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RESEARCH ARTICLE **OPEN ACCESS**

Evaluation of Anxiety Symptoms and Sleep Quality among Patients Undergoing Coronary Angiography

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Abstract:

Background: Patients with cardiovascular disorders often experience poor sleep quality and heightened anxiety. Coronary Angiography (CAG), an invasive procedure used to diagnose and treat cardiovascular conditions, can further impact anxiety levels and sleep quality. This study aimed to examine the relationship between sleep quality and anxiety symptoms in patients undergoing CAG.

Methods: This cross-sectional study included 218 patients undergoing CAG in Shahroud, Iran. Data collection tools included the demographic profile form, Generalized Anxiety Disorder (GAD-7) questionnaires, and the Saint Mary's Hospital Sleep Quality Questionnaire (SMHSQ). The participants were evaluated in the morning and before the angiography. The data were collected through self-reporting using online questionnaires and then analyzed using descriptive and inferential statistics (multivariate linear regression analysis).

Results: The average age of the patients was 60.76 ± 10.55. About half of the subjects reported severe anxiety symptoms and moderate sleep disturbance. Sleep disorder had a significant and direct relationship with the level of anxiety symptoms. Also, variables such as younger age, female gender, lack of secondary support, and lack of health insurance coverage were recognized as factors of higher anxiety ($P < .05$).

Conclusion: The high prevalence of sleep disorders and anxiety symptoms in patients awaiting CAG can adversely affect their clinical outcomes. Therefore, implementing strategies to enhance sleep hygiene and alleviate psychological distress is essential, ideally through the collaborative efforts of a multidisciplinary team of healthcare professionals.

Keywords: Anxiety, Coronary angiography, Sleep quality, Health insurance coverage, Questionnaires, Percutaneous coronary intervention.

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1. INTRODUCTION

Although many advances have been made in understanding pathophysiology, risk factors, and technologies for diagnosing and treating cardiovascular diseases in recent years, Coronary Artery Disease (CAD) is still the leading cause of death worldwide [1]. The American Heart Association states that cardiovascular diseases cause 17.3 million deaths per year [2]. CAD is a disorder that causes atherosclerotic plaques in the walls of coronary arteries, resulting in the narrowing or blockage of coronary arteries and acute clinical symptoms such as angina pectoris and myocardial infarction [3]. Coronary Angiography (CAG) is a highly accurate coronary artery imaging method for diagnosing cardiovascular diseases. This procedure has been known as the golden standard diagnostic method for CAD [4].

Angiography is an invasive treatment that is typically accompanied by adverse psychological effects such as emotional discomfort and worry [5]. One of the most prevalent mental diseases is anxiety. It is a natural emotional response to mental pressure that presents itself through psychological and physical symptoms [6]. A high level of anxiety affects all aspects of one's life, lowering the prognosis for patients with CAD and delaying their recovery and length of hospitalization [7, 8]. Waiting for angiography, fear of the cardiac catheterization unit, fear of death, and the side effects of angiography are the leading causes of anxiety symptoms among CAG patients [9]. A rise in anxiety symptoms in cardiovascular patients can have numerous negative impacts on both physical and psychological health. Anxiety feelings in individuals with cardiovascular illness are typically connected with vascular endothelial dysfunction, higher heart and breathing rates, high blood pressure, and a consequent decline in immunity [10]. According to the literature review, one of the factors contributing to the anxiety in angiography patients is a decrease in sleep quality [11]. Therefore, controlling anxiety in CAG patients is crucial due to its direct impact on cardiovascular function and procedural outcomes. Increased anxiety can elevate heart rate, blood pressure, and vascular resistance, thereby raising the risk of perioperative complications. Furthermore, unmanaged anxiety may impair patient cooperation during the procedure, potentially extending the duration of the CAG and affecting diagnostic accuracy [12]. In addition to its immediate effects, anxiety has been associated with longer hospital stays, delayed recovery, and a poorer quality of life following the procedure. Therefore, addressing anxiety not only enhances patient comfort but also contributes to improved cardiovascular outcomes and overall well-being [13].

Sleep quality refers to a person's sleep experience. It can be measured objectively (*via* a set of indicators such as awakenings, amounts and percentages of sleep stages, rapid eye movement delay, number of apneas or hypopneas, and periodic sleep movements measured by polysomnography or actigraphy) or subjectively (*via* sleep diaries or self-reported surveys) [14]. Patients' exposure to noise, light, and numerous procedures in the intensive care unit increases nightly awakenings, resulting in poor sleep quality (a typical stressor in cardiac care units), decreased daily energy levels, depressed symptoms, as well as exhaustion [15, 16]. Furthermore, new research has shown that poor sleep quality increases sympathetic activity, blood pressure, and heart rate, which can be linked to more severe coronary artery damage, systemic inflammation, and endothelial problems [17]. Öneği *et al*. (2021) found that patients receiving CAG have poor sleep quality and significant exhaustion as a result of a variety of causes. The causes of poor sleep quality in hospitalized patients must be identified, and appropriate therapies must be implemented [16]. According to Lewandowska *et al*. (2020), patients in intensive care units blame their sleep issues on factors such as separation from loved ones, anxiety about seeing the deaths of others, misunderstandings over medical language and equipment alarms, and an inability to adapt to the new environment [18]. Earlier studies have shown that patients with cardiovascular disorders, particularly those undergoing angiography, frequently have a range of sleep disturbances, including apnea, insomnia, and frequent awakenings [19, 20].

Given the importance of excellent sleep quality and mental distress control, such as anxiety symptoms, in cardiovascular disorders, the present study investigated the relationship between anxiety symptoms, sleep quality, and other parameters in CAG patients.

2. METHODS AND MATERIALS

2.1. Study Design and Settings

This cross-sectional study was conducted from February to August 2023 at Imam Hossein Hospital in Shahroud, Iran. After securing the appropriate permissions, 218 qualified patients undergoing CAG were selected using the convenience sampling method under conditions as similar as possible in terms of patient care, light control, sound control, and traffic in the morning and before the angiography [16]. Participants were required to be over 18 years old, able to read and write, with established hearing and speaking abilities, and have a confirmed diagnosis of Coronary Artery Disease (CAD) based on cardiology examinations and paraclinical tests. Exclusion criteria were designed to minimize confounding factors that could influence physiological and psychological responses during the procedure. Patients were excluded if they experienced severe pain that interfered with sleep, required emergency angiography, or had taken sedative medications within one hour prior to the procedure. Furthermore, individuals who consumed alcohol, caffeine, or smoked were excluded, as these substances can impact cardiovascular responses, anxiety levels, and hemodynamic stability, potentially influencing study outcomes. A history of bleeding disorders was also an exclusion criterion due to the increased risk of complications during Coronary Angiography (CAG) [5]. Moreover, patients with severe mental illness (diagnosed by a psychiatrist) or those on neuroleptic medications were excluded to avoid variability in psychological

responses that could affect the study's results.Therefore, two participants were excluded due to neuroleptic drug use, leaving a total of 218 patients assessed.

2.2. Tools

This study used the Generalized Anxiety Disorder (GAD) questionnaire, a Saint Mary Hospital Sleep Quality Index, and a demographics questionnaire to collect its data. Only those who could read and write were required to take part.

The St. Mary's Hospital Sleep Questionnaire was created by Ellis in 1981. Those having trouble falling asleep, staying asleep, waking up in the middle of the night, or getting up too early are all investigated by the aforementioned instrument. This questionnaire has a scoring range of 11-44, with 1 being a “never” response, 2 a “very little” response, 3 a “slightly” response, and 4 a “lot” response. The lowest sleep disorder score is 11, indicating no sleep disturbance. The highest score is 44, indicating the most severe level of sleep disorder. Mild sleep disturbance is indicated by a score of 11–21, moderate by 22–32, and severe by 33–44. This questionnaire has been published in the previous study [21]. Moeini *et al.* evaluated the reliability of the Persian version of the questionnaire using Cronbach's alpha equal to 91% [22].

Spitzer *et al.* (2006) developed the Generalized Anxiety Disorder questionnaire (GAD-7). This questionnaire consists of seven questions graded on a four-point Likert scale beginning at zero (never = 0, some days = 1, more than half the time = 2, and nearly every day = 3). The minimum and maximum possible scores are 0 and 21, respectively. The higher the score on this questionnaire, the greater the anxiety level of the respondents. This questionnaire has a threshold score of 10, thus a score of 10 or higher shows the presence of anxiety in individuals. Further information about this questionnaire has been presented in the recently published study [23]. The internal consistency of the Persian version of this questionnaire in the study by Hasanpour *et al.* (2021) was assessed using Cronbach's alpha, which was 0.86 [24].

2.3. Sample Size

The sample size based on the anxiety variable is 189 participants. According to the study by Ivziku *et al.* conducted in 2019 [25], the standard deviation of anxiety is 5.61, taking into account the error of 0.8. It was estimated that 220 persons were determined, with a 15% chance.

2.4. Data Analysis

Finally, the data were analyzed using descriptive (frequency, percentage, mean, and standard deviation) and inferential statistics tests (Pearson correlation coefficient and the multiple linear regression analysis) in SPSS software. To evaluate the normality of quantitative variables, particularly anxiety as the dependent variable in the linear regression analysis, the Kolmogorov-Smirnov test was conducted. Results indicated that all quantitative variables followed a normal distribution ($P > 0.05$). Univariate linear regression analyses were first performed individually for each variable. Variables with a significance level of less than 0.2 were then included in the multiple linear regression model. In order to perform statistical tests, a significance level of less than 0.05 was considered.

2.5. Ethics

In the current study, after discussing the objectives and nature of the study, each subject provided informed consent to participate in the study. They were provided with all of the essential information on confidentiality and the option to withdraw from the study. Taking into account all ethical factors, the current study has been accepted by the Shahroud University of Medical Sciences Ethics Council with the code (IR.SHMU.REC.1401.163).

3. RESULTS

The results showed that 123 patients (56.4%) were male, and about a quarter (55 people) were freelancers. Also, 137 patients (62.8%) had no previous history of CAG. The average age of the patients was 60.76 ± 10.55. Additional results are listed in Table **1**.

Table 1. Demographic characteristics of patients.

Variables		n (%)
Gender	Male	123 (56.4)
	Female	95 (43.6)
Marital status	Married	197 (90.4)
	Single	21 (9.6)
Educational level	Secondary school	159 (72.9)
	High School	39 (17.9)
	Academic degree	20 (9.2)
Employment status	Unemployed	8 (3.7)
	Self employed	55 (25.2)
	Employed	10 (4.6)
	Retired	56 (25.7)
	Housewife	89 (40.8)

(Table 1) contd.....

Variables		n (%)
History of CAG	Yes	81 (37.2)
	No	137 (62.8)
Coverage by supportive organizations	Yes	26 (11.9)
	No	192 (88.1)
Health insurance coverage	Yes	163 (74.8)
	No	55 (25.2)
		Mean (SD)
Age (years)		60.76 (10.55)

N: frequency; %:percent; SD: Standard deviation; CAG: Coronary angiography

Table 2. Levels of sleep disturbance and anxiety symptoms among participants.

Variables		n (%)
Sleep disturbance	Low	75 (34.4)
	Moderate	108 (49.5)
	Severe	35 (16.1)
Anxiety symptoms	Low	104 (47.7)
	High *	114 (52.3)

N: frequency; %:percent; *: defined as patients who scored ≥ 10 points;

According to the findings of the current study, 34.4, 49.5, and 16.1% of patients had mild, moderate, or severe sleep disorders, respectively. Also, almost half of the participants (114) had severe anxiety symptoms. Table **2** provides further details.

The Kolmogorov-Smirnov test confirmed that the mean anxiety score was normally distributed ($p = 0.193$). Pearson's correlation analysis revealed a positive and significant relationship between the mean anxiety score and sleep disturbances ($r = 0.289$, $p < 0.001$). A backward multivariable linear regression model revealed that the variables inside the model explain 29% of the variance in people's anxiety scores. According to this, each unit increase in the sleep disorder score raises the average anxiety level by 0.239 units. The anxiety in female patients increased by 2.046 units when compared to male patients. The average anxiety score drops by 0.063 with each year of age. Also, being assisted by support organizations and health insurance reduces the average anxiety score by 1.983 and 4.335 units, respectively (Table **3**).

4. DISCUSSION

Patients hospitalized in the cardiac care unit most frequently suffer from sleep disorders and anxiety [11]. Most patients with cardiovascular disorders experience anxiety before undergoing CAG as a treatment method because of the procedure's invasive nature [26]. This study aimed to examine the connection between CAG patients' anxiety symptoms and their sleep quality. The current study's preliminary findings indicated that approximately 50% of the study participants showed significant levels of anxiety. A study conducted by Uzun *et al.* in 2008 found that people's typical and observable levels of anxiety prior to angiography were roughly average [27]. In addition, a study conducted by Shohani *et al.* in 2018 found that most CAG patients experienced at least moderate levels of anxiety [28]. However, Asgari *et al.* (2019) showed that before CAG, about half of the participants reported feeling mild anxiety and about 40% felt moderate anxiety [26]. The current study's smaller sample size and use of the GAD-7 tool instead of the Spielberger State-Trait Anxiety Inventory (STAI), which was used in all of the aforementioned studies, may explain the discrepancy.

According to the current study's findings, half of the studied subjects had a moderate level of sleep disorder, which is consistent with the findings of a study conducted by Rafi *et al.* in 2020 [29]. Previous research by Onegi *et al.* conducted in 2021 found that angiography patients, on average, had fairly poor sleep [16]. In this present study, patients were assessed before undergoing angiography, which may account for the differences in findings compared to previous research where evaluations were conducted post-angiography and after hospitalization in the cardiac intensive care unit. It is important to note that a significant proportion of patients with Coronary Artery Disease (CAD) who undergo Percutaneous Coronary Intervention (PCI) experience declines in both physical and mental health, negatively impacting their sleep quality. A study conducted by Liu *et al.* in 2018 found that sleep disorders, depression, and anxiety were common during the final month of hospitalization among elderly patients undergoing PCI, with the severity of psychological symptoms (depression and anxiety) showing an inverse relationship with both sleep quality and overall quality of life [30]. Furthermore, having a prior history of sleep disorder prior to admission to the hospital or poor sleep quality in patients during hospitalization (due to factors such as ward noise and changing the patient's resting place) may worsen these people's clinical prognosis [31]. For example, a study conducted by Lushan *et al.* in 2022 found that there was a significant increase in the slow-flow phenomenon during PCI in patients who had sleep disorders prior to their hospitalization [32].

Table 3. The role of independent variables on anxiety in patients based on the multivariate regression method.

Variables	-	β	SE	t	P-value
Constant value		15.442	2.222	6.950	< 0.001
Sleep disturbance		0.239	0.059	4.087	< 0.001
Age		-0.063	0.028	-2.247	0.026
Gender	Male	Reference			
	Female	2.046	0.592	6.459	0.001
Health insurance coverage	Yes	Reference			
	No	4.335	0.667	-6.503	< 0.001
Coverage by supportive organizations	Yes	Reference			
	No	-1.983	0.901	-2.201	0.029

SE: Standard error.

Due to the invasive nature of CAG, the patient may experience emotional distress, such as anxiety [5]. The current study found that hospital sleep disorders were a predictor of more severe anxiety symptoms in patients prior to PCI. According to the study by Liu *et al*. conducted in 2018, the severity of a person's sleep disorder is correlated with the severity of their anxiety symptoms [30]. The connection between sleep disturbances and anxiety varies between the general population and patients undergoing Coronary Angiography (CAG) due to differing psychological and physiological influences. In the general population, sleep problems often stem from chronic stress, lifestyle habits, and underlying mental health conditions, which can gradually increase anxiety levels [33]. In contrast, CAG patients typically experience sleep disturbances triggered by acute procedural anxiety, fear of diagnostic results, and concerns about the invasiveness of the procedure. The anticipation of serious health outcomes amplifies anxiety, leading to a cycle of poor sleep and increased distress. Physiological factors, such as heightened cortisol levels and autonomic dysfunction, may further intensify this relationship in cardiac patients, highlighting the need for targeted strategies to manage anxiety and sleep disturbances before CAG [34]. Insomnia, a form of sleep disorder, was found to be an independent risk factor for high preoperative anxiety in a study conducted by Li *et al*. in 2021, supporting the current finding [35]. The cultural and healthcare context in Iran likely influenced the anxiety levels and sleep disturbances observed in this study. In Iranian society, strong family involvement in patient care and cultural perceptions of illness can shape how patients experience and cope with anxiety [36]. Furthermore, differences in healthcare practices (such as the extent of pre-procedure counseling and patient education) may affect patients' psychological responses, potentially leading to variations in anxiety and sleep patterns compared to populations in other healthcare settings [37].

Sleep disorders, particularly insomnia, can cause or aggravate anxiety symptoms [38]. Low sleep quality is physiologically regarded as a stressful factor because it raises the heart rate, breathing rate, blood pressure, and ultimately, the heart's need for oxygen *via* excessive catecholamine secretion, which can lead to heart rhythm disorders, ischemia, and postoperative complications [39]. Sleep disorders play a role in psychopathology and can help identify the biopsychological basis for experiencing symptoms or suffering from anxiety disorders. A meta-analysis found that people with anxiety disorders or anxiety symptoms were more likely to have mental sleep disorders, were less likely to get enough sleep overall, and were less likely to get deep sleep [40]. It is worth noting that the inverse is also true: pre-op insomnia can be a result of a patient's experiencing psychological distress like anxiety or depression. Insomnia prior to surgery is negatively impacted by pain and anxiety, as demonstrated by Sun *et al*. in 2021 [41].

This study's findings showed that women, in comparison to men, experienced more anxiety before CAG. In accordance with this result, a study by Asgari *et al*. in 2019 confirmed a similar finding in CAG candidate patients [26]. A study conducted by Mommersteeg *et al*. in 2017 found that women with nonobstructive CAD reported higher rates of psychological distress than men [42]. One of the independent risk factors for high preoperative anxiety was found to be female gender, according to the previous research [35]. Women understand negative emotions better than men and are more affected by them, which may explain this finding. Women are predicted to experience more anxiety symptoms than men in these situations because patients describe anxiety in the therapeutic environment as an unpleasant mental state of the unknown regarding diagnostic methods, treatment, and consequences. One possible explanation for the disparity in anxiety levels between sexes is that men and women deal with stress in different ways [43].

The results of this study indicated that participants' anxiety decreased with age. Abensur Vuillaume *et al*. (2022) confirmed a similar conclusion regarding anxiety during angiography [44]. In addition, another study by Ghods *et al*. conducted in 2019)revealed that the anxiety of patients undergoing coronary artery bypass surgery decreased with increasing age [45]. This finding suggests that the angiographic procedure may affect young people disproportionately. When admitted to cardiac intensive care units, it may be easier for older adults to maintain high-quality social contact than it is for younger adults. In addition to having greater experience and more effective emotional coping strategies for a variety of stressors,

older people also have superior emotional regulation. Folkman *et al.* (1987) found that age differences are effective in individuals' coping with stressful situations; therefore, younger adults seek interpersonal social support, whereas older adults use emotion-focused intrapersonal coping [46].

People who were covered by health insurance and supported by organizations reported significantly fewer anxiety symptoms, according to additional findings of this study. In this regard, a study by Tel *et al.* conducted in 2011 demonstrated that patients with health insurance had significantly fewer anxiety symptoms prior to angiography [47]. In accordance with the findings of the present study, those without health insurance tend to experience economic strain, which may manifest as psychological symptoms such as anxiety and depression [48]. Due to the costs of hospitalization and, in some cases, their poor economic conditions, it should be noted that patients or their families require economic support, and if necessary, they should be covered by these supports (evidence of being covered by insurance or even being supported by support organizations such as non-governmental organization (NGO), welfare, and charity). Therefore, as a study by Pourghane *et al.* conducted in 2018 confirmed the above evidence, people's worries due to a lack of access to appropriate and desirable treatment services will manifest as anxiety symptoms or provoke and exacerbate anxiety symptoms if such resources are unavailable [49].

One key limitation of this study is its cross-sectional design, which limits causal inferences between anxiety and sleep disturbances in patients undergoing CAG. While the findings offer valuable insights, they capture data at a single time point. Future longitudinal studies could better track how anxiety and sleep patterns evolve before, during, and after CAG, providing stronger causal evidence and guiding interventions. Another limitation is the lack of analysis of sociocultural factors contributing to higher anxiety levels in women. Cultural expectations, gender roles, and societal pressures may influence anxiety but were not examined in this study. Future research should explore these factors to better understand gender disparities and develop targeted interventions. The reliance on self-reported measures for anxiety and sleep disturbances may introduce bias due to subjective interpretation and social desirability. Future studies should incorporate objective sleep assessments, such as actigraphy or polysomnography, for more accurate evaluations. Additionally, the studydid not account for variables like quality of life, death anxiety, medication use, or pre-existing mental health conditions, which could confound the results. Including these factors in future research would allow for a more comprehensive understanding of anxiety and sleep disturbances in patients undergoing CAG. While the GAD-7 was used to assess anxiety, it primarily focuses on generalized anxiety and may not fully capture situational or procedural anxiety related to CAG. Future studies should consider using tools like the Spielberger State-Trait Anxiety Inventory (STAI) for a more nuanced assessment. The use of convenience sampling from a single hospital in Iran may limit the generalizability of the findings due to cultural and socioeconomic factors. Randomized sampling across multiple centers would enhance external validity. Additionally, exploring interventions such as psychological support, sleep hygiene education, and pharmacological treatments could help develop strategies to reduce anxiety and improve sleep quality. Finally, the study did not assess factors like fear of the procedure, lack of familiarity with the medical team, or anxiety about potential complications, which could influence anxiety levels. Despite these limitations, this study offers valuable insights into the psychological state of CAG patients and highlights the importance of addressing anxiety and sleep disturbances to improve clinical outcomes.

CONCLUSION

There is a notable association between sleep disturbances and anxiety symptoms in patients undergoing CAG. Introducing targeted interventions to enhance sleep hygiene and manage anxiety could significantly improve patients' preoperative well-being. A multidisciplinary approach involving psychiatric nurses, psychiatrists, and psychologists is essential to deliver comprehensive care through psychological support, educational programs, and, when appropriate, complementary therapies.

AUTHORS' CONTRIBUTIONS

The authors confirm their contribution to the paper as follows: study conception and design: F. A., S. H., S. M., H. E., data collection: F. A., S. H., S. M., analysis and interpretation of results: M.H. B., draft manuscript: F. A., S. H., S. M., M.H. B., H. E.. All authors reviewed the results and approved the final version of the manuscript.

LIST OF ABBREVIATIONS

CAG	=	Coronary Angiography
GAD-7	=	7-item Generalized Anxiety Disorder Scale
SMHSQ	=	Saint Mary's Hospital Sleep Quality Questionnaire
CAD	=	Coronary Artery Disease
STAI	=	Spielberger State-trait Anxiety Inventory
PCI	=	Percutaneous Coronary Intervention
NGO	=	Non-Governmental Organization

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study has been approved by the Shahroud University of Medical Sciences Ethics Council, Iran with the code (IR.SHMU.REC.1401.163).

HUMAN AND ANIMAL RIGHTS

This study adhered to the principles outlined in the Declaration of Helsinki, ensuring participants' rights to freely engage in the research, avoidance of harm, the right to withdraw from the study, and preservation of data confidentiality.

CONSENT FOR PUBLICATION

Informed consent was obtained from participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The raw data and materials supporting the findings of this study are available from the corresponding author [S.M] upon reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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