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Assessing awareness of heuristic medical decision-making in specialized physicians

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Abstract

Background: Heuristics, characterized as direct, concise, and often intuitive decision-making strategies, whether consciously or unconsciously employed, play a pivotal role in facilitating swift and efficient choices. Their utilization within clinical decision-making is particularly compelling, given the necessity for prompt and accurate judgments in the medical domain, which frequently entail substantial risk. This study sought to elucidate the intricate relationship between self-reported heuristic use and objective performance in tasks that invoke intuitive cognitive processes.
Methods: This research involved the participation of 162 Greek physicians from various specialties in pathology and surgery (N = 110 males, age range = 30 to 72 years (M = 46.8 years, SD = 9.81), representing diverse specializations in pathology and surgery. The researchers developed and validated the "Heuristics in Medical Decision-Making Questionnaire" (HMDM) to assess participants' subjective reports concerning the frequency of heuristic application. Objective assessments involved four Hypothetical Scenarios and the Cognitive Reflection Test.
Results: The exploratory factor analysis of the HMDM revealed two distinct factors: one relating to heuristics associated with overconfidence/confirmation and the other with anchoring/availability heuristics, displaying satisfactory reliability metrics. Despite physicians reporting infrequent use of heuristics, the objective task data revealed a substantial reliance on intuitive thinking in medical decision-making. Furthermore, a multivariate analysis of variance demonstrated that the factor of age group significantly affected the employment of overconfidence/confirmation heuristics among the physicians. However, the associations between scores derived from subjective and objective measures did not yield statistically significant correlations. The findings suggest several potential explanations for this disparity, including potential social desirability biases influencing responses on self-report measures such as the HMDM, as well as a general lack of awareness regarding the cognitive underpinnings of decision-making.
Conclusions: In conclusion, this research highlights the imperative need for meticulous instruments to evaluate heuristic usage among physicians. Such tools will contribute to targeted interventions aimed at enhancing physicians' metacognitive awareness when navigating the intricate landscape of medical decision-making.

Keywords

heuristics, assessment, medical decision-making, intuitive thinking

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Introduction

The decision-making process within the healthcare domain significantly impacts the diagnosis and treatment of patients, establishing itself as an essential element of medical practice (1, 2). This process aligns with the information processing theory, involving two systems of thinking (3, 4). The first system, defined as intuitive (Type 1), operates swiftly and subconsciously, correlating new information with pre-existing memory, without overburdening the working memory (5) and often involves the application of heuristics. Conversely, the second type, analytical-reflective (Type 2), is more controlled, conscious, and comparably slower, significantly engaging the working memory (6, 7). The demand for rapid decision-making in medical practice often makes applying an analytical thinking approach impractical, leading physicians to resort to heuristics (8). Heuristics embody direct, concise, and intuitive strategies used to navigate decision-making or problem-solving while adhering to the principle of cognitive economy (9).

Within the medical realm, the application of heuristic methods is pervasive in clinical decision-making and can be influenced by various factors such as age, experience, social status of healthcare professionals, successful previous heuristic use, the decision's risk, and time constraints. Previous research indicates that deviating from analytical thinking correlates with biases that can result in medical errors among medical professionals, residents, specialists, and medical students (10, 11, 12, 13). The present study aimed to examine the following heuristics that are predominantly used by physicians in their decision-making processes [for a comprehensive review, see Saposnik et al. (14)]:

Anchoring Heuristic: This phenomenon transpires when an individual's decision-making process is swayed by a particular reference point or information, referred to as an "anchor," which they persist in utilizing without considering new or emerging data (15). In the medical sphere, this tendency can be characterized as physicians adhering staunchly to a prior diagnosis despite evidence or symptoms that challenge its validity (16). It stands as one of the prevalent heuristics frequently employed among physicians (8) and is often linked with diagnostic inaccuracies (17, 14) as well as complications in patient treatment or management (16, 10).

Availability Heuristic: This heuristic embodies a propensity for individuals to base their decisions and seek solutions upon probabilities, frequencies, and the initial elements that spring to mind. In medical practice, this inclination may prompt physicians to arrive at a diagnosis by recognizing prevalent symptoms observed in previous cases they have encountered (18). In such instances, the physician may employ this heuristic as a cognitive bias, potentially leading to an incorrect diagnosis.

Confirmation Heuristic: This heuristic characterizes the predisposition of individuals to actively search for supporting evidence or information that aligns with their pre-existing perspectives, assumptions, and expectations (18). It has the potential to impact the decision-making process of physicians and create circumstances where confirming evidence upholds an inaccurate diagnosis (19). This tendency could have adverse implications on efficiency and accurate decision-making in high-stakes environments, such as emergency departments within a hospital.

Overconfidence Heuristic: This heuristic strategy involves individuals relying on their self-assurance, knowledge, strengths, and capabilities to make decisions or resolve issues. For instance, when a physician holds strong confidence in their diagnosis, they might forego reassessment or verification of their diagnostic conclusions (20).

Mitigating cognitive errors through the utilization of heuristics can be attained via reflective thinking, enabling the identification of errors stemming from intuitive thinking and fostering the application of analytical reflection, specifically involving the utilization of the Type 2 system in the decision-making process (21).

Taking all the above into account, it is evident that investigating the frequency of physicians' reliance on heuristics in decision-making and their level of awareness regarding this practice is of utmost importance. Nevertheless, no existing study has comprehensively addressed the awareness of physicians regarding their decision-making processes or the influential factors behind such awareness. Hence, the primary objective of this research was to develop the Heuristics in Medical Decision-Making Questionnaire (HMDMQ), specifically designed to assess physicians' consciousness of the frequency of heuristic usage in decision-making. A secondary objective aimed to explore the correlations between physicians' self-reported tendencies and objective metrics that incite heuristic thinking. Lastly, a tertiary objective was to examine potential variations in heuristic utilization among physicians concerning individual differences, particularly in terms of gender and age.

Methods

Participants

The research sample consisted of 162 specialized physicians ($N = 110$ males) from diverse medical specialties and regions across Greece. Their ages ranged from 30 to 72 years (*mean* = 46.8, $SD = 9.81$), divided into four age groups: 30-39years ($N = 41$, mean = 34.78, $SD = 2.83$), 40-49years ($N = 65$, mean = 45.29, $SD = 2.82$), 50-59years ($N = 33$, mean = 53.70, $SD = 2.60$), 60-70years ($N = 23$, mean = 64.17, $SD = 2.73$). Utilizing the classification of medical specialties, physicians were categorized into two broad groups: pathology/laboratory specialty (i.e., Cardiology, Pulmonology, Dermatology, Pediatrics, Psychiatry, etc.) (58.6%) and surgical specialty (i.e., General Surgery, Urology, Ophthalmology, Thoracic Surgery, Otorhinolaryngology, Orthopedics, etc.) (41.4%). The vast majority of the physicians their urban origin (87%) while a smaller proportion reported coming from towns (16%) and rural areas (5%).

Instruments

For the purposes of this study, the researchers administered the Heuristics in Medical Decision-Making Questionnaire, a questionnaire constructed for this study, along with a cognitive assessment test, the Hypothetical Scenarios.

Heuristics in Medical Decision-Making Questionnaire (HMDMQ)

The construction of the HMDMQ involved detailed discussions with a qualified medical professional for the purpose of item selection. It was created explicitly for this study, and encompassed four heuristic factors, each theoretically defined and composed of four questions. Initially, there were 16 questions evaluating availability, anchoring, confirmation, and overconfidence heuristics. Responses were solicited on a five-point Likert scale, measuring the likelihood of heuristic implementation, with scores ranging from 1 ("not likely at all") to 5 ("highly likely"). However, as detailed in the Results section of this research, some questions that displayed inadequate suitability were omitted. Consequently, the final version of the questionnaire included 9 questions (see Results). Questions 4, 7, and 9 were reverse-scored.

Hypothetical Scenarios (HS, 22)

To explore the application of intuitive thinking (System 1) in medical decision-making, the Hypothetical Scenarios were deliberately chosen as an objective tool of measurement. This cognitive task encompassed four hypothetical medical scenarios ("Hospital," "Disease," "Vegetarianism," "Smokers") engineered to provoke cognitive fallacies within intuitive thinking during the decision-making process. Upon reading these scenarios, the physicians were required to pinpoint the correct response among various answer choices. The physicians' responses were evaluated for accuracy and received one point for each correct answer, with a maximum total score of 4, if they responded correctly to all questions."

Procedure

The current study was conducted with the approval of the Ethics and Deontology Committee of the University of Western Macedonia. The research adheres to both international and national regulations in accordance with the Declaration of Helsinki. The physicians voluntarily and anonymously participated in the study, providing written consent after being informed about the research objectives. The assessments were completed individually and in person at a convenient location. The total duration of administering the tools did not exceed 20 minutes.

Results

HMDMQ validity and reliability analysis

As previously mentioned, the HMDMQ was initially constructed to encompass 16 questions. However, certain questions were removed due to their simultaneous loading on multiple factors. Consequently, subsequent analyses were conducted on a reduced set of 9 questions. Specifically, an exploratory factor analysis was performed using an orthogonal Varimax rotation of axes. This analysis revealed two factors that collectively accounted for 39% of the total variance. The Kaiser-Meyer-Olkin measure verified the sample adequacy (KMO = .70), and Bartlett's test of Sphericity showed statistical significance [χ^2 (36) = 148.38, $p < .001$]. The first factor pertains to the heuristics of overconfidence/confirmation and is delineated by 4 questions assessing the use of these specific heuristics ($\alpha = .60$). Simultaneously, the second factor encompasses the heuristics of anchoring/availability, identified by 5 respective questions ($\alpha = .60$). Hence, acceptable internal consistency was established for the factors and the entire set of questions ($\alpha = .60$) (see Table 1).

Table 1. Factor loadings, eigenvalues, and percentages of variance for the factors of the HMDMQ

Scale items	**Factor 1** Overconfidence/ Confirmation Heuristics	**Factor 2** Anchoring/ Availability Heuristics
1. How likely are you to be so certain about a diagnosis that you won't investigate other symptoms that don't match the diagnosis?	.75	
2. How likely is your confidence in your knowledge to prevent you from seeking and studying research sources (e.g., scientific articles) in your field?	.70	
2. How likely are you to be so certain about your level of knowledge that you refuse to seek a second opinion from a colleague?	.68	
1. How likely are you to consider other diseases beyond the cardiac problem for a patient diagnosed with anxiety and body numbness?	.48	
3. How likely are you to explore alternative diagnoses after your initial diagnosis to ensure you've made the correct decision?		.63
8. How likely are you to think about other diseases besides cardiac problems in a patient with symptoms similar to three other patients you've recently examined, but who is older, overweight, and a smoker?		.63
4. Since the appearance of Covid-19, how likely were you to believe that a patient was suffering from a different virus with identical symptoms?		.55
9. How likely are you to change your initial diagnosis after new symptoms appear in a patient, possibly inconsistent with the previous diagnosis?		.50
3. How likely are you to consider that a patient may have a disease outside your specialty?		.45
Eigenvalues Percentage of variance explained by the factors	1.913 (21.26%)	1.609 (17.88%)

Descriptive statistics

As apparent from the Means in Table 2, physicians reported moderate to low likelihood of using heuristics in decision-making (i.e., values around 2 to 2.5, with a maximum of 5 and a small range).

Table 2. Mean, standard deviation, minimum, and maximum of the sample's scores on HMDMQ and HS

HMDMQ Items	Mean	*SD*	Minimum	Maximum
1	2.65	1.02	1	5
2	2.67	1.29	1	5
3	2.19	1.00	1	5
4	2.52	1.17	1	5
5	1.84	1.03	1	5
6	2.14	.92	1	5
7	2.59	1.11	1	5
8	2.37	1.03	1	5
9	1.76	.73	1	4
factor 1	9.69	3.04	4	18
factor 2	11.04	2.69	5	20
HMDMQ total score	20.73	4.15	9	29
Hypothetical Scenarios (HS)				
Scenario 1	.61	.49	0	1
Scenario 2	.13	.34	0	1
Scenario 3	.68	.47	0	1
Scenario 4	.46	.50	0	1
HS total score	1.88	1.04	0	4

The mean performance in each hypothetical scenario consists of decimal values around zero. This is based on the rating method, where correct responses are assigned a value of 1 and incorrect ones are given a score of 0. Specifically, as delineated in Table 2, participants predominantly provided intuitive responses, often leading to inaccuracies. On average, the overall performance score of the sampled individuals was moderate (Mean = 1.88 out of 4), accompanied by a relatively limited standard deviation (*SD* = 1.04).

Correlation analysis between self-reported and objective use of heuristics

To explore the relationship between physicians' self-reported likelihood of using heuristics, as indicated by their responses on HMDMQ, and their performance in hypothetical scenarios, Pearson correlation coefficients (*r*) were calculated. The majority of the correlations established were either nonsignificant or displayed marginal significance.

Impact of demographic variables on physicians' self-reported use of heuristics

To examine the potential influence of physicians' demographic variables on their responses to the questionnaire, a 2x3 multivariate analysis of variance (MANOVA) was conducted. The independent variables included age group and gender, while the dependent variables were the scores on the factors of HMDMQ. The results indicated that only the age group of physicians significantly differentiated the scores on the HMDMQ (Pillai's Trace = .081, $F(2,170) = 3.209$, $p = .046$, $\eta^2 = .041$), although with a moderate effect size. More specifically, the results demonstrated a statistically significant effect of the age group only on the scores related to the first factor of the HMDMQ, concerning the likelihood of using heuristics of overconfidence/confirmation by physicians ($F(3, 356) = 3.209$, $p = .025$). Subsequent application of the multiple comparison test using the Bonferroni correction revealed statistically significant differences ($p < .029$) between the first age group (30-39 years) (Mean = 8.41, *SD* = 3.03) and the second age group (40-49 years) (Mean = 10.11, *SD* = 2.78), with younger physicians reporting a lower likelihood of using heuristics of overconfidence/confirmation compared to those in the immediate older age group. A second significant difference was found between the mean scores of the first and the fourth age group (60-70 years) ($p = .031$), where the older age group of physicians again showed a higher mean score (Mean = 10.61, *SD* = 2.99) compared to the younger physicians. The third age group (50-59 years) also indicated a higher likelihood of using heuristics compared to the first group, although this difference did not reach statistical significance.

Discussion

The primary focus of this study entailed evaluating the awareness of heuristic utilization among physicians. To achieve this, we constructed the Heuristics in Medical Decision-Making Questionnaire (HMDMQ). The initial objective was to evaluate the psychometric properties of this tool, alongside examining its correlation with objective assessments. A secondary aim was to investigate how demographic factors would influence the self-reports provided by physicians.

To begin with, results from the psychometric evaluation of the HMDMQ yielded that among the four theoretically defined factors, physicians acknowledged two heuristic factors. Essentially, the heuristics of overconfidence and confirmation merged into the first factor of the EBMH, representing a shared conceptual notion of certainty. Moreover, three out of the four questions retained in the final questionnaire belonged to the heuristic of overconfidence, while one question on confirmation remained in the questionnaire. The concept of certainty, whether relating to oneself or the propensity to confirm

personal knowledge, was deemed a unified construct. This finding is not surprising, considering the subtle and indistinct differences between questions concerning the application of overconfidence and confirmation heuristics within the same individual (23). Similarly, the secondary factor presented physicians perceiving anchoring and availability heuristics as a unified concept. In this case, all the questions remained aligned with the anchoring heuristic, while only one item persisted concerning availability. This underscores the interrelation between anchoring to active elements in our memory, such as knowledge or recent events that remain active and available in our working memory (24).

The moderate indices of reliability and validity present in the HMDMQ could be attributed to a range of factors, including the selection of the HMDMQ items and the limited number of retained queries, which amounted to only nine. Conversely, in similar studies utilizing self-report questionnaires (e.g., 25) related to physicians' diagnostic uncertainty displayed moderate psychometric properties as well (e.g., $\alpha = 0.62$, and no more than 20.27% of variance explained by the first factor). Generally, cognitive research employing self-report questionnaires raises concerns among researchers (26, 27). Specifically, participants in such studies might answer quite differently to questions about behavior or decision-making based on their motivations or the desire to give a socially acceptable or obvious response (28, 29). The variance in participants' responses to questions on behavior or decision-making could be driven by motivations or the inclination to offer socially acceptable or obvious responses (26, 30, 31), without necessarily endorsing them. Social desirability bias, where participants do not consistently respond with complete candor and objectivity but rather base their responses on perceived social desirability, is a potential explanation within the current study. As evident from the research's descriptive statistics, most physicians underreported their utilization of heuristics when making medical decisions. This trend potentially arises from the certainty often induced by the professional roles of doctors. Essentially, acknowledging higher scores reflecting frequent heuristic use might imply an admission that their decisions on critical medical matters are not solely based on analytical or rational processes but are influenced by intuitive perceptions. For instance, a specific question from the overconfidence/confirmation factor in the HMDMQ ("How likely are you to be so sure that you reject seeking a second opinion from a colleague?") conveys a direct inquiry, and an affirmative response implies unwavering certainty, obviating the need for an additional opinion. This rationale is readily comprehensible to physicians, and within interdisciplinary frameworks, a higher score in this question might signify a point for critique. Correspondingly, in a comprehensive review on evidence-based medical decision-making and the reduction of unjustified variations in these decisions, it was concluded that self-confidence is a pervasive factor inevitably influencing medical decision-making, regardless of the physician's specialty or work environment (32).

In the context of the objective assessment represented by the Hypothetical Scenarios, the medical practitioners involved in this study predominantly relied on intuitive reasoning, revealing lower performances indicative of heuristic utilization. These hypothetical scenarios, employed as a means to assess heuristics, have demonstrated considerable efficacy across various studies (33, 34, 35). Irrespective of the scientific field in which decision-making was assessed, individuals consistently activated biases (36, 37, 38, 10, 35).

Therefore, despite their self-reported likelihood of using heuristics in the HMDMQ, their practical usage exceeded their perceptions or understanding. This particular aspect accounts for the discrepancy in scores between the two evaluation tools. Another interpretation for physicians' low self-reports in the HMDMQ might be associated with insufficient cognitive awareness. Relevant findings were confirmed by Grubenhoff and colleagues (39) who attempted to acquaint a sample of pediatricians with heuristics and diagnostic errors Initially, clinicians were prompted to select familiar heuristics regularly encountered in pediatric cases, aiming to elucidate and define them. None of the 70 physicians were able to provide entirely accurate definitions Flavell (40) initially defined metacognition as an individual's awareness of their own knowledge. The connection of metacognition with effective decision-making was established later, referring to the context where individuals are aware of the thought process they employ and the rationale behind their choices (41, 42). As previously mentioned, medical environments are notably demanding, characterized by environmental constraints such as time constraints, an abundance of cases, and heightened responsibilities, rendering the comprehensive analysis of all variables, and consequently, effective decision-making, particularly challenging (43).

Norman (44) further argues that decisions associated with negative attributes (in this case, intuitive/heuristic thinking) have the potential to threaten individual well-being and self-assurance. This contention could also be applied to the responses in the HMDMQ, given that a form of self-assessment was required, which might have negatively influenced the participants, prompting defenses.

The examination of the impact of demographic characteristics on self-reports in the HMDMQ highlighted that only the factor of age group significantly affected the responses provided by the physicians. Specifically, the results indicated that as physicians progressed in age, particularly after completing the first decade in specialization, they reported a higher frequency of relying on confirmation/overconfidence heuristics in their medical decision-making processes. Considering the scarcity of studies that have delved into the use of heuristics by physicians through questionnaires, and no similar research exists exploring the role of age, our findings can only be compared to one study that employed hypothetical scenarios. In this study, Oh et al. (45) revealed that younger physicians expressed less certainty in their responses and knowledge, preferring to rely more on artificial intelligence for decision-making compared to their older counterparts. Conversely, older physicians, possessing substantial years of specialized training and clinical experience, exhibited a sense of assurance and confidence in their responses, albeit leading to errors, as evidenced by their performance in hypothetical scenarios (45).

Conclusions

Despite physicians in the sampled group appearing to underreport the frequency of heuristic application for the reasons previously discussed, their self-reports successfully categorized heuristics into two primary groupings. Conversely, performance in hypothetical scenarios more accurately revealed that physicians employed intuitive thinking much more frequently than acknowledged in the reference questionnaire, as their performances were notably low. Hence, we contend that direct and objective assessments of heuristics surpass the methodological difficulties posed by self-report questionnaires. Finally, greater experience in the medical field might lead to errors due to the overconfidence experienced by more experienced physicians compared to younger ones. Limitations of the current research include the small research sample and the lack of equal gender representation. Future research would be worthwhile to explore heuristic use among a more diverse range of healthcare professionals, such as psychologists, nurses, as well as health profession students, employing a variety of measurements.

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