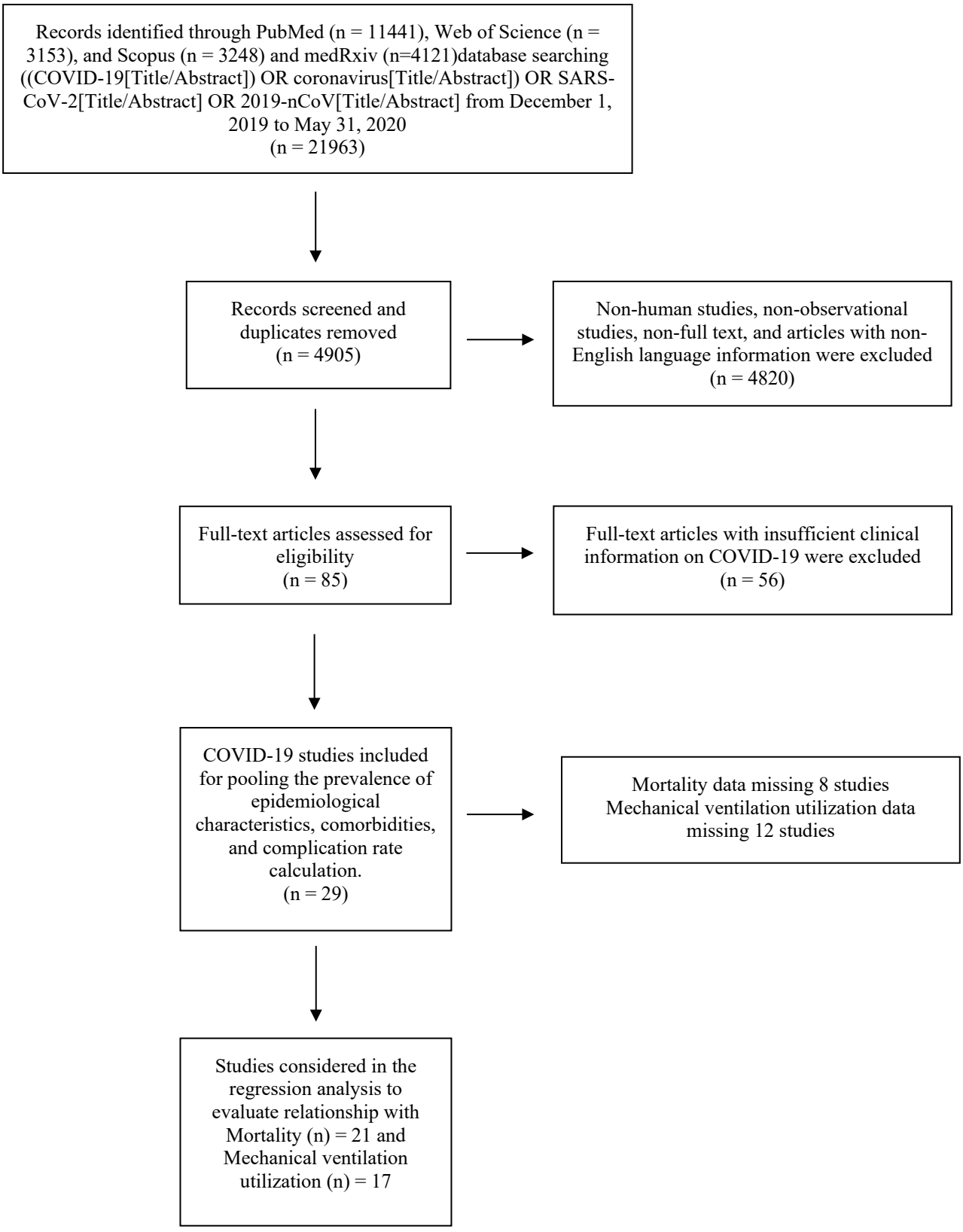
**eSupplemental file (1): Flow diagram of literature search and study selection process of COVID-19**



**eSupplemental file (2): 29 observational studies included in this meta-analysis**


1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet. 2020;395(10223):497-506. doi:10.1016/S0140-6736(20)30183-5

2. Guan W-j, Ni Z-y, Hu Y, Liang W-h, Ou C-q, He J-x, et al. Clinical Characteristics of Coronavirus Disease 2019 in China. New England Journal of Medicine. 2020. doi:10.1056/NEJMoa2002032

3. Zhao X-Y, Xu X-X, Yin H-S, Hu Q-M, Xiong T, Tang Y-Y, et al. Clinical characteristics of patients with 2019 coronavirus disease in a non-Wuhan area of Hubei Province, China: a retrospective study. BMC Infectious Diseases. 2020;20(1):311. doi:10.1186/s12879-020-05010-w

4. Young BE, Ong SWX, Kalimuddin S, Low JG, Tan SY, Loh J, et al. Epidemiologic Features and Clinical Course of Patients Infected With SARS-CoV-2 in Singapore. Jama. 2020. doi:10.1001/jama.2020.3204

5. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China. Jama. 2020;323(11):1061-9. doi:10.1001/jama.2020.1585.

6. Ng Y, Li Z, Chua YX, et al. Evaluation of the Effectiveness of Surveillance and Containment Measures for the First 100 Patients with COVID-19 in Singapore — January 2–February 29, 2020. MMWR Morb Mortal Wkly Rep 2020;69:307-311. DOI: http://dx.doi.org/10.15585/mmwr.mm6911e1

7. Spiteri G, Fielding J, Diercke M, Campese C, Enouf V, Gaymard A, et al. First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. Euro Surveill. 2020;25(9):2000178. doi:10.2807/1560-7917.ES.2020.25.9.2000178

8. COVID-19, Australia: Epidemiology Report 6 (Reporting week ending 19:00 AEDT 7 March 2020). Communicable diseases intelligence (2018). 2020;44. doi:10.33321/cdi.2020.44.21

9. Xu X-W, Wu X-X, Jiang X-G, Xu K-J, Ying L-J, Ma C-L, et al. Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-Cov-2) outside of Wuhan, China: retrospective case series. BMJ. 2020;368:m606. doi:10.1136/bmj.m606

10. Bajema K, Oster A, McGovern O, Lindstrom S, Stenger M, Anderson T, et al. Persons Evaluated for 2019 Novel Coronavirus — United States, January 2020. MMWR. Morbidity and mortality weekly report. 2020;69. doi:10.15585/mmwr.mm6906e1

11. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet. 2020;395(10223):507-13. doi:10.1016/s0140-6736(20)30211-7

12. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. The Lancet. Respiratory medicine. 2020. doi:10.1016/s2213-2600(20)30079-5

13. Wang Z, Yang B, Li Q, Wen L, Zhang R. Clinical Features of 69 Cases with Coronavirus Disease 2019 in Wuhan, China. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2020. doi:10.1093/cid/ciaa272

14. Mo P, Xing Y, Xiao Y, Deng L, Zhao Q, Wang H, et al. Clinical characteristics of refractory COVID-19 pneumonia in Wuhan, China. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2020. doi:10.1093/cid/ciaa270

15. Arentz M, Yim E, Klaff L, Lokhandwala S, Riedo FX, Chong M, et al. Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State. Jama. 2020. doi:10.1001/jama.2020.4326

16. Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, et al. Risk Factors Associated With Acute Respiratory Distress Syndrome and Death in Patients With Coronavirus Disease 2019 Pneumonia in Wuhan, China. JAMA internal medicine. 2020. doi:10.1001/jamainternmed.2020.0994

17. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet. 2020;395(10229):1054-62. doi:https://doi.org/10.1016/S0140-6736(20)30566-3

18. Wang L, He W, Yu X, Hu D, Bao M, Liu H, et al. Coronavirus disease 2019 in elderly patients: Characteristics and prognostic factors based on 4-week follow-up. The Journal of infection. 2020. doi:10.1016/j.jinf.2020.03.019

19. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, et al. Cardiovascular Implications of Fatal Outcomes of Patients With Coronavirus Disease 2019 (COVID-19). JAMA Cardiol. 2020:e201017. doi:10.1001/jamacardio.2020.1017

20. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. Jama. 2020;323(20):2052-9. doi:10.1001/jama.2020.6775

21. Goyal P, Choi JJ, Pinheiro LC, Schenck EJ, Chen R, Jabri A, et al. Clinical Characteristics of Covid-19 in New York City. New England Journal of Medicine. 2020;382(24):2372-4. doi:10.1056/NEJMc2010419

22. Ruan Q, Yang K, Wang W, Jiang L, Song J. Correction to: Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. Intensive care medicine. 2020. doi:10.1007/s00134-020-06028-z

23. Qian G-Q, Yang N-B, Ding F, Ma AHY, Wang Z-Y, Shen Y-F, et al. Epidemiologic and clinical characteristics of 91 hospitalized patients with COVID-19 in Zhejiang, China: a retrospective, multi-centre case series. QJM: An International Journal of Medicine. 2020. doi:10.1093/qjmed/hcaa089

24. Paranjpe I, Russak A, De Freitas JK, Lala A, Miotto R, Vaid A, et al. Clinical Characteristics of Hospitalized Covid-19 Patients in New York City. medRxiv. 2020:2020.04.19.20062117. doi:10.1101/2020.04.19.20062117

25. Lauer SA, Grantz KH, Bi Q, Jones FK, Zheng Q, Meredith HR, et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application. Annals of internal medicine. 2020;172(9):577-82. doi:10.7326/M20-0504

26. Chang D, Lin M, Wei L, Xie L, Zhu G, Dela Cruz CS, et al. Epidemiologic and Clinical Characteristics of Novel Coronavirus Infections Involving 13 Patients Outside Wuhan, China. Jama. 2020;323(11):1092-3. doi:10.1001/jama.2020.1623

27. Kim ES, Chin BS, Kang CK, Kim NJ, Kang YM, Choi JP, et al. Clinical Course and Outcomes of Patients with Severe Acute Respiratory Syndrome Coronavirus 2 Infection: a Preliminary Report of the First 28 Patients from the Korean Cohort Study on COVID-19. Journal of Korean medical science. 2020;35(13):e142-e. doi:10.3346/jkms.2020.35.e142

28. Qin C, Zhou L, Hu Z, Zhang S, Yang S, Tao Y, et al. Dysregulation of immune response in patients with COVID-19 in Wuhan, China. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2020. doi:10.1093/cid/ciaa248

29. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ, et al. Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. Allergy. 2020. doi:10.1111/all.14238

**eSupplemental file (3): Unadjusted factors associated with mortality and needs of mechanical ventilator amongst COVID-19 patients**

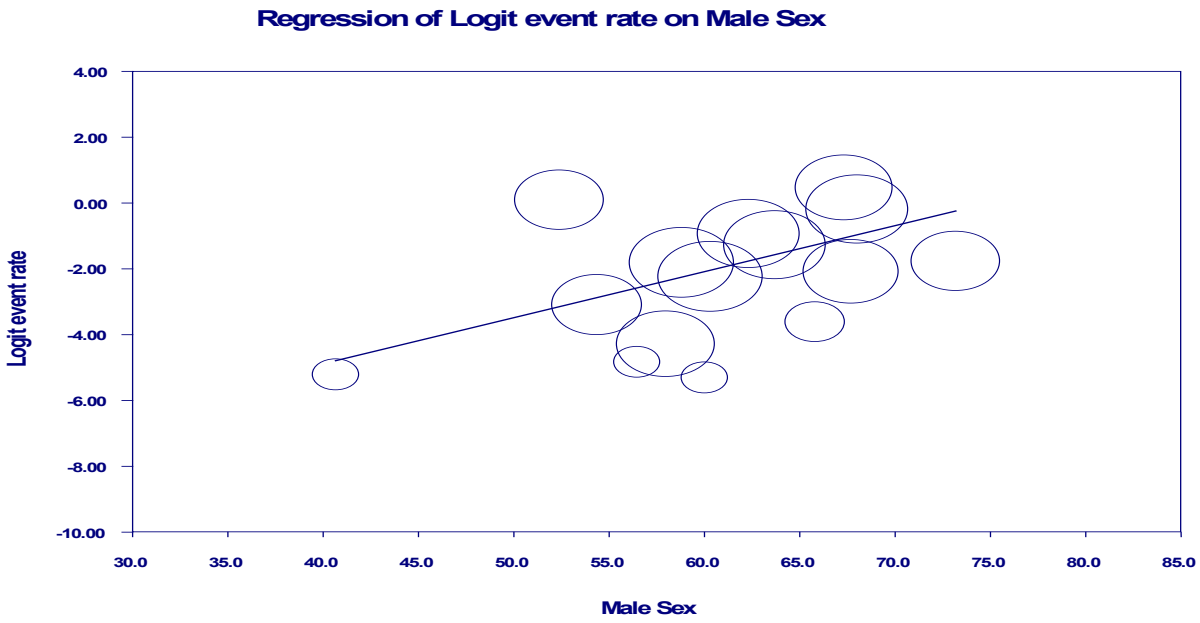
| Covariate | Mortality | | | | Mechanical ventilation utilization | | | |
|---|---|---|---|---|---|---|---|---|
| | Correlation coefficient (95% CI); p value | Odds Ratio e^coefficient | Analogous index ($R^2$) | Heterogeneity $I^2$ (%)#; Cochran's $Q_{model}$; $Tau^2_{unexplained}$ | Correlation coefficient (95% CI); p value | Odds Ratio e^coefficient | Analogous index ($R^2$) | Heterogeneity $I^2$ (%)#; Cochran's $Q_{model}$; $Tau^2_{unexplained}$ |
| Age | 0.073 (0.03-0.11); 0.0003 | 1.08 (1.03-1.12) | 0 | 96;12.9; 0.62 | 0.11 (0.06-0.17); <0.0001 | 1.12 (1.06-1.19) | 0 | 95;17.5; 0.55 |
| Age <50 | -1.86 (-2.67--1.04); <0.0001 | 0.16 (0.07-0.35) | 0.15 | 95;19.86; 0.49 | -2.18 (-2.99--1.38); 0.0000 | 0.11 (0.05-0.25) | 0.37 | 93; 28.5; 0.31 |
| Age >50 | 1.86 (1.04-2.67); <0.0001 | 6.42 (2.83-14.44) | 0.15 | 95;19.86; 0.49 | 2.18 (1.38-2.99); <0.0001 | 8.85 (3.97-19.89) | 0.37 | 93; 28.5; 0.31 |
| Male vs Female | 0.053 (0.002-0.10); 0.041 | 1.05 (1-1.11) | 0 | 96; 4.16; 0.60 | 0.03 (-0.03-0.09); 0.32 | 1.03 (0.97-1.09) | 0 | 95; 0.99; 0.50 |
| Intensive care unit | 0.037 (0.02-0.51); <0.0001 | 1.04 (1.02-1.67) | 0.33 | 95; 26.7; 0.46 | 0.04 (0.02-0.05); <0.0001 | 1.04 (1.02-1.05) | 0.59 | 92; 32.7; 0.33 |
| Mechanical ventilation | 0.056 (0.04-0.07); <0.0001 | 1.06 (1.04-1.07) | 0.72 | 89; 48.9; 0.26 | - | - | - | - |
| Comorbidities | | | | | | | | |
| Smoking | -0.037 (-0.09-0.02); 0.238 | 0.96 (0.91-1.02) | 0 | 97; 1.39; 1.38 | -0.01 (-0.06-0.04); 0.62 | 0.99 (0.94-1.04) | 0 | 97; 0.25; 0.94 |
| Diabetes mellitus | 0.07 (0.02-0.12); 0.008 | 1.07 (1.02-1.13) | 0 | 96.1; 6.9; 0.62 | 0.08 (0.01-0.14); 0.0143 | 1.08 (1.01-1.15); 0.014 | 0 | 97; 6; 0.80 |
| Hypertension | 0.03 (-0.01-0.07); 0.116 | 1.03 (0.99-1.07) | 0 | 96; 2.47; 0.59 | 0.04 (0.01-0.07); 0.023 | 1.04 (1.01-1.07) | 0 | 96; 5.16; 0.59 |
| Malignancy | -0.03 (-0.02-0.13); 0.69 | 0.97 (0.98-1.14) | 0 | 96; 0.16; 0.56 | 0.01 (-0.19-0.20); 0.96 | 1.01 (0.83-1.22); 0.97 | 0 | 97; 0; 0.60 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pulmonary disease | 0.04 (-0.003-0.08); 0.06 | 1.04 (1-1.08) | 0 | 97; 3.31; 0.59 | 0.05 (0.01-0.10); 0.02 | 1.05 (1.01-1.11) | 0 | 97; 5.45; 0.73 |
| Cerebrovascular disease | 0.37 (0.20-0.54); <0.0001 | 1.45 (1.22-1.72) | 0.40 | 96; 18; 0.65 | 0.28 (0.12-0.44); 0.0005 | 1.32 (1.13-1.55) | 0.38 | 91; 12.19; 0.40 |
| Chronic liver disease | 0.085 (0.01-0.16); 0.028 | 1.09 (1.01-1.17) | 0.21 | 96; 4.81; 0.92 | * | | | |
| Cardiovascular disease | 0.02 (-0.06-0.10); 0.67 | 1.02 (0.94-1.11) | 0 | 95; 0.18; 1.01 | 0.28 (0.12-0.44); 0.0005 | 1.32 (1.13-1.55) | 0.38 | 91; 12.19; 0.40 |
| Complications | | | | | | | | |
| Pneumonia | -0.013 (-0.33-0.01); 0.19 | 0.99 (0.72-1.01) | 0.09 | 96; 1.69; 1.31 | -0.02 (-0.04--0.002; 0.026 | 0.98 (0.96-1.00) | 0.19 | 96; 4.91; 1.1 |
| Acute respiratory distress syndrome | 0.04 (0.03-0.63); <0.0001 | 1.04 (1.03-1.06) | 0.58 | 91; 21.4; 0.48 | 0.04 (0.03-0.06); <0.0001 | 1.04 (1.03-1.06) | 0.86 | 82; 44.68; 0.16 |
| Septic shock/DIC | 0.10 (-0.04-0.25); 0.16 | 1.11 (0.96-1.28) | 0.19 | 95; 2; 1.40 | 0.04 (-0.12-0.20); 0.63 | 1.04 (0.89-1.22) | 0 | 99; 0.24; 1.74 |
| Secondary infection | 0.001 (-0.07-0.07); 0.98 | 1 (0.93-1.07 | 0 | 96; 0; 1.1 | -0.01 (-0.06-0.04); 0.64 | 0.99 (0.94-1.04) | 0 | 93; 0.21 ;0.53 |
| Cardiac complications | 0.04 (-0.13-0.092); 0.14 | 1.04 (0.88-1.10) | 0 | 94; 2.18; 1.11 | -0.01 (-0.04-0.06); 0.726 | 0.99 (0.96-1.06) | 0 | 93; 0.12; 0.75 |

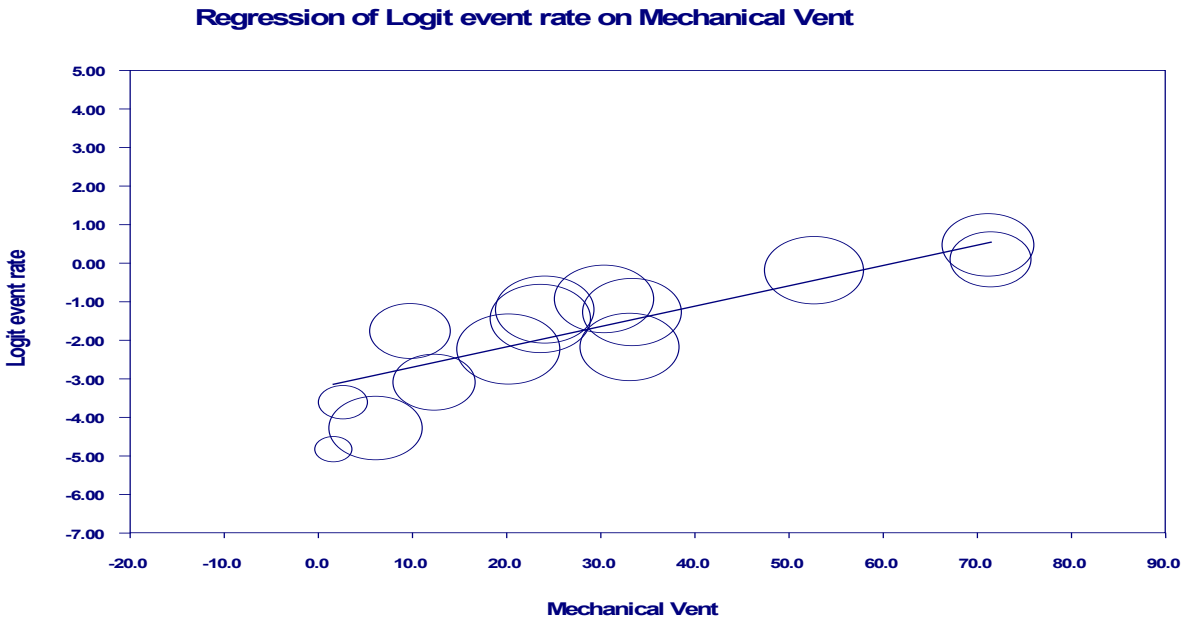
Meta-regression models are based on random effects
# Statistically significant at p<0.001
* Not enough data to run the analysis

**eSupplemental file (4): Age-adjusted meta-regression between mortality (log-event) and risk factors**

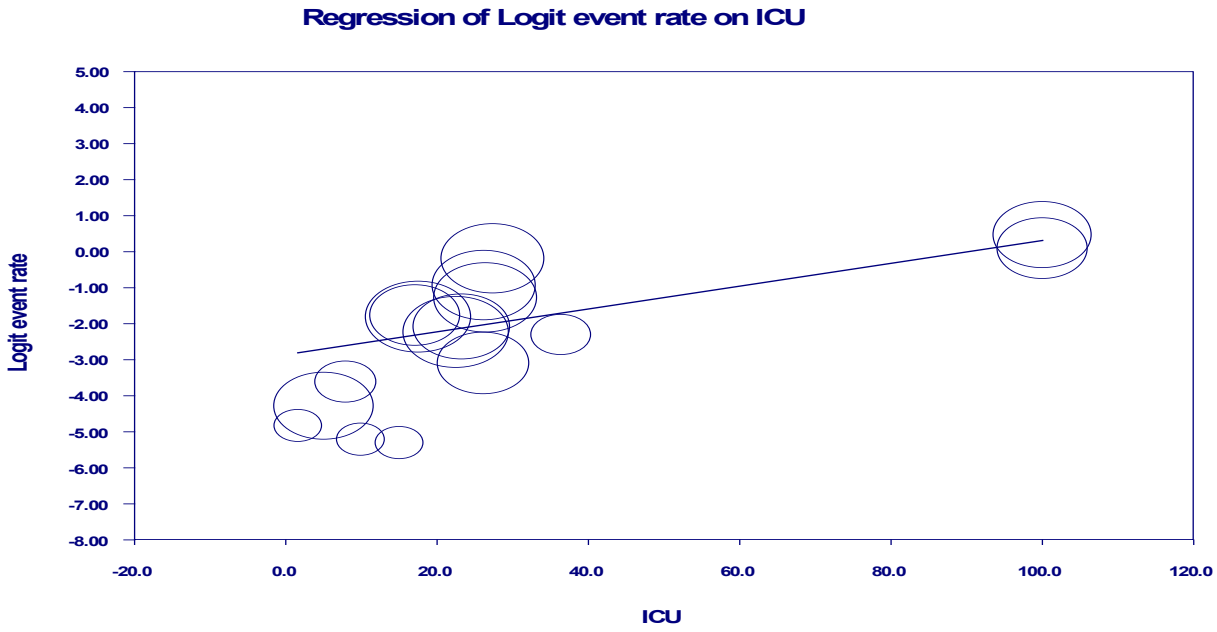
**[a] Mortality and Male**



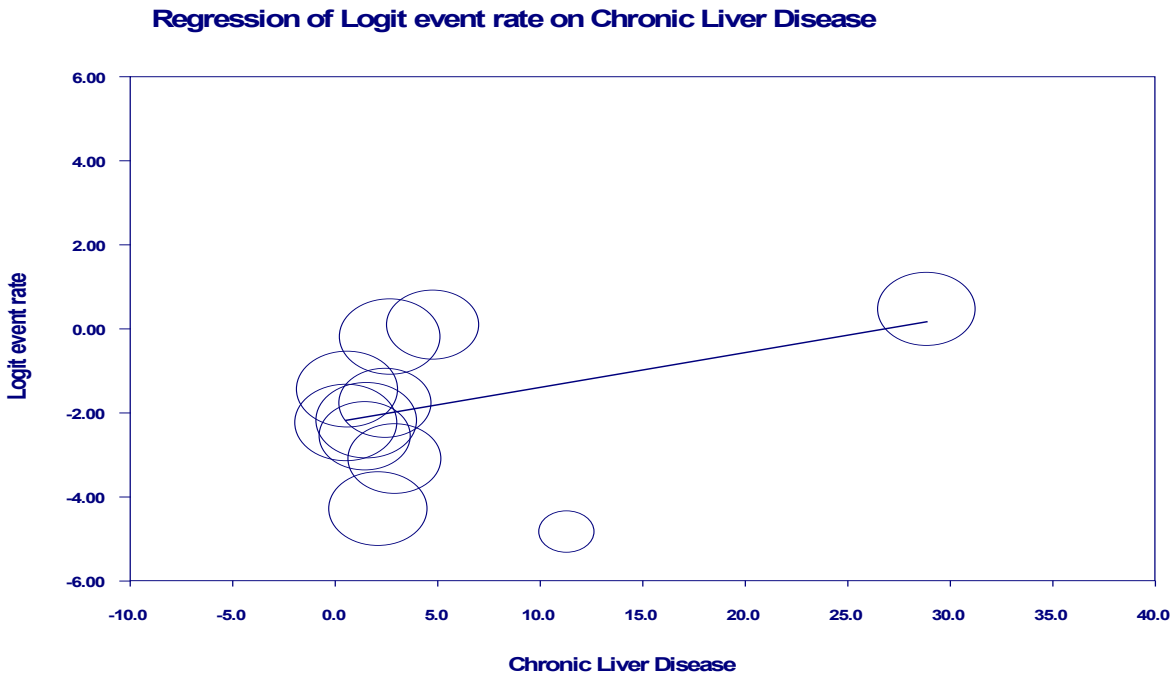

**[b] Mortality and Mechanical ventilation**



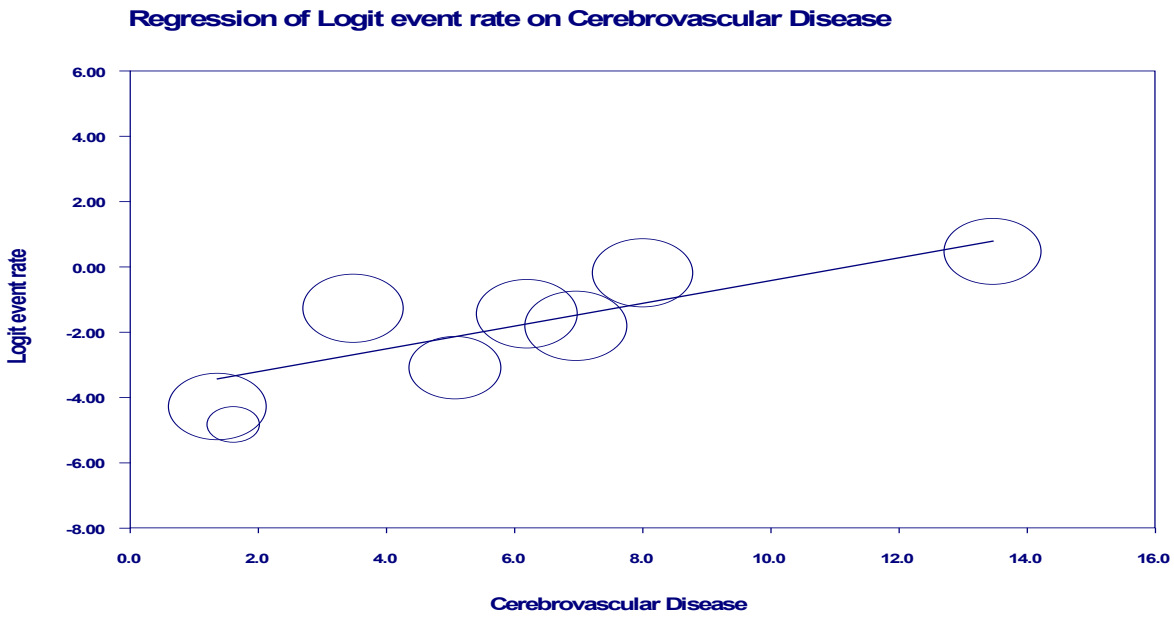
**[c] Mortality and ICU**



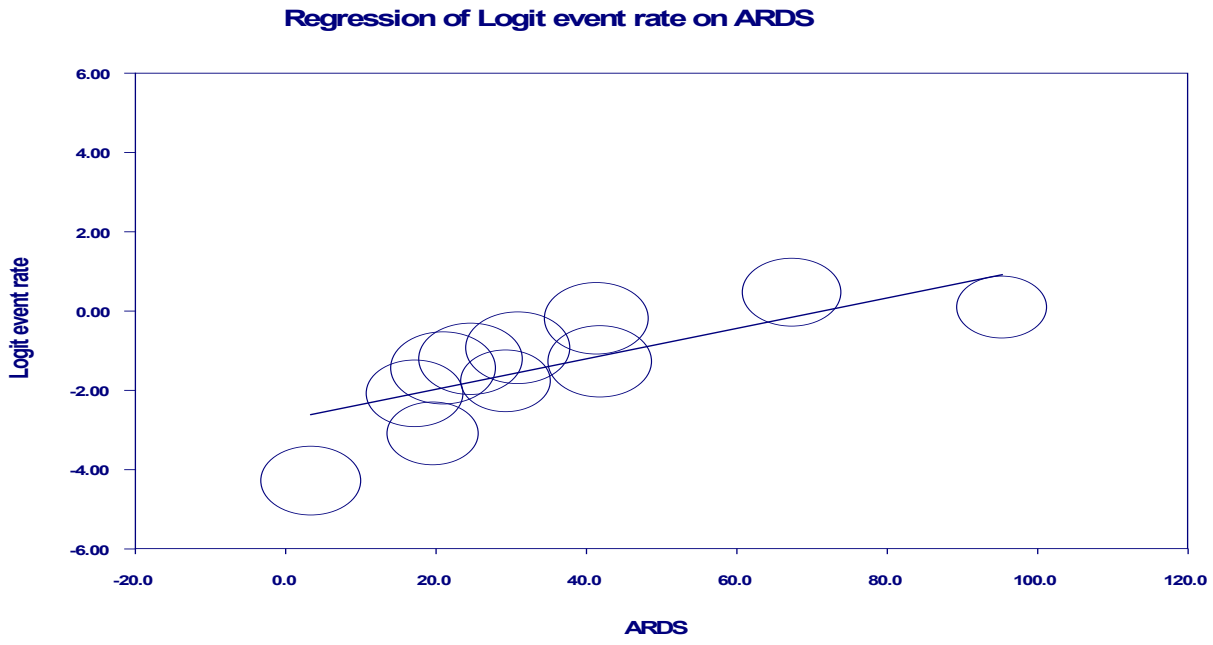

**[d] Mortality and Chronic liver disease**



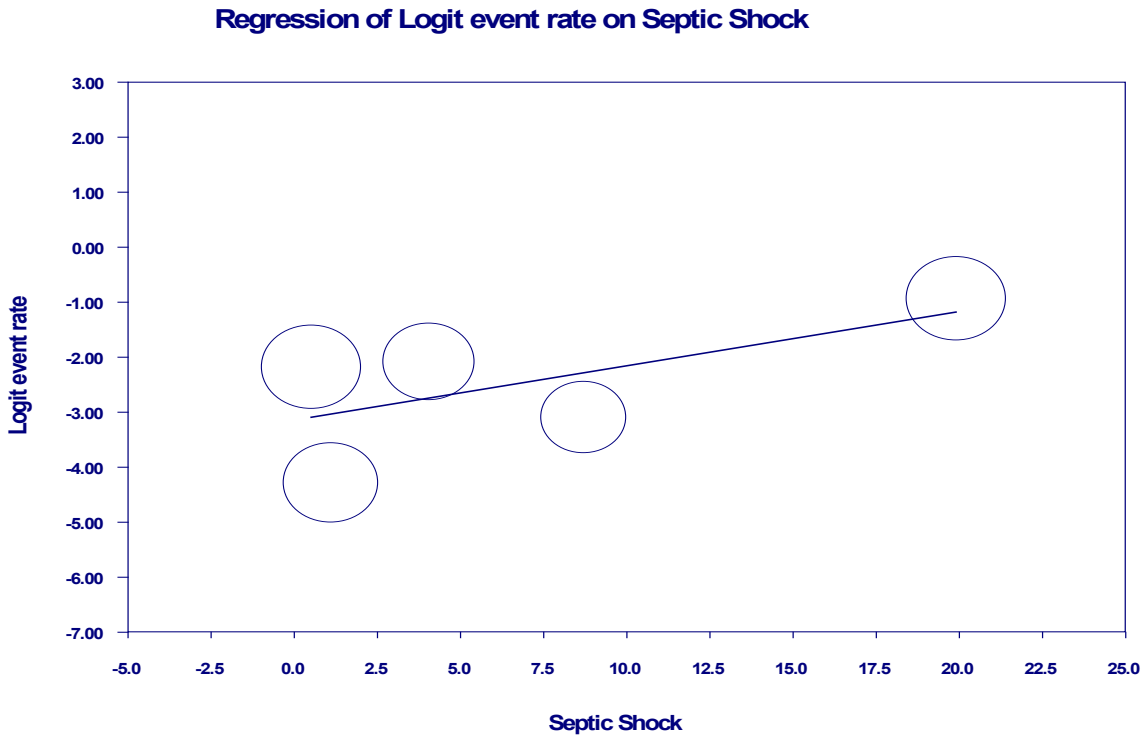

**[e] Mortality and Cerebrovascular disease**




**[f] Mortality and Acute respiratory distress syndrome**

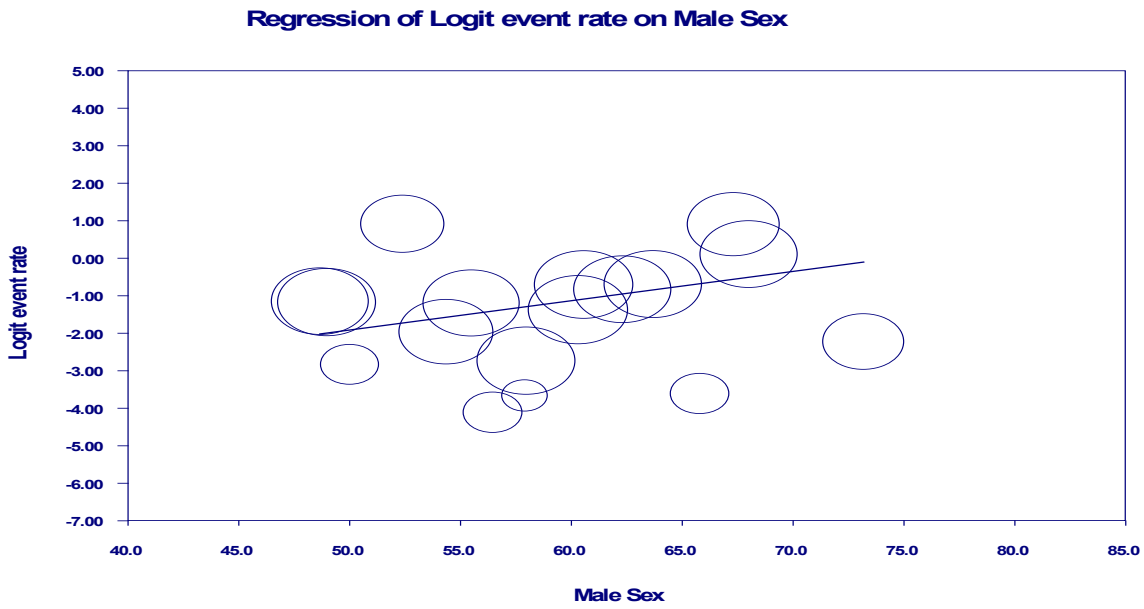


**[g] Mortality and Septic shock**

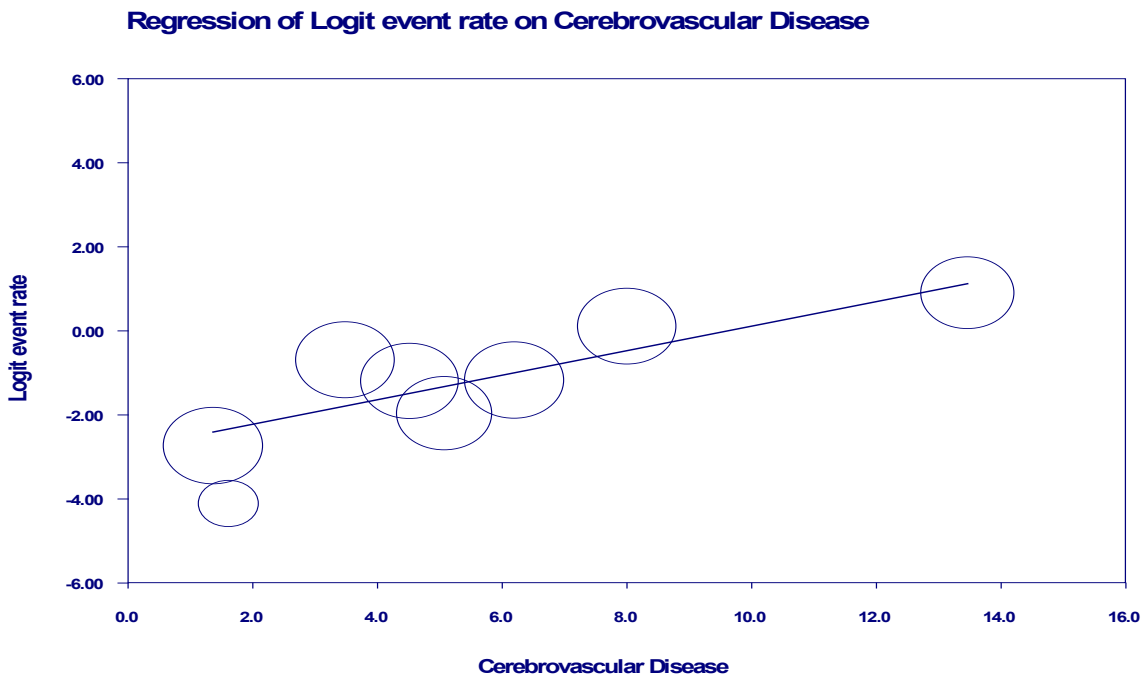


**eSupplemental file (5): Age-adjusted meta-regression between mechanical ventilation utilization (log-event) and risk factors**

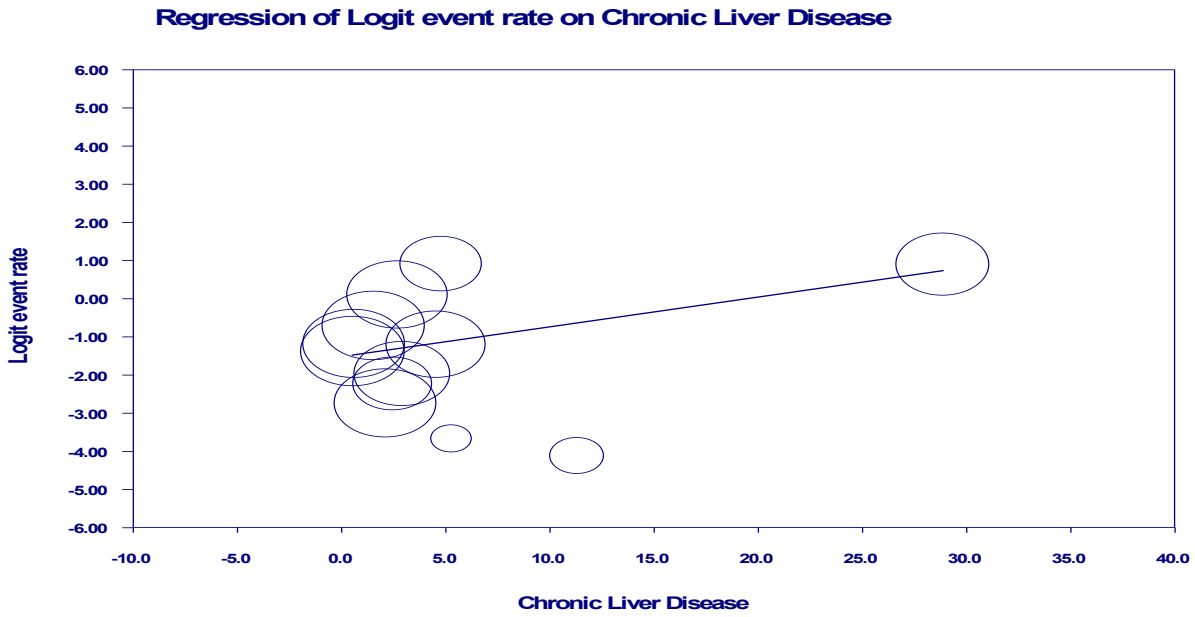
**[a] Mechanical ventilation utilization and Male**



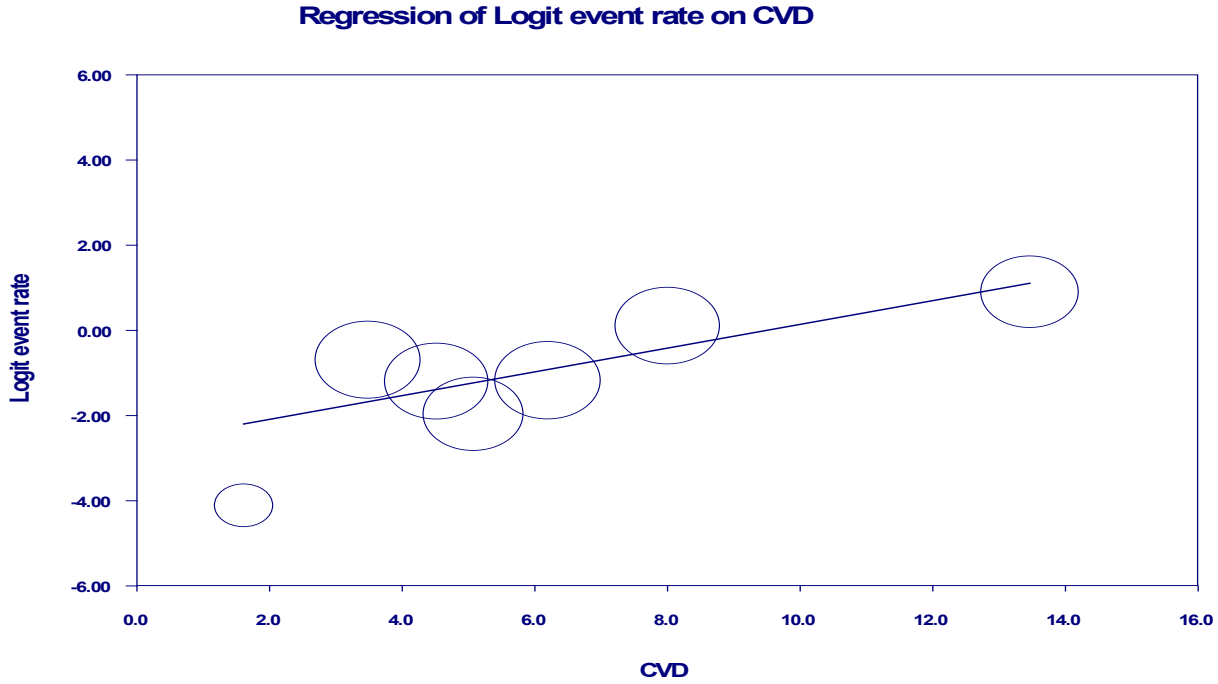

**[b] Mechanical ventilation utilization and Cerebrovascular disease**



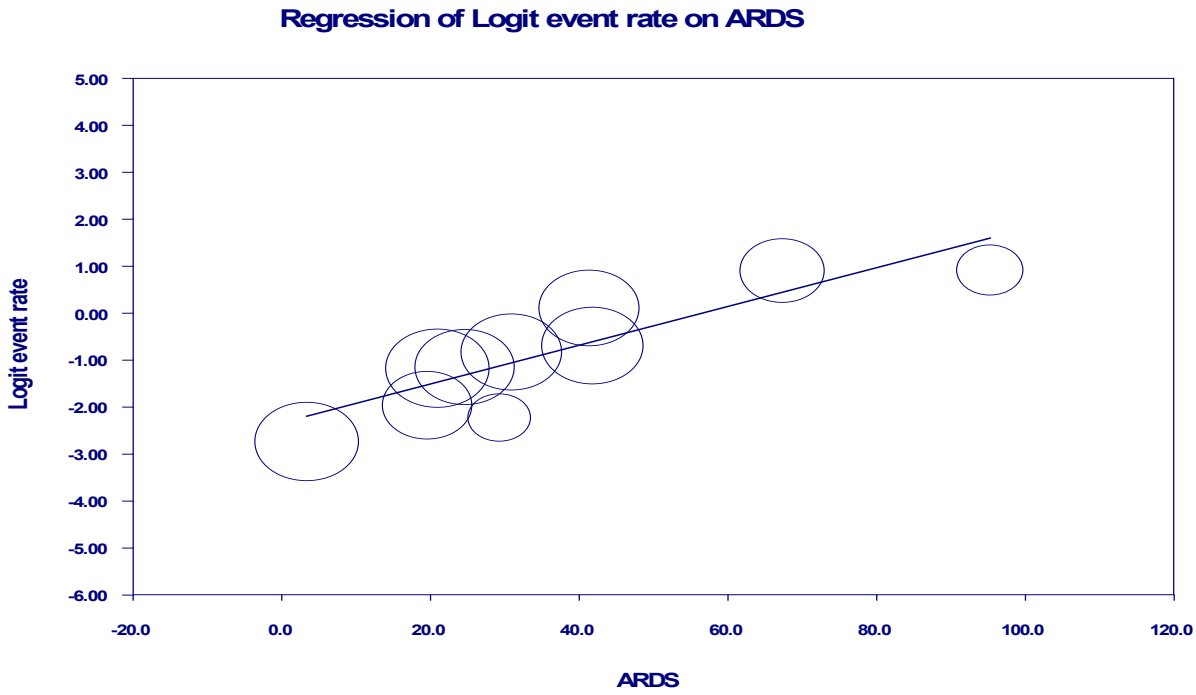
**[c] Mechanical ventilation utilization and Chronic liver disease**




**[D] Mechanical ventilation utilization and Cardiovascular disease**



**[e] Mechanical ventilation utilization and Acute respiratory distress syndrome**



**eSupplemental file (6): Risk of bias of included studies**

| Study | Newcastle–Ottawa Scale | | | Overall risk of bias |
|---|---|---|---|---|
| | Selection | Comparability | Outcome | |
| Huang et al., Jan 2020 | *** | * | * | Moderate |
| Guan et al., Feb 2020 | ** | * | ** | Moderate |
| Zhao et al., Mar 2020 | *** | * | * | High |
| Young et al., Mar 2020 | *** | * | ** | Moderate |
| Wang et al., Feb 2020 | ** | * | * | High |
| Ng et al., Mar 2020 | ** | * | ** | Moderate |
| Spiteri et al., Mar 2020 | *** | * | ** | Moderate |
| COVID-19 National Incident Room Surveillance Team, Mar 2020 | *** | * | ** | Moderate |
| Xu et al., Feb 2020 | ** | * | ** | High |
| Bajema et al., Feb 2020 | *** | * | ** | Moderate |
| Chen et al., Jan 2020 | ** | * | ** | High |
| Yang et al., Feb 2020 | *** | * | ** | Moderate |
| Wang et al., Mar 2020 | ** | * | ** | High |
| Mo et al., Mar 2020 | ** | * | * | High |
| Arentz et al., Mar 2020 | ** | * | * | High |

| | | | | |
|---|---|---|---|---|
| Wu et al., Mar 2020 | *** | * | ** | Moderate |
| Zhou et al., Mar 2020 | *** | * | * | Moderate |
| Wang et al., Mar 2020 | *** | * | ** | Moderate |
| Guo et al., Mar 2020 | ** | * | ** | Moderate |
| Richardson et al., Apr 2020 | *** | * | * | Moderate |
| Goyal et al., Apr 2020 | ** | * | * | High |
| Ruan et al., Mar 2020 | ** | * | * | High |
| Qian et al., Mar 2020 | ** | * | * | High |
| Paranjpe et al., Apr 2020 | ** | * | ** | High |
| Lauer et al., Mar 2020 | *** | * | ** | Moderate |
| Chang et al., Feb 2020 | *** | * | * | Moderate |
| Ki et al., Feb 2020 | *** | * | ** | Moderate |
| Qin et al., Mar 2020 | ** | * | * | High |
| Zhang et al., Feb 2020 | *** | * | * | Moderate |