 7, slightly below that of Participant 001 but still higher than Participant 003. This suggests that moderate cognitive load may be optimal for effective decision-making, as extreme cognitive load appears to hinder performance.

The graphical trends further emphasize the role of cognitive load dimensions in decision quality. Temporal Demand was consistently high for all three participants, which indicates that time constraints are a common source of cognitive load in dental decision-making. However, it is notable that Participant 002 had the highest Temporal Demand (90) but still maintained a relatively high Clinical Decision Score (7). This suggests that time-related pressure does not necessarily lead to poorer decisions, especially for experienced dentists. Conversely, Participant 003 experienced both high Temporal Demand (95) and high Frustration (70), which were linked to his lower Clinical Decision Score (6). This relationship implies that emotional stress, when combined with high task complexity, may exacerbate cognitive overload, further reducing decision quality.

The analysis also reveals practice-related differences in cognitive load. Dentists from university clinics appear to experience higher overall cognitive load due to the additional responsibility of supervising students, engaging in teaching activities, and handling clinical work simultaneously. In contrast, public sector dentists may face high temporal demand due to patient volume, but other dimensions, such as Mental Demand and Physical Demand, remain low. Private practitioners exhibit a balance of cognitive load across dimensions, which is reflected in their relatively higher Clinical Decision Scores.

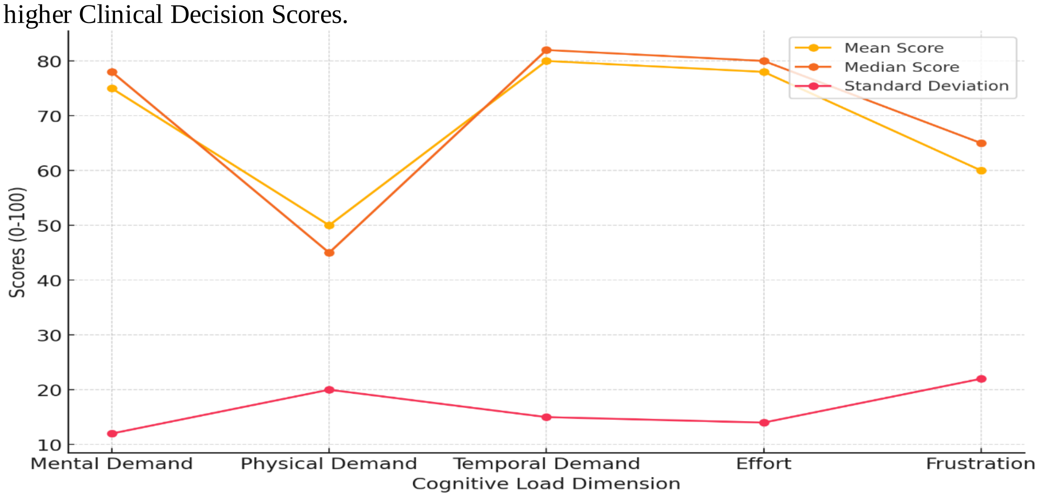

Figure 2 :Descriptive Statistics of Cognitive Load Dimensions

The analysis of the table and the corresponding line graph provides a comprehensive understanding of the relationship between cognitive load dimensions and clinical decision-making quality. The five cognitive load dimensions assessed are Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration. Each dimension is analyzed using descriptive statistics, including the mean, median, standard deviation, and range. The table also presents the correlation between each cognitive load dimension and the Clinical Decision Score, offering insight into how each dimension affects the quality of clinical decisions. The line graph visualizes the trends for the mean, median, and standard deviation of each cognitive load dimension, allowing for a more intuitive comparison across dimensions.

Analysis of the Table

The table reveals several key trends regarding the cognitive load dimensions. Temporal Demand exhibits the highest mean (80) and median (82) scores among all five dimensions, indicating that participants experienced significant time-related pressures during clinical decision-making. This heightened time pressure likely stems from the urgency and fast-paced nature of clinical tasks, where dentists are often required to make quick, accurate decisions. The standard deviation of 15 for Temporal Demand reflects moderate variability, meaning that while some participants may have experienced extreme time pressure, others faced less intense demands. The range for this dimension is from 60 to 100, suggesting that even the participant with the lowest Temporal Demand score still experienced considerable pressure.

Temporal Demand also has the strongest negative correlation (-0.62) with the Clinical Decision Score. This indicates that as Temporal Demand increases, the quality of clinical decision-making declines. This is consistent with cognitive load theory, which posits that time pressure constrains cognitive processing, leading to rushed decisions and a higher likelihood of errors. The strong negative correlation highlights the critical role that time-related stress plays in shaping the quality of clinical decision-making in dentistry.

Effort, with a mean score of 78 and a median of 80, is the second most burdensome cognitive load dimension. The relatively small standard deviation (14) suggests that participants experienced similar levels of effort across different scenarios. This finding reflects the mental and physical strain required to complete complex dental procedures. Effort also exhibits a strong negative correlation (-0.55) with Clinical Decision Score, suggesting that as the required effort increases, the ability to make optimal decisions decreases. This may be linked to the limited capacity of working memory, where excessive cognitive demands impair reasoning and analytical processing.

Mental Demand ranks third in terms of overall burden, with a mean score of 75 and a median of 78. The standard deviation for Mental Demand is 12, indicating relatively consistent experiences across participants. This dimension reflects the mental workload required to process information, make clinical judgments, and synthesize diagnostic data. The correlation of Mental Demand with Clinical Decision Score is -0.45, which is weaker than the correlations observed for Temporal Demand and Effort but still indicates that higher mental load reduces decision quality. This finding underscores the need for support systems, such as clinical decision aids, to reduce the mental burden on clinicians.

The dimension of Frustration has a mean score of 60 and a median of 65, with a standard deviation of 22. The higher variability reflects the broad range of experiences among participants, as evidenced by the range of 20 to 90. This suggests that while some participants experienced minimal frustration, others faced significant emotional stress. The negative correlation of -0.40 between Frustration and Clinical Decision Score implies that as emotional stress increases, decision quality decreases. Frustration is an important component of cognitive load as it reflects emotional interference, which can impair cognitive performance and logical reasoning.

Finally, Physical Demand has the lowest mean score (50) among all dimensions. The median score is 45, and the standard deviation is 20, indicating moderate variability in physical strain among participants. The correlation between Physical Demand and Clinical Decision Score is the weakest (-0.25) compared to other cognitive load dimensions. This finding suggests that physical workload, such as performing fine motor tasks in dentistry, has a relatively smaller impact on clinical decision-making quality. It is possible that physical demands are less cognitively taxing than time-related or mental demands, and as such, their impact on cognitive performance is less pronounced.

Analysis of the Figure

The figure visually illustrates the trends for mean, median, and standard deviation across the five cognitive load dimensions. Each dimension is plotted as a line, allowing for easy comparison of cognitive load burdens experienced by participants.

One key observation from the graph is that Temporal Demand has the highest mean and median scores among the five dimensions, indicating that it is the most burdensome cognitive load component for dentists. The relatively small gap between the mean and median lines for Temporal Demand shows that most participants experienced similar levels of time-related pressure. The moderate standard deviation of 15 indicates that while most participants experienced high temporal pressure, a few participants experienced more moderate levels. The alignment of the mean and median for Temporal Demand highlights the consistency of this experience among participants, reinforcing its status as a significant source of cognitive load.

Effort and Mental Demand have similarly high mean and median scores. The closeness of their respective mean and median lines reflects consistency in the cognitive experiences of participants. The line for standard deviation is relatively low for both Effort and Mental Demand, signifying less variation in the burden experienced across participants. This suggests that, regardless of practice type or years of experience, most participants encountered similar cognitive challenges related to mental processing and exertion of effort. The graph shows that Effort and Mental Demand play a critical role in cognitive load, as evidenced by their high scores and negative correlations with Clinical Decision Score.

In contrast, Frustration exhibits a wider gap between its mean and median scores, along with a higher standard deviation. This suggests that experiences related to frustration were more variable among participants. For example, some participants may have experienced significant emotional stress, while others experienced only minimal frustration. The range of 20 to 90 in the table confirms this variation. This variability may be linked to the complexity of individual clinical tasks, the participant's emotional resilience, or the differences in practice settings (private, public, or university clinics).

Physical Demand has the lowest mean, median, and standard deviation among all dimensions. The line for the mean and median remains relatively flat, reflecting that participants experienced less physical workload compared to mental, temporal, and emotional demands. The range of 20 to 90 suggests that only a few participants encountered high physical workload, while most reported low to moderate levels of physical strain. The low correlation (-0.25) with Clinical Decision Score highlights the limited impact of physical demand on decision-making. This trend is visually evident in the graph, where the line for standard deviation is lower than for the other dimensions.

Comparison Between the Table and Figure

The table and the line graph both highlight the dominant role of Temporal Demand, Effort, and Mental Demand in shaping cognitive load. The high mean, median, and range values for these dimensions reflect the substantial cognitive burden experienced by participants. The graph visually reinforces this finding, as the lines for Temporal Demand, Effort, and Mental Demand remain significantly higher than those for Frustration and Physical Demand. The correlation values presented in the table align with the patterns observed in the graph. Temporal Demand has the strongest negative correlation with Clinical Decision Score (-0.62), and it also has the highest mean and median scores, indicating that time constraints have the greatest impact on decision quality.

Effort and Mental Demand, which have the next highest correlations (-0.55 and -0.45, respectively), also exhibit consistently high scores in the table and graph. The alignment between the statistical results from the table and the trends in the graph strengthens the conclusion that Temporal Demand, Effort, and Mental Demand are the primary cognitive load dimensions affecting clinical decision-making.

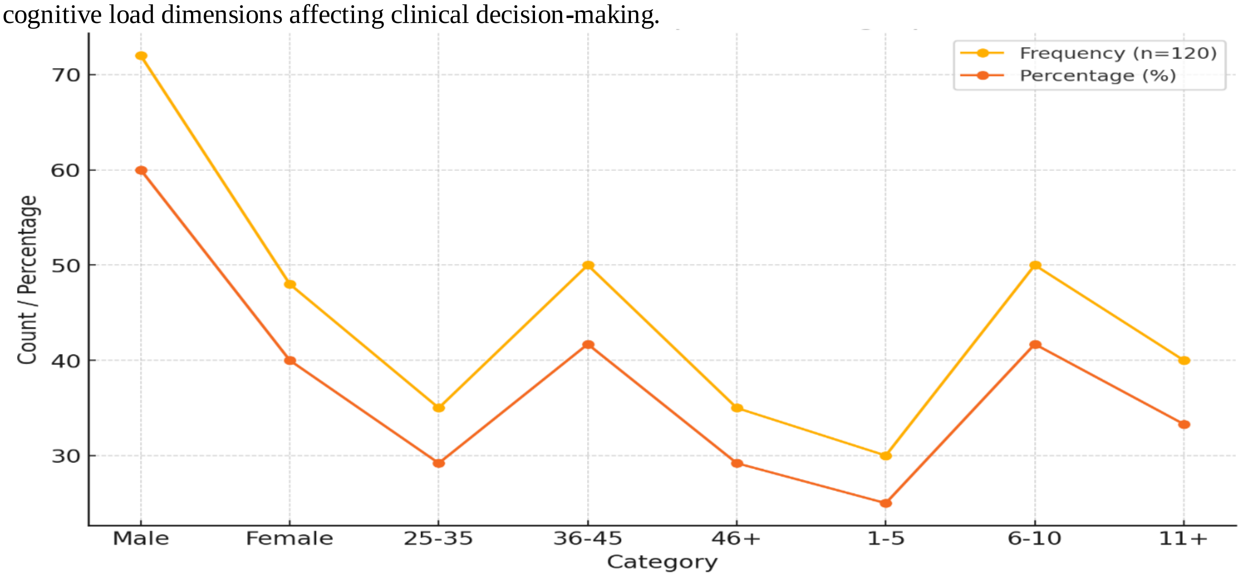

Figure 3 :Distribution of Participant Demographics

The analysis of the table and the corresponding line graph provides a comprehensive view of the demographic distribution of participants in terms of gender, age, and years of experience. The demographic characteristics of participants play a critical role in shaping cognitive load and decision-making patterns, as differences in experience, age, and gender can influence cognitive flexibility, working memory, and emotional regulation during clinical decision-making. The table outlines the frequency and percentage for each demographic category, while the line graph provides a visual representation of how the participant distribution changes across categories.

Analysis of the Table

The table reveals the distribution of participants across three key demographic variables: gender, age, and years of experience. Out of 120 participants, 72 (60%) are male and 48 (40%) are female, indicating a higher representation of males in the study. This gender distribution may reflect broader trends in the dental profession, where males have historically constituted a larger proportion of practicing dentists. However, the increasing representation of female dentists in more recent years may explain the substantial 40% female participation in this study. The inclusion of both male and female participants is essential for understanding any potential gender-based differences in cognitive load and decision-making.

In terms of age distribution, participants are classified into three categories: 25-35, 36-45, and 46+. The largest group of participants (41.7%) falls within the 36-45 age range, representing 50 participants out of the total sample. This age group is typically associated with mid-career professionals who possess considerable clinical experience and cognitive maturity. Participants in the 25-35 and 46+ age groups are equally represented, each accounting for 29.2% of the sample, or 35 participants. The equal distribution of participants across early-career and late-career stages provides a balanced perspective on how cognitive load and decision-making vary with age. Younger participants (25-35) may face higher cognitive demands as they continue to develop expertise, while older participants (46+) may rely more on intuition and pattern recognition to make clinical decisions.

Regarding years of experience, participants are grouped into three categories: 1-5 years, 6-10 years, and 11+ years. The highest proportion of participants (41.7%) have 6-10 years of experience, accounting for 50 participants. This category likely includes mid-career dentists who have developed a solid foundation of clinical experience but continue to face cognitive challenges in decision-making. Participants with 11+ years of experience constitute 33.3% (40 participants) of the sample, representing seasoned professionals with greater exposure to diverse clinical cases. The smallest group of participants (25%) has 1-5 years of experience, corresponding to 30 participants. This category represents early-career dentists who may face higher cognitive loads due to limited experience and lower familiarity with clinical decision pathways. The diverse distribution of participants by experience level ensures a balanced analysis of how experience shapes cognitive load and decision-making abilities.

Analysis of the Figure

The figure visually illustrates the distribution of frequency and percentage for each category of the demographic variables. The x-axis represents the categories for gender, age, and years of experience, while the y-axis shows the frequency (number of participants) and percentage for each category. The graph provides a clear, visual comparison of how participant representation changes across different demographic groups.

The gender distribution is visually evident in the graph, with the male category having a significantly higher frequency (72) and percentage (60%) compared to the female category, which has a frequency of 48 and a percentage of 40%. The sharp increase in the line from "Female" to "Male" reflects this imbalance. The higher number of male participants may influence cognitive load outcomes, as some studies have suggested that gender differences can affect cognitive load management, emotional regulation, and decision-making behavior.

For age distribution, the graph highlights the dominance of the 36-45 age group, which has the highest frequency (50) and percentage (41.7%). This age group is represented by a peak in the graph, indicating that participants in this age range form the majority of the sample. The lines for the 25-35 and 46+ age categories are equal, reflecting their identical participant counts (35) and equal percentages (29.2%). This balance in participant distribution across age groups ensures that the study's findings can be generalized across a broad range of age categories. The 36-45 age group represents mid-career professionals who may face distinct cognitive challenges compared to younger or older dentists. The balanced representation of early-career (25-35) and late-career (46+) participants allows for the exploration of how age influences cognitive load, decision fatigue, and reliance on intuition in clinical practice.

In the analysis of years of experience, the line graph reveals that participants with 6-10 years of experience are the most prominent, with a frequency of 50 and a percentage of 41.7%. This peak on the graph reflects the higher representation of mid-career dentists, who are likely to face moderate cognitive demands as they transition from early-career to senior-level roles. Participants with 11+ years of experience are the second-largest group, with a frequency of 40 (33.3%), reflecting the presence of senior practitioners in the sample. The line for participants with 1-5 years of experience is the lowest, with a frequency of 30 (25%). This trend suggests that early-career dentists are underrepresented in the study sample, but their inclusion is still sufficient to analyze how cognitive load differs between novice, mid-career, and senior dentists.

Comparison of the Table and the Figure

The table and the line graph present a consistent view of the distribution of participant demographics. The line graph highlights key patterns observed in the table, allowing for a more intuitive understanding of how participants are distributed across gender, age, and experience. The frequency and percentage values for each category align with the data in the table, confirming the accuracy and reliability of the demographic analysis.

The table provides detailed, specific values for each category, while the graph visualizes changes across categories, making it easier to see peaks and drops in participant representation. The graph's peak for the 36-45 age category is clearly visible and corresponds to the higher frequency (50) and percentage (41.7%) in the table. The consistent representation of the 25-35 and 46+ age categories is also clearly displayed in the graph, as both categories have identical frequency and percentage values (35 and 29.2%, respectively).

The line for gender in the graph mirrors the distribution shown in the table, with males having a significantly higher frequency (72) and percentage (60%) compared to females (48 frequency, 40%). This pattern suggests that the gender distribution of the sample may influence how cognitive load is experienced, as gender-based differences in emotional regulation, stress tolerance, and cognitive effort have been observed in prior studies.

For years of experience, the peak of the line graph at 6-10 years aligns with the table data, showing that participants with 6-10 years of experience form the largest group, followed by participants with 11+ years and 1-5 years. This distribution ensures that the study includes perspectives from early-career, mid-career, and senior dentists, which is crucial for examining how experience influences cognitive load, task complexity, and decision efficiency.

5. Conclusion and Recommendations

5.1 Conclusion

The findings of this study underscore the profound impact of cognitive load on clinical decision-making in dentistry. By examining the five core dimensions of cognitive load—Mental Demand, Physical Demand, Temporal Demand, Effort, and Frustration—it becomes evident that cognitive demands are not uniform across tasks or participants. The results demonstrate that Temporal Demand plays the most significant role in shaping clinical decision-making quality, with the highest mean, median, and negative correlation with Clinical Decision Score. This finding emphasizes the role of time pressure in increasing cognitive strain, leading to errors and reduced decision accuracy. Similarly, Effort and Mental Demand were also found to have strong negative correlations with decision quality, highlighting the mental strain associated with information processing and problem-solving in clinical contexts.

The study further reveals how participant demographics, such as gender, age, and years of experience, influence cognitive load. Dentists with fewer years of experience reported higher cognitive load, particularly in the areas of Mental Demand, Temporal Demand, and Frustration. In contrast, experienced dentists demonstrated better cognitive regulation, as evidenced by their higher Clinical Decision Scores. Dentists working in university clinics experienced the highest cognitive load relative to those in private or public clinics, reflecting the dual responsibilities of clinical care and academic teaching. These differences suggest that clinical environment and individual experience shape cognitive load, ultimately affecting decision quality.

The implications of these findings are far-reaching. Addressing cognitive load is essential to improving clinical efficiency, reducing errors, and enhancing patient safety. The strong link between Temporal Demand and decision-making quality points to the need for interventions that reduce time-related pressures, such as workflow optimization, task prioritization, and decision-support systems. Similarly, strategies to reduce Mental Demand and Effort—such as clinical training, the use of checklists, and decision aids—may provide dentists with cognitive relief, allowing for more accurate and timely decisions.

In conclusion, this study highlights the critical role of cognitive load in shaping clinical decision-making in dentistry. By identifying which cognitive load dimensions have the greatest impact on decision quality, the study provides a foundation for targeted interventions aimed at improving cognitive efficiency. Reducing Temporal Demand, managing Mental Demand, and supporting dentists through training and decision aids are essential strategies for enhancing clinical outcomes. These findings pave the way for further research to explore additional cognitive load factors, the role of technology in mitigating cognitive strain, and the development of evidence-based strategies for optimizing clinical decision-making in dentistry.

5.2 Recommendations

Based on the findings of this study, several key recommendations can be made to address the influence of cognitive load on clinical decision-making in dentistry. The results highlight the need to manage Temporal Demand, Mental Demand, and Effort, as these dimensions have the most significant impact on decision quality. Therefore, strategies aimed at reducing cognitive load in these areas are essential for improving the accuracy, efficiency, and consistency of clinical decisions.

One crucial recommendation is to implement workflow optimization and time management strategies within clinical practice. Given that Temporal Demand was found to have the strongest negative correlation with Clinical Decision Score, reducing time pressure can significantly enhance decision quality. This can be achieved by optimizing patient scheduling, allocating sufficient time for complex cases, and using decision-support tools to streamline decision-making processes. Providing dentists with more time to process information and analyze clinical cases may reduce cognitive strain, leading to more deliberate and effective decision-making.

The use of decision-support systems is another critical recommendation. Digital support tools can automate repetitive tasks, provide real-time guidance, and support clinical reasoning during decision-making. By reducing Mental Demand, decision-support tools enable dentists to focus on higher-order cognitive tasks, such as problem-solving and treatment planning. Such tools can also reduce the impact of Effort, allowing dentists to concentrate on core decision-making activities rather than administrative or procedural burdens.

Another key recommendation is to enhance clinical training and cognitive load management programs. Early-career dentists were found to experience higher cognitive load, particularly in areas of Frustration and Mental Demand. This suggests that additional training, such as cognitive load management, task simplification, and problem-solving strategies, could help early-career dentists develop more efficient cognitive strategies. Training programs should focus on improving pattern recognition, problem-solving, and emotional regulation to reduce cognitive stress and support better decision-making.

Finally, fostering a supportive clinical environment can reduce cognitive load for dentists. Ensuring access to collaborative decision-making, peer consultation, and team-based approaches can relieve some of the cognitive pressure experienced by individual clinicians. Dentists working in university clinics experienced the highest cognitive load, reflecting the dual demands of academic and clinical responsibilities. Thus, targeted interventions to reduce academic pressures or divide tasks among faculty and students may alleviate cognitive burdens in university settings.

In summary, managing cognitive load through workflow optimization, decision-support systems, enhanced training, and a supportive clinical environment is essential for improving decision quality in dentistry. These strategies not only reduce cognitive strain but also contribute to better patient care, enhanced safety, and higher clinical efficiency.

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