Factors related to loss of appetite in postoperative cardiac surgery patients: A systematic review [version 1; peer review: 1 approved with reservations]

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Abstract
Background: Postoperative cardiac surgery patients often experience appetite loss. Although nutritional status is known to be associated with time of recovery, functional status, and length of stay, less is known about factors related to patient's loss of appetite after cardiac surgery. This review aimed to identify and understand factors related to loss of appetite in postoperative cardiac surgery patients, systematic review with narrative summary design was applied. Data sources including CINAHL, SCOPUS, PubMed, ProQuest, ScienceDirect, ThaiLIS, ThaiJo, and E-Thesis were searched without restriction on publication year through August 2020.

Methods: We conducted the review following the Joanna Briggs Institute methodology, using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist to categorize methodological quality and the PRISMA flow diagram to record the studies' factors.

Results: Six studies reported one or more of 16 factors related to loss of appetite: older age, sex (female), illiteracy, history of chronic disease, not knowing someone in health field, pain score ≥ 7, pain medications containing codeine, constipation, depression, heart-lung machine ≥ 120 minutes, preoperative serum creatinine levels ≥ 179 µmol/L, emergency surgery, perfusion pressure ≤ 40 mmHg, low cardiac output syndrome, mechanical ventilation ≥ 96 hours, and a New York Heart Association class III and IV.

Conclusion: The small number of publications restrict our conclusions. Future research should focus on multiple factors related to appetite loss in postoperative cardiac surgery patients. Additional research will provide a foundation for evidence-based interventions to reduce appetite loss and improve patient nutritional status after cardiac surgery. Nurses and other health professionals should assess postoperative cardiac surgery patients for the presence of the 16 significant factors. To promote patients' nutritional status, there
should be evidence-based practice guidelines on the management of postoperative symptoms such as pain management, treatment of constipation, and reduction of emotional stress and depression.

**Keywords**
anorexia, cardiac surgery, heart surgery, loss of appetite, poor appetite, systematic review

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**Author roles:** Prasankok C: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Software, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; Banharak S: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing

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**Introduction**

Heart disease is one of the leading causes of death in both developed and developing countries. Although treatment depends on severity and types of heart disease, first line approaches include lifestyle changes involving nutrition, exercise, and medication. As patients' symptoms worsen or complications increase, cardiac surgery often becomes the next treatment of choice.

There are various types of cardiac surgery. These include coronary artery bypass graft, valve replacement and repair, great vessel surgery, and septum repair for those with congenital heart disease. Most of these surgeries require the use of the heart-lung machine as a cardiopulmonary bypass to take over the function of the heart and lungs during surgery to help surgeons repair a diseased heart’s malfunctioning. Because there have been adverse effects from using the heart-lung machine on the various body systems, an off-pump coronary artery bypass technique was developed as an alternative. Nevertheless, the cardiopulmonary bypass remains widely used during open heart surgery. Prevention and management of possible deleterious effects from its use require ongoing assessment.

**Background**

Alterations in postoperative physiological/psychological functioning contribute to loss of appetite. Surgery and the use of the heart-lung machine cause injuries in tissues and peripheral nerves that can lead to a nociceptive and inflammatory response, causing prostaglandins, bradykinins, and substance P to become increased that produces physical pain. Postoperative pain and the use of the heart-lung machine are stressors that produce a physiological response such as the systemic inflammatory response syndrome. The syndrome is a disturbance in the balance of the coagulation system that decreases the production of platelets and fibrinogen with increases in prothrombin time, leading to a higher risk of postoperative bleeding. The immune system responds by decreasing the polymorphonuclear neutrophils and also macrophages in the lungs, which heighten the risk of infections, including pneumonia. Cardiac surgery also intensifies catabolism and insulin resistance, resulting in higher blood sugar levels in both patients with and without a history of diabetes. These factors directly and indirectly disturb the postoperative physiological/psychological interconnections to produce a loss of appetite and a nutritional imbalance.

Food consumption behaviors change when patients consume small volumes of food, coupled with physical decline, less body movement/mobility, depression, and postoperative stress. Ėččislo et al. (2019) found that after the cardiac surgery, 50% of patients had loss of appetite with an increased risk of poor nutrition, 35.4% had postoperative complications, and 10% had a decreased body mass index (BMI). The study affirmed that a decrease in BMI after surgery is associated with postoperative complications. Chermesh et al. (2014) found similarly that poor nutritional status increases the severity and number of complications in postoperative patients. Ringaitiené et al. (2016) reported that recovery is delayed in patients who have a loss of appetite and consume less food, causing longer hospitalizations.

Based on clinical experiences in caring for patients who had undergone cardiac surgery, we observed that some patients had decreased appetite, difficulty eating, ate less or had early satiety, and suffered bouts of nausea and vomiting. We further observed that these same postoperative cardiac surgical patients tended to have a late recovery, longer duration of hospitalization, and poorer prognosis than others without the symptoms. To the best of our knowledge, we found no literature that summarized and explained our observations. Therefore, the purpose of this systematic review of the literature was to contribute to a body of knowledge by focusing on all known factors related to loss of appetite in postoperative cardiac surgery patients. Understanding these factors will provide a foundation that is necessary to support nursing practice of cardiac surgical patients and inform future researchers what further aspects of loss of appetite need to be studied.

**Purpose**

The purpose of this review was to systematically identify and understand the collective factors related to loss of appetite in postoperative cardiac surgery patients as found in published research.

**Methods**

**Design**

We followed the systematic review process with narrative summary as prescribed by the Joanna Briggs Institute (JBI) methodology by formulating the review question, defining the inclusion and exclusion criteria, developing the search strategy, locating and selecting studies, assessing their quality, extracting data, and analyzing and interpreting the results. Moreover, the protocol for systematic review was registered at PROSPERO on February 1, 2021 and registration number was CRD42021234615.

**Search methods**

We searched CINAHL, SCOPUS, PubMed, ProQuest, ScienceDirect, ThaiLIS, ThaiJo, and E-Thesis databases and used snowballing through reference lists of defined studies. The search for both English and Thai published papers was made without restriction on publication year through August 2020. The search strategy used the keywords “cardiac surgery” OR “open-heart surgery” AND “poor appetite” OR “loss of appetite” OR “decreased appetite” OR “change in appetite” OR “anorexia.” The selection of studies was made based on the following inclusion criteria: (a) research in humans related to cardiac surgery; (b) results about factors related to loss of appetite in postoperative cardiac surgery patients; (c) patients aged 18 years and older; and (d) published in the English or Thai language.

**Search outcomes**

There were 5,774 original studies from the databases and two from hand searches. The winnowing process began with deduplication, which left 3,320 studies. Only 74 studies had full-text availability, of which 68 were excluded because they did not fully meet the inclusion criteria. As a result, six empirical research articles remained for appraisal. Figure 1 displays the PRISMA flow diagram of the information flow during the review process.
Quality appraisal
We individually reviewed the six selected articles using the standardized critical appraisal instrument from the JBI for analytical cross-sectional studies\(^1\). The studies were required to meet a positive response (i.e., “yes”) on a minimum of four of the eight questions on the critical appraisal tool. Methodological quality was grouped into the four categories of very low, low, moderate, and high quality.

Data abstraction
On the JBI data extraction form (Aromataris & Munn, 2018)\(^2\), we recorded the studies’ authors, study designs, settings, participants, levels of evidence certainty and methodological quality, types of surgery, times of outcomes measuring, and factors related to loss of appetite. Prior to starting the review, we practiced article screening, data extraction, and quality assessment with two other researchers who independently verified that the process and results we had undertaken were accurate. If there were incongruent opinions during the actual review process, we reached consensus in mutual discussion.

Synthesis
Extraction of quantitative data to conduct meta-analysis was not possible due to the heterogeneity of the study population, different types of cardiac surgery, outcome measures, and data analysis across the studies. The findings have been presented and discussed in tabular and narrative form to aid the data presentation.

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Flowchart of the Review Process.
Results
Six research articles met the inclusion criteria. They were all descriptive studies. Five had a moderate level of quality, and one had a high level of quality (Table 1 & Table 2). Two studies were published before the year 2000, and four were published on or after 2000. Patients in five studies had undergone coronary artery bypass graft surgery; patients in three studies had undergone valve surgery; and patients in one study had both a septum repair for congenital heart disease and a repair of the aorta. The surgeries reported in five studies required cardiopulmonary bypass, whereas one study did not specify its use. Although five studies addressed patients postoperatively and after-discharge, one study described the preoperative, operative, and postoperative phases (Table 3).

There were 16 factors identified in the six studies related to loss of appetite and they were divided into three phases. The preoperative factors were (a) age ≥ 60 years old; (b) sex (female); (c) history of a chronic disease, such as diabetes, hypertension, hyperlipidemia; (d) illiteracy; (e) not knowing someone in the health field; and (f) preoperative serum creatinine level ≥ 179 µmol/L. The operative factors were (a) emergency surgery; (b) using the heart-lung machine ≥ 120 minutes; (c) perfusion pressure ≤ 40 mmHg; and (d) low cardiac output syndrome. Finally, the postoperative factors were (a) using mechanical ventilation ≥ 96 hours; (b) moderate or higher pain score (≥ 7 points); (c) using pain medications containing codeine; (d) constipation; (e) depression; and (f) New York Heart Association (NYHA) class III and IV. Nevertheless, the study of Zang et al. (2009) reported specifically that the patient’s sex and types of cardioplegia solutions had no impact on loss of appetite in postoperative cardiac surgery patients (Table 3).

Discussion
We found that there were 16 factors related to loss of appetite in cardiac surgery patients. They were present in the preoperative, operative, or postoperative/discharge phases.

Preoperative phase
The aging process in itself can produce a loss of appetite due to a decrease in taste and smell, resulting in discontent with eating and a poor appetite. Older people (≥ 60 years) experience a decrease in ghrelin or a hunger hormone, an increase in leptin and insulin, and changes in the gastrointestinal system and inflammatory process, such as an increase in interleukin 1 (IL-1) and 6 (IL-6) and tumor necrosis factor alpha (TNF-α) that contribute to a loss of appetite. Older females, with low estrogen levels transitioning through menopause or post menopause, are more likely to have a loss of appetite with cardiac surgery, although needs further study, since Zang et al. (2009) found there was no statistical difference between the two. Chronic disease, such as diabetes or hypertension, can lead to an inflammatory process and an increase in interleukin and tumor necrosis factor alpha, which are known to be related to appetite. Moreover, increased blood sugar and high blood pressure can produce physiological stress. Both may directly and indirectly cause loss of appetite by pathophysiological and psychological pathways.

Operative phase
During the use of the heart-lung machine, chemical substances are produced by a systemic inflammatory response named proinflammatory cytokine. This substance includes interleukin (IL), tumor necrosis factor alpha (TNF-α), interferon gamma (IFNγ) and granulocyte-macrophage colony stimulating factor (GM-CSF). Higher levels of chemical substances are strongly related to loss of appetite. These chemical substances also become substantially increased in patients with cancer, affecting appetite. After the heart-lung machine is disconnected, the substances can remain at high levels for 48 hours after surgery. Not only does the heart-lung machine produce a systemic inflammatory response, but the digestive system is interrupted. Prolonged use of the heart-lung machine can lead to weariness and loss of appetite after cardiac surgery.

Low cardiac output syndrome, low perfusion pressure, and emergency surgery may indirectly affect loss of appetite. These three factors correlate with extended stays in the intensive care unit, total lengths of hospitalization, and prolonged intubation times. Low cardiac output and low perfusion pressure place patients at risk of acute kidney injury that can lead to high serum creatinine; and emergency cardiac surgery causes more postoperative complications in patients than planned surgery. These three conditions may collectively bring about stress and depression, leading to loss of appetite.

Postoperative phase
Prolonged mechanical ventilation requires suctioning patients’ endotracheal tubes to clear the airway, leading to post-extubation fatigue and loss of appetite. It is a significant factor affecting patients’ appetite levels after their endotracheal tubes are removed. Longer periods of postoperative mechanical ventilation are also influenced by higher levels of preoperative creatinine, low cardiac output, and psychological depression, further contributing to loss of appetite. Depression itself is a source of appetite loss by the hypoactivation of the brain’s insular regions, especially mid-insular cortex that supports the body’s physiological control of eating. Depressed patients have an increase in their hypothalamic-pituitary-adrenal drive that can cause high levels of cortisol, which is
Table 1. The results of critical appraisal for the selected six analytical cross-sectional studies.

<table>
<thead>
<tr>
<th>Critical Appraisal Checklist for Analytical Cross-sectional Studies (Joanna Briggs Institute)</th>
<th>Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were the criteria for inclusion in the sample clearly defined?</td>
<td>√</td>
</tr>
<tr>
<td>Were the study subjects and the setting described in detail?</td>
<td>√</td>
</tr>
<tr>
<td>Was the exposure measured in a valid and reliable way?</td>
<td>√</td>
</tr>
<tr>
<td>Were objective, standard criteria used for measurement of the condition?</td>
<td>√</td>
</tr>
<tr>
<td>Were confounding factors identified?</td>
<td>√</td>
</tr>
<tr>
<td>Were strategies to deal with confounding factors stated?</td>
<td>√</td>
</tr>
<tr>
<td>Were the outcomes measured in a valid and reliable way?</td>
<td>√</td>
</tr>
<tr>
<td>Was appropriate statistical analysis used?</td>
<td>√</td>
</tr>
<tr>
<td>Overall appraisal (include)</td>
<td>6/8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Grap et al., 1996</th>
<th>King &amp; Parrinello, 1988</th>
<th>Corrêa &amp; Cruz, 2000</th>
<th>Miller &amp; Grindel, 2004</th>
<th>Zhang et al., 2009</th>
<th>Ammouri et al., 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Were the criteria for inclusion in the sample clearly defined?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Were the study subjects and the setting described in detail?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Was the exposure measured in a valid and reliable way?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Were objective, standard criteria used for measurement of the condition?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Were confounding factors identified?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Were strategies to deal with confounding factors stated?</td>
<td>√</td>
<td>√</td>
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<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Were the outcomes measured in a valid and reliable way?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Was appropriate statistical analysis used?</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Overall appraisal (include)</td>
<td>6/8</td>
<td>6/8</td>
<td>8/8</td>
<td>6/8</td>
<td>6/8</td>
<td>6/8</td>
</tr>
</tbody>
</table>

Associated with decreased appetite and hypoactivation of food-motivation neurocircuitry. The interactivity and interaction among these regions, however, contribute to individual differences in patients with depression-related appetite changes.

After open heart surgery, patients experience pain and discomfort during routine postoperative care, such as deep breathing and coughing to expand the lungs and clear secretions, using an incentive spirometer, moving/turning in bed coupled with early ambulation, and undergoing physical therapy with possible rehabilitation activities. Pain decreases the movement and mobility of patients, so the stomach and intestine are relatively less functional. Patients can feel anxious, insecure, and uncertain about the disease and success of the surgery, causing them to have emotional stress. These complicated reactions are intercorrelated and can affect the appetite directly and indirectly. As a result, these patients may experience a decrease in appetite with a distorted perception of smell and gustatory dysfunction, leading to a lower consumption of food.

Pain that occurs immediately after cardiac surgery is called acute pain, whereas pain after hospital discharge is chronic pain. Both can stimulate the inflammatory process, which causes the release of cytokine, especially IL-6. Interleukine-6 is related to loss of appetite. Because the release of cytokine leads to the pain cycle, postoperative patients require analgesics, usually with codeine. Medications containing codeine coupled with less physical movement and stomach/intestinal dysfunction may cause constipation. Constipation affects loss of appetite because patients feel that food remains in the gastrointestinal system, which produces abdominal discomfort.

Patients with NYHA Class III & IV heart failure may have a loss of appetite due to hypervolemia, especially if there is congestion in the lungs, liver, and intestine. Congestion directly affects the function of the respiratory and gastrointestinal systems, producing dyspnea, fatigue, and inactivity, all related to loss of appetite. Liver and intestinal congestion leads to gastrointestinal hypomotility of the stomach and intestine. This may cause abdominal distension and discomfort, thus inhibiting patient activities would stimulate appetite. In addition, medications that treat and control heart failure, such as digoxin and simvastatin, not only impact appetite indirectly by affecting the function of the gastrointestinal system but also decrease appetite directly.

Five out of the six studies had a moderate level of methodological quality. The researchers did not report their confounding factors, missing data, or how they managed the statistical challenges. Only one study (Corrêa & Cruz, 2000) reported controlling for two confounding factors that may have affected loss of appetite (i.e. level of pain and onset of having pain). Pain is both a rapidly (state variable) and slowly (trait variable) changing factor. A state variable can change in a short time period and at a specific moment, whereas a trait variable takes much longer to change. Corrêa and Cruz (2000) divided
Table 2. Grading results of the six selected studies from the quality assessment of the evidence by GRADE guideline.

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk of bias (confounding factors, missing data, adherence measurement)</th>
<th>Precision (statistical certainty, amount of information on a certain factor how precisely an object of study is measured)</th>
<th>Directness (extent to which the people, interventions, and outcome measures are similar to those of interest, confident results come from the direct evidence)</th>
<th>Consistency (relevant measurement application where several items that propose to measure the same general construct produce similar scores, no overlapping and missing, statistical significance)</th>
<th>Certainty of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Moderate</td>
</tr>
<tr>
<td>17</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Moderate</td>
</tr>
<tr>
<td>15</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>High</td>
</tr>
<tr>
<td>18</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Moderate</td>
</tr>
<tr>
<td>19</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Moderate</td>
</tr>
<tr>
<td>14</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

a = Risk of bias; b = Precision; c = Directness; d = Consistency

GRADE Working Group Grades of Evidence for certainty of evidence

High: The research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low.

Moderate: The research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate.

Low: The research provides some indication of the likely effect. The likelihood that it will be substantially different (a large enough difference that it might have an effect on a decision) is high.

Very low: The research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different (a large enough difference that it might have an effect on a decision) is very high.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Design</th>
<th>Participants</th>
<th>Setting</th>
<th>Time of Outcomes Measured</th>
<th>Outcomes Measured</th>
<th>Types of Surgery</th>
<th>Level, Certainty of Evidence and Methodological Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grap et al., 1996</td>
<td>Observational analytical study without a control group</td>
<td>34</td>
<td>A large university medical center</td>
<td>After discharge</td>
<td>Constipation: 6th and 12th week after discharge; Depression was correlated with poor appetite at 2nd and 6th weeks after discharge.</td>
<td>Coronary artery bypass graft surgery/None</td>
<td>Level 3.e Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
<tr>
<td>King &amp; Parrinello, 1988</td>
<td>Observational analytical study without a control group</td>
<td>122</td>
<td>Two medical schools</td>
<td>After discharge</td>
<td>Pain score ≥ 7 was related to loss of appetite after surgery</td>
<td>Coronary artery bypass graft surgery and valve surgery/Cardio-pulmonary bypass surgery</td>
<td>Level 3.e Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
<tr>
<td>Corrêa &amp; Cruz, 2000</td>
<td>Observational analytical study: cohort study</td>
<td>80</td>
<td>Not available</td>
<td>Postoperative</td>
<td>Depression was correlated with poor appetite at 2nd and 6th weeks after discharge.</td>
<td>Heart Surgery/Cardio-pulmonary bypass surgery</td>
<td>Level 3.e Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
<tr>
<td>Miller &amp; Grindel, 2004</td>
<td>Observational analytical study without a control group</td>
<td>102</td>
<td>University hospital</td>
<td>Postoperative</td>
<td>Age ≥ 65 years was related to loss of appetite at 6th week after surgery</td>
<td>Coronary artery bypass graft surgery/Cardio-pulmonary bypass surgery</td>
<td>Level 3.e Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
<tr>
<td>Zhang et al., 2009</td>
<td>Observational analytical study: Case-controlled study</td>
<td>412</td>
<td>Hospital</td>
<td>Pre/Under/Postoperative</td>
<td>Sex (non-significant); Cardioplegia Cold crystal, warm blood, cold blood (non-significant); Preoperative serum creatinine ≥ 179 µmol/L; Emergency surgery; Perfusion Pressure ≤ 40mmHg; Low cardiac output syndrome; On ventilator ≥ 96 hours; Age ≥ 61 years; Heart failure NYHA Class III &amp; IV; Not knowing somebody in health field</td>
<td>Coronary artery bypass graft surgery/Cardio-pulmonary bypass surgery</td>
<td>Level 3.d Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
<tr>
<td>Ammour et al., 2016</td>
<td>Observational analytical study without a control group</td>
<td>100</td>
<td>Two teaching hospitals and three private hospitals</td>
<td>Postoperative</td>
<td>- Age ≥ 60 years; - Female; - Illiteracy; - Chronic disease (e.g. diabetes, hypertension, dyslipidemia)</td>
<td>Coronary artery bypass graft surgery/Cardio-pulmonary bypass surgery</td>
<td>Level 3.e Moderate (6/8) ⊕⊕⊕ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥ ⊥</td>
</tr>
</tbody>
</table>

Table 3. A summary of the reviewed studies and factors related to poor appetite in postoperative cardiac surgery patients.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Design</th>
<th>Setting</th>
<th>Participants</th>
<th>Level, Certainty of Evidence and Methodological Quality†</th>
<th>Types of Surgery</th>
<th>Time of Outcomes Measured</th>
<th>Factors Related to Loss of Appetite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joanna Briggs Institute levels of evidence</td>
<td>Level 3.c - Observational analytical study: Cohort study with control group</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Level 3.d - Observational analytical study: Case-controlled study</td>
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</tr>
<tr>
<td></td>
<td>Level 3.e - Observational analytical study: Observational study without a control group</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>GRADE Working Group Grades of Evidence for certainty of evidence</td>
<td>High: The research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Moderate: The research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Low: The research provides some indication of the likely effect. The likelihood that it will be substantially different (a large enough difference that it might have an effect on a decision) is high.</td>
<td></td>
<td></td>
<td></td>
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<td>Very low: The research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different (a large enough difference that it might have an effect on a decision) is very high.</td>
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Explanations
a. Risk of bias (low, unclear, high)
b. Consistency (consistency, inconsistency, unknown/non applicable)
c. Directness (direct, indirect)
d. Precision (precise, imprecise)

†The scores of Methodological Quality of the Studies are shown in fractions based on Joanna Briggs Institute and the Mixed Methods Appraisal Tools.
⊕◯◯◯ = Very low quality; ⊕◯◯ = Low quality; ⊕⊗⊗ = Moderate quality; ⊕⊗⊗ ⊗ = High quality
the samples into several groups based on the level and onset of pain and compared the differences of loss of appetite between each group to identify more clearly the factors related to loss of appetite. Because only one of the six studies demonstrated high methodological quality by controlling for confounding factors, we cannot make firm conclusions on the overall results of the systematic review.

Some of the 16 factors we report are not exclusive to postoperative cardiac surgery patients. Other types of surgery can produce changes in eating behaviors, food intake, loss of appetite, and malnutrition in postoperative patients. Factors may include older age; sex (female); type of illness or chronic disease, such as type 2 diabetes mellitus; medications; length of hospital stay; and psychological factors, such as stress, depression, psychopathology, and well-being. In addition to those reported for general surgery patients, our systematic review expanded knowledge of other specific factors related to loss of appetite in postoperative cardiac surgery patients.

Strengths and limitations
We searched extensively the published literature in eight national and international databases, restricting the studies to those in English or Thai. Out of a large potential number of studies, only six met the specific criterion related to loss of appetite in postoperative cardiac surgery patients. None of the studies had loss of appetite as a primary research objective. Methodological problems in some studies could have been strengthened by having larger sample sizes, reporting how missing data were handled, and mentioning how confounding factors were controlled. In the studies with a larger sample size, subgroup analysis on individual factors could have brought better understanding of their influence on loss of appetite. None of the six studies used an experimental research design and long-term evaluation.

Conclusions and implication
This systematic review provides initial knowledge for the development of nursing interventions based on the factors related to loss of appetite in postoperative cardiac surgery patients. Clinical assessment by nurses and other health professionals should include whether patients were on the heart-lung machine ≥ 120 minutes, had emergency surgery, reported having a low cardiac output syndrome, or required mechanical ventilation ≥ 96 hours. To promote patient’s nutritional status, there should be evidence-based practice guidelines on the management of postoperative symptoms related to loss of appetite. These would include pain management, treatment of constipation, and reduction of emotional stress and depression. Additional information on self-care should be given to patients and families before hospital discharge to relieve their stress and depression, enhance knowledge of nutrition to promote healing, and prevent loss of appetite. However, nurses and health professionals should first assess health literacy to ensure that patients and families adequately understand the discharge instructions. Discharge planning should provide instruction on how to support self-care ability and reduce post-discharge problems, especially guidance in nutrition after coronary artery bypass graft surgery. A multidisciplinary approach, including physician, nurse, dietitian/nutritionist, and pharmacist, should be considered as part of the holistic care given to postoperative cardiac surgery patients because loss of appetite can result from multiple factors that lead to poor nutrition and inhibit healing.

Future research should focus on the identified factors related to appetite loss in postoperative cardiac surgery patients. The use of multiple research methods and longitudinal studies will provide a foundation for evidence-based interventions to reduce loss of appetite and improve nutritional status for patients after cardiac surgery.

Data availability
Underlying data
All data underlying the results are available as part of the article and no additional source data are required.

Reporting guidelines
Figshare: PRISMA checklist for ‘Factors related to loss of appetite in postoperative cardiac surgery patients: A systematic review’, https://doi.org/10.6084/m9.figshare.1447318

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

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References


Open Peer Review

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Bingyang Ji

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The authors systematically reviewed the factors related to appetite loss after cardiac surgery, which is a quite interesting topic. I have several suggestions:

- The INTRODUCTION section introduced background knowledge of cardiac surgery. I think the authors should discuss less about it and merge this part with the BACKGROUND section.

- I have some concerns on the methods of systematic review. The authors listed PRISM flowchart, some important data were not reported. After excluding duplications, 3246 articles were excluded because they were not published in English/Thai, did not report heart surgery patients or other reasons. The authors should better report the exact number of patients excluded in every step. This may allow replication by other researchers.

- Table 2 reported Quality Assessment of the Evidence by GRADE Guideline, and all six articles were of high or moderate quality. I suggest the authors reported more details on assessing the article. It's better to not just report whether it is precise, but report the details of how you decide it's precise.

- I recommend the authors to ask for language editing, as some syntax errors existed. e.g. Page 6, Paragraph 4, Line 6, 'Pain is both a rapidly (state variable) and slowly (trait variable) changing factor.'

Are the rationale for, and objectives of, the Systematic Review clearly stated?
Partly

Are sufficient details of the methods and analysis provided to allow replication by others?
Partly
Is the statistical analysis and its interpretation appropriate?
Yes

Are the conclusions drawn adequately supported by the results presented in the review?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** The blood conservation and organ protection during cardiopulmonary bypass. Improving the prognosis of extracorporeal life support.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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Author Response 28 Sep 2021

**Samoraphop Banharak,** Faculty of Nursing, Khon Kaen University, Khon Kaen, Thailand

- The **INTRODUCTION** section introduced background knowledge of cardiac surgery. I think the authors should discuss less about it and merge this part with the **BACKGROUND** section.
- **Response:** Thank you for suggestion. The introduction and Background to an academic paper are different things and both are essential. The Introduction comes first and is a relatively short section of the manuscript which sets the study we are reporting in its widest context. However, the Background is the place to begin to focus on what, specifically, we investigated. In other words, the INTRODUCTION is the overview, however, BACKGROUND is more scope and focus of what is the phenomenon of this study. For these reasons, we would like to separate and keep these two parts if possible.

- I have some concerns on the methods of systematic review. The authors listed PRISM flowchart, some important data were not reported. After excluding duplications, 3246 articles were excluded because they were not published in English/Thai, did not report heart surgery patients or other reasons. The authors should better report the exact number of patients excluded in every step. This may allow replication by other researchers.
- **Response:** We would like to say thanks for this useful comment and agree with this suggestion. We can add more detail about how many articles were excluded for each reason. There were 347 for not published in English/Thai; 1,245 not heart surgery patients; 109 animal study; and 1,545 not research article.

- Table 2 reported Quality Assessment of the Evidence by GRADE Guideline, and all six articles were of high or moderate quality. I suggest the authors reported more details on assessing the article. It's better to not just report whether it is precise, but report the details of how you decide it's precise.
- **Response:** Thank you so much for useful suggestion. We have followed the GRADE Guideline from Joanna Briggs Institute and provide the standard reported table of
GRADE following "Quality Assessment of the Evidence by GRADE Guideline." However, we can add more detail about the reason for giving score for risk of bias, precision, directness, and consistency at the Table 2.

- **Unclear** = The researchers did not indicate or reported how they designed for controlling confounding factors and dealing with missing data
- **Precise** = The researchers described how to measure their primary and secondary outcomes and used appropriate statistic for their data analysis
- **Direct** = The researchers demonstrated they measured primary and secondary outcomes in intervention and control groups in the same way
- **Consistent** = The researchers demonstrated they measured primary and secondary outcomes in intervention and control groups in the same construct and measurement

- *I recommend the authors to ask for language editing, as some syntax errors existed. e.g. Page 6, Paragraph 4, Line 6, ‘Pain is both a rapidly (state variable) and slowly (trait variable) changing factor.’*
- **Response:** Thank you so much for suggestion. We have edited this sentence as "Pain is both a rapid (state variable) and slow (trait variable) changing factor." Moreover, this manuscript will be proved again by the English native speaker before publishing the final version.

**Competing Interests:** Non-Financial Competing Interests

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