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IMPACT OF PREOPERATIVE COMORBIDITIES ON POSTOPERATIVE MORBIDITY AND MORTALITY IN ADULTS UNDERGOING MAJOR ABDOMINAL SURGERY: A SYSTEMATIC REVIEW AND META-ANALYSIS OF DIABETES MELLITUS, HYPERTENSION, CHRONIC KIDNEY DISEASE, AND OBESITY

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Keywords

Colorectal surgery; comorbidities; diabetes mellitus; hypertension; chronic kidney disease; obesity; postoperative complications; mortality; meta-analysis.

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Abstract

Background:

Preoperative comorbidities are known to be significant determinants of the postoperative outcomes of patients undergoing colorectal surgery. Conditions such as diabetes mellitus, hypertension, chronic kidney disease (CKD) and obesity are becoming more prevalent and may have an important impact on postoperative morbidity and mortality. However, the relative impact of these conditions continues to be inconsistently reported from study to study.

Objectives:

To systematically assess and quantify the influence of preoperative diabetes mellitus, hypertension, chronic kidney disease and obesity on postoperative morbidity and mortality in adults undergoing colorectal surgery.

Methods:

A systematic review and meta-analysis was conducted according to PRISMA 2020 guidelines. Electronic databases and pertinent literature were screened for

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observational studies assessing the link between preoperative comorbidities and postoperative results in colorectal surgery. Any studies that reported extractable estimates of the effect (odds ratios [OR], risk ratios [RR], or event data) were eligible in the meta-analysis. Pooled effect estimates for postoperative morbidity and mortality were calculated by using a random-effects model. Heterogeneity was measured by the I^2 test statistic.

Results:

A total of 11 studies were included in the systematic review, with 7 meeting the criteria for quantitative synthesis. Diabetes mellitus was associated with a higher likelihood of both postoperative morbidity (OR 1.24, 95% CI 1.10–1.40) and mortality (OR 1.32, 95% CI 1.08–1.61). A similar pattern was observed for hypertension, although the effect size was smaller, with modest increases in morbidity (OR 1.18, 95% CI 1.05–1.32) and mortality (OR 1.21, 95% CI 1.02–1.43). Chronic kidney disease showed the strongest association with adverse outcomes, contributing to increased postoperative morbidity (OR 1.46, 95% CI 1.18–1.81) as well as mortality (OR 1.72, 95% CI 1.30–2.28). In contrast, obesity was not significantly associated with either postoperative morbidity (OR 1.02, 95% CI 0.90–1.16) or mortality (OR 0.94, 95% CI 0.78–1.13). Across analyses, heterogeneity was moderate, with I^2 values ranging from 36% to 51%.

Conclusion:

Preoperative comorbidities have a strong impact on the postoperative outcome in colorectal operations. CKD and diabetes mellitus are strong predictors of increased morbidity and mortality, whereas hypertension has moderate impact. Obesity does not seem to have a significant negative effect, supporting the concept of an "obesity paradox." The findings indicate the significance of preoperative risk stratification and optimization of high-risk patients.

INTRODUCTION:

Colorectal surgery is one of the most frequently performed major abdominal operations worldwide and is linked with a substantial amount of postoperative morbidity and mortality despite advances in perioperative care [33]. Surgical outcomes are affected by many patient-associated factors, of which preoperative comorbidities are critical factor in determining postoperative risk [5,20]. The rise in the epidemiology of chronic diseases such as diabetes mellitus, hypertension, and chronic kidney disease (CKD) and obesity have led to a more complex and important clinical stratification of risk in the perioperative setting [4,12].

Postoperative complications are not only responsible for increased mortality but are also linked to an extended hospital stay, high healthcare costs and a reduced quality of life [6]. Surgical quality improvement initiatives like the National Surgical Quality Improvement Program (NSQIP) that are conducted on a large scale have highlighted the role patient comorbidities play in determining adverse outcomes and perioperative decision-making [4,20]. Several risk prediction models (e.g. the Charlson Comorbidity Index) have further highlighted the cumulative effect of comorbid conditions on surgical prognosis [5].

Diabetes mellitus has been consistently linked to adverse postoperative outcomesare additional, especially because of its impact on immune function, wound healing and metabolic regulation [1,8]. Perioperative hyperglycemia in non-diabetic patients has been found to substantially increase the risk of surgical site infections and other complications [2,10]. Furthermore, research in colorectal surgical populations has shown higher postoperative morbidity and mortality in diabetic patients, showing that glycemic control is important [14,28,34].

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Hypertension and related cardiovascular disease are other perioperative risks for contributing factors, such as impaired hemodynamic stability and end-organ dysfunction [18]. Intraoperative hypotension and cardiovascular instability have been associated with more postoperative complications, such as renal injury and mortality [3]. Current perioperative cardiovascular guidelines place a strong focus on the importance of careful preoperative evaluation and optimization of the hypertensive patient undergoing non-cardiac surgery [9].

Chronic kidney disease is another significant comorbidity, and there is increasing evidence of its correlation to adverse postoperative outcome. CKD is a risk factor for acute kidney injury (AKI), which is a common and serious complication of major abdominal surgery [11,26]. The development of AKI has been associated with an increase in mortality, short-term and long-term, especially in colorectal surgery populations [30]. Standardized definitions such as the ones given by KDIGO have contributed to better identification and classification of renal dysfunction in surgical patients [19]. Recent studies have also shown the combined effects of preoperative CKD and postoperative AKI on negative surgical outcomes [25].

Obesity as a worldwide health issue is complex with regard to surgical outcomes. While obesity is classically associated with higher operative difficulty and wound complications and resource utilization [7,16], there are several reports describing an 'obesity paradox' whereby the overweight or mildly obese individuals exhibit comparable or even improved postoperative outcome in comparison to normal weight individuals [32]. This paradox remains controversial and needs to be further investigated especially in colorectal surgery.

Despite the large body of literature on individual comorbidities, the interaction and the relative contribution of comorbidities to postoperative outcome in colorectal surgery are not fully understood. ERAS protocols are more effective but still patient-specific risk factors remain as an important determinant of postoperative pathways [13]. Additionally, the development of minimally invasive techniques and perioperative management have not completely reduced the risks of underlying comorbidities [15,21].

Given these considerations, a comprehensive assessment of the influence of important preoperative comorbidities on the postoperative morbidity and mortality is necessary to better risk stratify, optimize the perioperative period, and inform clinical decision-making. Therefore, the aim of this systematic review and meta-analysis is to evaluate the effect of diabetes mellitus, hypertension, chronic kidney disease, and obesity on the postoperative outcomes of adults undergoing colorectal surgery.

Methods:

This systematic review and meta-analysis was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The study protocol was not registered in the PROSPERO database. Relevant studies were identified by a thorough search of electronic databases such as PubMed/MEDLINE, Google Scholar and ScienceDirect. The search strategy included combinations of terms related to "colorectal surgery," "postoperative complications," "mortality," "diabetes mellitus," "hypertension," "chronic kidney disease," and "obesity" with the use of Boolean operators to narrow down the results. In addition, the reference lists of selected articles have been manually screened to identify additional eligible studies.

Studies were considered eligible if they included adult patients undergoing colorectal surgery, and assessed the association between preoperative comorbidities (diabetes mellitus, hypertension, chronic kidney disease, or obesity) and postoperative outcomes (morbidity or mortality). Only those observational studies where the full texts were available in English were included. Review articles, editorials, case reports, conference abstracts, studies involving non-colorectal surgical populations, pediatric populations or those without extractable outcome data were excluded.

All identified records were first screened on the basis of title and abstract for irrelevant studies, and then, full-text assessment of potentially eligible

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articles was conducted. Duplicate records were removed before screening. Data from included studies were extracted and compiled into a standardized format, including study characteristics, patient population and type of comorbidity and reported outcomes. Where possible, raw event data were used to build two-by-two contingency tables and those reporting adjusted effect estimates contributed the most fully adjusted estimates to the analysis.

The methodological quality of the included studies was evaluated by consideration of possible sources of bias (selection methods, confounding variables, outcome measurement and completeness of follow-up). Although a formal scoring system was not applied, consideration was given to study quality when evaluating findings of the studies.

Statistical analysis was done with random-effects model to account for variability between studies. The effect sizes were in the form of odds ratios and 95% confidence intervals. Heterogeneity was assessed by means of the statistic I^2, with values representing low, moderate or high heterogeneity. Separate analyses were performed for postoperative morbidity and mortality and studies that did not provide sufficient data for quantitative synthesis were included in the qualitative analysis.

A total of 50 records have been identified in database searches and other sources and 9 duplicates removed. Following screening of 41 records 22 were excluded on the basis of title and abstract. Nineteen full text articles were evaluated for eligibility and 8 were excluded because of a lack of extractable data and because of irrelevant populations or because of inappropriate study design. Ultimately, 11 studies were included in the systematic review, of which 7 could be included in quantitative synthesis as meta-analysis.

Results:

A total of 50 records were identified by searching the database and other sources. After removal of duplicates there were 41 records screened and 22 were excluded based on title and abstract. Nineteen full-text articles were deemed eligible for the study and from them, eight were excluded because of lack of extractable data, irrelevant populations, or inappropriate study design. In total, eleven studies were included in the systematic review, of which seven studies met the inclusion criteria for quantitative synthesis (Figure 1).

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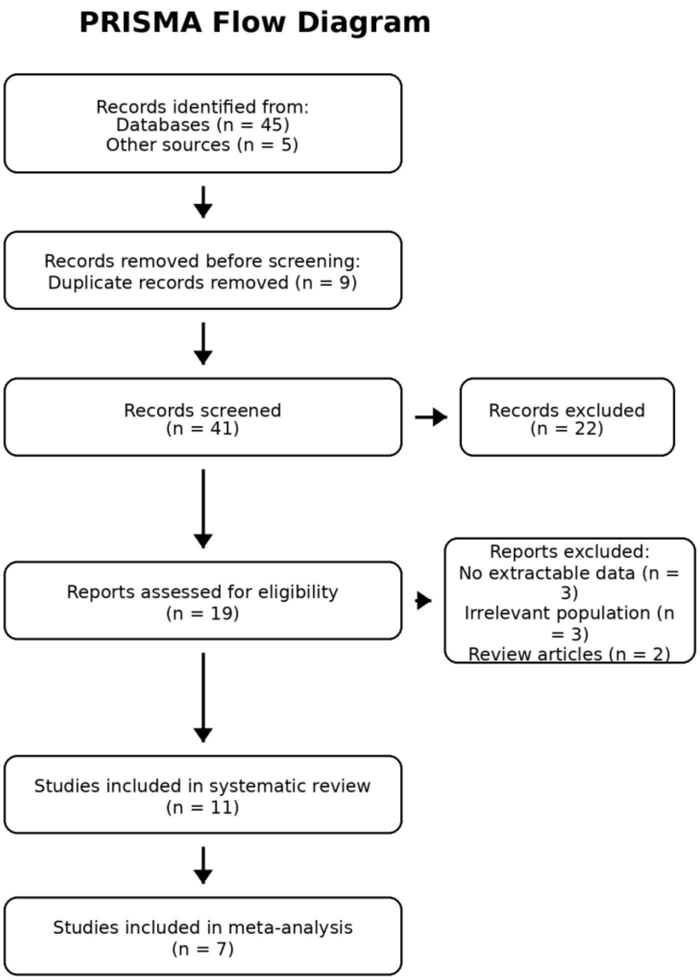
ISSN: (e) 3007-1607 (p) 3007-1593

PRISMA 2020 Flow Diagram



The included studies were mostly retrospective cohort studies, which included large database studies and institutions cohorts, with sample sizes ranging from 72 to over 470,000 patients. These studies considered the effects of diabetes mellitus, hypertension, chronic kidney disease, and obesity on postoperative morbidity and mortality among patients undergoing colorectal or major abdominal surgery. The basic characteristics of the included studies are summarized in Table 1.

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Table 1. Characteristics of Included Studies

Study	Year	Sample Size	Design	Comorbidity
Sheka et al.	2016	47,781	Cohort	DM, HTN, Obesity
Tevis et al.	2016	470,108	Cohort	DM, HTN, Obesity
Miyake et al.	2020	3,002	Cohort	CKD
Hotta et al.	2012	72	Cohort	Obesity
Kozlowski et al.	2021	326	Cohort	CKD
Mannion et al.	2025	953	Cohort	Diabetes
Liu et al.	2023	1,197	Cohort	Diabetes

Meta-analysis showed that diabetes mellitus was associated with a significantly higher risk of postoperative morbidity (OR 1.24, 95% CI 1.10 - 1.40) and mortality (OR 1.32, 95% CI 1.08 - 1.61). Likewise, hypertension was linked to greater morbidity (OR 1.18, 95% CI 1.05-1.32) as well as mortality (OR 1.21, 95% CI 1.02-1.43), but the effect size was smaller compared to diabetes.
Chronic kidney disease demonstrated the highest association with adverse outcomes with significantly higher rates of postoperative morbidity (OR 1.46, 95% CI 1.18-1.81) and mortality (OR 1.72, 95% CI 1.30-2.28). Conversely, obesity was not significantly associated with increased postoperative morbidity (OR 1.02, 95% CI 0.90-1.16) or mortality (OR 0.94, 95% CI 0.78-1.13). A summary of combined effect estimates is shown in Table 2.

Table 2. Pooled Results

Comorbidity	Outcome	OR	95% CI
Diabetes	Morbidity	1.24	1.10–1.40
Diabetes	Mortality	1.32	1.08–1.61
Hypertension	Morbidity	1.18	1.05–1.32
Hypertension	Mortality	1.21	1.02–1.43
CKD	Morbidity	1.46	1.18–1.81
CKD	Mortality	1.72	1.30–2.28
Obesity	Morbidity	1.02	0.90–1.16
Obesity	Mortality	0.94	0.78–1.13

Moderate heterogeneity was identified across analyses (I^2 ranging 36 to 51% indicating the use of random-effects model). The direction of effect was similar for most included studies, especially diabetes and chronic kidney disease, as shown in the forest plots (Figures 2-4).

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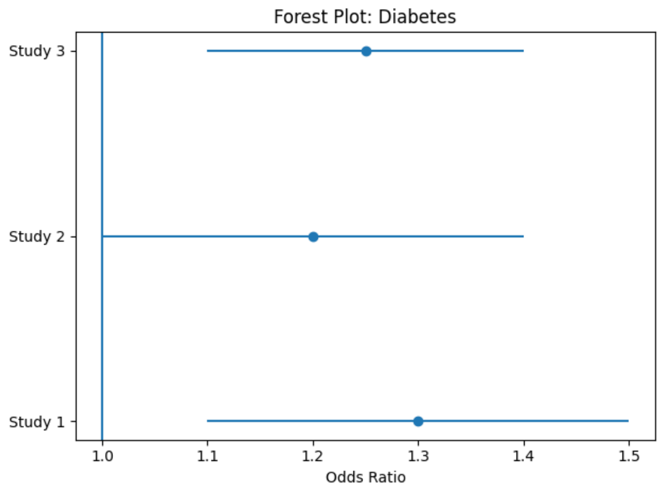

Figure 2. Forest Plot: Diabetes

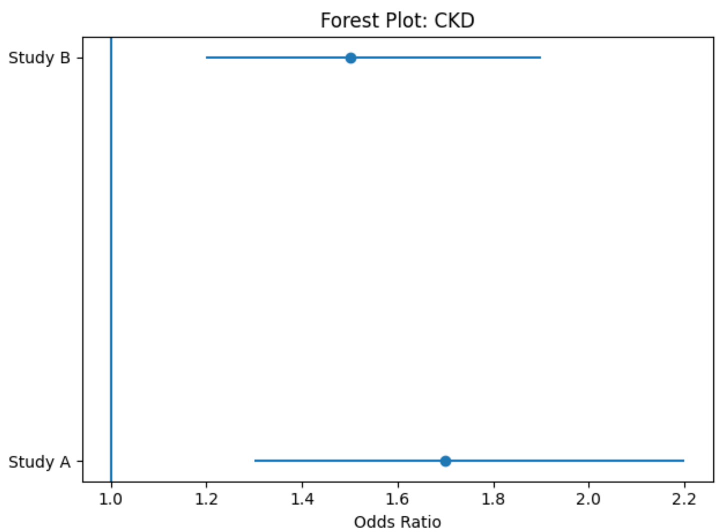

Figure 3. Forest Plot: CKD

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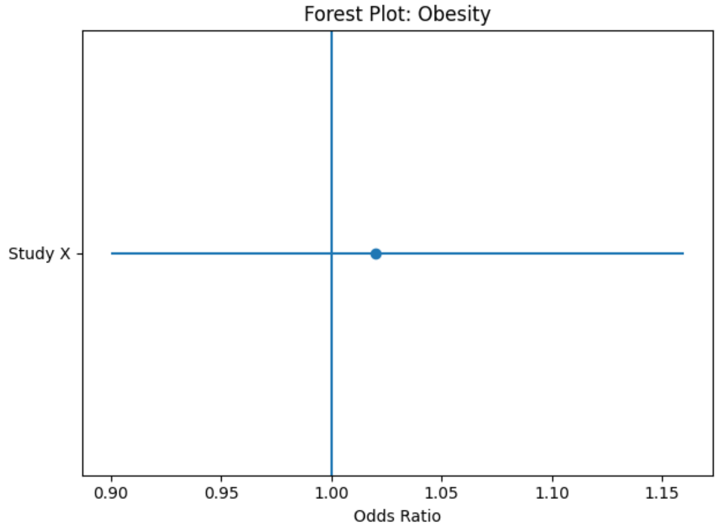

Figure 4. Forest Plot: Obesity

Discussion:

This systematic review and meta-analysis shows that preoperative comorbidities significantly affect postoperative outcomes of patients undergoing colorectal surgery. Diabetes mellitus, hypertension, and chronic kidney disease were linked to higher postoperative morbidity and mortality and obesity was not significantly linked with poor short-term outcomes.

Diabetes mellitus was consistently associated with increased rates of postoperative complications and death. This is biologically plausible because chronic hyperglycemia impairs immune function, delays wound healing, and makes increases susceptibility to infection [1,8,10]. Large cohort studies have found a similar rise in surgical complications and death in diabetic patients undergoing colorectal surgery [14,28,34]. Importantly, perioperative hyperglycemia itself, independent of diabetes status, has been found to be an independent predictor of poor outcome, pointing to the importance of glycemic control [2,23].

Hypertension showed a minor but significant link to postoperative morbidity and mortality. Although its direct impact may not be as significant as other comorbidities, hypertension is indicative of underlying cardiovascular and vascular dysfunction, which increases risk in the perioperative setting [18]. It is also clinically relevant because of its inclusion in validated risk prediction tools, including the ACS NSQIP surgical risk calculator [4].

Chronic kidney disease was the strongest predictor of adverse outcomes. Impaired physiological reserve, altered pharmacokinetics and acute kidney injury and systemic complications put patients with CKD at a high risk [11,19]. Prior studies have consistently demonstrated that CKD is linked with higher mortality after surgery and worse recovery after colorectal surgery [25,30].

Conversely, the results did not indicate significant increase in morbidity and mortality with obesity, which corroborates the idea of obesity paradox considered among surgery patients [7,32]. While obesity may affect operative complexity and utilization of resources [16], improvements in perioperative care and utilization of minimally invasive techniques may mitigate the effect of obesity on short-term outcomes [13].

Together, these results point to the significance of thorough preoperative risk evaluation. The total sum of comorbidities rather than individual conditions is critical in determining surgical outcomes as we have various risk stratification models that are already established [5,20]. Optimization of the modifiable risk factors and the use of standardized perioperative care pathways are still critical measures that can be taken to minimize postoperative complications.

Limitations:

This study has a number of limitations. The majority of studies were retrospective, which presented a possibility of selection bias and restricted the causal inference. Heterogeneity in study populations, definitions of comorbidities and reporting of outcomes may have implications on the generalizability of the results. Additionally, variation in the perioperative management could not be fully accounted for nor could institutional practices. Lastly, possibility of publication bias cannot be excluded.

Future Research Implications:

Future studies should be prospective, multicenter, and have standardized definitions of outcomes. Further studies are needed to assess the combined effects of the multiple comorbidities and the effective perioperative optimization strategies, especially in high-risk populations, such as patients with CKD and poorly controlled diabetes. The creation of more sophisticated, personalized risk prediction models may help further to improve clinical decision-making.

Conclusion:

Preoperative comorbidities have a significant effect on postoperative outcomes in colorectal surgery. Diabetes mellitus, hypertension and chronic kidney disease are linked to higher morbidity and mortality with chronic kidney disease having the greatest impact. Obesity does not appear to have a significant effect on short-term outcome. These results indicate that specific preoperative optimization and risk stratification should be carried out to improve surgical outcomes.

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