Prevalence of Depression in Coronary Artery Bypass Surgery: A Systematic Review and Meta-Analysis

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Abstract: Coronary artery bypass graft surgery (CABG) might adversely affect the health status of the patients, producing cognitive deterioration, with depression being the most common symptom. The aim of this study is to analyse the prevalence of depression in patients before and after coronary artery bypass surgery. A systematic review and meta-analysis was carried out, involving a study of the past 10 years of the following databases: CINAHL, LILACS, MEDLINE, PsycINFO, SciELO, Scopus, and Web of Science. The total sample comprised \( n = 16,501 \) patients. The total number of items was \( n = 65 \), with \( n = 29 \) included in the meta-analysis. Based on the different measurement tools used, the prevalence of depression pre-CABG ranges from 19–37\%, and post-CABG from 15–33\%. There is a considerable presence of depression in this type of patient, but this varies according to the measurement tool used and the quality of the study. Systematically detecting depression prior to cardiac surgery could identify patients at potential risk.

Keywords: coronary artery bypass graft; depression; mental health; meta-analysis; prevalence; surgery; systematic review

1. Introduction

Coronary artery disease (CAD) is one of the leading causes of death in developed countries, and it is associated with deteriorated quality of life, disability, and premature death [1]. The usual surgical treatment involves coronary artery bypass graft surgery (CABG). This technique is based on revascularisation by diverting blood flow to other arteries to increase the blood supply to the heart muscle [2].

Although CABG surgery increases life expectancy [3], it is associated with multiple physical complications, including myocardial infarction, stroke, and even kidney failure [4]; in addition to psychological consequences, such as mood disorders, fatigue, weakness, stress, anxiety, and depression [5].
Short-term recovery factors include a longer hospital stay, pain, and infection, which may predispose towards cognitive disorders, like anxiety and depression [6]. In the long term, it is estimated that at least 25% of patients will experience deteriorated quality of life after a CABG; and, it even doubles the post-surgery risk of future cardiac events and mortality related to high levels of anxiety and depression [7].

In particular, depression is considered to be one of the main reasons for reduced well-being, having a negative impact on a patient’s quality of life, as well as their social and family life. It is a strong risk factor for mortality, being related to the occurrence of new cardiac events and reduced functionality up to six months post-CABG surgery, increasing the risk of hospital readmission in up to 20% of patients, due to complications including infection, arrhythmia, and volume overload [8].

Diagnosis is sometimes difficult, since symptoms, such as loss of appetite, sleep cycle disturbance, and constant fatigue, may be superimposed over the same symptoms that were derived from surgery. For this reason, determining the degree to which a CABG can affect a patient’s mental, psychological, and social skills, and, specifically, analysing the level of depression, requires the use of multiple tools validated during a clinical interview [9,10].

A number of factors seem to influence the relationship between depression and CABG, including biological alterations (cardiac rhythm alterations, tone of cardiac muscle, hormone levels, and reduced brain perfusion) [11]. However, in many cases, the high prevalence of mood disorders cannot be explained by the severity of the illness, but is instead related to psychosocial factors, such as socioeconomic status, lifestyle (adherence to the recommended diet or prescribed treatment), or the level of social support [12].

Even though the effects of CABG have been studied in terms of morbidity, mortality, and organ function, the effect or influence it has on mood disorders, like depression, remains unclear. It seems that depression predicts how much a patient’s health will deteriorate. Therefore, it is extremely important to assess how the disease affects a patient, as this can influence the therapeutic benefit and, consequently, which interventions and care are prioritised, and which self-care strategies are implemented both before and after surgery [13,14].

Although depression is considered to have a negative impact on patient recovery, few studies have examined the association between CABG and depression. Some systematic reviews have analysed the risk factors [15], and there are also reports regarding the effect of certain interventions [16,17]. However, to our knowledge, no meta-analysis studies that include a prevalence analysis have been exclusively undertaken on CABG patients.

Describing the levels of depression in CABG patients is essential for analysing the importance of this surgery with regard to depression levels. The purpose of this work is, therefore: (1) to analyse the prevalence of depression in patients both before and after CABG surgery; and, (2) to analyse the depression levels over time.

2. Materials and Methods

The data were extracted and analysed based on the recommendations of preferred reporting items for systematic review and meta-analysis (PRISMA) 2015 [18].

2.1. Search Strategy

A search was conducted of CINAHL, LILACS, MEDLINE, PsychINFO, SciELO, Scopus, and Web of Science in January 2020. MeSH descriptors were used, with the search strategy being: “(depression OR depressive disorder) AND (coronary artery bypass grafting)”.  

2.2. Inclusion and Exclusion Criteria

The inclusion criteria were the following: (1) full text of quantitative primary studies; (2) men and women aged over 18; (3) no psychiatric pathology or illness; (4) CABG surgery; (5) study of depression
levels prior to or after CABG; (6) the use of a validated scale; (7) written in English, Portuguese, Spanish, or French; and, (8) published in the last 10 years.

The exclusion criteria were the following: (1) paediatric population; (2) a different type of cardiac surgery that was not exclusively CABG (CABG with valve replacement); (3) measurement of depression in relatives; (4) patients with an active treatment deriving from a psychiatric disorder; (5) data from duplicate articles in previous studies; and, (6) no depression data extracted using a validated scale.

2.3. Selection of Articles and Information Analysis

Firstly, two authors checked the title and abstract, and, secondly, the full text of the article. A third author was consulted in the case of discrepancy.

For the meta-analysis, we selected the data from those studies that used the same measurement tool, since the inclusion of several measurement tools would not permit the results to be integrated, due to different scores.

2.4. Data Extraction

The following variables were recorded: (1) data on the study (author, year, country); (2) type of CABG (first time, elective or emergency); (3) study characteristics (sample, type of study, sex, and follow-up time); (4) measurement tool; and, (5) mean, standard deviation, prevalence of depression. For clinical trials or quasi-experimental studies, we selected only the levels of depression prior to the programme intervention (baseline) or those relating to the control group.

We used the intraclass correlation coefficient to analyse coding reliability, obtaining an average value of 0.97 (minimum = 0.93; maximum = 1), and the Cohen’s kappa coefficient with a mean value of 0.94 (minimum = 0.92; maximum = 1).

2.5. Assessment of Quality and Measurement of Bias

Two independently authors assessed the quality of the studies, consulting with a third party in the event of a disagreement.

For observational studies (cohort and cross-sectional), we followed the guidelines in “Strengthening the Reporting of Observational Studies in Epidemiology” (STROBE) [19]. We followed the standards in the Cochrane Collaboration Risk of Bias tool for clinical trials [20].

We used a second quality assessment tool to analyse the level of evidence in accordance with the recommendations of the Oxford Centre for Evidence-Based Medicine [21] (Table 1).

2.6. Data Synthesis and Statistical Analysis

The meta-analysis included those studies that used the same tool for measuring depression. We performed six meta-analyses using a random-effects model and two meta-analyses using a fixed-effect model, for prevalence levels and confidence intervals, through the statistical package StatsDirect (version 3, StatsDirect Ltd., Cambridge, UK).

We used $I^2$ to analyse the heterogeneity, grouping values into low (25%), moderate (50%), or high (75%) heterogeneity [22]. The publication bias was assessed using Egger’s test.

3. Results

The search yielded a total of $n = 1874$ articles. After reading the title and abstract, 662 were excluded. Figure 1 shows the study selection process.
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3.1. Characteristics of Included Studies

The total sample comprised 16,501 patients, predominantly male (\( n = 54 \)). Most of the studies were cohort studies (\( n = 34 \)), followed by cross-sectional studies (\( n = 12 \)). Thirteen studies evaluated the levels prior to surgery, 23 after surgery, and 29 both before and after. Most of the studies were carried out in the USA (\( n = 17 \)), followed by Germany (\( n = 7 \)), Iran (\( n = 7 \)), and Australia (\( n = 6 \)) (Table 1). The depression follow-up ranged from a month prior to surgery [23] up to six years after surgery [24,25].

**Figure 1.** Preferred reporting items for systematic review and meta-analysis (PRISMA) flow-chart of included studies.

3.1. Characteristics of Included Studies

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Table 1. Studies reporting prevalence and levels of coronary artery bypass graft surgery (CABG) depression.

| Study | CABG (First, Elective, Emergency) | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RR |
|-------|----------------------------------|-------------------|---------------------------------|----------------------|-------------------|--------------|--------|
| Abbott et al., [26] | USA Elective CABG | RCT n = 226 83% male | HADS | After CABG | – | Cluster 1: 5.9 (4.3) | Elderly patients with more symptoms and chronic illnesses are more prone to depression | 1a/A |
| Aburuz, [27] | Jordan Elective CABG | Cohort n = 227 78% male | HADS | 2-weeks before, 1-month after | 12.76 (6.80) Normal: 57.26% Mild: 11.90% Moderate-severe: 30.84% | Pre-operative depressive symptoms increased postoperative hospital length of stay | 2c/B |
| Açikel, [28] | Turkey Elective CABG | Cohort n = 65 76.9% male | BDI | 1-day before 3–7 days, 1-month after | 8.12 (5.44) Normal: 61.5% Mild: 30.8% Moderate: 7.7% Severe: 0% | Depression levels increase during postoperative CABG period | 2c/B |

3rd day: 12.43 (6.36) Normal: 35.4% Mild: 40.0% Moderate: 23.1% Severe: 1.5% 7th day: 11.66 (6.95) Normal: 40.0% Mild: 30.8% Moderate: 27.7% Severe: 1.5% 1 month: 12.29 (9.08) Normal: 47.7% Mild: 26.2% Moderate: 23.1% Severe: 3.1%
| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results |
|-------|-------------------|--------------------------------|---------------------|------------------|--------------|
| Afri ati et al., [29] Pakistan First-time CABG | Cohort n = 134 84.3% male | HAM-D | 2 days before, at discharge, 6-months follow-up | Pre | At discharge: 80.6% 98.5% 98.5% M (SD) Prevalence Main Results EL/RG |
| Afri ati et al., [29] Pakistan First-time CABG | Cohort n = 134 84.3% male | HAM-D | 2 days before, at discharge, 6-months follow-up | Post | Mild: 71.6% Moderate: 23.9% Severe: 1.5% Very severe: 1.5% |
| Ajtahed et al., [30] Iran First-time CABG | RCT n = 75 67% male | DASS | After CABG | – | Control group: Group 1: Normal: 60% Mild: 40% Moderate: 24% Severe: 12% Extremely severe: 0% |
| Amouri et al., [31] Jordan First-time CABG | Cross-sectional n = 100 80% male | CSS | 2-weeks after discharge | – | 3% Pain, leg swelling, poor appetite and trouble sleeping are the most frequent symptoms after CABG |
| Amouzeshi et al., [32] Iran Elective CABG | Cross-sectional n = 54 68% male | BDI | 1 day before and after ICU | Male: 31.5 (10.60) 11.7 (7) Minimal: 55.4% Mild: 28.6% Moderate: 16.1% Female: 29.3 (10.55) Minimal: 0% Mild: 17.9% Moderate: 32.1% Severe: 46.4% |
| Amouzeshi et al., [32] Iran Elective CABG | Cross-sectional n = 54 68% male | BDI | 1 day before and after ICU | Male: 31.5 (10.60) 11.7 (7) Minimal: 55.4% Mild: 28.6% Moderate: 16.1% Female: 29.3 (10.55) Minimal: 0% Mild: 17.9% Moderate: 32.1% Severe: 46.4% |
| Depression is commonly reported before and after CABG and influences the quality of life of the patients |
| Training cognitive rehabilitation can improve cognitive functions and quality of life in patients after CABG surgery | 2c/B 1a/A | 2c/B | 2c/B |
Table 1. Cont.

| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RG |
|-------|------------------|---------------------------------|----------------------|-------------------|--------------|-------|
| Azzopardi & Lee, [33]  
Australia Elective CABG | Cohort  
n = 48 85.4% male | BDI | Before, 6-weeks after, 1–2 years follow-up | 7.31 (4.1) 2 years: 7.90 (7.1) | Depression levels 2 years after CABG were not severe | 2b/B |
| Bay et al., [34]  
USA Elective CABG | RCT  
n = 170 75% male | HADS | Baseline, 1–6 months after | Control group:  
7.3 (3.7)  
Control group:  
1-month: 3.0 (3.1)  
6-months: 3.0 (3.1) | A coping religious intervention can reduce depression levels up to 6 months after surgery | 1a/A |
| Beresnevaite et al., [35]  
Lithuania Elective CABG | Cross-sectional  
n = 109 100% male | SCL-90R | 1-day before after | 63.13 (8.22)  
High level: 23% | Preoperative depression score is related with a length stay hospital (p < 0.001) and perioperative complications (p < 0.05) | 2b/B |
| Cebeci & Çelik, [36]  
Turkey First-time CABG | Quasi-experimental  
n = 52 80.8% male | HADS | 1-day before, 1-day, 1-week, 1-month after | 8.3 (3.6)  
At discharge: 7.9 (4.2)  
1-week: 8.2 (4.3)  
1-month: 7.7 (4.3) | At the time of admission, patients had a higher level of depression than at the time of discharge | 1b/A |
| Chocron et al., [37]  
France First-time CABG | RCT  
n = 361 | BDI | Before CABG | 39% | Antidepressant treatment did not affect the morbidity and mortality events after CABG surgery | 1a/A |
| Colella et al., [38]  
Canada First-time CABG | RCT  
n = 124 100% male | BDI | At discharge, 6–12 weeks after | Control group:  
After: 8.87 (4.74)  
6-weeks: 5.84 (5.30)  
12-weeks: 4.43 (5.26) | Physiological and psychological challenges after CABG increases the depression risk | 1a/A |
| Dal Boni et al., [39]  
Brazil Elective CABG | Cross-sectional  
n = 78 67% male | BDI | Before, 2-months after | 8.49 (6.87)  
5.01 (6.61) | CABG had a positive impact on the patient’s quality of life | 2b/B |
| Doering et al., [40]  
USA First-time CABG | Cohort  
n = 67 100% female | HAM-D | At discharge, 1 month after | – | Six months after CABG, women with major depression have at increased risk for infections | 2b/B |
| Study CABC (First, Elective, Emergency) | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/UG |
|---------------------------------------|-------------------|---------------------------------|----------------------|-------------------|-------------|-------|
| Donohue et al., [41] USA Elective CABC | RCT n = 2485      | PHQ-2                           | At discharge         | –                 | 56%         | 1a/A  |
| Dunkel et al., [42] Germany Elective CABC | Cross-sectional n = 1238 72% male | PHQ-9                           | Before CABG          | 21.6%             |             | 2b/B  |
| Dunkel et al., [43] Germany Elective CABC | Cross-sectional n = 971 80.1% male | PHQ-9                           | 1-3 days before, 1 year after | 5.61 (4.31)       |             | 2b/B  |
| El-Baz et al., [44] Netherlands and Slovakia Elective CABC | Observational multicentre n total = 226 n1 = 114 Slovakia n2 = 112 Netherlands 80% male | HADS                           | Before CABG          | n1 = 5.01 (3.73) n2 = 4.96 (3.16) |             | 2b/B  |
| Elliott et al., [45] Australia Elective CABC | Cohort n = 174 80% male | POMS-D                          | Before, 2-6 months after | 10.50 (11.76) 2-months: 7.38 (9.41) 6-months: 8.32 (10.52) | The young, male and smoking are the main risk factors of depression | 2b/B  |
| Feuchtlinger et al., [46] Germany First-time CABC | Cross-sectional n = 24 37.5% male | HADS                           | 1-day before          | 6.7 (5.1) Low: 54.17% Moderate: 20.83% Severe: 25% | –                   | 2b/B  |
| Freedland et al., [47] USA Elective CABC | RCT n = 123 50% male | BDI HAM-D                       | 1 year after          | –                 | BDI = 22.26 (1.3) HAM-D = 19.53 (1) | 1a/A  |
| Gallagher & McKinley, [48] Australia Elective CABC | Cohort n = 155 74% male | HADS                           | Before, after surgery, 2-weeks after | 4.10 (3.22) 16% After: 18.2% 4.67 (3.49) 2-weeks: 45% 6.58 (4.03) | 26.5% of patients reported low perceptions of control before CABC, 22% after surgery and 10.3% at discharge | 2b/B  |
Table 1. Cont.

| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RG |
|-------|-------------------|---------------------------------|----------------------|-------------------|--------------|-------|
|       | CABG (First, Elective, Emergency) | | | | | |
| Gelogahi et al., [49] | RCT | DASS | Before, after | 6.67 (4.7) | | 1a/A |
| Iran | Elective CABG | | | 12.1 (8.1) | Nurses interventions can reduce depression levels after surgery | |
| Hazavei et al., [50] | Quasi-experimental | CDS | Before, 4-8 weeks after | 104.5 (30.4) | 2-months after: 89.2 (27.8) | 1b/A |
| Iran | First-time CABG | | | | Most patients lacked the skills in health education and lifestyle-related with coronary artery disease | |
| Horne et al., [51] | Cohort | PHQ-9 | Before | 60.6% | | 2b/B |
| Canada | Elective CABG | | | | Length of stay (more than 7 days) is associated with a higher risk of depression | |
| Hweidi et al., [52] | Cross-sectional | SDS | 2 days after | – | Mild: 32.2% Moderate: 60.1% Severe: 5.6% | 2b/B |
| Jordan | Elective CABG | | | | Depression is related to female, unmarried and unemployed patients | |
| Kendel et al., [53] | Cohort | PHQ-9 | 2 months, 2 years after | – | Male: 5.38 (4.2) Female: 6.84 (4.8) | 2b/B |
| Germany | Elective CABG | | | | Females have a higher level of depressive symptoms | |
| Kendel et al., [54] | Cohort | PHQ-9 | 1–3 days before | 5.38 (4.09) | – | 2b/B |
| Germany | Elective CABG | | | 8.5% | | |
| Khoueiry et al., [55] | Cohort | BDI | Before, 1–3–6–9 months follow-up | 8% | After: 60% 3-months: 44% 6-months: 40% 9-months: 44% | 2b/B |
| USA | Elective CABG | | | | Age and gender are not correlated with depression levels | |
| King et al., [56] | Cohort | BDI | At discharge, 6–12–36 weeks follow-up | – | BDI At discharge: 8.08 (4.76) 4.3% 6-weeks: 5.82 (5.36) 1.9% 12-weeks: 4.81 (4.73) 1.9% 36-weeks: 4.31 (5.81) 2.1% CDS At discharge: 74.46 (24.29) 17.2% 6-weeks: 59.58 (25.19) 7.6% 12-weeks: 54.36 (23.06) 6.7% 36 weeks: 51.22 (23.17) 4.3% | 2b/B |
| Canada | First-time CABG | | | | Family reduces the risk of depression | |
### Table 1. Cont.

| Study Description | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/AG |
|-------------------|-------------------|---------------------------------|----------------------|-------------------|-------------|------|
| Korbmacher et al., [57] Germany Elective CABG | Cohort n = 135 77% male | HADS | 1–2 days before, 1-week, 6-months after | 4.3 (3.1) 20.7% | 1-week: 5 (3.9) 24% 6-months: 4.7 (4.3) 28% | High levels of depression are not associated with mortality. A 24.2% of patients with normal scores before surgery suffered depression 6-months later. 2b/B |
| Kozora et al., [58] USA Elective CABG | Cohort n = 1156 99.2% male | BDI | After, 1-year follow-up | 9.9 (7.65) 8.9 (7.85) | Older age and lower education are related to depression levels. 2b/B |
| Macken et al., [59] USA Elective CABG | Quasi-experimental n = 34 76.5% male | PHQ-9 | After CABG | – | Control group: 18% An intervention cardiac program can reduce depressive symptoms. 1b/A |
| McGrady et al., [60] USA Elective CABG | Quasi-experimental n = 91 | BDI | After CABG | – | 9.2 (7.5) The symptoms can affect adherence to prescribed treatment and may also affect morbidity and mortality. 1b/A |
| McKenzie et al., [61] UK Elective or emergency CABG | Cross-sectional n = 111 82.9% male | HADS | After CABG | – | 3.16 (3.61)13.5% | Post-operative depression predicts activities of daily living functioning. 2b/B |
| McKhann et al., [24] USA Elective CABG | Cohort n = 220 73.6% male | CES-D | After, 3-months, 1–3–6 years after | – | Baseline: 13.2 (9.8) 32.4% 3-months: 10.2 (9.9) 24.1% 1 year: 9.1 (9.8) 17.3% 3 year: 8.9 (9.5) 11.8% 6 year: 10.1 (9.4) 16.8% | Depressed patients tended to have more memory complaints. 2b/B |
| Modica et al., [62] Italy Elective CABG | Cross-sectional n = 1179 80% male | HADS | After CABG | – | Moderate-severe: 10.4% Male: 9.2% Female: 15.4% | Female gender is related to a higher depression score. 2b/B |
| Moser et al., [63] USA Elective CABG | Observational multicentre n = 131 94% male | MAACL | After CABG | – | 13.0 (5.5) 53% | Factors such as being a woman and having lower educational attainment are related to depression. 2b/B |
| Murphy et al., [64] Australia Elective CABG | Cohort n = 184 79% male | HADS | Before, 2–6 months follow-up | 5.35 (4.01) | 2-months: 4.16 (3.71) 6-months: 3.87 (3.51) | Over 6-months follow-up patients show a minor score of depression. 2b/B |
| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RG |
|-------|-------------------|---------------------------------|----------------------|-------------------|-------------|-------|
| Nair et al., [65] | India Elective CABG | HADS | 6 months after | Pre – | 20.2% | 11.6% of patients after CABG adhered to healthy lifestyle practices | 1b/A |
| Nemati & Astaneh, [66] | Iran Elective CABG | HADS | Before, 4-weeks after | Male: 13.58 (8.54)  Female: 17.88 (7.54) | Male: 9.51 (6.00)  Female: 15.05 (6.63) | CABG surgery can decrease the level of depression in a short-term follow-up | 2b/B |
| Nunes et al., [67] | Brazil Elective CABG | BDI | Before, 6-months after | Minimal: 56.14%  Mild: 26.32%  Moderate: 12.28%  Severe: 5.26% | Minimal: 49.12%  Mild: 29.82%  Moderate: 17.54%  Severe: 3.51% | Improvement the quality of life with CABG surgery reducing depressive symptoms | 2b/B |
| Okamoto et al., [68] | Japan Elective or emergency CABG | HADS | 1–5 years after | – | Mild: 10.1%  Moderate-severe: 10.1% | Depression in CABG patients is related to a decrease in functional status or activities of daily living | 2b/B |
| Oldham et al., [69] | USA First-time CABG | HAM-D, PHQ-9, GDS | Before | HAM-D: 9.9%  PHQ-9: 56.2%  GDS: 6.9 (3.6) | – | Preoperative depression predicts post-CABG cognitive health | 2b/B |
| Perrotti et al., [70] | France Elective CABG | BDI | Before, 1 year after | 39.6% | – | In the first year after CABG, depressed patients have a lower improvement and quality of life | 1a/A |
| Perrotti et al., [71] | France Elective CABG | HADS | 2-weeks before | 6% | – | CABG surgery improve the functional mobility, quality of life and maintenance of an independent status | 2b/B |
| Phillips-Bute et al., [72] | USA Elective CABG | CES-D | Before, 6 months, 1 year after | Mild-Severe: Male: 28%  Female: 37% | Mild-severe: Male: 28%  1-year: 17%  Female: 6-months: 17%  1-year: 33%  1-year: 32% | Depressed patients are more prone than nondepressed patients to have a new cardiac event within 2 years of CABG | 2b/B |
| Poole et al., [23] | UK First-time CABG | BDI | 29 days before, after surgery | 8.68 (6.61)  30.3%  Minimal: 69.7%  Mild: 25.3%  Moderate-severe: 4.8% | 8.33 | Pre-operative depression is associated with longer postoperative hospital stays. The young, female gender, overweight, smoking and hypertension variables are related to depression symptoms | 2b/B |
### Table 1. Cont.

| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RG |
|-------|-------------------|---------------------------------|---------------------|-------------------|--------------|--------|
| **Pourafkari et al., [73]**<br>Iran<br>Elective CABG | Quasi-experimental<br>n = 40<br>82% male | BDI | After CABG | – | 25%<br>Minimal: 75%<br>Mild: 12%<br>Moderate: 8%<br>Severe: 5% | The emergence of new-onset depression after CABG is associated with a poor outcome | 1b/A |
| **Rezaei et al., [74]**<br>Iran<br>Elective CABG | Cohort<br>n = 135<br>75% male | SCL-90R | 6 months after | – | 1.17 (0.75)<br>44.22% | The prevalent mental disorder after CABG is depression followed by sensitivity, paranoia, hostility, anxiety, obsession, somatization, phobia, and psychosis | 2b/B |
| **Sandau et al., [75]**<br>USA<br>Elective CABG | Cohort<br>n = 54<br>78% male | CES-D | Before, 3-months after | 14.2 (8.6)<br>20% | 10.4 (7.5) | Depressive symptoms remain constant from pre-to postoperatively at 3 months | 2b/B |
| **Schwarz et al., [76]**<br>Germany<br>Elective CABG | Cohort<br>n = 47<br>89% male | HADS | Before, 3-months after | 5.0 (3.4)<br>3.8 (3.1) | Depression and health-related quality of life are not associated with cognitive dysfunction after CABG | 2b/B |
| **Selnes et al., [25]**<br>USA<br>Elective or emergency CABG | Cohort<br>n = 152<br>76% male | CES-D | Before, 12-72 months follow-up | 13.2 (9.6)<br>33% | 9.5 (9.2)<br>13% | CABG patients had a decline of score 72-months after | 2b/B |
| **Sorensen & Wang, [77]**<br>USA<br>First-time CABG | Cohort<br>n = 70<br>66% male | GDS | Before, 6-weeks after | 3.1 (2.5)<br>24.2% | 2.4 (2.3)<br>15.9% | Women had greater depression pre-operative and post-operative. Length of stay and age are not related to depression | 2b/B |
| **Spezzaferri et al., [78]**<br>Italy<br>Elective CABG | Cohort<br>n = 118<br>100% male | CBA 2.0-D | At discharge, 1 year after | – | At discharge: 12.7%<br>1 year: 5.9% | 1 year after CABG depression level decreased | 2b/B |
| **Stenman & Sartipy, [79]**<br>Sweden<br>Elective and emergency CABG | Cohort<br>n = 302<br>60% male | PHQ-9 | Before | 29% | – | Depressive symptoms are twice as frequent in women as in men | 2b/B |
| **Thomas et al., [80]**<br>India<br>First-time CABG | Quasi-experimental<br>n = 100<br>85% male | HADS | Before, 1-week, 1 month after | 4.10 (3.30)<br>1-week: 2.03 (2.60)<br>1-month: 1.26 (1.82) | Medical adherence behavior is related to depression six weeks after surgery | 1b/A |
| **Tsai et al., [81]**<br>Taiwan<br>First-time CABG | Cohort<br>n = 198<br>81% male | CSS | Before, 1-6 weeks, 3 months follow-up | 2.42 (2.64)<br>1-week: 1.41 (2.00)<br>6-weeks: 1.24 (1.86)<br>3-months: 0.96 (1.70) | Age, a longer stay in ICU, smoking, and lack of exercise are related to worse symptoms. 88% of patients have a trajectory of depression levels that decrease over time | 2b/B |
| Study | Design and Sample | Depression Screening Instrument | Timing of Assessment | M (SD)/Prevalence | Main Results | EL/RC |
|-------|-------------------|--------------------------------|----------------------|-------------------|-------------|-------|
| Tully et al. [82] Australia First-time CABG | Cohort $n = 226$ 83% male | DASS | Before, 4 days after | 20.1% | 23.5% | Readmission is related to a higher depression score. Depression symptoms are associated with morbidity | 2b/B |
| Tully et al. [83] Australia First-time CABG | Cohort $n = 226$ 83% male | BDI | Before, after surgery | 8.62 (6.23) | 9.05 (6.40) | Pessimism, past failure, self-criticalness and, worthlessness are associated with cardiac morbidity and mortality | 2b/B |
| Yang et al. [84] China First-time CABG | Cohort $n = 232$ 81% male | PHQ-9 | 3-days before, 6-months after | 4.8 (5.0) | 4.2 (5.0) | Preoperative depression is associated with women gender | 2b/B |
| Yang et al. [85] Taiwan Elective and emergency CABG | Cross-sectional $n = 87$ 74.7% male | HADS | 1 week, 1 month after | – | – | Depression is related to sleep quality after CABG surgery | 2b/B |
| Yüksel et al. [86] Turkey Elective and first-CABG | Cohort $n = 63$ | BDI | Before | G1:14.9 (9.5) | 66.6% | Patients in both groups were found to be depressed and hopeless about the future | 2b/B |
| | G1: diagnosed after experiencing an ACS | | | G2: 12.1 (7.4) | Mild: 22.2% Moderate-severe: 44.4% | | |
| | G2: diagnosed without an ACS | | | | | | |
| Zimmerman et al. [87] USA Elective CABG | RCT $n = 226$ 83% male | CSS | At discharge | – | 19% | Health care providers must assist the patients before hospital discharge to identify the risks and difficulties in patients after CABG up to 6 months after surgery | 1a/A |

ACS = Acute Coronary Syndrome; BDI = Beck Depression Inventory; CABG = Coronary Artery Bypass Graft; CBA 2.0-D = Depression scales of the Cognitive Behavioural Assessment; CDS = Cardiac Depression Scale; CES-D = Center for Epidemiological Studies Depression Scale; CSS = Cardiac Symptom Survey; DASS = Depression, Anxiety, Stress scale; GDS = Geriatric Depression Scale; HADS = Hospital Anxiety and Depression Scale; HAM-D = Hamilton Rating Scale for Depression; ICU = Intensive care unit; MAACL = Multiple Affect Adjective Checklist; PHQ-2 = Patient Health Questionnaire 2-item; PHQ-9 = Patient Health Questionnaire 9-item; POMS-D = Profile of Mood State Depression Scale; RCT = Randomized Clinical Trial; SDS = Self-rating Depression Scale; SCL-90R = Symptom Checklist-90 Revised.
3.2. Measurement of Depression

We used a total of 15 measurement tools. The Hospital Anxiety and Depression Scale (HADS) \((n = 18)\), Beck Depression Inventory (BDI) \((n = 17)\), nine-item Patient Health Questionnaire (PHQ-9) \((n = 9)\), and Centre for Epidemiological Studies Depression Scale (CES-D) \((n = 4)\) were the measurement tools used (Table 1 and Supplementary Table S1).

3.3. Meta-Analysis

A total of 1217 patients were included in the meta-analysis prior to CABG surgery, and 596 patients after the operation. Egger’s test showed no publication bias in any case.

For the HADS tool, the prevalence of depression prior to surgery \((n = 144)\) was 19% \((95\% \text{ CI} = 9–31)\) with a high degree of heterogeneity \((I^2 = 93.4\%)\), while the prevalence after surgery \((n = 394)\) was 19% \((95\% \text{ CI} = 13–26)\) with \(I^2 = 92.2\%\), according to the random effects model (Figures 2 and 3).

**Figure 2.** Forest plot for pre-CABG depression using Hospital Anxiety and Depression Scale (HADS).

**Figure 3.** Forest plot for post-CABG depression using HADS.
For the BDI tool, the prevalence of depression prior to surgery ($n = 469$) was 37% (95% CI = 28–46) with a high degree of heterogeneity ($I^2 = 89.4\%$), while the prevalence afterwards ($n = 97$) was 33% (95% CI = 12–59) with a high degree of heterogeneity ($I^2 = 96.6\%$), according to the random effects model (Figures 4 and 5).

**Figure 4.** Forest plot for pre-CABG depression using Beck Depression Inventory (BDI).

**Figure 5.** Forest plot for post-CABG depression using Beck Depression Inventory (BDI).
According to the PHQ-9 tool, the prevalence prior to surgery \((n = 543)\) was 22\% (95\% CI = 12–33) with a high degree of heterogeneity \((I^2 = 97.5\%)\) according to the random effects model; and, the prevalence of depression after surgery \((n = 48)\), using the fixed effects model, was 18\% (95\% CI = 14–23) (Figures 6 and 7), with a low degree of heterogeneity \((I^2 = 2\%)\).

**Figure 6.** Forest plot for pre-CABG depression using Patient Health Questionnaire (PHQ-9).

**Figure 7.** Forest plot for post-CABG depression using PHQ-9.
Finally, for CES-D, the prevalence of pre-CABG depression \( (n = 61) \) using the random effects model was 28\% (95\% CI = 17–40) with a moderate degree of heterogeneity \( (I^2 = 66.9\%) \); while the prevalence after surgery \( (n = 57) \) was 15\% (95\% CI = 12–19) with a low degree of heterogeneity \( (I^2 = 2\%) \), according to the fixed effects model (Figures 8 and 9).

![Figure 8. Forest plot for pre-CABG depression using Centre for Epidemiological Studies Depression Scale (CES-D).](image)

3.4. Levels of Depression Before and After CABG Surgery and Follow Up

Prior to CABG surgery, most of the authors report depression levels within the normal range, although others found mild [36,55,58,83,86] and moderate levels [27,35,66,69] (Table 1).

Post-surgery, most authors report normal levels, while others found mild [28,36,49,53,58,60,66,83,85,88], moderate [27,47,69], and severe [32] levels.

The majority of authors observed a positive impact on depression prevalence and levels after surgery, as well as in the short and medium term, although others found that these levels increased after surgery [28,32,33,48,49,55,57,89].

4. Discussion

The prevalence of depression obtained in this study varied between 19\% and 37\% prior to surgery, and between 15\% and 33\% after surgery, depending on the type of measurement tool.
used. Other studies that combine CABG with valve replacement have reported similar percentages, with depression prevalence ranging from 15% pre-CABG [90] to 37.7% post-CABG [51,91], associated with the development of the disease, worse quality of life, longer hospital stays, and high rates of hospital readmissions [8].

Normal levels of pre-CABG depression are observed, although other studies have indicated higher levels, from moderate to severe [92]. However, more than 25% of patients with normal levels are at risk of worsening, for which reason continuous reassessment can identify patients with transient symptoms of depression [93].

High levels of depression prior to the operation predict a worse quality of life [94,95], worse survival after a CABG [12,96], and more symptoms up to six months after surgery [97].

We have observed that depression levels did not go to remission, but they tend to improve in depressive symptoms, which is probably due to an improvement in the patient’s quality of life [98], and even due to greater optimism that facilitates commitment to adaptation [99]. Some authors have found a positive impact on patients from eight weeks [100], while others report a slight improvement from the first month post-CABG surgery [101]. For the majority of patients, depression persists after the surgery. Recent meta-analyses demonstrated that patients undergoing heart valve surgery are at risk of cognitive dysfunction up to six months after surgery [102,103].

Although there is a relationship between depression and CABG, its temporal onset is not clear. Depression can be a pre-existing condition, which increases the risk of cardiovascular disease that is related to behavioural alterations in diet, physical activity level, toxic habits, or poor adherence to treatment and recommendations [45]; or, can appear as a consequence of multiple postoperative complications, such as longer hospital stays [23], readmissions [104,105], general pain [104], or even when facing a series of lifestyle changes [12].

Without evaluation, it is unlikely that depression is being treated correctly. Some authors report that more than 50% of patients were receiving medical treatment for depression, even though they had no symptoms of depression [106]. For this reason, the use of measurement tools to confirm the presence and levels of depression makes it possible to identify the at-risk patients, and therefore carry out a more in-depth post-CABG follow-up, of at least nine months [93].

The current study highlights the importance of depression measures before and after CABG in assessing clinically meaningful mood disturbance, in order to provide early intervention. Systematic screening for depression in the period both before and after this procedure is crucial. Planned coaching combined with counselling can reduce these levels [36]. Cardiac rehabilitation programmes [107,108] and cognitive-behavioural therapies are also available, which reduce the levels of depression and even decrease the length of hospital stays [109]. However, further studies are needed to understand the potential prognostic implication of depression and investigate the best ways to approach the treatment of depression in this patient group.

Depression counselling prior to surgery can influence the post-surgical depression levels by positively improving a patient’s perception of illness control and management [13]. Planning is therefore an essential part of the healthcare process as it has the potential to promote self-care [36].

From a clinical perspective, these results suggest that strategies that are aimed to improve depression as a disorder, such as the application of policies and depression assessment protocols prior to CABG by health care providers, are essential, because the depression level might help risk stratification in patients undergoing CABG identifying the high-risk groups and the trajectory of recovery experienced [11].

This study has several limitations. Firstly, the heterogeneity in terms of prevalence is due to different estimation methods over time, differences in the timing of assessment and demographic differences between samples, different uses of cut-offs on questionnaire measures, as well as the use of various tools for assessing the symptoms of depression. Secondly, the measuring tools assess the severity of depression symptoms, but they do not replace a formal clinical diagnosis of depression.
5. Conclusions

There is a high presence of depression both before and after CABG surgery. While this study found an overall improvement in depressive symptoms after CABG, depression persists after the surgery for the majority of patients. The depression levels present prior to the operation may affect postoperative recovery.

Given the prevalence of depression and its impact, early detection is crucial, since it enables the identification of at-risk patients, through a clinical interview that uses validated measurement tools. This enables the medical team to implement preventive strategies as well as monitor the development of the depression.

Supplementary Materials: The following are available online at http://www.mdpi.com/2077-0383/9/4/909/s1, Table S1: Depression Assessment Instruments Used by the 65 Studies Included in the Systematic Review [110–122].

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