



Effect of Kolcaba's Comfort Intervention on Perceived Stress and Tolerance in Coronary Angiography: A Quasi-Experimental Study

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Abstract

Background: Coronary angiography is a common procedure for the diagnosis and treatment of cardiovascular diseases; however, it often causes substantial stress and anxiety among patients. These psychological responses can reduce patient comfort and procedural tolerance, underscoring the need for nursing strategies to improve the quality of care.

Objectives: This study investigated the effects of a nursing intervention based on Kolcaba's Comfort Theory on perceived stress, comfort, and tolerance in patients undergoing coronary angiography at a hospital affiliated with Shahrekord University of Medical Sciences in 2024.

Methods: In this two-group quasi-experimental study, conducted over 6 months in the cardiology department and angiography unit of Hajar Educational Hospital, affiliated with Shahrekord University of Medical Sciences, 80 participants were selected using convenience sampling and then allocated to the intervention and control groups using a computer-generated random sequence. Data were collected using four instruments: a demographic questionnaire, the Perceived Stress Scale, the Visual Analogue Scale (VAS) to measure patient comfort, and a tolerability assessment scale. The intervention, based on Kolcaba's Comfort Theory, consisted of four 30-minute sessions addressing the physical, psychospiritual, sociocultural, and environmental dimensions of comfort. Data were analyzed using descriptive and inferential statistics with SPSS version 22.

Results: After the care intervention and coronary angiography, the mean perceived stress scores were 48.6 ± 5.76 in the control group and 45.28 ± 6.06 in the intervention group. An independent t-test indicated a statistically significant difference between the groups ($P < 0.01$). After the care intervention and coronary angiography, the mean comfort scores were 2.9 ± 0.55 in the control group and 3.65 ± 1.01 in the intervention group. An independent t-test indicated a statistically significant difference between the groups ($P < 0.01$). The mean $\pm$ standard deviation (SD) tolerance score during the procedure was 10.80 ± 0.73 in the intervention group and 8.77 ± 1.61 in the control group. After the procedure, the mean $\pm$ SD tolerance score was 10.78 ± 2.17 in the intervention group and 8.86 ± 2.00 in the control group. An independent t-test demonstrated a statistically significant difference between the groups at both time points ($P < 0.001$).

Conclusions: Nursing interventions for patients undergoing invasive procedures, such as angiography, based on Kolcaba's nursing model facilitate greater acceptance of the procedure, thereby providing a foundation for reduced stress and improved comfort during the procedure.

Keywords: Coronary Angiography, Perceived Stress, Comfort, Tolerability, Patient Tolerability

1. Background

Cardiovascular diseases are widely recognized as the leading cause of death worldwide, accounting for approximately 30% of global mortality (1, 2). Over the past 4 decades, the prevalence of heart disease among adults has increased fourfold and now affects approximately 10% of the population; in the United States alone, cardiovascular disease was responsible for 659,041 deaths in 2019, making it the leading cause of death in the country (3).

Various noninvasive and invasive methods are used to assess the severity and extent of coronary artery involvement; however, coronary angiography remains the gold standard for diagnosing coronary artery disease (4) and is one of the most common and reliable diagnostic techniques for cardiac conditions (5). Since its introduction in the 1940s, the role of coronary angiography in elucidating cardiac anatomy, circulation, physiology, and pathology has been clinically validated, and it is particularly superior to electrocardiography,

echocardiography, and thallium scanning when cardiac surgery is indicated (6).

Despite its numerous advantages in diagnosing coronary artery disease, coronary angiography poses substantial challenges for patients, including anxiety and stress (7, 8). Candidates for surgery and invasive procedures experience a preprocedural state that predisposes them to severe anxiety and stress, with substantial psychological effects and adverse physiological consequences. Therefore, various pharmacological and nonpharmacological interventions are used to manage this situation (9). Furthermore, invasive procedures, whether diagnostic, such as coronary angiography, or therapeutic, such as cardiac surgery, are associated with multiple stressors, including pain, anxiety, fear of the unknown, enforced immobility, and separation from family, all of which can substantially reduce patient comfort (10).

In this context, nurses, who are essential members of the treatment team and spend more time with patients than other health care professionals, should be able to use low-cost, accessible interventions to enhance patient comfort and tolerance while reducing stress. One such intervention is the application of nursing theories. Kolcaba's Comfort Theory, a nursing theoretical framework developed by Katharine Kolcaba in the 1990s, centers on comfort as the fundamental goal and outcome of nursing care. By providing a comprehensive and holistic framework, Kolcaba's Comfort Model enables nurses to identify and address patient needs across four dimensions—physical, psychospiritual, sociocultural, and environmental—extending beyond the management of physical symptoms to promote ease, relief from discomfort, and transcendence (11). This model defines comfort as the outcome of addressing an individual's needs and creating relaxation through the integration of these four dimensions, thereby providing a foundation for supporting the individual in overcoming problems (12).

According to Momeni et al., nursing care based on Kolcaba's Comfort Theory is highly practical in pediatric departments for increasing the comfort of children and their families (13), while Seyedfatemi et al. found that the use of Kolcaba's Comfort Care Model was associated with reduced anxiety among children undergoing endoscopy. Research findings have further demonstrated that the application of the Comfort Model not only reduces stress but also increases patient tolerance during procedures (14). In addition, a randomized controlled trial of patients undergoing open-heart valve surgery showed that Kolcaba-based care significantly enhanced overall patient comfort and reduced pain intensity (15).

The primary goal of nursing care is to promote individual comfort and well-being, and a comfort-based care model can effectively support this objective. Nursing strives to achieve comfort as an essential, reinforcing process for recovery. Implementing Kolcaba's Model transforms care from a merely task-oriented approach into a patient-centered, holistic process, contributing not only to improved clinical outcomes, such as fewer complications and shorter hospital stays, but also to enhanced quality of care and patient satisfaction (16).

2. Objectives

To address the question of the effectiveness of a care model based on Kolcaba's framework in invasive cardiac procedures, this study examined the effects of a nursing intervention grounded in the Comfort Model on perceived stress, comfort, and tolerance among patients undergoing coronary angiography at the Angiography Center of Hajar Hospital, affiliated with Shahrekord University of Medical Sciences.

3. Methods

3.1. Study Design and Setting

This quasi-experimental study was conducted among candidates for coronary angiography at a hospital affiliated with Shahrekord University of Medical Sciences during 2024 - 2025 (Iranian calendar year 1403).

3.2. Participants and Sampling

Based on the following formula, a type I error (alpha) of 0.01, a type II error (beta) of 0.05, and the findings of Aksoy Darya et al., who reported a 7-point difference in mean comfort scores between the intervention and control groups after the intervention, with standard deviations of 8.79 and 9.30, respectively, the minimum required sample size was calculated as 35 participants per group. After accounting for a 20% attrition rate, the sample size was increased to 40 participants per group (17).

$$N = \frac{(s_1^2 + s_2^2)(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

Initially, participants were recruited using convenience sampling. All patients who were scheduled for coronary angiography by the cardiologist collaborating with the research team and who met the eligibility criteria were invited to participate. After providing informed consent and enrollment, participants were randomly assigned to

the intervention or control group using a computer-generated randomization sequence. The randomization sequence was generated independently of participant recruitment, and allocation concealment was ensured using sequentially numbered, opaque, sealed envelopes. After enrollment, the appropriate envelope was opened by a member of the research team who was not involved in outcome assessment, and the participant was assigned to the group specified in the envelope. Randomization continued until the predetermined sample size of 80 participants (40 per group) was reached. To minimize potential confounding related to procedure timing, coronary angiography for the two groups was performed during comparable time periods but on different days, with the intervention group undergoing the procedure on odd-numbered days and the control group on even-numbered days. Both groups received care in the same angiography unit and were managed by the same clinical team.

3.3. Inclusion and Exclusion Criteria

All inpatients and outpatients scheduled for coronary angiography and on the waiting list for the procedure were assessed for eligibility. The inclusion criteria were literacy, defined as the ability to read and write; voluntary agreement to participate and provision of written informed consent; no previous coronary angiography; no impaired level of consciousness; nonemergency angiography; and angiography performed through the radial artery (transradial approach). Patients were excluded if they did not cooperate with the research team, experienced deterioration of their clinical condition during angiography, died, or did not undergo the angiography procedure. No additional limitations were imposed on case selection, and all eligible patients were included without restriction.

3.4. Data Collection and Instruments

Data were collected using four instruments: a demographic questionnaire, the Perceived Stress Scale, the Visual Analogue Scale (VAS) for measuring patient comfort, and a tolerability assessment scale.

3.4.1. Perceived Stress Scale

The Perceived Stress Scale was developed in 1983 by Cohen, Kamarck, and Mermelstein. Each item is answered using a 5-point Likert scale ranging from "never" to "very often," with response options scored as 0, 1, 2, 3, and 4, respectively. The scale comprises two subscales: 1) the negative perception of stress subscale, including items 1, 2, 3, 4, 11, 12, and 14; and 2) the positive perception of stress

subscale, including items 5, 6, 7, 8, 9, 10, and 13, which are reverse-scored. The Perceived Stress Scale assesses the extent to which individuals perceive situations in their lives as stressful. Internal consistency reliability coefficients, measured using Cronbach's alpha, have been reported to range from 0.84 to 0.86 among two groups of students and one group of smokers in a cessation program.

In the study by Ahmadian, item analysis yielded correlation coefficients ranging from 0.49 to 0.70 for the positive perception of stress and from 0.52 to 0.77 for the negative perception of stress. Correlation coefficients for the total Perceived Stress Scale items ranged from 0.51 to 0.78.

3.4.2. Comfort Visual Analogue Scale

The VAS for measuring comfort consists of a 10-cm horizontal line, with each end representing an opposing state. For example, "the worst imaginable comfort" is described at one end and "the best imaginable comfort" at the other.

Patients are instructed to mark a point on the line corresponding to their perceived level of comfort at that moment. The score is determined by measuring the distance, in millimeters, from the marked point to the left end of the line, which represents "the worst imaginable comfort." Scores range from 0 to 100. A score of 0 indicates the worst imaginable comfort, or maximum discomfort, whereas a score of 100 indicates the best imaginable comfort, or maximum comfort. Thus, higher scores reflect greater comfort and less discomfort, whereas lower scores indicate less comfort and greater discomfort.

This scale was developed by Kolcaba to assess patient comfort (18). It has been widely used in various studies, and its validity and reliability have been well established (19).

3.4.3. PRO-STEP Scale

The PRO-STEP standard scale was developed and validated by Forbes and colleagues in 2021 and demonstrates acceptable psychometric properties. PRO-STEP is specifically designed to assess a patient's physical tolerability during and after an invasive procedure. The instrument consists of six items across two main domains. The intraprocedural domain includes two items assessing discomfort and pain and awareness and consciousness during the procedure. The postprocedural domain includes four items assessing pain, nausea, bloating and abdominal distention, and throat pain. Each item is rated on a 10-point Likert scale ranging from 0 to 10. The final score for each domain or the total score is calculated as the sum or mean of the item scores, with higher scores indicating worse tolerability and greater discomfort. The

psychometric properties of the instrument were evaluated in an initial study involving 255 patients undergoing colonoscopy, gastroscopy, and endoscopic retrograde cholangiopancreatography (ERCP), with satisfactory results. Internal consistency was assessed using Cronbach's alpha, and consistency between the two intraprocedural domain items, awareness and discomfort, was reported as 0.71, which is considered acceptable (20).

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Each of the six items is rated on a 10-point Likert scale ranging from 0 to 10, where 0 indicates the worst tolerability, that is, the greatest discomfort and intolerance, and 10 indicates the best tolerability, that is, the least discomfort and complete tolerability. The score for each domain is calculated as the mean of the item scores within that domain, and the total scale score is calculated as the mean of all six item scores. Accordingly, a higher score indicates better tolerability and less discomfort, whereas a lower score indicates worse tolerability and greater discomfort. The psychometric properties of the instrument were evaluated in an initial study involving 255 patients undergoing colonoscopy, gastroscopy, and ERCP, with satisfactory results. Internal consistency was assessed using Cronbach's alpha, and consistency between the two intraprocedural domain items, awareness and discomfort, was reported as 0.71, which is considered acceptable (20).

3.5. Procedure

After approval of the study protocol and receipt of the ethics code and an official authorization letter from the Research and Technology Vice-Chancellery of Shahrekord University of Medical Sciences, the research team coordinated with the hospital admission office, the head of the cardiology ward, and the angiography unit 1 day before the scheduled coronary angiography. The team then met with patients scheduled for coronary angiography, with 6–8 patients per session. An educational video explaining the angiography procedure was shown to participants in the hospital amphitheater. Subsequently, patients were familiarized with the angiography unit, and their questions and concerns were addressed.

On the day of the procedure, in addition to routine care, nursing interventions based on Kolcaba's Comfort Theory were implemented in a calm environment across four dimensions of care—physical, psychospiritual, sociocultural, and environmental—over four 30-minute sessions. In the physical dimension, interventions included monitoring and recording vital signs, positioning the patient comfortably, and providing an appropriate care environment. In the psychospiritual dimension, interventions included active listening, emotional support, positive communication, psychological reassurance, alleviation of fears related to angiography, and family support on the day of the procedure. In the sociocultural dimension, emphasis was placed on establishing trust, providing appropriate information about the diagnostic procedure, and respecting the patient's cultural values. In the environmental dimension, interventions included maintaining a quiet, orderly, and safe environment and controlling ambient lighting and noise to create a calm and comfortable setting.

On the morning of angiography, immediately after admission to the angiography unit, all patient information questionnaires were completed. Thereafter, the care process was continuously monitored and implemented from admission to the unit, throughout the patient's stay, during the procedure, and after completion. All educational, supportive, and follow-up interventions were delivered by the principal investigator, a master's student in nursing.

Participants in the control group received routine preprocedural care in accordance with the standard policies and protocols of the unit. Although these patients were accompanied to the angiography unit by the research team and completed the same questionnaires as the intervention group, the research team acted solely as facilitators of the unit's routine procedures and provided no additional or nonroutine interventions. Participants in the intervention group underwent angiography on even-numbered mornings, whereas those in the control group underwent the procedure on odd-numbered mornings, with procedures performed by the same angiography team. The medical interventions and nursing care provided to both groups were identical. After angiography, the Perceived Stress Scale, Comfort Questionnaire, and Patient Tolerance Questionnaire were completed for participants in both groups by the principal investigator (CONSORT flowchart).

3.6. Statistical Analysis

Descriptive statistics were used to summarize the data. Frequencies and percentages were used for qualitative variables, whereas mean $\pm$ standard deviation was used for

quantitative variables with a normal distribution. Normality was assessed using the Kolmogorov-Smirnov test. Fisher's exact test and the chi-square test were used to compare qualitative variables between groups, whereas independent-samples t-tests and paired t-tests were used for normally distributed quantitative variables. In all tests, $P < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS version 22.

3.7. Ethical Considerations

The study protocol was approved by the institutional ethics committee of Shahrekord University of Medical Sciences (Approval Code: IR.SKUMS.REC.1402.130). Participants voluntarily agreed to participate and provided written informed consent.

4. Results

4.1. Sample Characteristics

In the intervention group, 37.5% of participants were aged 50 - 59 years, whereas 52.5% of participants in the control group were aged 60 - 69 years; however, there was no statistically significant difference between the groups ($P > 0.2$). In the intervention group, 55% of participants were male, whereas in the control group, 52.5% were female; nevertheless, there was no statistically significant difference between the groups ($P > 0.23$). Other demographic variables also showed no meaningful differences, confirming homogeneity between the intervention and control groups (Table 1).

4.2. Perceived Stress

Before the intervention, mean perceived stress scores were 47.05 ± 4.707 in the intervention group and 47.60 ± 6.380 in the control group, with no meaningful difference ($P > 0.662$). After the intervention, the scores were 45.28 ± 6.068 and 48.60 ± 5.768 , respectively, indicating a meaningful difference ($P > 0.014$). The paired t-test showed that the mean perceived stress score in the intervention group decreased significantly from before angiography to after angiography ($P < 0.03$), whereas the change in the control group was not significant ($P > 0.06$) (Table 2).

4.3. Comfort

Before angiography, the mean comfort score was 3.58 ± 1.083 in the intervention group and 3.05 ± 1.037 in the control group. After angiography, these scores changed to 3.65 ± 1.001 and 2.90 ± 0.955 , respectively, indicating a meaningful difference between the groups ($P > 0.001$). The paired t-test showed that the mean comfort score in the

intervention group increased significantly from before angiography to after angiography ($P < 0.001$), whereas in the control group, the change was also significant, as the mean comfort score decreased ($P < 0.001$) (Table 3).

4.4. Tolerance

During angiography, tolerance scores were 8.77 ± 1.61 in the control group and 10.8 ± 2.49 in the intervention group, indicating a meaningful difference between the groups ($P < 0.001$). After angiography, the scores were 8.86 ± 2.19 and 10.78 ± 2.17 in the control and intervention groups, respectively, indicating a meaningful difference ($P > 0.01$). The paired t-test showed that the mean tolerance scores in the intervention and control groups did not change significantly from during angiography to after angiography ($P > 0.05$) (Table 4).

5. Discussion

The findings of the present study demonstrated that a nursing intervention based on Kolcaba's Comfort Theory significantly reduced perceived stress among patients undergoing coronary angiography. Specifically, the mean perceived stress score decreased significantly in the intervention group compared with the control group ($P < 0.05$).

The findings of Sarac et al. indicate that postangiography comfort is significantly influenced by high levels of preprocedural fear and anxiety. Consequently, anxiety management and individualized preangiography care can enhance patient comfort and overall procedural ease (21). Similarly, another studies confirmed the effectiveness of Kolcaba's comfort-based care model in reducing anxiety and stress among patients undergoing invasive procedures. Furthermore, Liu et al. investigated children undergoing strabismus surgery and demonstrated that nursing care guided by Kolcaba's Comfort Theory significantly reduced preoperative anxiety and stabilized physiological stress responses. The authors concluded that nursing interventions based on the Kolcaba model can reduce anxiety levels and improve patients' mental health (22).

The positive effects of nursing interventions grounded in Kolcaba's Comfort Theory may be attributable to their capacity to enhance physical and psychological comfort, mitigate fear of the unknown, foster a greater sense of control, reduce the secretion of stress-related hormones, and redirect patients' attention away from negative rumination. Moreover, Kolcaba's holistic approach facilitates comprehensive patient care by addressing multiple dimensions of comfort, thereby alleviating psychological distress and enhancing the overall

Table 1. Demographic Characteristics of the Study Participants ^a

Variables	Intervention	Control	P-Value
Sex			0.23
Male	22 (55)	19 (47.5)	
Female	18 (45)	21 (52.5)	
Marital status			0.1 ^b
Single	4 (10)	7 (17.5)	
Married	36 (90)	33 (82.5)	
Hypertension			0.6 ^b
Yes	26 (65)	28 (70)	
No	14 (35)	12 (30)	
Total	40 (100)	40 (100)	
Age, y			0.2 ^c
30 - 39	3 (7.5)	2 (5)	
40 - 49	10 (25)	5 (12.5)	
50 - 59	15 (37.5)	12 (30)	
60 - 69	12 (30)	21 (52.5)	
Total	40 (100)	40 (100)	

^a Values are expressed as No. (%).^b Fisher's exact test.^c Chi-squared test.**Table 2.** Mean and Standard Deviation of Perceived Stress Scores in the Intervention and Control Groups ^a

Stage	Intervention	Control	Independent t-Test P-Value
Before angiography	47.05 ± 4.70	47.60 ± 6.38	0.662
After angiography	45.28 ± 6.06	48.60 ± 5.76	0.014
Paired t-test P-value	0.03	0.06	

^a Values are expressed as Mean ± SD.**Table 3.** Mean and Standard Deviation of Comfort Scores in the Intervention and Control Groups. ^a

Stage	Intervention	Control	Independent t-Test P-Value
Before angiography	3.58 ± 1.08	3.05 ± 1.03	0.03
After angiography	3.65 ± 1.01	2.90 ± 0.55	0.001
Paired t-test P-value	0.001	0.01	

^a Values are expressed as Mean ± SD.

effectiveness of nursing care. The consistency of these findings with the present study supports the applicability of Kolcaba's Comfort Theory across diverse clinical settings and cultural contexts. Nevertheless, variations in reported effect sizes may be attributable to differences in patient characteristics, such as age, sex, and educational level; the severity of the underlying disease; previous familiarity with angiography; fidelity of intervention implementation

by nursing staff; and instruments used to assess perceived stress.

Comparison of mean comfort scores between the intervention and control groups before and after the intervention showed that comfort levels declined in the control group but increased significantly in the intervention group ($P < 0.01$). These findings indicate the

Table 4. Mean and Standard Deviation of Tolerance Scores in the Intervention and Control Groups ^a

Stage	Intervention	Control	Independent t-Test P-Value
During angiography	10.8 ± 2.49	8.77 ± 1.61	0.001
After angiography	10.78 ± 2.17	8.86 ± 2.19	0.001
Paired t-test P-value	0.55	0.95	

^a Values are expressed as mean ± SD.

substantial effectiveness of the Kolcaba-based nursing intervention in improving patient comfort throughout the diagnostic process.

The present findings are consistent with those reported by Jones, who, in a quasi-experimental study, found that implementing a comfort-based nursing model significantly reduced stress and improved pain tolerance among patients in the intervention group. Likewise, Jafari and Hassanzadeh reported that comfort-oriented nursing interventions significantly enhanced patient comfort. Although no studies with contradictory findings were identified, consistent evidence across previous investigations suggests that implementing nursing care based on a theoretical framework, particularly Kolcaba's Comfort Theory, with its holistic focus on patients' multidimensional needs, effectively addresses the physical, psychological, sociocultural, and environmental needs of hospitalized patients, especially during invasive procedures, thereby promoting comfort (23).

Kolcaba's Comfort Theory delivers care across four domains—physical, psychospiritual, sociocultural, and environmental—which collectively contribute to reducing muscle tension, improving breathing patterns, promoting psychological relaxation, and strengthening patients' sense of control. These effects may subsequently reduce the secretion of stress-related hormones, including cortisol and catecholamines, thereby preventing the accumulation of physiological and psychological tension. This mechanism enhances patients' resilience and adaptive capacity, enabling them to remain calmer when confronted with invasive medical procedures (16).

Comparison of mean tolerance scores between the intervention and control groups during and after the intervention demonstrated that patients in the intervention group had significantly higher tolerance during and after angiography than those in the control group ($P < 0.001$). These findings indicate that nursing care based on Kolcaba's Comfort Theory enhances patients' ability to tolerate procedural pain and procedure-related discomfort during and after coronary angiography.

Several previous studies support these findings. Foroughi and Hosseini, in a randomized controlled trial,

reported that psychological and nursing interventions significantly improved pain tolerance. Similarly, Yousofian and Bahrami, in a quasi-experimental study, demonstrated that the implementation of Comfort Theory significantly increased pain tolerance among patients in the intervention group. Furthermore, Kolcaba reported that interventions grounded in Comfort Theory reduce anxiety and distress while enhancing patients' capacity to tolerate medical and surgical procedures (18).

The observed improvement in patient tolerance may be explained by several complementary mechanisms. By reducing anxiety and perceived stress, comfort-based interventions increase the pain threshold and modulate adverse physiological responses to pain through activation of the parasympathetic nervous system. In addition, promoting psychological relaxation and strengthening patients' sense of control enhance their ability to cope with invasive procedures. Collectively, these mechanisms reduce perceived discomfort and improve overall tolerance during and after coronary angiography.

5.1. Study Limitations

This study has several limitations. First, its single-center design and relatively small sample size restrict the generalizability of the findings to broader clinical settings and patient populations with differing demographic and cultural characteristics. Second, reliance on self-reported outcome measures, combined with the inherent inability to blind participants and nurses to the intervention, may have introduced response bias and may have been influenced by unmeasured patient-specific factors. Future multicenter studies with larger cohorts, longer follow-up periods, and objective physiological indicators of stress are warranted to confirm these results.

5.2. Clinical Application

By implementing a nursing intervention program based on the Comfort Model, nurses can provide comprehensive, holistic care that extends beyond physical care alone. This approach may substantially reduce stress,

improve tolerance, and enhance comfort among patients undergoing coronary angiography.

5.3. Conclusions

Nursing interventions for patients undergoing invasive procedures, such as angiography, based on Kolcaba's nursing model facilitate improved patient acceptance of the procedure, thereby providing a foundation for reduced stress and improved patient comfort during the procedure.

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Footnotes

AI Use Disclosure: deep seek and copilot and mendeley were used for translation and reference support in the introduction and reference[15 - 13] section at a Minor, Minor level.

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