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ORIGINAL RESEARCH

Postoperative pulmonary complications in adult surgical patients in low- to middle-income countries: a systematic review and meta-analysis

Supplements:

Supplementary Table I: Definitions* of low-income, lower middle-income, upper middle-income and high-income countries at the time of the study

Classification	Definition (for the 2020 fiscal year)
Low-income	Low-income economies are those with a GNI per capita, calculated using the World Bank Atlas method, of US$1 025 or less in 2018.
Lower middle-income	Lower middle-income economies are those with a GNI per capita between US$1 026 and $3 995.
Upper middle-income	Upper middle-income economies are those with a GNI per capita between US$3 996 and $12 375.
High-income	High-income economies are those with a GNI per capita of US$12 376 or more.

*These definitions have been obtained from the World Bank. Information available at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519 (accessed 24 May 2020).
GNI – gross national income, US$ – United States dollar

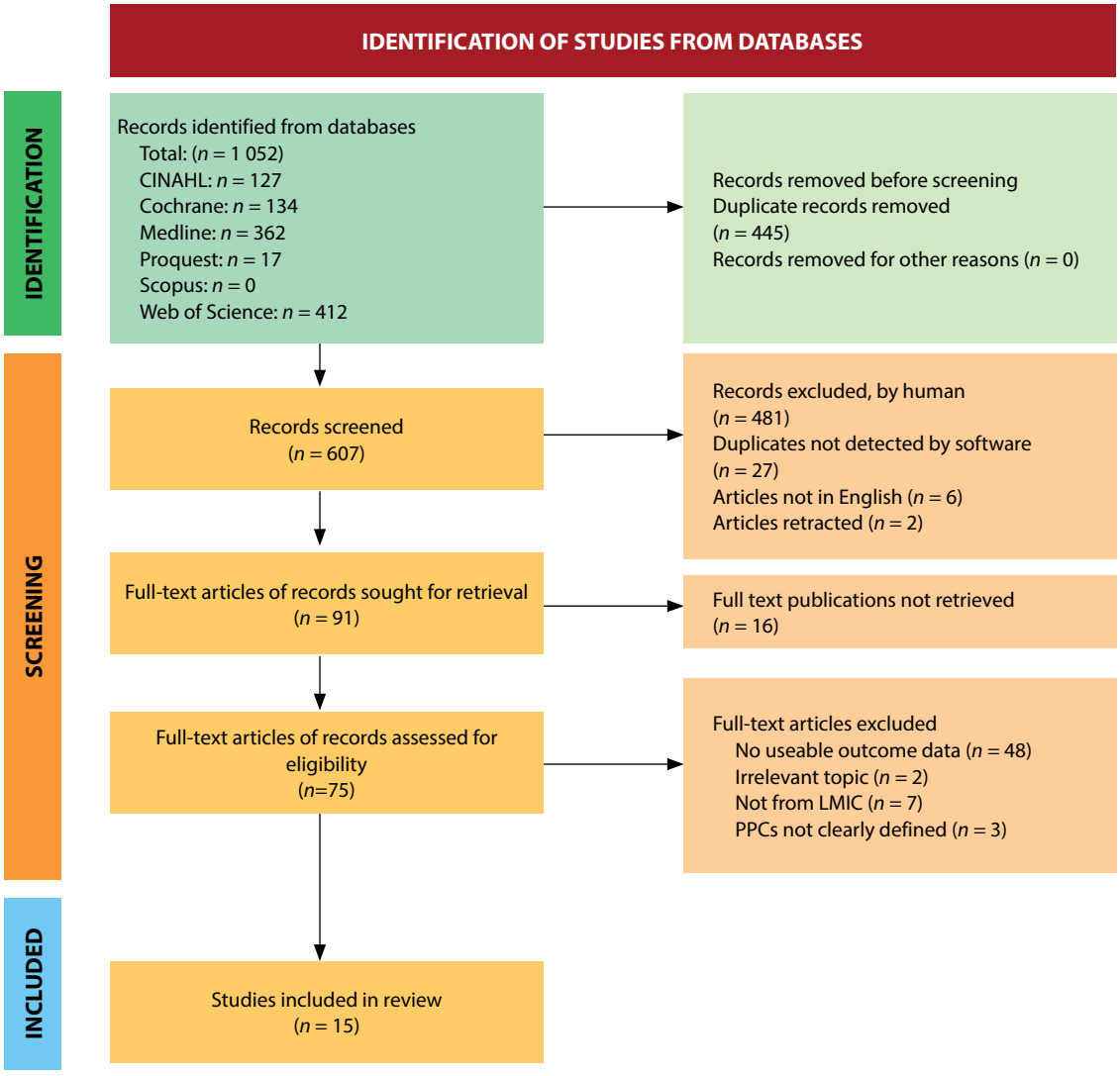
Supplementary Table II: PRISMA 2020 Checklist[30]

Section and topic	Item #	Checklist item	
TITLE			
Title	1	Identify the report as a systematic review.	✓ p. 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for abstracts checklist.	✓ p. 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	✓ p. 3–5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	✓ p. 5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	✓ p. 6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	✓ p. 6
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	✓ p. 6–7 Supplementary Table VII
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	✓ p. 6–7
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	✓ p. 7
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	✓ p. 7
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	✓ p. 7
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	✓ p. 8 Supplementary Table IV
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	✓ p. 8

Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	✓ p. 8
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	✓ p. 8
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	✓ p. 8
	13d	Describe any methods used to synthesise results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	✓ p. 8
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	✓ p. 8
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesised results.	✓ p. 8 Supplementary Figures 7–11
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	✓ p. 8 See Supplementary Figure 2–3
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	✓ p. 8
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	✓ p. 9 Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	✓ p. 9
Study characteristics	17	Cite each included study and present its characteristics.	✓ p. 9 Table I
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	✓ p. 9 Supplementary Table V
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	✓ p. 9 Figure 1–2 Supplementary Figures 4–6
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	✓ p. 10–11
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	✓ p. 9–11 Figure 1–2 Supplementary Figures 4–6
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	✓ p. 10–11
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesised results.	✓ p. 10 Supplementary Figures 7–11
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	✓ p. 10 Supplementary Figure 2–3
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	✓ p. 9–11 Figure 1–2 Supplementary Figures 4–6
DISCUSSION			

Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	✓ p. 13
	23b	Discuss any limitations of the evidence included in the review.	✓ p. 12
	23c	Discuss any limitations of the review processes used.	✓ p. 12
	23d	Discuss implications of the results for practice, policy, and future research.	✓ p. 15
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	✓ p. 6
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	✓ p. 6
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	✓ p. 6
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	✓ p. 16
Competing interests	26	Declare any competing interests of review authors.	✓ p. 16
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	✓ p. 16

Source: Page et al. (2021)[60]



Supplementary Figure 1: Prisma flow diagram[30]
LMIC – low- to middle-income countries, PPC – postoperative pulmonary complications, CINAHL – Cumulative Index to Nursing and Allied Health Literature

Supplementary Table III: Search strategy used for this review

Restrictions	Keywords	Database (date search conducted)	Search strategy
No restrictions applied to when studies were published. Search strategy limited to include the title of search results.	Hypoxia Pneumonia Aspiration pneumonia Dyspnoea Respiratory failure Respiratory distress syndrome Respiratory complications Prolonged ventilation Pulmonary oedema Postoperative pulmonary complications Postoperative respiratory complications Atelectasis Bronchospasm Lung injury Acute lung injury Pneumothorax PPC Pulmonary complications Respiratory aspiration Respiratory tract infection Surgical procedures Surgery Operation General surgery Interventions Operative Surgical interventions Mortality Morbidity Prognosis Outcome Intraoperative complications Postoperative complications Fatal outcome Postoperative care Outcome assessment Perioperative complications	Medline (27 March 2021)	TI (''Hypoxia'' OR ''Pneumonia'' OR ''Aspiration pneumonia'' OR ''Dyspnoea'' OR ''Respiratory failure'' OR ''Respiratory distress syndrome'' OR ''Respiratory complications'' OR ''Prolonged ventilation'' OR Reintubation'' OR ''Pulmonary oedema'' OR ''Postoperative pulmonary complications'' OR ''Postoperative respiratory complications'' OR ''Atelectasis'' OR ''Bronchospasm'' OR ''Lung injury'' OR ''Acute lung injury'' OR ''Pneumothorax'' OR ''PPC'' OR ''Pulmonary complications'' OR ''Respiratory aspiration'' OR ''Respiratory tract infection'') AND TI (''Surgical procedures'' OR ''Surgery'' OR ''Operation'' OR ''General surgery'' OR ''Interventions'' OR ''Operative'' OR ''Surgical interventions'') AND TI (''Mortality'' OR ''Morbidity'' OR ''Prognosis'' OR ''Outcome'' OR ''Intraoperative complications'' OR ''Postoperative complications'' OR ''Fatal outcome'' OR ''Postoperative care'' OR ''Outcome assessment'' OR ''Perioperative complications'')
		CINAHL via EBSCOHOST (27 March 2021)	TI (''Hypoxia'' OR ''Pneumonia'' OR ''Aspiration pneumonia'' OR ''Dyspnoea'' OR ''Respiratory failure'' OR ''Respiratory distress syndrome'' OR ''Respiratory complications'' OR ''Prolonged ventilation'' OR Reintubation'' OR ''Pulmonary oedema'' OR ''Postoperative pulmonary complications'' OR ''Postoperative respiratory complications'' OR ''Atelectasis'' OR ''Bronchospasm'' OR ''Lung injury'' OR ''Acute lung injury'' OR ''Pneumothorax'' OR ''PPC'' OR ''Pulmonary complications'' OR ''Respiratory aspiration'' OR ''Respiratory tract infection'') AND TI (''Surgical procedures'' OR ''Surgery'' OR ''Operation'' OR ''General surgery'' OR ''Interventions'' OR ''Operative'' OR ''Surgical interventions'') AND TI (''Mortality'' OR ''Morbidity'' OR ''Prognosis'' OR ''Outcome'' OR ''Intraoperative complications'' OR ''Postoperative complications'' OR ''Fatal outcome'' OR ''Postoperative care'' OR ''Outcome assessment'' OR ''Perioperative complications'')
		SCOPUS (27 March 2021)	(TITLE (''hypoxia'' OR ''pneumonia'' OR ''aspiration AND pneumonia'' OR ''dyspnoea'' OR ''respiratory AND failure'' OR ''respiratory AND distress AND syndrome'' OR ''respiratory AND complications'' OR ''prolonged AND ventilation'' OR reintubation'' OR ''pulmonary AND oedema'' OR ''postoperative AND pulmonary AND complications'' OR ''postoperative AND respiratory AND complications'' OR ''atelectasis'' OR ''bronchospasm'' OR ''lung AND injury'' OR ''acute AND lung AND injury'' OR ''pneumothorax'' OR ''ppc'' OR ''pulmonary AND complications'' OR ''respiratory AND aspiration'' OR ''respiratory AND tract AND infection'') AND TITLE (''surgical AND procedures'' OR ''surgery'' OR ''operation'' OR ''general AND surgery'' OR ''interventions'' OR ''operative'' OR ''surgical AND interventions'') AND TITLE (''mortality'' OR ''morbidity'' OR ''prognosis'' OR ''outcome'' OR ''intraoperative AND complications'' OR ''postoperative AND complications'' OR ''fatal AND outcome'' OR ''postoperative AND care'' OR ''outcome AND assessment'' OR ''perioperative AND complications''))
		Web of Science (27 March 2021)	((TI=(''Hypoxia'' OR ''Pneumonia'' OR ''Aspiration pneumonia'' OR ''Dyspnoea'' OR ''Respiratory failure'' OR ''Respiratory distress syndrome'' OR ''Respiratory complications'' OR ''Prolonged ventilation'' OR Reintubation'' OR ''Pulmonary oedema'' OR ''Postoperative pulmonary complications'' OR ''Postoperative respiratory complications'' OR ''Atelectasis'' OR ''Bronchospasm'' OR ''Lung injury'' OR ''Acute lung injury'' OR ''Pneumothorax'' OR ''PPC'' OR ''Pulmonary complications'' OR ''Respiratory aspiration'' OR ''Respiratory tract infection'')) AND TI=(''Surgical procedures'' OR ''Surgery'' OR ''Operation'' OR ''General surgery'' OR ''Interventions'' OR ''Operative'' OR ''Surgical interventions'')) AND TI=(''Mortality'' OR ''Morbidity'' OR ''Prognosis'' OR ''Outcome'' OR ''Intraoperative complications'' OR ''Postoperative complications'' OR ''Fatal outcome'' OR ''Postoperative care'' OR ''Outcome assessment'' OR ''Perioperative complications'')
		Cochrane Central Register of Controlled Trials (27 March 2021)	(''Hypoxia'' OR ''Pneumonia'' OR ''Aspiration pneumonia'' OR ''Dyspnoea'' OR ''Respiratory failure'' OR ''Respiratory distress syndrome'' OR ''Respiratory complications'' OR ''Prolonged ventilation'' OR Reintubation'' OR ''Pulmonary oedema'' OR ''Postoperative pulmonary complications'' OR ''Postoperative respiratory complications'' OR ''Atelectasis'' OR ''Bronchospasm'' OR ''Lung injury'' OR ''Acute lung injury'' OR ''Pneumothorax'' OR ''PPC'' OR ''Pulmonary complications'' OR ''Respiratory aspiration'' OR ''Respiratory tract infection''):ti AND (''Surgical procedures'' OR ''Surgery'' OR ''Operation'' OR ''General surgery'' OR ''Interventions'' OR ''Operative'' OR ''Surgical interventions''):ti AND (''Mortality'' OR ''Morbidity'' OR ''Prognosis'' OR ''Outcome'' OR ''Intraoperative complications'' OR ''Postoperative complications'' OR ''Fatal outcome'' OR ''Postoperative care'' OR ''Outcome assessment'' OR ''Perioperative complications''):ti
		Proquest (27 March 2021)	title(''Hypoxia'' OR ''Pneumonia'' OR ''Aspiration pneumonia'' OR ''Dyspnoea'' OR ''Respiratory failure'' OR ''Respiratory distress syndrome'' OR ''Respiratory complications'' OR ''Prolonged ventilation'' OR Reintubation'' OR ''Pulmonary oedema'' OR ''Postoperative pulmonary complications'' OR ''Postoperative respiratory complications'' OR ''Atelectasis'' OR ''Bronchospasm'' OR ''Lung injury'' OR ''Acute lung injury'' OR ''Pneumothorax'' OR ''PPC'' OR ''Pulmonary complications'' OR ''Respiratory aspiration'' OR ''Respiratory tract infection'') AND title(''Surgical procedures'' OR ''Surgery'' OR ''Operation'' OR ''General surgery'' OR ''Interventions'' OR ''Operative'' OR ''Surgical interventions'') AND title(''Mortality'' OR ''Morbidity'' OR ''Prognosis'' OR ''Outcome'' OR ''Intraoperative complications'' OR ''Postoperative complications'' OR ''Fatal outcome'' OR ''Postoperative care'' OR ''Outcome assessment'' OR ''Perioperative complications'')

Supplementary Table IV: Risk of bias assessment of each study according to the Modified Newcastle-Ottawa Scale[31]

Reference First author (year)	Risk of bias assessment		
	Selection (Max. ****)	Comparability (Max. **)	Outcome (Max. ***)
Chai (2021)[45]	***	–	**
Charokar (2020)[34]	****	–	***
De Ávila (2017)[42]	***	–	**
Gülsen (2020)[35]	****	–	***
Gupta (2020)[41]	****	–	***
Hooda (2019)[48]	****	–	***
Jing (2018)[46]	***	–	***
Kanat (2007)[36]	****	–	***
Kodra (2016)[43]	***	–	***
Kumar (2018)[37]	***	–	**
Özdï lekcan (2004)[38]	***	–	**
Pramanik (2020)[39]	**	–	***
Sogame (2008)[44]	***	–	***
Vasu (2019)[40]	**	–	**
Wang (2017)[47]	**	–	***

Max – maximum

Supplementary Table V: Definitions of postoperative pulmonary complications

Reference First author (year)	Definition
Chai (2021)[45]	No distinction made between different postoperative pulmonary complications. Diagnosis of PPCs is based on clinical symptoms (cough, phlegm, fever, SpO_2 below 90%, dyspnea) and the obvious adverse changes of postoperative pulmonary CT compared with the preoperative pulmonary imaging examination, including pleural effusion, atelectasis, pulmonary consolidation, pulmonary inflammatory infiltration, expansion, and more.
Charokar (2020)[34]	Defined in the criteria of the European task force (EPCO).[1]
De Ávila (2017)[42]	Defined and classified as established by Silva et al.[61]
Gülsen (2020)[35]	Defined in the criteria of the European task force (EPCO).[1]
Gupta (2020)[41]	Defined in the criteria of the European task force (EPCO).[1]
Hooda (2019)[48]	Modified from those established by Silva et al.[61] ***Atelectasis:*** Defined as documented lobar collapse on chest radiograph. ***Pneumonia:*** pulmonary infiltrates are present on the chest X-ray along with two documented signs among purulent tracheobronchial secretions, elevation of body temperature (> 38.3°C), and abnormal leucocyte count (< 4 000 or > 12 000/ mm^3). ***Tracheobronchitis:*** a documented increase in the quantity or change of the colour or purulent aspect of tracheobronchial secretion with normal chest radiograph. ***Bronchospasm:*** present for any recorded episode of wheezing associated with acute respiratory symptoms and relieved by bronchodilators. ***ARDS/acute respiratory failure:*** considered if mechanical ventilation is initiated in view of respiratory distress with acutely deficient exchange of gases on arterial blood gas analysis. ***Prolonged mechanical ventilation:*** defined as continuation of postoperative ventilation beyond 48 hours. ***Weaning failure:*** defined as need for re-intubation within 24 hours of extubation.
Jing (2018)[46]	***Pulmonary oedema:*** Clinically diagnosed on relevant symptoms and signs, and by measuring pulmonary capillary wedge pressure and identifying typical radiographic changes. ***Pneumonia:*** diagnosed according to the American Thoracic Society guidelines. ***ARDS:*** as per Berlin definition.[62] ***Type 1 respiratory failure:*** PaO_2 less than 8.0 kPa. ***Type 2 respiratory failure:*** PaO_2 less than 8.0 kPa and $PaCO_2$ more than 6.5 kPa.
Kanat (2007)[36]	***Atelectasis:*** Clinical and radiological evidence of collapse and dyspnea. ***Pulmonary emboli:*** diagnosed if the patient has dyspnoea, tachypnoea, chest pain, blood gas abnormality and consistent chest radiography for pulmonary emboli. ***Bronchitis:*** diagnosed if the preoperatively stable patient has dyspnea, wheezing, rhonchi and increased sputum production postoperatively. ***Pneumonia:*** diagnosed if the patient has fever, purulent sputum, leukocytosis, clinical and/or radiological evidence of consolidation or infiltration not present in the preoperative chest roentgenograms. ***Pneumonitis:*** diagnosed if the patient has new infiltrations in postoperative chest roentgenograms without any clinical evidence of pneumonia and/or atelectasis. ***Acute respiratory failure:*** diagnosed if the patient has arterial blood gas abnormalities of PaO_2 < 50 mmHg and/or $PaCO_2$ > 45 mmHg.
Kodra (2016)[43]	Using clinical, laboratory and radiology data, including respiratory failure requiring mechanical ventilation, pneumonia, macroscopic atelectasis (by chest radiography) and pneumothorax, mass pleural effusion requiring percutaneous intervention.

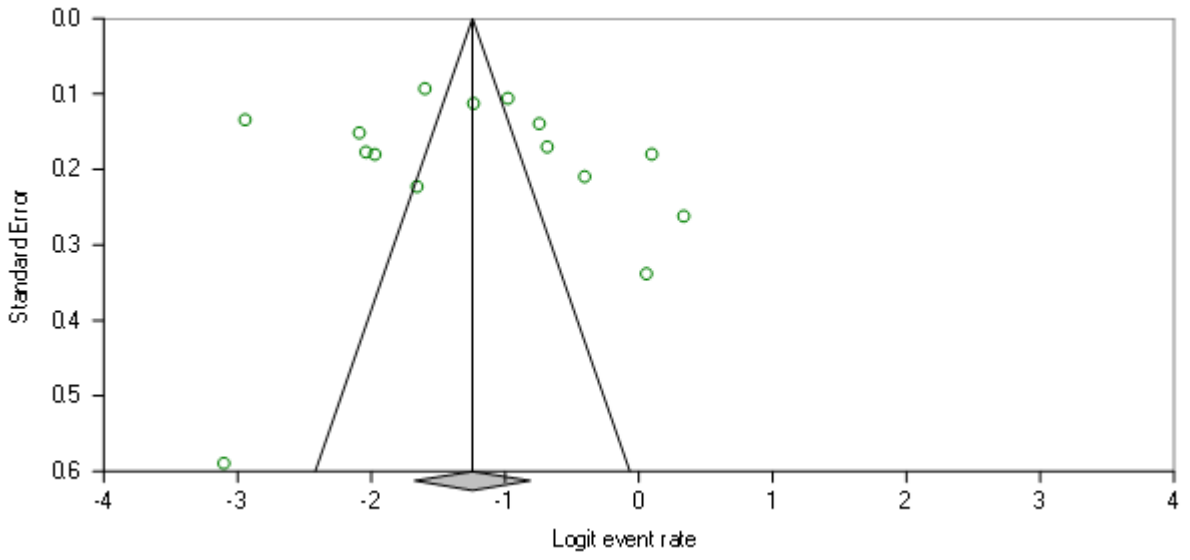
Supplementary Table V: Definitions of postoperative pulmonary complications

Reference First author (year)	Definition	
Kumar (2018)[37]	Postoperative pulmonary complication defined as any two or more of the following: (1) respiratory rate > 25/min; (2) saturation < 90% room air; < 94% on oxygen for > 2 hours; (3) cough with sputum + fever suggestive of chest infection; (4) abnormal breath sounds: rhonchi/rales/decreased breath sounds; (5) X-ray consolidation/infiltrates/ effusion: any new findings; (6) broncho-alveolar lavage/sputum culture positive: infective cause confirmed.	
Özdí lekcan (2004)[38]	Pulmonary complications were classified as follow: ***Death:*** death occurring during the same hospital stay. ***Pneumonia:*** a new infiltrate on a chest radiograph combined with fever, leukocytosis and a positive sputum Gram stain or culture. ***Pleurisy:*** defined as radiological evidence of pleural fluid by puncture. ***Bronchitis:*** diagnosed if dyspnea, purulent sputum, wheezing, rhonchus develops. ***Asthma exacerbation:*** the occurrence of asthma symptoms in a patient with or without history of asthma, but in stable status preoperatively. ***Atelectasis:*** if the patient has clinical and radiological evidence of collapse. ***Pulmonary embolism:*** diagnosed if the patient has clinical suspicion confirmed with ventilation-perfusion lung scan.	
Pramanik (2020)[39]	Patients are considered to have PPC if they have one or more of the following: (1) antibiotics for suspected infection with one or more of the following: new or changed sputum, new or changed lung opacities, fever > 38°C, white blood cell count > 12×10^9/L; (2) ventilator dependence for > 1 postoperative day or re-intubation; (3) need for postoperative mechanical ventilation > 48 h; (4) requiring non-invasive ventilation (NIV); (5) pleural effusion; (6) pneumothorax; (7) bronchospasm; (8) postoperative PaO_2 < 8 kPa (60 mmHg) in room air, a PaO_2:FIO_2 ratio of < 40 kPa (300 mmHg), or arterial oxyhaemoglobin saturation measured with pulse oximetry < 90% and requiring oxygen therapy; (9) pulmonary oedema.	
Sogame (2008)[44]	Defined and classified as established by Silva et al.[61]	
Wang (2017)[47]	Thoracic morbidity and mortality (TM & M) classification of surgical complications.[6]3	
Vasu (2019)[40]	Grade 1	Cough, dry. ***Micro-atelectasis:*** abnormal lung findings and temperature 37.5°C without other documented cause; results of chest radiograph either normal or unavailable. Dyspnea, not due to other documented cause.
	Grade 2	Cough, productive, not due to other documented cause. ***Bronchospasm:*** new wheezing or pre-existent wheezing resulting in change therapy. Hypoxemia. ***Atelectasis:*** radiological confirmation plus either temperature > 37.5°C or abnormal lung findings. Hypercarbia, transient, requiring treatment, such as naloxone or increased manual or mechanical ventilation.
	Grade 3	Pleural effusion, resulting in thoracentesis. ***Pneumonia suspected:*** radiological evidence without bacteriological confirmation. ***Pneumonia proved:*** radiological evidence and documentation of pathological organism by Gram stain or culture. Pneumothorax. Re-intubation postoperative or intubation, period of ventilator dependence (non-invasive or invasive ventilation) ≤ 48 hours.
	Grade 4	***Respiratory failure:*** postoperative non-invasive ventilation dependence ≥ 48 hours, or re-intubation with a subsequent period of ventilator dependence ≥ 48 hours.
	Postoperative hypoxemia was defined as a PaO_2 < 60 mmHg or SpO_2 < 90% on room air. Pneumonia suspected on the presence of new and/or progressive pulmonary infiltrates on chest radiograph plus two or more of the following criteria: fever ≥ 38.5°C or hypothermia < 36°C; leukocytosis ≥ 12 000 WBC/mm^3 or leukopenia < 4 000 WBC/mm^3; purulent sputum and/or a new onset or worsening cough or dyspnea. Atelectasis defined as lung opacification with shift of the mediastinum, hilum, or hemidiaphragm toward the affected area and compensatory overinflation in the adjacent non-atelectatic lung.	

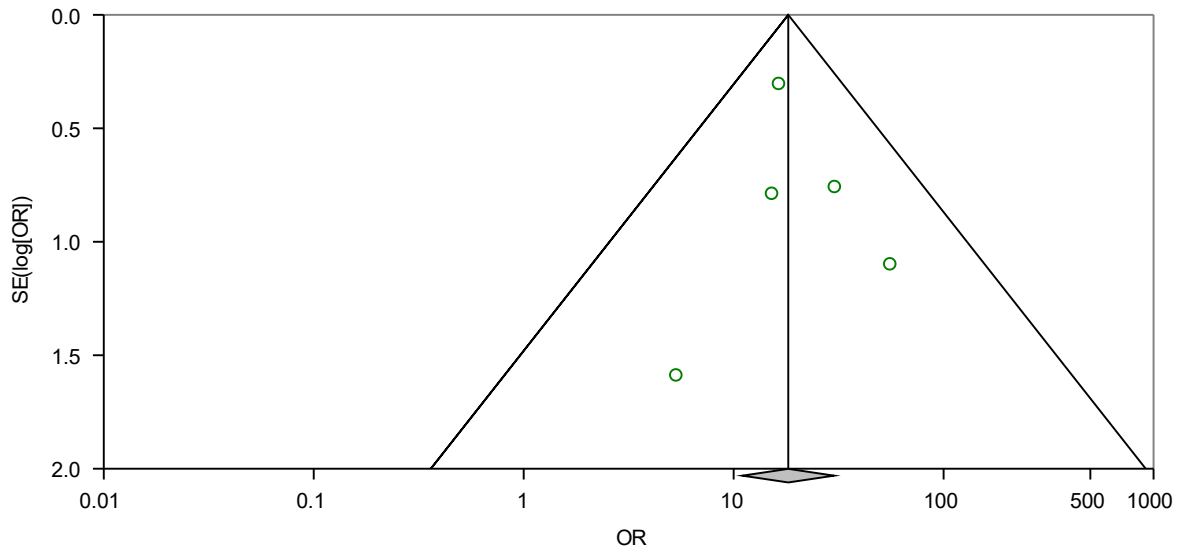
Supplementary Table VI: Modified Newcastle-Ottawa Scale[31]

Categories	Assessed items*
Selection	1. Representativeness of the exposed cohort (a) truly representative of the average adult postoperative patient in the community of LMICs* (b) somewhat representative of the average adult postoperative patient in the community of LMICs* (c) selected group of users, e.g. nurses, volunteers (d) no description of the derivation of the cohort 2. Selection of the non-exposed cohort (a) drawn from the same community as the exposed cohort* (b) drawn from a different source (c) no description of the derivation of the non-exposed cohort 3. Ascertainment of exposure (a) secure record (e.g. surgical records)* (b) structured interview* (c) written self-report (d) no description 4. Demonstration that outcome of interest was not present at start of study (a) yes* (b) no
Comparability	1. Comparability of cohorts on the basis of the design or analysis (a) study controls for comorbidity risk factors (logistic regression or case-control studies)* (b) study controls for interventions (use of specific anaesthetic technique or type of surgery)
Outcome	1. Assessment of outcome (a) independent blind assessment* (b) record linkage* (c) self-report (d) no description 2. Was follow-up long enough for outcomes to occur (a) yes (30 days or discharge from hospital or death)* (b) no ***3. Adequacy of follow-up of cohorts*** (a) complete follow-up – all subjects accounted for* (b) subjects lost to follow up unlikely to introduce bias – small number lost – follow-up rate > 90% or description of those lost* (c) follow-up rate < 90% and no description of those lost (d) no statement

*A maximum of one star can be awarded for each numbered item within the selection and outcome categories. For comparability, a maximum of two stars can be awarded.



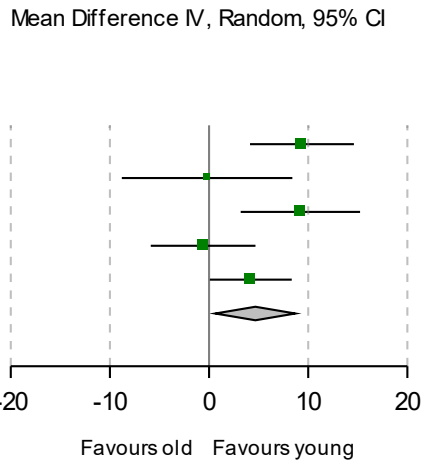
Supplementary Figure 2: Funnel plot for overall event rate for postoperative pulmonary complications in postoperative patients undergoing abdominal surgery in low- to middle-income countries



Supplementary Figure 3: Funnel plot of in-hospital mortality associated with postoperative pulmonary complications for adult surgical patients in low- tomiddle-income countries

Study	PPC Mean	PPC SD	PPC Total	No PPC Mean	No PPC SD	No PPC Total	Weight	Mean Difference IV, Random, 95% CI
Gülsen, 2020	62.69	14.7	65	53.32	15	59	21.4%	9.37 [4.13, 14.61]
Kanat, 2007	53.5	15	35	53.7	17.9	25	13.3%	-0.2 [-8.8, 8.4]
Kumar, 2018	60.5	13.51	24	51.29	15.14	126	19.2%	9.21 [3.19, 15.23]
Özdïlekcan, 2004	60.3	12.5	38	60.9	13.4	57	21.3%	-0.6 [-5.88, 4.68]
Pramanik, 2020	65.67	3.06	3	61.46	9.4	67	24.8%	4.21 [0.08, 8.34]
Total (95% CI)			**165**			**334**	**100%**	**4.67 [0.63, 8.7]**

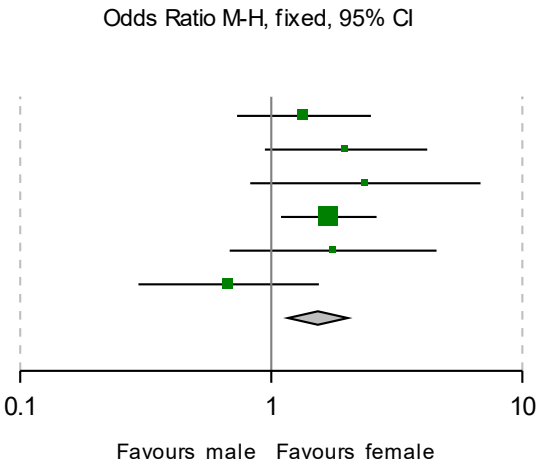
Heterogeneity: $Tau^2 = 12.64$; $Chi^2 = 10.38$, df = 4 (P = 0.03); $I^2 = 61\%$
Test for overall effect: Z = 2.27 (P = 0.02)



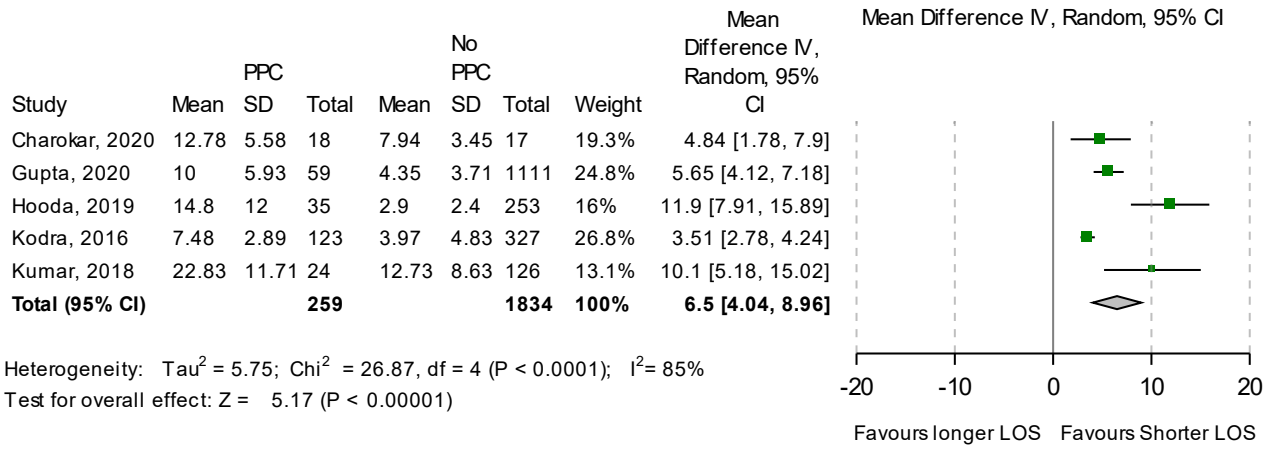
Supplementary Figure 4: Meta-analysis of postoperative pulmonary complications associated with age for adult surgical patients in low- to middle-income countries
PPCs – postoperative pulmonary complications, IV – inverse variance, SD – standard deviation, CI – confidence interval

Study	Male Events	Male Total	Female Events	Female Total	Weight	Odds Ratio M-H, fixed, 95% CI
Chai, 2021	31	253	18	192	21.3%	1.35 [0.73, 2.49]
Gülsen, 2020	27	61	18	63	11.7%	1.99 [0.94, 4.18]
Kanat, 2007	20	29	15	31	5.3%	2.37 [0.82, 6.81]
Kodra, 2016	84	267	39	183	37.6%	1.69 [1.09, 2.63]
Kumar, 2018	17	90	7	60	8.1%	1.76 [0.68, 4.55]
Özdïlekcan	19	53	19	42	16.1%	0.68 [0.30, 1.55]
Total (95% CI)	**198**	**753**	**116**	**571**	**100%**	**1.53 [1.17, 2.02]**

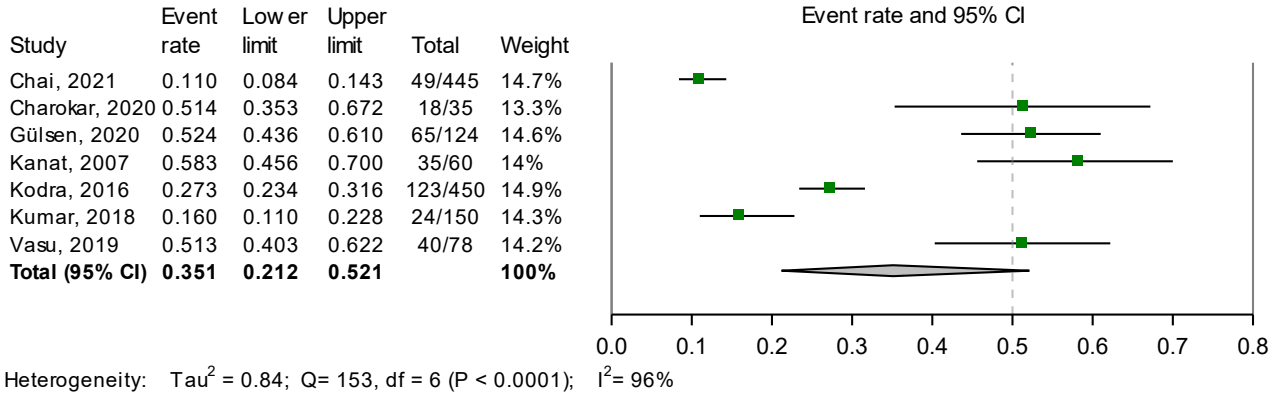
Heterogeneity: $Chi^2 = 5.32$, df= 5 (P = 0.38); $I^2 = 6\%$
Test for overall effect: Z = 3.06 (P = 0.002)



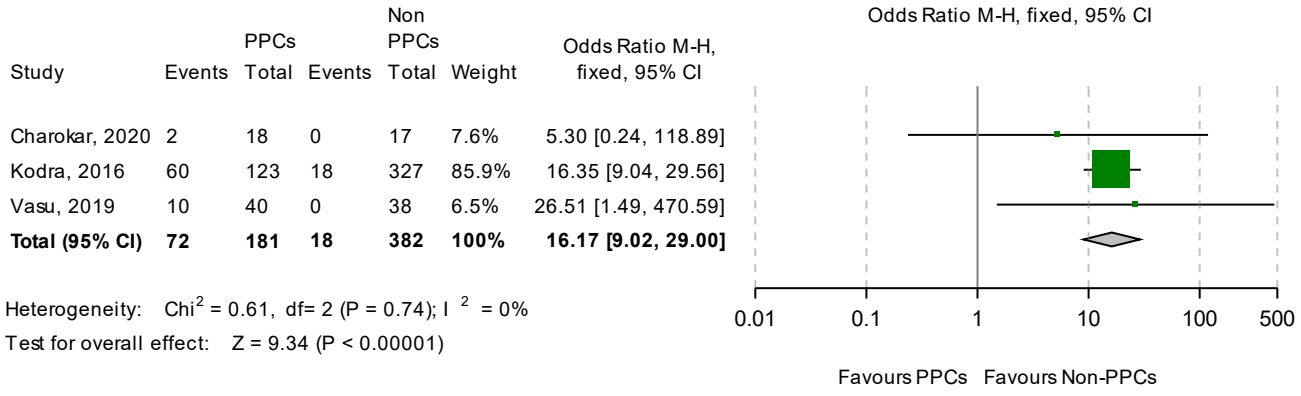
Supplementary Figure 5: Meta-analysis of postoperative pulmonary complications associated with sex for adult surgical patients in low- to middle-income countries
M-H – Mantel-Haenszel, CI – confidence interval



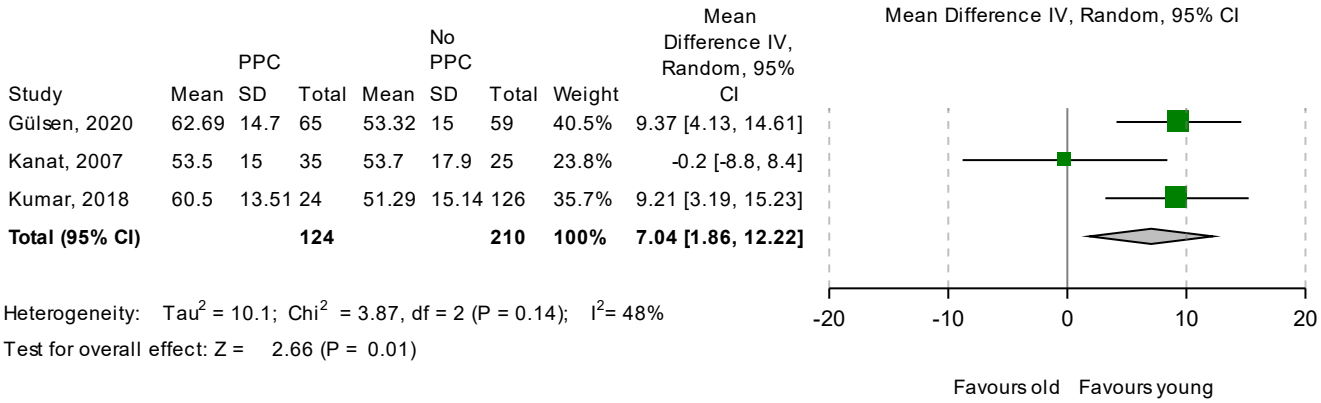
Supplementary Figure 6: Meta-analysis of postoperative pulmonary complications associated with length of stay for adult surgical patients in low- to middle-income countries
PPCs – postoperative pulmonary complications, IV – inverse variance, SD – standard deviation, CI – confidence interval, LOS – length of stay, LMICs – low- to middle-income countries



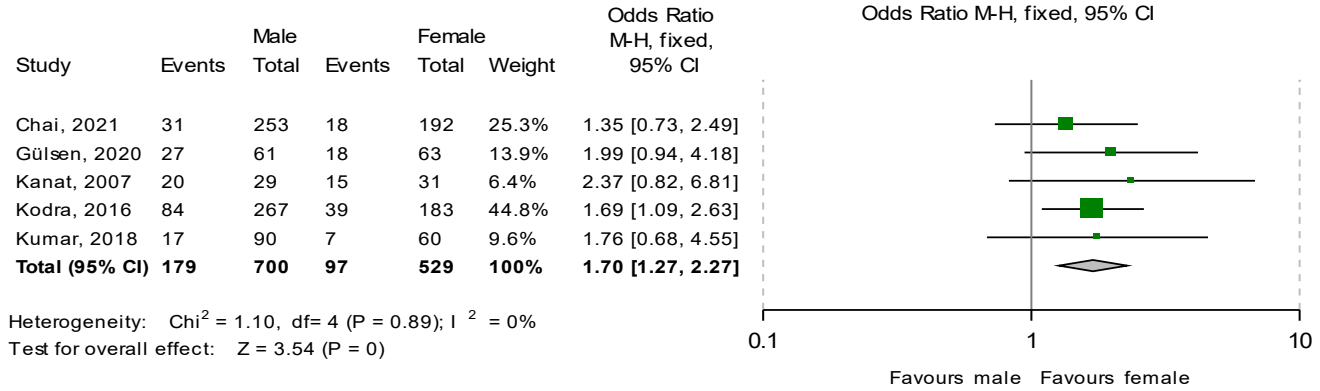
Supplementary Figure 7: Sensitivity analysis – meta-analysis of overall event rate for postoperative pulmonary complications in postoperative patients undergoing abdominal surgery from low- to middle-income countries
CI – confidence interval



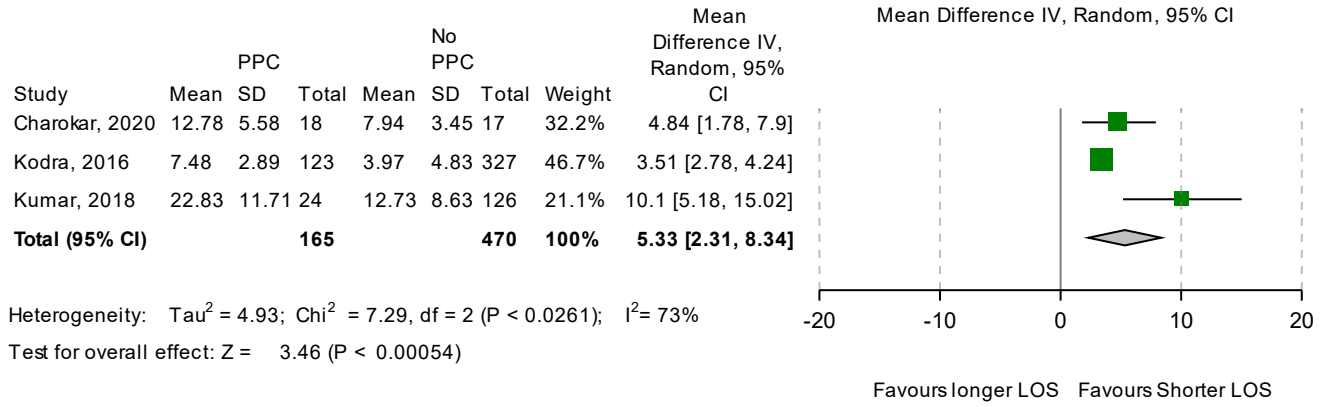
Supplementary Figure 8: Sensitivity analysis – meta-analysis of in-hospital mortality associated with postoperative pulmonary complications for adult surgical patients undergoing abdominal surgery in low- tomiddle-income countries
PPCs – postoperative pulmonary complications, M-H – Mantel-Haenszel, CI – confidence interval



Supplementary Figure 9: Sensitivity analysis – meta-analysis of postoperative pulmonary complications associated with age for adult surgical patients undergoing abdominal surgery in low- to middle-income countries
PPCs – postoperative pulmonary complications, IV – inverse variance, SD – standard deviation, CI – confidence interval



Supplementary Figure 10: Sensitivity analysis – meta-analysis of postoperative pulmonary complications associated with sex for adult surgical patients undergoing abdominal surgery in low- to middle-income countries
M-H – Mantel-Haenszel, CI – confidence interval



Supplementary Figure 11: Sensitivity analysis – meta-analysis of postoperative pulmonary complications associated with length of stay for adult surgical patients undergoing abdominal surgery in low- to middle-income countries
PPCs – postoperative pulmonary complications, IV – inverse variance, SD – standard deviation, CI – confidence interval, LOS – length of stay, LMICs – low- to middle-income countries