



## Review Article

Online ISSN (3219-2789)

## Psychophysiological Response in Patients Undergoing Percutaneous Coronary Intervention: A Systematic Review and Walker–Avant Concept Analysis

Nonok Karlina<sup>1,2</sup> , Sidik Awaludin<sup>2</sup> , Dewi Erna Marisa<sup>1\*</sup> 

<sup>1</sup>Institut Teknologi dan Kesehatan Mahardika, Cirebon, West Java, Indonesia; <sup>2</sup>Universitas Jendral Soedirman, Central Java, Indonesia

Received: 8 December 2025; Revised: 22 January 2026; Accepted: 4 February 2026

## Abstract

**Background:** Psychological well-being is crucial for breast cancer survivors facing chronic illness and psychosocial challenges, yet psychological well-being remains inconsistently defined in the literature. **Objective:** To clarify the definitions, attributes, antecedents, consequences, and empirical indicators of psychological well-being using the Walker-Avant concept analysis. **Methods:** A systematic literature review was conducted using PubMed, ScienceDirect, Google Scholar, and ProQuest. Empirical and theoretical full-text studies addressing psychological well-being were selected following PRISMA guidelines. Seven articles were analyzed using the eight steps of the Walker-Avant method. **Results:** Key frameworks from Ryff, Ryan and Deci, WHO, Diener et al., Keyes, Zhou et al., and Grassi et al. indicate that psychological well-being is a motivational process characterized by self-acceptance, emotional regulation, adaptive coping, positive social relationships, meaning in life, autonomy, and adaptive capacity. Antecedents include illness perception, early distress, social support, and self-efficacy, while consequences involve positive adaptation, improved quality of life, and emotional stability. **Conclusions:** Psychological well-being is a multidimensional, dynamic construct essential to the adaptation of breast cancer survivors aged 10–25 years and provides a theoretical basis for developing evidence-based nursing interventions to improve mental health and quality of life.

**Keywords:** Concept analysis; PCI; Psychological well-being; Walker and Avant.

الاستجابة النفسية الفسيولوجية لدى المرضى الذين يخضعون لتدخل تاجي عبر الجلد: مراجعة منهجية وتحليل مفاهيم ووكر-أفانت

## الخلاصة

**الخلفية:** الرفاهية النفسية ضرورية للناجين من سرطان الثدي الذين يواجهون أمراضاً مزمنة وتحديات نفسية اجتماعية، ومع ذلك لا تزال الرفاهية النفسية غير محددة بشكل متسق في الأدبيات. **الهدف:** توضيح التعريفات والصفات والسوابق والعواقب والمؤشرات التجريبية للرفاهية النفسية باستخدام تحليل المفاهيم ووكر-أفانت. **الطرق:** أجريت مراجعة أدبيات منهجية باستخدام PubMed و ScienceDirect و Google Scholar و ProQuest. تم اختيار دراسات نصية كاملة تجريبية ونظرية تتناول الرفاهية النفسية وفقاً لإرشادات PRISMA. تم تحليل سبع مقالات باستخدام الخطوات الثمانية لطريقة ووكر-أفانت. **النتائج:** تشير الأطر الرئيسية من ريف، رايان وديسي، منظمة الصحة العالمية، دينر وآخرون، كيز، تشو وآخرون، وغراسي وآخرون إلى أن الرفاهية النفسية هي عملية تحفيزية تتميز بقبول الذات، وتنظيم المشاعر، والتكيف التكيفي، والعلاقات الاجتماعية الإيجابية، والمعنى في الحياة، والاستقلالية، والقدرة التكيفية. تشمل السوابق إدراك المرض، الضيق المبكر، الدعم الاجتماعي، والكفاءة الذاتية، بينما تشمل العواقب التكيف الإيجابي، وتحسين جودة الحياة، والاستقرار العاطفي. **الاستنتاجات:** الرفاهية النفسية هي بناء متعدد الأبعاد وديناميكي ضروري لتكيف الناجين من سرطان الثدي الذين تتراوح أعمارهم بين 10 و 25 عاماً، وتوفر أساساً نظرياً لتطوير تدخلات ترميضية قائمة على الأدلة لتحسين الصحة النفسية وجودة الحياة.

\* **Corresponding author:** Dewi E. Marisa. Institut Teknologi dan Kesehatan Mahardika, Cirebon, West Java, Indonesia; Email: [dewi.erna@mahardika.ac.id](mailto:dewi.erna@mahardika.ac.id)

**Article citation:** Karlina N, Awaludin S, Marisa DE. Psychophysiological Response in Patients Undergoing Percutaneous Coronary Intervention: A Systematic Review and Walker–Avant Concept Analysis. *Al-Rafidain J Med Sci.* 2026;10(1):134-144. doi: <https://doi.org/10.54133/ajms.v10i1.2663>

© 2026 The Author(s). Published by Al-Rafidain University. This is an open access journal issued under the CC BY-NC-SA 4.0 license (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).



## INTRODUCTION

Percutaneous coronary intervention (PCI) is a cornerstone therapy in the management of coronary artery disease (CAD) and acute coronary syndromes, with substantial evidence demonstrating its effectiveness in reducing morbidity and mortality, improving myocardial perfusion, and enhancing survival outcomes [1-3]. As a minimally invasive yet high-stakes cardiovascular procedure, PCI has become a routine intervention in modern cardiology. Nevertheless, from the patient's perspective, undergoing PCI is frequently experienced as a threatening and highly stressful event, particularly during the peri-procedural period encompassing pre-

procedure preparation, catheterization, and early post-procedural recovery [4,5]. During this peri-PCI phase, patients commonly report intense psychological responses, including anxiety, fear of death, uncertainty about procedural outcomes, and a perceived loss of control [6,7]. These psychological reactions are not isolated phenomena but are closely intertwined with physiological stress responses, such as increased heart rate, elevated blood pressure, heightened sympathetic nervous system activity, and activation of neuroendocrine stress pathways [8,9]. The bidirectional interaction between psychological distress and physiological arousal reflects a psychophysiological process that may significantly influence patients' tolerance of the procedure, intra

procedural stability, and early recovery [10-12]. Growing evidence suggests that unmanaged psychophysiological stress during PCI may have clinically meaningful consequences. Elevated anxiety levels have been associated with increased pain perception, hemodynamic instability, prolonged recovery, and reduced engagement in post-PCI treatment and rehabilitation [13,14]. Furthermore, persistent anxiety or depressive symptoms following PCI have been linked to poorer quality of life, suboptimal adherence to secondary prevention strategies, and increased risk of adverse cardiovascular outcomes [15,16]. These findings underscore that psychophysiological responses are not merely transient emotional reactions but integral components of patients' overall adaptation to PCI. From a nursing perspective, understanding psychophysiological responses in PCI patients is particularly important. Nurses are at the forefront of peri-PCI care, responsible for continuous monitoring of vital signs, delivery of procedural information, implementation of anxiety-reducing interventions, and provision of emotional support [17]. Nursing-led interventions such as patient education, therapeutic communication, relaxation techniques, music therapy, and structured psychosocial support have demonstrated potential to attenuate anxiety and stabilize physiological responses during invasive cardiac procedures [18,19]. However, the effectiveness of such interventions depends on a clear conceptual understanding of what constitutes a psychophysiological response and how it evolves throughout the peri-PCI trajectory. Despite increasing research attention, the concept of psychophysiological response in patients undergoing PCI remains inconsistently defined and operationalized across studies. Some investigations focus primarily on psychological outcomes such as anxiety or depression, while others emphasize physiological indicators such as heart rate variability or blood pressure changes, often without integrating these dimensions into a unified conceptual framework [20,21]. This lack of conceptual clarity limits the comparability of findings, hinders the development of standardized assessment tools, and constrains the design of targeted, theory-driven nursing interventions. Therefore, a systematic review combined with a concept analysis is warranted to clarify the meaning, defining attributes, antecedents, consequences, and empirical referents of psychophysiological response in patients undergoing PCI. Employing Walker and Avant's concept analysis method alongside a systematic synthesis of the literature provides a rigorous approach to refining this concept, strengthening its theoretical foundation, and enhancing its applicability to nursing practice and cardiovascular care. Clarifying the concept of psychophysiological response is essential to support holistic, patient-centered peri-PCI care that addresses both psychological and physiological dimensions of patient experience.

## **METHODS**

### ***Study design and setting***

This study utilized two complementary methodological approaches to guarantee conceptual rigor and empirical validation. First, a Systematic Literature Review (SLR) was conducted to identify, critically appraise, and synthesize empirical and theoretical evidence related to psychophysiological responses in patients undergoing percutaneous coronary intervention (PCI) across international studies. The SLR approach was selected because it enables a comprehensive overview of research trends, key psychophysiological variables including psychological distress and physiological stress responses, and determinants influencing patient responses throughout the peri-PCI period. This systematic synthesis provides a robust evidentiary foundation for conceptual clarification and theory development [22,23]. Second, a Walker and Avant concept analysis was applied to clarify the conceptual structure of psychophysiological response in peri-PCI patients by following the eight systematic steps proposed by Walker and Avant: (1) concept selection; (2) determination of the purpose of analysis; (3) identification of all uses of the concept; (4) determination of defining attributes; (5) construction of a model case; (6) development of borderline, related, and contrary cases; (7) identification of antecedents and consequences; and (8) identification of empirical referents [24,25]. The integration of SLR and Walker and Avant concept analysis was undertaken because the SLR provides a strong evidentiary base through systematic synthesis of empirical and conceptual literature, while the Walker and Avant method offers a structured analytical framework to clarify concepts that remain ambiguous or inconsistently defined. In the context of psychophysiological responses to PCI, definitions, attributes, and contributing factors vary considerably across studies, with some emphasizing psychological dimensions (e.g., anxiety and coping) and others focusing on physiological indicators (e.g., autonomic activation and hemodynamic responses). Integrating these methodologies guarantees that the resultant concept is theoretically sound, distinctly defined, and actionable, thereby facilitating subsequent research, nursing evaluation, and the formulation of specific psychosocial and clinical interventions in PCI care [26,27].

### ***Literature search strategy***

The literature search was conducted using three international electronic databases: Scopus, ScienceDirect, and PubMed. These databases were selected due to their comprehensive coverage of high-quality journals in cardiology, nursing, psychology, and health sciences, which are relevant to the multidisciplinary nature of psychophysiological research in PCI populations. Search strategies employed combinations of the following keywords and Medical Subject Headings (MeSH): percutaneous coronary intervention, PCI, psychophysiological response, psychological stress, anxiety, coping, physiological stress response, and nursing intervention. Boolean operators and were used to refine and optimize the search strategy. No publication year restrictions were applied to capture the full conceptual and

empirical development of psychophysiological responses associated with PCI. The search was limited to English-language articles with full-text availability and studies published within the disciplines of cardiology, nursing, psychology, public health, or health education. This approach ensured the inclusion of both empirical evidence and theoretical discussions relevant to systematic review and subsequent concept analysis.

### *PICOs framework*

The PICOS framework guided the eligibility criteria for this review [28]. The population of interest comprised adult patients undergoing percutaneous coronary intervention (PCI). The intervention or exposure included psychophysiological factors and interventions occurring during the PCI process, such as psychological stress, anxiety, coping strategies, patient education, relaxation techniques, and nursing-led interventions. Comparisons were made between patients experiencing lower versus higher levels of psychophysiological stress or between standard care and supportive, educational, or psychosocial interventions. The outcomes of interest encompassed psychological outcomes, including anxiety, emotional distress, coping ability, and perceived control, as well as physiological responses, such as heart rate, blood pressure, and autonomic nervous system activity, alongside recovery-related outcomes. Eligible study designs included quantitative, qualitative, and mixed-methods studies, as well as theoretical or conceptual papers addressing psychophysiological responses in patients undergoing PCI.

### *Study selection*

Study selection was conducted in accordance with the PRISMA guidelines and followed four sequential stages: identification, screening, eligibility, and inclusion [29]. During the identification stage, all records retrieved from the selected databases were compiled, and duplicate articles were removed. In the screening stage, titles and abstracts were independently reviewed to assess their relevance to the study focus. Subsequently, full-text articles were evaluated for eligibility based on the predefined inclusion and exclusion criteria. Finally, studies that met all eligibility requirements were included in the final synthesis. A PRISMA flow diagram was used to transparently illustrate the number of records identified, screened, excluded, and included at each stage of the selection process.

### *Concept analysis (Walker-Avant)*

The concept analysis was conducted using the eight systematic steps proposed by Walker and Avant [19]. The concept of psychophysiological response in patients undergoing percutaneous coronary intervention (PCI) was selected due to its central role in understanding patient experiences during invasive cardiac procedures and the lack of conceptual consistency across existing literature. Although

psychophysiological responses are frequently examined in terms of isolated psychological or physiological outcomes, an integrated and clearly defined conceptual framework remains limited. The analysis aimed to clarify the meaning of the concept, identify its defining attributes, examine the relationships among psychological and physiological components, and establish clear operational boundaries relevant to peri-PCI care. A review of pertinent literature from cardiology, nursing, psychology, and mental health sciences was conducted to ascertain the various applications and contextualizations of the concept in both clinical and research environments. Defining attributes consistently identified included cognitive appraisal of the procedure, emotional regulation, autonomic physiological arousal, adaptive coping strategies, perceived control and self-efficacy, and utilization of social and professional support [30,31]. A model case was developed to illustrate the full manifestation of these attributes, along with borderline, related, and contrary cases to further delineate conceptual boundaries. Additionally, antecedents and consequences were identified to explain conditions preceding the emergence of psychophysiological responses and the outcomes resulting from adaptive or maladaptive responses during the peri-PCI period. Finally, empirical referents were established using measurable indicators and validated instruments, including the Hospital Anxiety and Depression Scale (HADS), State-Trait Anxiety Inventory (STAI), Brief COPE, Multidimensional Scale of Perceived Social Support (MSPSS), and objective physiological measures such as heart rate, blood pressure, heart rate variability, and cortisol levels, to operationalize the concept of psychophysiological response in PCI patients.

## **RESULTS**

After removing 153 duplicate records, 552 articles were screened based on titles and abstracts, of which 458 were excluded due to irrelevance to PCI, lack of psychophysiological variables, or exclusive focus on biomedical outcomes.

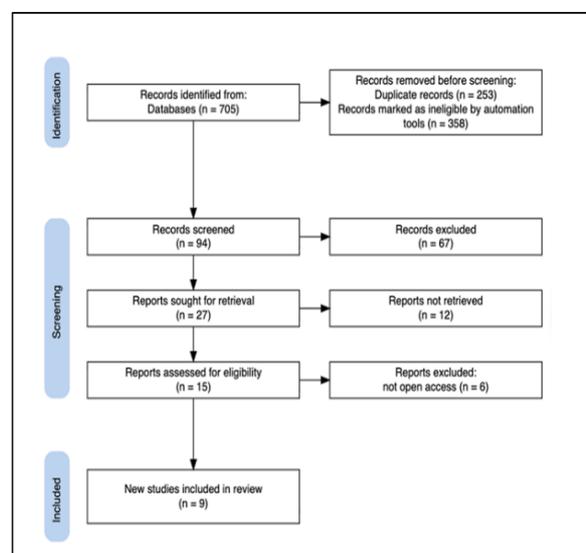


Figure 1: PRISMA analysis.

Subsequently, 94 full-text articles were assessed for eligibility, and 67 were excluded for not addressing peri-PCI psychophysiological responses, focusing solely on physiological outcomes, lacking empirical or conceptual analysis, or having inaccessible full texts. Ultimately, 27 studies met the inclusion criteria and were included in the systematic review. Of these, 9 key articles were selected as core sources for the Walker and Avant concept analysis because they explicitly addressed defining attributes, antecedents, consequences, or empirical indicators of psychophysiological responses (Figure 1). Article data

extraction (Table 1) indicates that psychophysiological responses in PCI patients involve interconnected psychological distress and physiological stress reactions. Anxiety and emotional distress are common and may persist after PCI, influencing recovery and quality of life. Interventional studies demonstrate that these responses are modifiable through psychological and nursing interventions, supporting psychophysiological response as a dynamic adaptation process relevant for concept analysis.

**Table 1:** Articles extracted

Author (year)	Title	Method	Sample	Key variables	Main findings	Contribution to concept
Ashour <i>et al.</i> (2023) [58]	Anxiety changes during PCI procedures	Descriptive	PCI patients	Procedural anxiety, distress	Anxiety peaks during catheterization	Defines peri-procedural emotional attributes Shen-2018-Effects-of-a-psycho
Limonti <i>et al.</i> (2025) [76]	Telerehabilitation after PCI	Systematic review	Post-PCI adults	Stress, QoL, psychosocial recovery	Telerehabilitation improved psychosocial adaptation	Supports intervention-related consequences and recovery outcomes journal.pone.0263004
Mujtaba <i>et al.</i> (2020) [62]	Depression and anxiety in patients undergoing PCI for ACS	Cross-sectional	n= 153 post-PCI patients	Anxiety (SAS), depression (BDI)	Anxiety and depression remained prevalent after PCI	Identifies emotional attributes and psychological burden post-procedure PJMS-36-1100
Munk <i>et al.</i> (2012) [57]	Symptoms of anxiety and depression after PCI are associated with decreased HRV, impaired endothelial function, and increased inflammation	Prospective cohort	Post-PCI patients with ACS	Anxiety, depression, HRV, endothelial function, CRP	Psychological distress correlated with autonomic dysregulation, inflammation, and poorer prognosis	Defines core physiological-psychological linkage and negative consequences of maladaptive response first-page-pdf
Olsen <i>et al.</i> (2018) [4]	Depression, anxiety, and quality of life after PCI	Cohort	Post-PCI adults	Anxiety, depression, QoL	Psychological distress persisted and affected recovery trajectories	Supports longitudinal consequences of maladaptive psychophysiological response nihms-87912
Shen <i>et al.</i> (2018) [15]	Effects of a psychological intervention program on mental stress, coping style and immune function in PCI patients	RCT	n= 60 PCI patients	Anxiety, stress, coping style, cortisol, IL-2	Psychological intervention reduced stress and cortisol, improved coping and immune response	Clarifies modifiable attributes (coping, emotional regulation) and positive consequences of adaptation Shen-2018-Effects-of-a-psycho...
Tang <i>et al.</i> (2025) [5]	Anxiety disorders following PCI for AMI	Comprehensive review	PCI-AMI patients	Anxiety disorders, autonomic activation, adherence	Post-PCI anxiety common and worsens cardiac outcomes	Defines core emotional attributes and clinical consequences journal.pone.0263004
Yamaguchi <i>et al.</i> (2025) [75]	Coping strategies and type D personality after PCI	Observational cohort	n= 84 PCI patients	Coping strategies, Type-D personality, depression	Adaptive coping reduced depressive tendency	Identifies individual antecedents and coping-based attributes journal.pone.0316639
Yuan & Yuan (2021) [71]	Effectiveness of nursing intervention on anxiety and self-efficacy after PCI	Observational cohort	n= 136 elderly PCI patients	Anxiety, depression, self-efficacy	Nursing interventions reduced anxiety and improved self-efficacy	Links nursing intervention to adaptive psychophysiological outcomes medi-100-e26899

This conceptual framework (Figure 2) illustrates the psychophysiological response in patients undergoing PCI as a dynamic interaction between antecedents, defining attributes, and consequences, derived from PRISMA-guided literature synthesis. Antecedents such as coronary artery disease diagnosis, pre-procedural anxiety, and perceived procedural risk trigger simultaneous psychological and physiological

responses. These responses are characterized by mind-body interaction, including anxiety, fear, and hemodynamic changes. The resulting consequences influence clinical outcomes, ranging from hemodynamic instability and prolonged recovery to improved adaptation when responses are effectively managed.

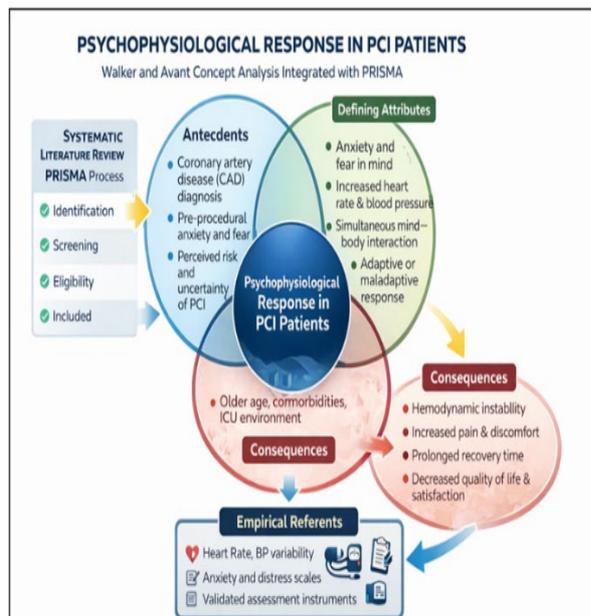


Figure 2: Concept analysis.

Empirical referents enable objective assessment of this concept in clinical and research settings. Characteristics or defining attributes represent the essential components that distinguish a concept and allow it to be clearly identified [32]. In the context of psychophysiological responses among patients undergoing percutaneous coronary intervention (PCI), defining attributes describe the integrated psychological and physiological reactions that arise in response to procedural stress (Table 2). These attributes were derived from stress adaptation theories, psychocardiology literature, and empirical studies in peri-PCI [33-35] (Table 3). The defining attributes presented in the table illustrate that psychophysiological response in patients undergoing PCI is a multidimensional and integrative construct. The attributes demonstrate how patients' cognitive appraisal and emotional regulation interact with physiological stress responses, shaping the overall adaptation to the PCI procedure.

Table 2: Defining attributes of psychophysiological response in patients undergoing percutaneous coronary intervention (PCI)

Defining Attribute	Description
Cognitive Appraisal of PCI	Patients' interpretation of PCI as a threatening or manageable procedure, influencing emotional and physiological stress responses.
Emotional Distress and Regulation	Presence of anxiety, fear, or uncertainty and the ability to regulate these emotions during the peri-PCI period.
Autonomic Physiological Arousal	Activation of physiological stress responses, including changes in heart rate, blood pressure, and autonomic nervous system activity.
Adaptive Coping Strategies	Use of behavioral and cognitive strategies such as relaxation, information seeking, positive reframing, or spiritual coping to manage stress.
Perceived Control and Self-Efficacy	Patients' sense of control, confidence, and involvement in understanding and managing the PCI procedure.
Utilization of Social and Professional Support	Engagement with nurses, physicians, and family members for emotional reassurance and informational support.
Adaptive Adjustment and Recovery Orientation	Psychological and physiological readiness to adjust after PCI, including engagement in recovery and lifestyle modification.

Table 3: Empirical Referents of Psychophysiological Response in Patients Undergoing PCI

Concept Dimension	Empirical Referents (Indicators)	Measurement Instruments
Cognitive appraisal	Perceived threat, understanding of PCI, illness perception	Brief Illness Perception Questionnaire (B-IPQ)
Emotional distress	Anxiety, fear, depressive symptoms	Hospital Anxiety and Depression Scale (HADS); State-Trait Anxiety Inventory (STAI)
Emotional regulation	Ability to manage anxiety and emotional reactions	STAI; observational emotional response
Autonomic physiological arousal	Heart rate, blood pressure, autonomic activation	Vital sign monitoring; Heart Rate Variability (HRV)
Stress response	Neuroendocrine stress activation	Salivary cortisol levels
Adaptive coping strategies	Problem-focused and emotion-focused coping	Brief COPE Inventory
Perceived control and self-efficacy	Confidence in managing PCI and recovery	Cardiac Self-Efficacy Scale; General Self-Efficacy Scale
Social and professional support	Perceived support from family and healthcare providers	Multidimensional Scale of Perceived Social Support (MSPSS)
Recovery and adaptation outcomes	Psychological adjustment, quality of life	SF-36; MacNew Heart Disease Health-Related Quality of Life

The presence of adaptive coping strategies, perceived control, and effective use of social and professional support further distinguishes adaptive responses from maladaptive ones. Collectively, these attributes clarify that psychophysiological response is not limited to emotional distress or physiological changes alone but represents a dynamic process that influences recovery orientation and engagement in post-PCI care [36,37].

### Case of patients undergoing PCI

#### Model case (all attributes present)

Mr. A, a 58-year-old man, was admitted to the cardiac catheterization unit for elective percutaneous coronary intervention (PCI) due to stable coronary artery disease. Upon being informed about the procedure, he initially experienced mild anxiety; however, he actively sought information from nurses and physicians regarding the steps, risks, and benefits of PCI. Mr. A practiced deep breathing techniques as

advised by the nurse and remained calm during the procedure. His vital signs stayed stable, with only small changes in his heart rate and blood pressure. He expressed confidence in the healthcare team, involved his family in decision-making, and perceived PCI as an opportunity to improve his health. After the procedure, he demonstrated adaptive coping, adhered to medical advice, and expressed motivation to participate in cardiac rehabilitation. This case illustrates the presence of all defining attributes, including positive cognitive appraisal, emotional regulation, controlled physiological arousal, adaptive coping, perceived control, and effective utilization of social and professional support.

#### ***Borderline case (partial attributes present)***

Mr. B, a 62-year-old patient undergoing PCI for acute coronary syndrome, exhibited considerable anxiety prior to the procedure and frequently inquired about the possible complications. Although he agreed to undergo PCI, he avoided discussing his fears with healthcare providers and declined relaxation guidance offered by the nurse. His blood pressure went up and down during the procedure, and he looked tense. Post-procedure, Mr. B followed medication instructions but remained fearful about his recovery and avoided engaging in discussions about lifestyle modification. While some attributes of psychophysiological response were present—such as acceptance of the procedure and partial coping—other attributes, including emotional regulation, perceived control, and support utilization, were incompletely manifested.

#### ***Contrary case (no attributes present)***

Mr. C, a 55-year-old man scheduled for emergency PCI, perceived the procedure as a certain threat to his life. He refused to listen to explanations provided by the healthcare team, expressed intense fear, and repeatedly stated that he would not survive the procedure. He exhibited panic, marked tachycardia, and severely elevated blood pressure prior to catheterization. Mr. C rejected emotional support from nurses and family members and attempted to withdraw consent for the procedure. Following PCI, he remained distressed, avoided communication, and refused participation in follow-up care. This case demonstrates the absence of defining attributes, characterized by maladaptive cognitive appraisal, uncontrolled emotional distress, excessive physiological arousal, ineffective coping, lack of perceived control, and rejection of social and professional support.

#### ***Antecedent***

Antecedents are conditions or events that must be present prior to the occurrence of a psychophysiological response. In patients undergoing PCI, several antecedents consistently precede the emergence of psychophysiological responses. Clinical antecedents include acute cardiac symptoms such as chest pain, dyspnea, and the diagnosis of acute coronary syndrome, which inherently trigger stress

responses [38,39]. Procedural antecedents involve exposure to an invasive cardiac procedure, unfamiliar catheterization environments, perceived procedural risks, and uncertainty regarding outcomes [40]. In addition, psychological antecedents such as pre-existing anxiety, depressive symptoms, maladaptive coping styles, and Type-D personality traits increase vulnerability to heightened psychophysiological stress [41,42]. Informational and contextual antecedents, including limited health literacy, inadequate pre-procedural education, and insufficient communication with healthcare providers, further contribute to negative cognitive appraisal and emotional distress [43,44].

#### ***Consequences***

Consequences are outcomes that occur as a result of the presence or absence of adaptive psychophysiological responses. Patients who demonstrate adaptive responses, such as effective emotional regulation, controlled physiological arousal, and constructive coping strategies, experience positive consequences. These outcomes are associated with improved hemodynamic stability, reduced anxiety, enhanced cooperation during PCI, faster recovery, and greater participation in cardiac rehabilitation and secondary prevention programs [45,46]. Conversely, maladaptive psychophysiological responses may result in negative consequences, such as persistent anxiety or depression, excessive sympathetic activation, unstable vital signs, increased pain perception, and delayed recovery [47,48]. Long-term consequences may include poor treatment adherence, avoidance of follow-up care, reduced quality of life, and an increased risk of adverse cardiovascular outcomes [37,49]. Thus, psychophysiological responses play a critical role in shaping both immediate procedural outcomes and longer-term recovery trajectories in PCI patients.

#### ***Empirical Referents***

Empirical referents represent measurable indicators used to determine the presence and manifestation of psychophysiological responses in patients undergoing percutaneous coronary intervention (PCI). In this study, empirical referents are presented in a table and encompass observable psychological reactions, physiological stress responses, adaptive behaviors, coping patterns, perceived control, and social support utilization, alongside validated psychometric and physiological measurement instruments [50,51]. Observable indicators encompass emotional expressions, including anxiety or calmness, behavioral engagement with healthcare providers, adherence to procedural instructions, and visible manifestations of stress or relaxation during the peri-PCI period. These indicators are complemented by standardized instruments measuring psychological dimensions such as anxiety, coping, and perceived support, as well as objective physiological markers, including heart rate, blood pressure, heart rate variability, and stress-related biomarkers [52,53]. The integration of observational indicators and validated measurement tools enables a

comprehensive and multidimensional assessment of psychophysiological responses in PCI patients, supporting both clinical evaluation and research rigor (Figure 2). Conceptual representation of empirical referents of psychophysiological response in patients undergoing PCI (Table 3). The empirical referents presented in the table demonstrate that psychophysiological response in patients undergoing PCI can be operationalized through a combination of subjective psychological measures and objective physiological indicators. Psychological instruments capture cognitive appraisal, emotional distress, coping strategies, perceived control, and social support, while physiological measures such as vital signs, heart rate variability, and cortisol levels reflect autonomic and neuroendocrine stress responses. The integration of these empirical referents enables a comprehensive and multidimensional assessment of psychophysiological response, supporting consistent measurement in both clinical practice and research settings.

## DISCUSSION

This systematic review, in conjunction with a Walker–Avant concept analysis, offers a thorough and conceptually sound comprehension of psychophysiological responses in patients undergoing percutaneous coronary intervention (PCI). The results unequivocally indicate that psychophysiological response is not simply a fleeting emotional reaction to an invasive cardiac procedure; instead, it constitutes a complex, dynamic, and multidimensional adaptation process that encompasses cognitive appraisal, emotional regulation, behavioral coping, and physiological stress responses throughout the periprocedural continuum [54-56]. By synthesizing empirical findings and clarifying conceptual boundaries, this study strengthens both the theoretical foundation and clinical applicability of psychophysiological response within cardiovascular and nursing science. Across the included studies, PCI consistently emerged as a significant psychological and physiological stressor. Patients frequently experience anxiety, fear, and uncertainty prior to catheterization, which are closely accompanied by sympathetic nervous system activation manifested as increased heart rate, elevated blood pressure, and reduced heart rate variability [57,58]. These findings are consistent with the transactional model of stress and coping, which posits that psychological appraisal of a perceived threat initiates neurophysiological stress responses through autonomic and endocrine pathways [59-61]. Significantly, this review enhances the current literature by conceptualizing psychophysiological response as an adaptive trajectory rather than a fixed state. Longitudinal evidence indicates that although anxiety levels may decrease after successful PCI, a substantial proportion of patients continue to experience psychological distress weeks to months after the procedure [4,62]. This persistence indicates incomplete psychological adaptation and underscores the necessity to conceptualize psychophysiological response as a continuum from adaptive to maladaptive patterns, rather than merely a transient peri-procedural

phenomenon. The Walker–Avant concept analysis identified several defining attributes that collectively characterize psychophysiological response in PCI patients. Among these, cognitive appraisal emerged as a foundational attribute. Patients who perceive PCI as a life-saving and controllable intervention demonstrate lower anxiety levels and more stable physiological responses, whereas those who appraise the procedure as life-threatening exhibit heightened emotional distress and exaggerated sympathetic activation [63-65]. This study underscores the central role of meaning-making and illness perception in shaping psychophysiological outcomes. Emotional regulation and adaptive coping strategies further differentiate adaptive from maladaptive responses. Interventional studies included in this review provide strong evidence that relaxation techniques, guided breathing, cognitive reframing, and structured psychological interventions significantly reduce anxiety and stabilize physiological stress markers during PCI [66-69]. These results support the idea that emotional regulation is not a fixed quality but a changeable one that can be improved with specific nursing and psychosocial interventions. The attribute of autonomic physiological arousal provides an objective bridge between psychological experience and physiological adaptation. Alterations in heart rate, blood pressure, heart rate variability, and inflammatory markers have been consistently associated with anxiety and depressive symptoms in PCI patients [27,70,71]. The integration of physiological indicators with psychological assessments strengthens the empirical grounding of the concept and enhances its clinical relevance. Perceived control and self-efficacy also play a critical role in psychophysiological adaptation. Patients who feel informed, involved, and empowered demonstrate reduced distress, improved cooperation during PCI, and greater engagement in recovery behaviors [66,3,72]. Healthcare professionals' quality of communication, patient education, and therapeutic relationships strongly influence perceived control in PCI settings. Finally, the use of social and professional support has become a key buffering factor. Supportive interactions with nurses, physicians, and family members reduce uncertainty, enhance emotional stability, and mitigate physiological stress responses [73,74]. These findings highlight how relationships and the situation affect how our body and mind respond, showing that having support from caregivers and family is crucial in heart care. The identification of antecedents gives clues to the factors that predispose patients to heightened psychophysiological stress. Clinical antecedents such as acute chest pain, emergency admission, and acute coronary syndrome create an immediate sense of threat that triggers stress responses [75]. Procedural antecedents, including unfamiliar catheterization environments, perceived procedural risks, and lack of predictability, further amplify stress [76-78]. Psychological antecedents, including pre-existing anxiety, depressive symptoms, maladaptive coping styles, and Type-D personality, were consistently associated with poorer psychophysiological adaptation [79-81]. Contextual antecedents such as limited health literacy and insufficient pre-procedural information also emerged

as critical factors, as patients who lack understanding of the PCI process are more likely to engage in catastrophic thinking and exaggerated stress responses [82-84]. These findings show the value of early psychosocial screening and risk stratification in peri-PCI care. The consequences of psychophysiological responses extend well beyond the immediate procedural period. Adaptive responses are associated with improved hemodynamic stability, reduced pain perception, enhanced cooperation during PCI, shorter recovery times, and greater participation in cardiac rehabilitation programs [85-87]. Over the long term, adaptive psychophysiological responses facilitate medication adherence, lifestyle modification, and secondary prevention behaviors essential for reducing recurrent cardiovascular events. Conversely, maladaptive responses may result in persistent anxiety or depression, prolonged sympathetic activation, unstable vital signs, delayed recovery, and poorer quality of life [88,89]. Emerging evidence further suggests that unresolved psychological distress following PCI is associated with reduced adherence to follow-up care and an increased risk of adverse cardiovascular outcomes [52,90]. These findings confirm that psychophysiological responses are clinically consequential and warrant systematic assessment and intervention.

### Implications for Nursing Practice

From a nursing perspective, the clarified concept of psychophysiological response offers a robust framework for holistic peri-PCI care. Nurses are uniquely qualified to evaluate psychological distress, observe physiological indicators, and execute prompt, evidence-based interventions that facilitate adaptive responses. The use of validated instruments such as the Hospital Anxiety and Depression Scale (HADS), State Trait Anxiety Inventory (STAI), Brief COPE, and physiological monitoring enable systematic identification of patients at risk for maladaptive psychophysiological responses [91-94]. Furthermore, the evidence supports the integration of nursing-led psychosocial interventions into routine PCI care pathways. Structured education, therapeutic communication, relaxation training, and family involvement should be considered essential components of peri-PCI nursing protocols. Addressing both psychological and physiological dimensions aligns with patient-centered care models and may improve both psychological well-being and cardiovascular outcomes [95-97].

### Theoretical and Research Implications

The integration of systematic review and Walker–Avant concept analysis advances theoretical clarity by providing a clear, operational definition of psychophysiological response in PCI patients [98-100]. This conceptual refinement promotes measurement consistency, improves study comparability, and aids in the formulation of theory-driven interventions. Future research should prioritize longitudinal and interventional designs to elucidate

causal mechanisms, explore cultural and contextual influences, and evaluate the effectiveness of tailored psychosocial nursing interventions across diverse PCI populations.

### Conclusion

This study demonstrates that psychophysiological response in patients undergoing PCI is a multifaceted and modifiable process with profound implications for clinical outcomes and quality of life. By clarifying its defining attributes, antecedents, consequences, and empirical referents, this review provides a strong foundation for advancing research, guiding nursing practice, and improving holistic cardiovascular care.

### ACKNOWLEDGMENTS

The authors thank the AJMS for giving the opportunity to do a public presentation.

### Conflict of interests

The authors declared no conflict of interest.

### Funding source

The authors did not receive any source of funds.

### Data sharing statement

N/A.

### REFERENCES

1. Renato de Oliveira M, Gondim de Almeida N, Cavalcante Guedes MV, da Silva LF, de Freitas MC, Martins Torres RA, et al. Betty Neuman systems model: Analysis according to Meleis. *SOJ Nur Health Care*. 2018;4(2):1-6. doi: 10.15226/2471-6529/4/2/00145.
2. Tovar G, Omaira L, Leticia DS, Fabián CM. Evidence-and Betty Neuman's model-based nursing care to prevent delirium in the intensive care unit. *Enfermería Global*. 2016;41:64-77.
3. Akhlaghi E, Babaei S, Abolhassani S. Modifying stressors using Betty Neuman system modeling in coronary artery bypass graft: A randomized clinical trial. *J Caring Sci*. 2020;9(1):13-19. doi: 10.34172/jcs.2020.003.
4. Olsen SJ, Schirmer H, Wilsgaard T, Bónaa KH, Hanssen TA. Cardiac rehabilitation and symptoms of anxiety and depression after percutaneous coronary intervention. *Eur J Prev Cardiol*. 2018;25(10):1017-1025. doi: 10.1177/2047487318778088.
5. Tang X, Liu G, Zeng YJ. Anxiety disorders following percutaneous coronary intervention for acute myocardial infarction: A comprehensive review of clinical manifestations and interventions. *World J Psychiatry*. 2025;15. doi: 10.5498/wjp.v15.i12.110290
6. Hassan A, Shutnan I, Athbi HA. Distraction Using Virtual Reality Reduces Pain and Anxiety After PCI. *Indonesian J Health Sci Med*. 2025;2. doi: 10.21070/ijhsm.v2i2.206.
7. Zhang G, F. Lin F. Influence of continuous nursing intervention on medication compliance and negative emotion of patients with acute myocardial infarction after percutaneous coronary intervention. *Chinese J Primary Med Pharm*. 2017;24(8):1156–1160. doi: 10.3760/cma.j.issn.1008-6706.2017.08.009.
8. Hilty DM, Randhawa K, Maheu MM, McKean AJS, Pantera R, Mishkind MC, et al. A review of telepresence, virtual reality, and augmented reality applied to clinical care. *J Technol Behav Sci*. 2020;5(1):1-28 doi: 10.1007/s41347-020-00126-x.
9. Chen L. Effectiveness of the Roy adaptation model-based nursing intervention in improving physiological, psychological, and social outcomes in patients with Parkinson's

- disease. *BMC Neurol.* 2025;25(1):219. doi: 10.1186/s12883-025-04232-2.
10. Pop SI, Procopciuc A, Arsintescu B, Mițariu M, Mițariu L, Pop RV, et al. Three-dimensional assessment of upper airway volume and morphology in patients with different sagittal skeletal patterns. *Diagnostics (Basel).* 2024;14(9):903. doi: 10.3390/diagnostics14090903.
  11. Salih SHA. Mode of referral and time to primary PCI in ST-elevation myocardial infarction. *Al-Rafidain J Med Sci.* 2025;(2):272–277. doi: 10.54133/ajms.v9i2.2553.
  12. Grimm W, Grimm K, Greene B, Parahuleva M. Predictors of pacing-dependency in patients with cardiovascular implantable electronic devices. *Cardiol J.* 2021;28(3):423-430. doi: 10.5603/CJ.a2019.0088.
  13. Calegari IB, Borges E Silva L, Silva FF, Dos Santos Felix MM, et al. Physiological and psychological changes in patients undergoing percutaneous coronary intervention: An integrative review. *Crit Care Nurse.* 2025;45(2):13-24. doi: 10.4037/ccn2025959.
  14. Yunita M, Laras PB, Hadi A, Aryani E, Prayogi F, Istiqomah OR. Optimism and quality of life post-PCI: Integrating psychological resilience into holistic rehabilitation. *Gen Hosp Psychiatry.* 2025;95:3-4. doi: 10.1016/j.genhosppsy.2025.03.007.
  15. Shen X, Zhu X, Wu Y, Zhou Y, Yang L, Wang Y, et al. Effects of a psychological intervention programme on mental stress, coping style and immune function in percutaneous coronary intervention patients. *PLoS One.* 2018;13(1):e0187745. doi: 10.1371/journal.pone.0187745.
  16. Ye R, Zhou X, Shao F, Xiong L, Hong J, Huang H, et al. Feasibility of a 5G-based robot-assisted remote ultrasound system for cardiopulmonary assessment of patients with coronavirus disease 2019. *Chest.* 2021;159(1):270-281. doi: 10.1016/j.chest.2020.06.068.
  17. Bhoja R, Guttman OT, Fox AA, Melikman E, Kosemund M, Gingrich KJ. Psychophysiological stress indicators of heart rate variability and electrodermal activity with application in healthcare simulation research. *Simul Healthc.* 2020;15(1):39-45. doi: 10.1097/SIH.0000000000000402.
  18. Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, et al. American Heart Association Statistics Committee; Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2016 Update: A Report From the American Heart Association. *Circulation.* 2016;133(4):e38-360. doi: 10.1161/CIR.0000000000000350.
  19. Li Y, Wang LH, Zeng H, Zhao Y, Lu YQ, Zhang TY, et al. Psychological consistency network characteristics and influencing factors in patients after percutaneous coronary intervention treatment. *World J Psychiatry.* 2025;15(3):102571. doi: 10.5498/wjp.v15.i3.102571.
  20. Sanford BT, Ciarrochi J, Hofmann SG, Chin F, Gates KM, Hayes SC. Toward empirical process-based case conceptualization: An idionomic network examination of the process-based assessment tool. *J Contextual Behav Sci.* 2022;25(4):10–25. doi: 10.1016/j.jcbs.2022.05.006.
  21. Martínez N, Connelly CD, Pérez A, Calero P. Self-care: A concept analysis. *Int J Nurs Sci.* 2021;8(4):418-425. doi: 10.1016/j.ijnss.2021.08.007.
  22. Di Carlo F, Vicinelli MC, Pettorruso M, De Risio L, Migliara G, Baccolini V, et al. Connected minds in disconnected bodies: Exploring the role of interoceptive sensibility and alexithymia in problematic use of the internet. *Compr Psychiatry.* 2024;129:152446. doi: 10.1016/j.comppsy.2023.152446.
  23. Pezeshki L, Sadeghian H, Mohebbi A, Keshmiri M, Haddadin S. Personalized assistance in robotic rehabilitation: Real-time adaptation via energy-based performance monitoring. *IEEE Transact Automat Sci Engineer.* 2025;22:13298-13309. doi: 10.1109/tase.2025.3552446.
  24. Khalili H, Heydari A. Poor care: A Walker and Avant concept analysis. *J Caring Sci.* 2022;12(1):25-32. doi: 10.34172/jcs.2023.30507.
  25. Luh N, Indrayani D. Trends of concept analysis in nursing science with Walker and Avant approaches: a literature review. *Innov Health Soc.* 2025;5(1):51–62. doi: 10.31603/ihs.12858.
  26. Campbell S, Greenwood M, Prior S, Shearer T, Walkem K, Young S, et al. Purposive sampling: complex or simple? Research case examples. *J Res Nurs.* 2020;25(8):652-661. doi: 10.1177/1744987120927206.
  27. Tang J, Klunklin P, Lirtmunlikapom S, Wang Y. Treatment adherence: A concept analysis using the Walker & Avant method. *Patient Prefer Adherence.* 2024;18:2067-2075. doi: 10.2147/PPA.S477615.
  28. Huang X, Lin J, Demner-Fushman D. Evaluation of PICO as a knowledge representation for clinical questions. *AMIA Annu Symp Proc.* 2006;2006:359-363.
  29. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev.* 2021;10:89. doi: 10.1186/s13643-021-01626-4.
  30. Alghamdi MG. Nursing workload: a concept analysis. *J Nurs Manag.* 2016;24(4):449-457. doi: 10.1111/jonm.12354.
  31. Diaz J, Danvers Perez K. Workload in nursing: A concept analysis. *Horiz Enferm.* 2018;29:204–211. doi: 10.7764/Horiz\_Enferm.29.3.204-211.
  32. Nadal C, Sas C, Doherty G. Technology acceptance in mobile health: Scoping review of definitions, models, and measurement. *J Med Internet Res.* 2020;22(7):e17256. doi: 10.2196/17256.
  33. Pimple P, Hammadah M, Wilmot K, Ramadan R, Al Mheid I, Levantsevych O, et al. The relation of psychosocial distress with myocardial perfusion and stress-induced myocardial ischemia. *Psychosom Med.* 2019;81(4):363-371. doi: 10.1097/PSY.0000000000000674.
  34. Sedaghat S, Rostami S, Ebadi A, Fereidooni-Moghadam M. Stressors in open-heart surgery patients: A qualitative study. *ARYA Atheroscler.* 2019;15(4):192-200. doi: 10.22122/arya.v15i4.1840.
  35. Umamaheswaran S, Dasari SK, Yang P, Lutgendorf SK, Sood AK. Stress, inflammation, and eicosanoids: an emerging perspective. *Cancer Metastasis Rev.* 2018;37(2-3):203-211. doi: 10.1007/s10555-018-9741-1.
  36. Zhou C, Zheng W, Tan F, Lai S, Yuan Q. Influence of health promoting lifestyle on health management intentions and behaviors among Chinese residents under the integrated healthcare system. *PLoS One.* 2022;17(1):e0263004. doi: 10.1371/journal.pone.0263004.
  37. Limonti F, Gigliotti A, Gravante F, Ramacciati N. The impact of cardiac telerehabilitation on health-related quality of life in patients undergoing percutaneous coronary intervention (PCI): A systematic review protocol. *Nurs Rep.* 2024;14(4):3984-3992. doi: 10.3390/nursrep14040291.
  38. Ahmad M, Mehta P, Reddivari AKR, Mungee S. Percutaneous coronary intervention. 2023 Jun 5. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan. PMID: 32310583.
  39. Alpert JS. New coronary heart disease risk factors. *Am J Med.* 2023;136(4):331-332. doi: 10.1016/j.amjmed.2022.08.002.
  40. Carney RM, Freedland KE. New perspectives on treatment of depression in coronary heart disease. *Psychosom Med.* 2023;85(6):474-478. doi: 10.1097/PSY.0000000000001219.
  41. Li L, Wang H, Wang Y, Gao X, Liu G, Zhao Z, et al. Path analysis for key factors influencing long-term quality of life of patients following a percutaneous coronary intervention. *Coron Artery Dis.* 2019;30(5):339-345. doi: 10.1097/MCA.0000000000000712.
  42. Douma ER, Kop WJ, Kupper N. Associations between psychological factors and adherence to health behaviors after percutaneous coronary intervention: The role of cardiac rehabilitation. *Ann Behav Med.* 2024;58(5):328-340. doi: 10.1093/abm/kaae008.
  43. Su CS, Shen CH, Chang KH, Lai CH, Liu TJ, Chen KJ, et al. Clinical outcomes of patients with multivessel coronary artery disease treated with robot-assisted coronary artery bypass graft surgery versus one-stage percutaneous coronary intervention using drug-eluting stents. *Medicine (Baltimore).* 2019;98(38):e17202. doi: 10.1097/MD.00000000000017202.
  44. Qiang H, Li L, Hua Y, Han L. Research progress on the depression status and nursing intervention in patients after percutaneous coronary intervention. *J Clin Nurs Res.* 2024;8(2):33–43. doi: 10.26689/jcnr.v8i2.5766.
  45. Wu S, Cao W, Fu S, Yao B, Yang Z, Yin C, et al. CardioAI: A multimodal AI-based system to support symptom monitoring and risk prediction of cancer treatment-induced cardiotoxicity. *Proc SIGCHI Conf Hum Factor Comput Syst.* 2025;2025:313. doi: 10.1145/3706598.3714272.
  46. Racodon M, Vanhove P, Fabre C, Malanda F, Secq A. Comparison between hybrid cardiac rehabilitation and center-based cardiac rehabilitation: a noninferiority randomized controlled trial. *Int J Rehabil Res.* 2025;48(1):25-30. doi: 10.1097/MRR.0000000000000658.

47. Celano CM, Daunis DJ, Lokko HN, Campbell KA, Huffman JC. Anxiety disorders and cardiovascular disease. *Curr Psychiatry Rep.* 2016;18(11):101. doi: 10.1007/s11920-016-0739-5.
48. Folkman S. The case for Acute Cardiac Events' in the stress process. *Anxiety Stress Coping.* 2008;21(1):3-14. doi: 10.1080/10615800701740457.
49. Edge D, Watkins ER, Limond J, Mugadza J. The efficacy of self-guided internet and mobile-based interventions for preventing anxiety and depression - A systematic review and meta-analysis. *Behav Res Ther.* 2023;164:104292. doi: 10.1016/j.brat.2023.104292.
50. Yang YC, Boen C, Gerken K, Li T, Schorpp K, Harris KM. Social relationships and physiological determinants of longevity across the human life span. *Proc Natl Acad Sci U S A.* 2016;113(3):578-583. doi: 10.1073/pnas.1511085112.
51. Eitenberger M, Casanova-Libreros R, Chávez-Chávez J, Cordoba-Silva JG, Betancourt-Zapata W, Maya R, et al. Effect of music therapy on short-term psychological and physiological outcomes in mechanically ventilated patients: A randomized clinical pilot study. *J Intensive Med.* 2024;4(4):515-525. doi: 10.1016/j.jointm.2024.01.006.
52. Mrug S, Pollock JS, Pollock DM, Seifert ME, Johnson KA, Knight DC. Early life stress, coping, and cardiovascular reactivity to acute social stress. *Psychosom Med.* 2023;85(2):118-129. doi: 10.1097/PSY.0000000000001165.
53. Maqsood A, Gul S, Noureen N, Yaswi A. Dynamics of perceived stress, stress appraisal, and coping strategies in an evolving educational landscape. *Behav Sci (Basel).* 2024;14(7):532. doi: 10.3390/bs14070532.
54. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: a theoretically based approach. *J Pers Soc Psychol.* 1989;56(2):267-283. doi: 10.1037//0022-3514.56.2.267.
55. Poulus D, Coulter TJ, Trotter MG, Polman R. Stress and coping in esports and the influence of mental toughness. *Front Psychol.* 2020;11:628. doi: 10.3389/fpsyg.2020.00628.
56. Radin A, Ganz PA, Van Dyk K, Stanton AL, Bower JE. Executive functioning and depressive symptoms after cancer: The mediating role of coping. *Psychosom Med.* 2021;83(3):291-299. doi: 10.1097/PSY.0000000000000926.
57. Munk PS, Isaksen K, Brønneck K, Kurz MW, Butt N, Larsen AI. Symptoms of anxiety and depression after percutaneous coronary intervention are associated with decreased heart rate variability, impaired endothelial function and increased inflammation. *Int J Cardiol.* 2012;158(1):173-176. doi: 10.1016/j.ijcard.2012.04.085.
58. Ashour A, Al-Rawashdeh S, Tanash M, Al-Smadi A, Alshraifeen A, Shajrawi A. Changes in the Anxiety levels of patients undergoing percutaneous coronary intervention. *Dimens Crit Care Nurs.* 2023;42(1):15-21. doi: 10.1097/DCC.0000000000000560.
59. Folkman S, (Ed.), Stress: Appraisal and coping, In: Encyclopedia of Behavioral Medicine. Sage Publisher; 2020; 2177-2179. doi: 10.4135/9781412952576.n198.
60. Huffman JC, Albanese AM, Campbell KA, Celano CM, Millstein RA, Mastromauro CA, et al. The positive emotions after acute coronary events behavioral health intervention: Design, rationale, and preliminary feasibility of a factorial design study. *Clin Trials.* 2017;14(2):128-139. doi: 10.1177/1740774516673365.
61. Dimsdale JE. Psychological stress and cardiovascular disease. *J Am Coll Cardiol.* 2008;51(13):1237-1246. doi: 10.1016/j.jacc.2007.12.024.
62. Mujtaba SF, Sial JA, Karim M. Depression and anxiety in patients undergoing percutaneous coronary intervention for acute coronary syndrome. *Pak J Med Sci.* 2020;36(5):1100-1105. doi: 10.12669/pjms.36.5.1749.
63. Yu X, Cao J, Xu J, Xu Q, Chen H, Yu D, et al L. Efficacy of telemedical interventional management in patients with coronary heart disease undergoing percutaneous coronary intervention: Randomized controlled trial. *J Med Internet Res.* 2025;27:e63350. doi: 10.2196/63350.
64. Zhou Y, Wen X, Han S, Li Y, Lv Y, Li Q. Effect of confucian-based acceptance and commitment therapy(C-ACT) on mental health and psychological flexibility improvement of college students: A randomized controlled trial. *Acta Psychol (Amst).* 2025;254:104808. doi: 10.1016/j.actpsy.2025.104808.
65. Segal ZV, Dimidjian S, Beck A, Boggs JM, Vanderkruik R, Metcalf CA, et al. Outcomes of online mindfulness-based cognitive therapy for patients with residual depressive symptoms: A randomized clinical trial. *JAMA Psychiatry.* 2020;77(6):563-573. doi: 10.1001/jamapsychiatry.2019.4693.
66. Mozaffari F, Tavangar H, Pourmovahed Z. Comparing the effects of muscle relaxation and music therapy on anxiety among candidates for coronary angiography: A randomized clinical trial. *Nurs Midwifery Stud.* 2020;9(3):124-129. doi: 10.4103/nms.nms.90.18.
67. Forooghi M, Mottahedian Tabrizi E, Hajizadeh E, Pishgoo B. Effect of music therapy on patients' anxiety and hemodynamic parameters during coronary angioplasty: A randomized controlled trial. *Nurs Midwifery Stud.* 2015;4(2):e25800. doi: 10.17795/nmsjournal25800.
68. Moghadam MS, Parvizifard A, Foroughi A, Ahmadi SM, Farshchian N. An examination of the effectiveness of mindfulness-integrated cognitive behavior therapy on depression, anxiety, stress and sleep quality in Iranian women with breast cancer: a randomized controlled trial. *Sci Rep.* 2025;15(1):11041. doi: 10.1038/s41598-025-85745-1..
69. Xu J, Ye C, Peng F, Lv H, Tang W, Xu, C. Impact of combined exercise rehabilitation and continuous health education on the quality of life and mental health of patients post-coronary stent implantation. *The Heart Surgery Forum.* 2024;27(8):E883-E890. doi: 10.59958/hsf.7717.
70. Li N, Chen X. Impact of evidence-based nursing interventions on psychological status and myocardial injury in patients with myocardial infarction following percutaneous coronary intervention for reperfusion injury. *Front Physiol.* 2025;16:1597416. doi: 10.3389/fphys.2025.1597416.
71. Yuan L, Yuan L. Effectiveness of nursing intervention on anxiety, psychology and self-efficacy among elderly patients with acute coronary syndrome after percutaneous coronary intervention. *Medicine (United States).* 2021;100. doi: 10.1097/MD.00000000000026899.
72. Frederix I, Caiani EG, Dendale P, Anker S, Bax J, Böhm A, et al. Overcoming challenges in digital health implementation in cardiovascular medicine. *Eur J Prev Cardiol.* 2019;26(11):1166-1177. doi: 10.1177/2047487319832394.
73. Dahlem NW, Zimet GD, Walker RR. The multidimensional scale of perceived social support: A confirmation study. *J Clin Psychol.* 1991;47(6):756-761. doi: 10.1002/1097-4679(199111)47:6<756::aid-jclp2270470605>3.0.co;2-1.
74. Yamaguchi D, Asano Y, Kuwahara K, Izawa A. Coping strategies and changes in type D personality were associated with depressive tendency at 9 months after percutaneous coronary intervention. *PLoS One.* 2025;20(1):e0316639. doi: 10.1371/journal.pone.0316639.
75. Limonti F, Gigliotti A, Cecere L, Varvaro A, Bosco V, Mazzotta R, et al. Evaluating the efficacy and impact of home-based cardiac telerehabilitation on health-related quality of life (HRQOL) in patients undergoing percutaneous coronary intervention (PCI): A systematic review. *J Clin Med.* 2025;14(14):4971. doi: 10.3390/jcm14144971.
76. Saini RK, Chaudhury S, Singh N, Chadha DS, Kapoor R. Depression, anxiety, and quality of life after percutaneous coronary interventions. *Ind Psychiatry J.* 2022;31(1):6-18. doi: 10.4103/ijp.ijp.126.21.
77. Shaikh Z, Khan AN, Maken GR, Shabbir S, Malik ES, Kumar M, et al. Frequency of depression and anxiety in patients with acute coronary syndrome. *Pak Heart J.* 2023;56(1):77-81. doi: 10.47144/phj.v56i1.2401.
78. Tully PJ, Baker RA. Depression, anxiety, and cardiac morbidity outcomes after coronary artery bypass surgery: a contemporary and practical review. *J Geriatr Cardiol.* 2012;9(2):197-208. doi: 10.3724/SP.J.1263.2011.12221.
79. Kang YS, Choi SY, Ryu E. The effectiveness of a stress coping program based on mindfulness meditation on the stress, anxiety, and depression experienced by nursing students in Korea. *Nurse Educ Today.* 2009;29(5):538-543. doi: 10.1016/j.nedt.2008.12.003.
80. Zhou T, Dong P, Hu Y, Wang J, Hu M, Chen X, et al. Reminiscence therapy-involved care program alleviates cognitive impairment and depression in elderly patients with acute coronary syndrome treated with percutaneous coronary intervention. *Int Heart J.* 2025;66(2):293-301. doi: 10.1536/ihj.24-637.
81. Bordbar M, Fereidouni Z, Morandini MK, Najafi Kalyani M. Efficacy of complementary interventions for management of anxiety in patients undergoing coronary angiography: A rapid systematic review. *J Vasc Nurs.* 2020;38(1):9-17. doi: 10.1016/j.jvn.2019.12.005.

82. Liu F, Liu F, Li J, Du Y, Han X. Effectiveness and safety of treating negative emotions after PCI from the perspective of Qi and blood: A systematic review and meta-analysis. *Evid Based Complement Alternat Med.* 2022;2022:8604472. doi: 10.1155/2022/8604472.
83. Khan AA, Hussain A, Maqbool R. Prevalence of psychological distress among the patients with cardiac issues: Gender and marital-status are in focus. *Human Nat J Soc Sci.* 2023;4(1):343-353. doi: 10.71016/hnjss/tdm00n67.
84. Rouhi Balasi L, Salari A, Nourisaeed A, Moaddab F, Shakiba M, Givzadeh H. Anxiety and depression in patients undergoing coronary angioplasty. *JCCNC.* 2016;2(4):231-238. doi: 10.32598/jccnc.2.4.231.
85. Trotter R, Gallagher R, Donoghue J. Anxiety in patients undergoing percutaneous coronary interventions. *Heart Lung.* 2011;40(3):185-192. doi: 10.1016/j.hrtlng.2010.05.054.
86. Malik M, Rehman H, Hussain A, Hashmi A, Al-Sunaidar KA, Balogh G, et al. Psychological burden and coping strategies among Pakistani adults: A cross-sectional survey study. *Epidemiologia (Basel).* 2025;6(3):30. doi: 10.3390/epidemiologia6030030.
87. Tofler GH, Stone PH, Maclure M, Edelman E, Davis VG, Robertson T, et al. Analysis of possible triggers of acute myocardial infarction (the MILIS study). *Am J Cardiol.* 1990;66(1):22-27. doi: 10.1016/0002-9149(90)90729-k.
88. Leaviss J, Davis S, Ren S, Hamilton J, Scope A, Booth A, et al. Behavioural modification interventions for medically unexplained symptoms in primary care: systematic reviews and economic evaluation. *Health Technol Assess.* 2020;24(46):1-490. doi: 10.3310/hta24460.
89. Freitas TH, Andreoulakis E, Alves GS, Miranda HL, Braga LL, Hyphantis T, et al. Associations of sense of coherence with psychological distress and quality of life in inflammatory bowel disease. *World J Gastroenterol.* 2015;21(21):6713-6727. doi: 10.3748/wjg.v21.i21.6713.
90. Pearlin LI, Lieberman MA, Menaghan EG, Mullan JT. The stress process. *J Health Soc Behav.* 1981;22(4):337-356.
91. Siska S, Marisa DE, Purbaningih ES, Karlina N. Application of deep breathing relaxation technique in hypertensive patients to reduce blood pressure. *Indogenius.* 2025;4(2A):59-67. doi: 10.56359/IG.V4I2A.717.
92. Sukarnaeni S, Muadi, Marisa DE. Efektivitas terapi relaksasi deep breathing dalam mengurangi ansietas pasien hemodialisis dengan gagal ginjal kronis. *Sci J Nurs.* 2025;11(3):403-407. doi: : 10.33023/JIKEP.V11I3.2619.
93. Sareban M, Treff G, Wuppinger T, Zimpfer D, Niebauer J. The valuable role of cardio-pulmonary exercise testing in the diagnosis of atrial septal defect in a competitive triathlete: a case report. *Eur Heart J Case Rep.* 2024;8(6):ytac278. doi: 10.1093/ehjcr/ytac278.
94. Oudkerk Pool MD, Hooglugt JQ, Schijven MP, Mulder BJM, Bouma BJ, de Winter RJ, et al. Review of digitalized patient education in cardiology: A future ahead? *Cardiology.* 2021;146(2):263-271. doi: 10.1159/000512778.
95. Ryff CD, Singer B. Psychological well-being: Meaning, measurement, and implications for psychotherapy research. *Psychother Psychosom.* 1996;65(1):14-23. doi: 10.1159/000289026.
96. Ryff CD, Keyes LM. The structure of psychological well-being revisited. *J Pers Soc Psychol.* 1995;69(4):719-727. doi: 10.1037//0022-3514.69.4.719.
97. Ryff CD. Psychological well-being revisited: Advances in science and practice. *Psychother Psychosom.* 2023;83(1):10. doi: 10.1159/000353263.
98. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today.* 2003;24(2):105-112. doi: 10.1016/j.nedt.2003.10.001.
99. Gunawan J, Aunguroch Y, Marzilli C. Beyond the classics: A comprehensive look at concept analysis methods in nursing education and research. *Belitung Nurs J.* 2023;9(5):406-410. doi: 10.33546/bnj.2544.
100. Luštrek M, Bohanec M, Cavero Barca C, Ciancarelli MC, Clays E, Dawodu AA, et al. A personal health system for self-management of congestive heart failure (HeartMan): Development, technical evaluation, and proof-of-concept randomized controlled trial. *JMIR Med Inform.* 2021;9(3):e24501. doi: 10.2196/24501.