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HIV infection as a risk factor for COVID 19: A systematic review and meta-analysis

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Resumen

Hay muchas preguntas sobre el comportamiento de la enfermedad por coronavirus 2019 (COVID-19) en personas que viven con el virus de la inmunodeficiencia humana (PVVIH). No está claro si tienen un mayor riesgo de complicaciones o una mayor mortalidad que la población general. Se comparó el riesgo de infección por síndrome respiratorio agudo severo coronavirus 2 (SARS-CoV-2), riesgo de síntomas graves por COVID-19 y riesgo de mortalidad por COVID-19 de PVVIH con personas sin virus de inmunodeficiencia humana (VIH). Se realizaron búsquedas en EMBASE, PubMed, Scopus, Cochrane Library, Web of Science, LILACS y SCIELO desde enero de 2020 hasta marzo de 2021. Se eligieron 22 estudios de cohortes/casos y controles. Se utilizó Software Review Manager 5.4 para el metanálisis. Se identificó un mayor riesgo de mortalidad (2,07) debido a la COVID-19 entre las personas con el virus de la inmunodeficiencia humana (VIH) en comparación con las personas sin VIH. La infección por VIH es un factor de riesgo para COVID-19; debe administrarse especialmente a pacientes con carga viral alta, conteo bajo de CD4 y que actualmente no estén recibiendo terapia antiviral (TAR).

Palabras clave: COVID-19, SARS-CoV-2, VIH, PVVIH, TAR

La infección por VIH como factor de riesgo para el COVID 19: Una revisión sistemática y metaanálisis

Abstract

There are many questions about the behavior of coronavirus disease 2019 (COVID-19) in people living with human Immunodeficiency virus (PLHIV). It is not clear whether they have a higher risk of complications or higher mortality than the general population. The risk of infection of Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), risk of severe symptoms by COVID-19, and risk of mortality by COVID-19 of PLHIV were compared with people without human immunodeficiency virus (HIV). EMBASE, PubMed, Scopus, Cochrane Library, Web of Science, LILACS and SCIELO were searched from January 2020 to March 2021. 22 cohort / case-control studies were chosen. Software Review Manager 5.4 was used for the meta-analysis. An increased risk of mortality (2.07) due to COVID-19 was identified among people with human immudeficiency virus (HIV) compared to people without HIV. HIV infection is a risk factor for COVID-19; it should be given special to patients with high viral load, low count CD4 and who are not currently receiving antiviral therapy (ART).

Keywords: COVID-19, SARS-CoV-2, HIV, PLHIV, ART

Introduction

SARS-CoV-2 infection can be asymptomatic or with mild symptoms, and around 15 to 20% can develop severe coronavirus disease 2019 (COVID-19), presenting hypoxemia, acute respiratory distress syndrome, multiple organ failure or death. The main risk factors for developing severe COVID-19 among the general population include advanced age, hypertension, diabetes, chronic kidney disease, chronic lung disease, and obesity[1].

The pandemic has a dramatic health course and this includes the approximately 38 million people living with HIV (PLHIV) in the world. Regardless of the impact of COVID-19 on access to health services, HIV infection can also increase susceptibility to SARS-CoV-2 infection, however, the available evidence on the influence of HIV on COVID-19 is insufficient and inconsistent[2]. On the one hand, studies have reported that immune dysfunction due to HIV infection could impose an additional risk of SARS-CoV-2 infection and increase its severity while on the other hand, other studies have mentioned that it could reduce the unwanted immune response, which usually complicates COVID-19 treatment[2]. A higher prevalence of comorbidities has also been observed among PLHIV, which may predispose to unfavorable COVID-19 results. Some antiretroviral drugs have been studied as possible treatments for COVID-19, but so far there is not enough evidence to recommend them systemically in the treatment of this disease[1].

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To contribute to the knowledge, it is necessary to summarize and elucidate whether PLHIV have a higher risk of infection by SARS-CoV-2 and if they have a worse clinical outcome than people without HIV.

The main objective of this systematic review and meta-analysis was to compare the risk of SARS-CoV-2 infection, risk of severe symptoms due to COVID-19, and risk of mortality due to COVID-19 of PLHIV with people without HIV, according to the published studies.

Methodology

Information sources

We conducted this Study[66] according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Supplementary Table S1)[67]. EMBASE, PubMed, Scopus, Cochrane Library, Web of Science, LILACS and SCIELO were searched from January 1, 2020 to March 31, 2021. In addition, we searched using the Google Scholar and Medrxiv servers to identify preprints or associated publications. In addition, a hand search of the reference lists of included studies, reviews or other relevant documents was performed. Studies that reported on susceptibility and death from COVID-19 in people with and without HIV infection were included in the search and analysis. The search was not limited to study design or country of publication in order to provide a complete picture. Articles published in English were adequately translated and included or excluded during the selection process.

The primary outcome was susceptibility to SARS-CoV-2 among people living with HIV (PLHIV) compared to the HIV negative population. The secondary outcome was the mortality risk of COVID-19 patients with HIV compared to COVID-19 patients without HIV.

Search strategy

The combination of predefined terms determined by Medical Subject Headings (MeSH) related to HIV / AIDS ("HIV", "human immunodeficiency virus", "Human immunodeficiency virus", "AIDS", "AIDS", "acquired immunodeficiency syndrome was used. ") And COVID-19 ("COVID-19", "SARS-CoV 2", "2019-nCoV", "nCoV", "novel coronavirus").

Selection of studies

We search studies with the following inclusion criteria:

1. Articles that mention the clinical behavior and outcome of the coinfection between HIV and SARS-CoV 2.
2. Original studies reported in the language of English and Spanish
3. Studies published between January 2020 to March 2021.

The studies for metanalysis were selected according to the following criteria based on participants, condition or outcome (s) of interest, study design, and context:

1. Participants (population): we included studies involving people with and without HIV who were tested for SARSCoV-2, regardless of age, country or antiretroviral treatment.
2. Condition or outcome (s) of interest: the primary outcome was susceptibility to SARS-CoV-2 among PLHIV compared to their HIV-negative counterparts. The secondary outcome was COVID-19 mortality risk for PPV compared to COVID-19 patients without HIV.
3. Study design and context: the studies eligible for analysis were randomized controlled trials, observational cohorts (prospective or retrospective), and case-control studies. We exclude case reports. Inclusion criteria included articles that reported the risk ratio (RR) of COVID-19 infection and severity in PPV people compared to people without HIV, or if a study provided enough information to calculate the RR of admission. In the intensive care unit (ICU), mechanical ventilation and death from COVID-19 among PLHIV compared to HIV-negative patients with COVID-19, studies of Systematic Reviews and Meta-analyzes related to the research were also included[1-12].

We excluded studies with the following criteria:

1. Studies that focused on pathophysiology, genetics, and molecular perspective that did not mention clinical behavior.
2. Reports such as editorials, letter to the editor, comments or consensus
3. Studies that did not contain primary data
4. Literature published in a language other than English and Spanish.

Data extraction

Two investigators individually screened all titles and abstracts according to the inclusion criteria. Articles were coded as "yes" or "no" for inclusion or exclusion. If both reviewers coded an article as ‘yes’ it was included for the full text review, if both reviewers coded ‘no’ it was removed from the subsequent selection process.

During the search, a total of 14,848 articles were identified from the databases EMBASE, PubMed, Scopus, Cochrane Library, Web of Science, LILACS, SCIELO; After considering the inclusion and exclusion criteria, eliminating duplicates, articles were examined by title and abstracts, finally a total of 59 articles were identified: 12 from systematic review and meta-analysis[1-12], 48 cohort / case studies- control[13-61] (Figure 1).

The following information was extracted: year of publication, sample size, PLHIV characteristics, COVID-19 rates in HIV positive and negative individuals, COVID-19 severity rates, COVID-19 mortality rates, average age, Last CD4 count <= 200, viral suppression, antiretroviral treatment, comorbidities.

For the meta-analysis, 22 cohort / case control studies were included, Software Review Manager 5.4 was used and the respective Forest Diagrams were constructed with their statistical parameters.

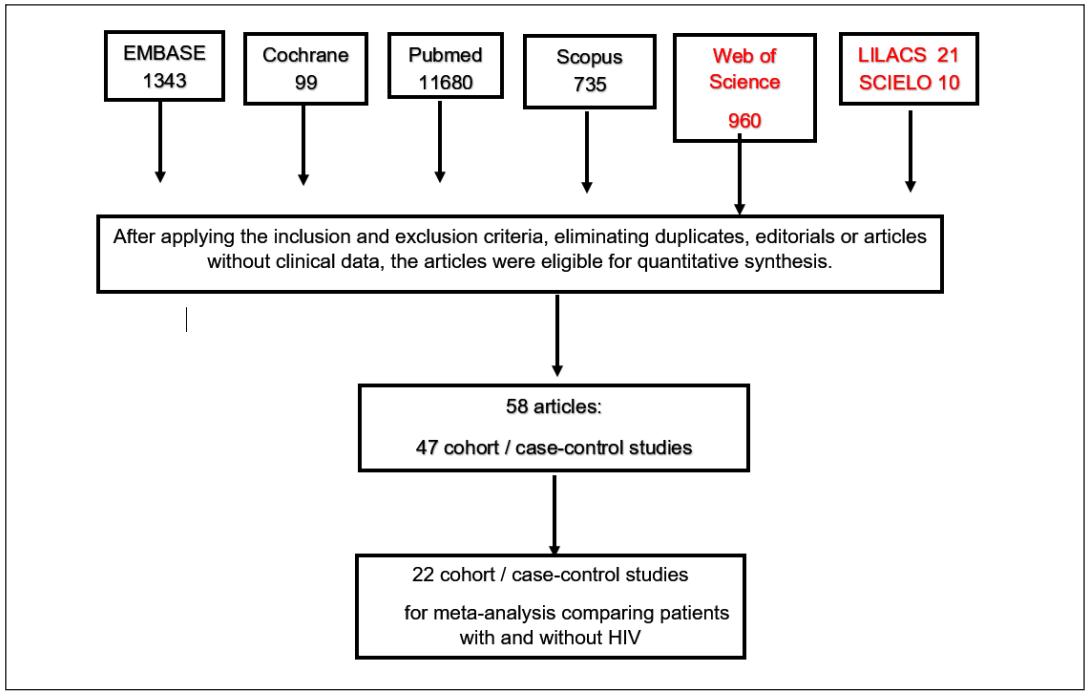

Figure 1. Literature search

Results

Risk of SARS-CoV-2 infection, severe COVID-19 symptoms and mortality among PLHIV and people without HIV[66].

Figures 2,3,4,5 show the data and graphs of the Forest Diagram for:

- Risk ratio of infection by SARS-CoV-2 comparing patients with and without HIV
- Risk ratio for severe symptoms due to COVID-19 comparing patients with and without HIV
- Mortality risk ratio for COVID-19 comparing patients with and without HIV
- Mortality risk ratio (Adjusted) for COVID-19 comparing patients with and without HIV
- Statistical significance was based on a P value of less than 0.05.

There was an increased risk of SARS-CoV-2 infection among PLHIV compared to HIV-uninfected people, the RR was 1.17 (95% CI, 1.15-1.20, n = 7, I2 = 0%). The risk of severe symptoms from COVID-19 was comparable between HIV-infected and HIV-uninfected individuals, with a RR = 0.98 (95% CI, 0.67-1.44, n = 9, I2 = 66%). To further evaluate the role of immune dysfunction in causing severe COVID-19, the risk rate of severe COVID-19 for patients with impaired immunity (CD4 <350 cells / mm3) can be compared[73] and found a higher risk in these patients, this difference is even more significant among people with a CD4 count below 200 cells / mm3[74].

The mortality risk ratio among HIV-SARS-CoV-2 patients compared to HIV-uninfected COVID-19 patients was RR = 1.02 (95% CI, 0.83-1.26, n = 17, I2 = 78), but the difference was not statistically significant. As the included studies also reported adjusted RR for other covariates such as age, sex and comorbidities, the results were synthesized separately and adjusted for the other covariates. A statistically significant increase in the risk of mortality was found for patients coinfected by HIV-SARS-CoV-2, the adjusted RR was 2.07 (95% CI, 1.73-2.47, n = 3, I2 = 0%) (Figure 5, Table 1).

A high Which2 whichs observed for most results, which means that there is statistical variability between the studies that are combined; It can come from many sources (more numerous in observational studies than in experimental designs): characteristics of the study population (for example, the underlying risk of the effect or different subgroups of high or low risk), variations in the design of the study (type of design, selection methods, sources of information, way of gathering information), different statistical methods and different adjustment schemes for confounding factors. The quality assessment of the studies was carried out using the NOS Assessment Scale, 22 studies included in the meta-analysis were evaluated (Table 2), 18 studies (82%) were classified as good quality and 4 studies (18%) of regular quality.

Discussion

Considering only hospitalized patients, Geretti et al (21) compared 122 HIV / COVID-19 coinfected patients with 47,470 HIV negative controls in a large UK-based study (the ISARIC WHO CCP study). The PLHIV were relatively younger with fewer comorbidities than the HIV-negative cohort. Although the cumulative crude mortality at 28 days was similar between PLHIV and HIV-negative patients (26.7% vs 32.1%, p = 0.16), after adjusting for age, PLHIV had a rate of 47% higher mortality.

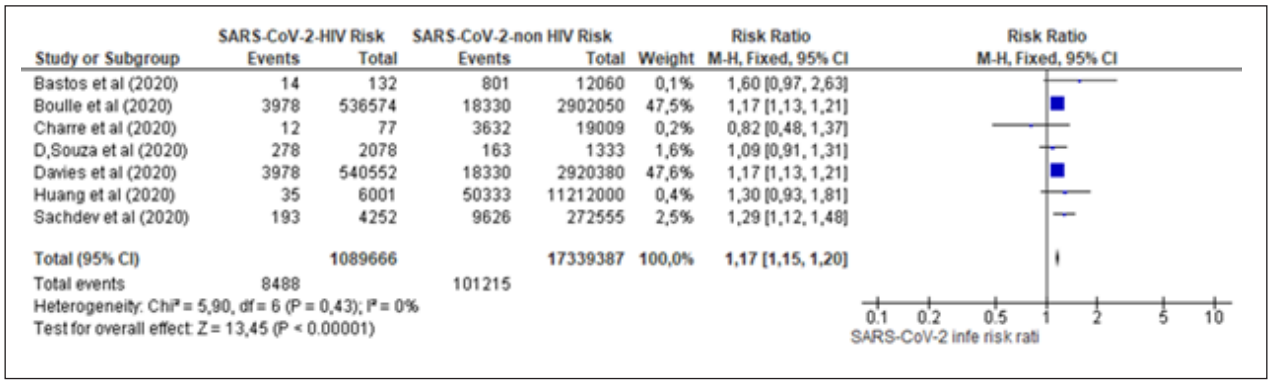

Figure 2. Forest diagram for the risk rate of infection by SARS-CoV-2 comparing patients with and without HIV.

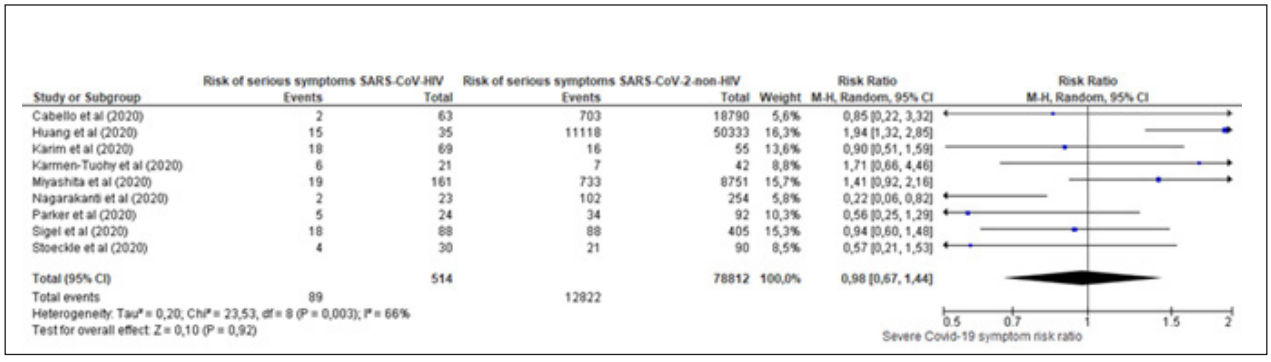

Figure 3. Forest diagram for the risk rate for severe symptoms due to SARS-CoV-2 comparing patients with and without HIV.

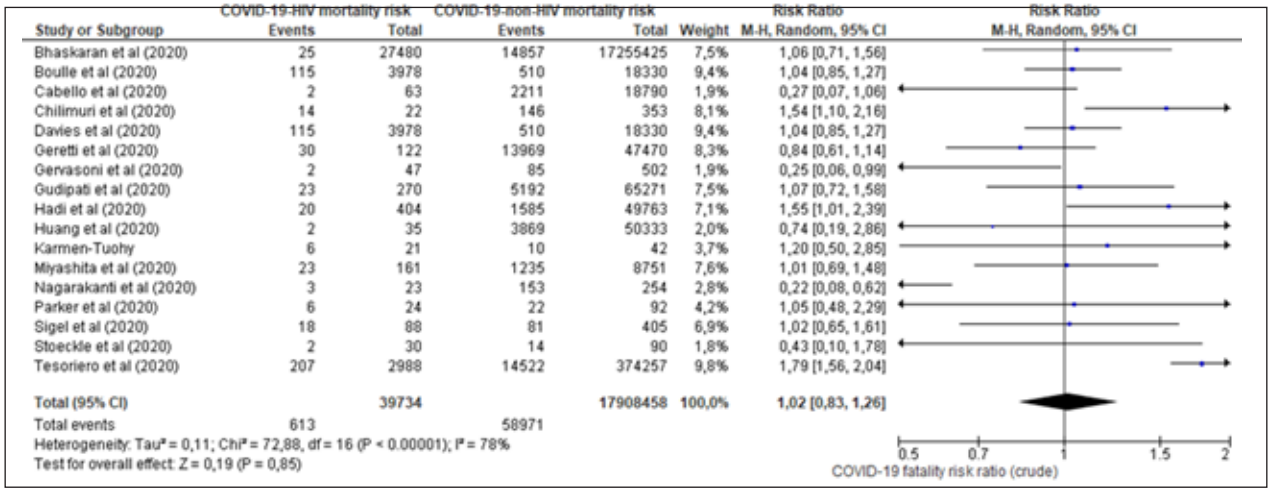

Figure 4. Forest diagram for the SARS-CoV-2 mortality risk rate comparing patients with and without HIV.

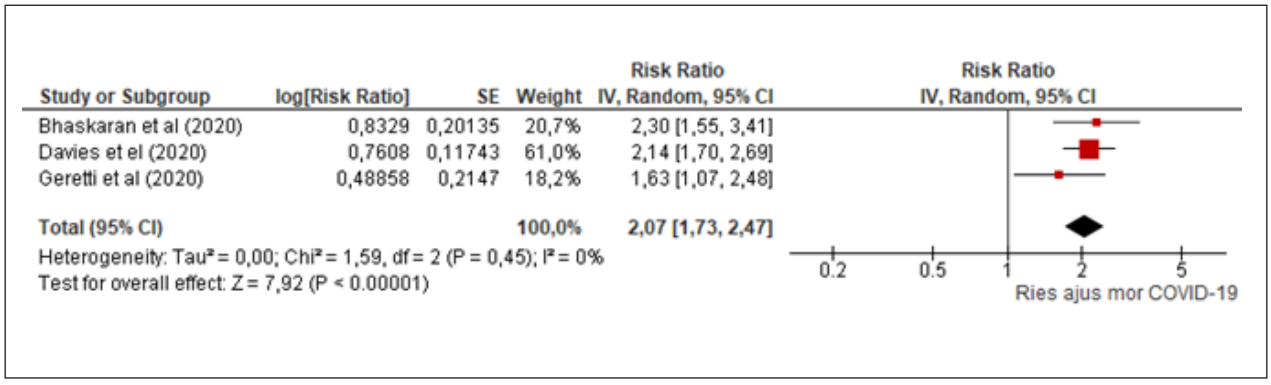

Figure 5. Forest diagram for the mortality risk rate (Adjusted) for COVID-19 comparing patients with and without HIV.

Table 1. COVID-19 Risk Ratio among HIV-positive and HIV-negative patients, taken from the Forest Diagrams.

	Risk Ratio	95% Confidence interval	Heterogeneity test, I^2	Heterogeneity test, P value	Number of studies
COVID-19 infection	1.17	1.15-1.20	0%	0.43	7
Severe symptoms due to COVID-19	0.98	0.67-1.44	66%	0.003	9
Mortality from COVID-19 (Crude)	1.02	0.83-1.26	78%	<0,00001	17
Mortality from COVID-19 (Adjusted)	2.07	1.73-2.47	0%	0.45	3

After adjusting for other variables (gender, ethnicity, age, baseline date, indeterminate / probable acquisition of COVID-19, 10 comorbidities, hypoxia / receiving oxygen at presentation), HIV was associated with a 69% higher mortality.

A much larger and more recent population study in New York State, Tesoreiro et al[18], collected information on COVID diagnoses from across the state (more than 19 million people), so it should not be Biased by the need for hospitalization, the risk of mortality once patients were hospitalized was similar to that of HIV-uninfected people, but taking into account the increased rates of diagnosis and admission, the standardized mortality rate for PLHIV was higher than that of the general population (1.23, 95% CI 1.13-1.48).

This study identified an increased risk of mortality due to COVID-19 among PLHIV compared to HIV-negative people, after possible confounding factors; also identified an increased risk of SARS-CoV-2 infection among PLHIV compared to HIV-uninfected individuals, revealing the vulnerability of PLHIV to SARS-CoV-2 infection during this pandemic. This could be explained by the destruction of T cells in the lung. Similarly in other tissues, CD4 + T cells were reduced in number in the lung among PLHIV[62]. The presence of HIV in lung tissue also causes an intense infiltration of HIV-specific CD8 + T cells, which induces lymphocytic alveolitis[63,64].

According to the study by Lee K W et al, the most common symptom in PLHIV coinfected with COVID-19 was fever (71.1%), followed by dry cough (66.3%) and dyspnea (46%). The most common comorbidity among all PLHIV with COVID-19 was hypertension (23.9%) followed by diabetes (12.2%)[65].

The present study has several limitations. First, the impact of potential confounders, such as information on HIV treatment and patient comorbidities related to COVID-19 treatment outcomes, must be carefully assessed when estimating relevant COVID-19 outcomes and comparing them. With other populations. This indicates the convenience of conducting more observational studies with more representative samples and higher qualities. Second, studies with adjusted results only came from the UK and South Africa. Studies of more diverse geographic regions are needed. Third, it is observed that the population included for the analysis tended to lean towards patients with good HIV control status. This limits the extension of the findings to the population whose HIV infection was not well controlled.

The added value of this study is that the risk of SARS-CoV-2 infection, severe COVID-19 symptoms and COVID-19 mortality among PLHIV compared to HIV-uninfected people were evaluated. Considering the increased risk of mortality due to COVID-19 among people living with human immunodeficiency virus compared to people without HIV, it is necessary that country governments, health care providers and local communities work together to intensify preventive measures against COVID-19 and treatment among people infected with HIV. In the meantime, there is a need to maintain HIV care during the COVID-19 pandemic such as HIV testing services, secured ART supplies, and timely connection to HIV treatment if infected.

In conclusion, HIV infection is a risk factor for COVID-19 and it is important that local health systems pay attention and deploy sufficient health resources to protect PLHIV from COVID-19.

Special attention should be paid to PLHIV with a high HIV viral load, low CD4 count, and who are not currently receiving ART.

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Ethical considerations

Protection of persons and animals. The authors declare that no experiments on humans or animals were performed in this article. The authors declare that the data were handled ethically and confidentially according to constitutional and legal norms on personal data protection.

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Table 2. The quality assessment of the included studies based on the Newcastle-Ottawa Scale (NOS)*

Selection					Comparability			Outcome			
					Comparability of cohorts on the basis of the esigno r analysis						
Study	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study	Sudy controls for HIV exposure	Study controls for COVID-19 exposure	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow up of cohorts	Overall score	Study Quality
Davies et al (2020	*	*	*	*	*	*	*	*	*	9	Good
Huang et al (2020)	*		*	*	*	*	*	*	*	8	Good
Charre et al (2020)			*	*	*	*	*	*	*	7	Good
Geretti et al (2020)		*	*	*	*	*	*	*	*	8	Good
Bhaskaran et al (2020)	*	*	*	*	*	*	*	*	*	9	Good
Sigel et al (2020)		*	*	*	*	*	*	*	*	8	Good
Karmen-Tuohy et al (2020)		*		*	*	*	*	*	*	7	Good
Gervasoni et al (2020)		*	*	*	*		*	*	*	7	Good
Tesoriero et al (2020)	*		*	*	*	*	*	*	*	8	Good
Gudipati et al (2020)			*	*	*	*	*		*	6	Fair
Sachdev et al 2020	*		*		*	*	*		*	6	Fair
Chilimuri et al (2020)		*	*	*	*	*	*	*	*	8	Good
Miyashita et al (2020)	*			*	*	*	*	*	*	7	Good
Boulle et al (2020)	*		*	*	*	*	*	*	*	8	Good
Nagarakanti et al (2020)			*	*	*	*	*		*	6	Fair
Karim et al (2020)	*		*	*	*	*	*	*	*	8	Good
Hadi et al (2020)	*		*	*	*	*	*	*	*	8	Good
Parker et al (2020)	*		*	*	*	*	*	*	*	8	Good
Bastos et al (2020)			*	*			*	*	*	5	Fair
Stoeckle et al (2020)		*	*	*	*	*	*	*	*	8	Good
Cabello et al (2020)	*	*	*	*	*	*	*	*	*	9	Good
DSouza et al (2020)	*	*	*	*	*	*	*	*	*	8	Good

*The NOS rating was converted according to the Agency for Healthcare Research and Quality – AHRQ – standards (Good quality: Score 7-9, Fair quality: Score 4-6, Poor quality: Score 0-3)

Conflict of interests. The authors declare that they have no conflict of interest.

Referencias

1. Mellor MM, Bast AC, Jones AC, et al. Risk of adverse COVID-19 outcomes for people living with HIV: a rapid review and meta-analysis. Medical Sciences Division, University of Oxford, Oxford, UK, 2020,1-0 DOI:https://DOI.org/10.1101/2020.09.22.20199661.
2. Cooper TJ, Woodward BL,Alom S and Harky A. Coronavirus disease 2019 (COVID-19) outcomes in HIV/AIDS patients: a systematic review.HIV Medicine (2020), 21, 567-77. DOI: 10.1111/hiv.12911,
3. Wang Y, Xie Y, Nie J, Marly G, Tang W. The Interaction between HIV Infection and COVID-19: A Systematic Review and Meta-Analysis. Available at SSRN: https://ssrn.com/abstract=3716873 or http://dx.DOI.org/10.2139/ssrn.3716873, 1,19.
4. Harlyanto T, Kurniawan A. Human immunodeficiency virus and mortality from coronavirus disease 2019: A systematic review and meta-analysis, Southern African Journal of HIV Medicine, April 2021**.** ISSN: (Online) 2078-6751, (Print), 1-7. DOI: 10.4102/sajhivmed.v22i1.1220,.
5. Ssentongo P, Heilbrunn ES, Ssentongo AE, Avani S et al. Epidemiology and

outcomes of COVID-19 in HIV-infected individuals: a systematic review and meta-analysis. Scientific Reports 2021. 1,12. https://DOI.org/10.1038/s41598-021-85359-3.

6. Baluku JB, Olum R, Agolor C, Nakakande J, et al. Prevalence, clinical characteristics and treatment outcomes of HIV and SARS-CoV-2 co-infection: a systematic review and meta-analysis. School of Medicine, Makerere University College of Health Sciences, Kampa Uganda. Preprint 2020, 1, 20. DOI **:**https://doi.org/10.1101/2020.05.31.20118497
7. Mirzaei H,McFarland W, Karamouzian M, Sharif H. COVID-19 Among People Living with HIV: A Systematic Review. AIDS and Behavior. 2020, 1,8. https://DOI.org/10.1007/s10461-020-02983-2.
8. Costenaro P, Minotti Ch, BarbieriE, Giaquinto C. et al. SARS-CoV-2 infection in people living with HIV: a systematic review. Rev Med Virol. 2021;31:e2155. John Wiley & Sons, Ltd 2020, 1,8. https://DOI.org/10.1002/rmv.2155.
9. Lee K.W, Yap SF, Ngeow YF, Lye MS. COVID-19 in People Living with HIV: A Systematic Review and Meta-Analysis. Int. J. Environ. Res. Public Health 2021, 18, 3554. Academic Editor: Paul B. Tchounwou, 1,25. https://DOI.org/10.3390/ijerph18073554.
10. Shareef MA, Bashaiwth HM, AlAkbari AO, Bahamran MS, AlAmodi MO, Albaiti SH, et al. A systematic review of contemporary evidence on SARS-CoV-2 and HIV coinfection: What does it look like up to date?. Avicenna J Med, 2020;10:189-97. DOI: 10.4103/ajm.ajm_175_20
11. Aghakishiyeva E.,Macallan D. Does HIV impact susceptibility to COVID-19 (SARS-CoV-2) infection and pathology? A review of the current literatura, Institute for Infection & Immunity, St George's, University of London, London, UK, Infection Care Group, St George's University Hospitals NHS Foundation Trust, London,UK, Preprint 2020.1,31., DOI:https://DOI.org/10.1101/2020.12.04.20240218,
12. Gao Y, Chen Y, Liu M, Shi S, Tian J. Impacts of immunosuppression and immunodeficiency on COVID-19: A systematic review and meta-analysis. The Journal of infection. 2020;81(2): e93-e5. DOI: https://doi.org/10.1016/j.jinf.2020.05.017.
13. Molina-Iturritza E, San-José-Muñiz I, Ganchegui-Aguirre M, et al. Coronavirus disease 2019 in patients with HIV in the province of Araba, Basque Country, Spain. *AIDS* [Online]. 2020;34(11). Available from: https://journals.lww.com/aidsonline/Fulltext/2020/09010/Coronavirus disease 2019 in patients with HIV in.18.aspx.1696,97. DOI: 10.1097/QAD.0000000000002608
14. Sachdev D, Mara E, Hsu L, Scheer S, Rutherford G, Enanoria W, et al. COVID-19 Susceptibility and Outcomes among People Living with HIV in San Francisco. *J Acquir Immune Defic Syndr*; 86(1): 19-21, 2021 01 01. DOI: 10.1097/QAI.0000000000002531,
15. Braunstein S, Lazar R, Wahnich A, Daskalakis DC, Blackstock OJ. COVID-19 infection among people with HIV in New York City: A population-level analysis of linked surveillance data, Clin Infect Dis. 2021 06 15; 72(12): e1021-e29. DOI: 10.1093/cid/ciaa1793
16. Cabello A, Zamarro B, Nistal S, et al. COVID-19 Disease in People Living With HIV: A Multicenter Case-Series Study. International Journal of infectious diseases 102 (2021) 310-15. DOI: 10.1016/j.ijid.2020.10.060
17. Kalyanaraman Marcello R, Dolle J, Grami S, Adule R, Li Z, Tatem K, et al. Characteristics and outcomes of COVID-19 patients in New York City's public hospital system. PLOS ONE 15(12): e0243027. 0243027. 2020; 1-16 /journal.pone. https://DOI.org/ 10.1371
18. Tesoriero JM, Swain C-AE, Pierce JL, et al. Elevated COVID-19 outcomes among persons living with diagnosed HIV infection in New York State: Results from a population-level match of HIV, COVID-19, and hospitalization databases. medRxiv, preprint [Online]. 2020. Available from DOI: https://doi.org/10.1101/2020.11.04.20226118 [Accessed November 2020].
19. Fernandez-fuertes M, Rodriguez-pineda E, Fuentes-lopez A, et al. Incidence of COVID-19 among people living with HIV in Southern Spain after one year of pandemic. Transbound Emerg Dis. Wileyonlinelibrary.com/journal/tbed, 2021;1–9. DOI: 10.1111/tbed.14293.
20. Boulle AA, Davies M, Hussey H, et al. Risk factors for COVID-19 death in a population cohort study from the Western Cape Province, South Africa. *Clin Infect Dis*. 2020; 1-31. DOI: 10.1093/cid/ciab803.
21. Geretti AM, Stockdale AJ, Kelly Sh, et al. Outcomes of COVID-19 related hospitalization among people with HIV in the ISARIC WHO Clinical Characterization Protocol (UK): a prospective observational study. *Clin Infect Dis* 2020. 1-11. DOI: 10.1093/cid/ciaa1605.
22. Nagarakanti SR, Okoh AK, Grinberg S, Bishburg E. Clinical outcomes of patients with COVID-19 and HIV coinfection. J Med Virol. 2021;93:1687–1693. DOI: 10.1002/jmv.26533
23. Charre C, Icard V, Pradat P, et al. Coronavirus disease 2019 attack rate in HIV-infected patients and in preexposure prophylaxis users. *AIDS*. 2020;34(12):1765–70. DOI: 10.1097/QAD.0000000000002639
24. Miyashita H, Kuno T. Prognosis of coronavirus disease 2019 (COVID-19) in patients with HIV infection in New York City. HIV Med. 2020. British HIV Association, 1-2. DOI: 10.1111/hiv.12920
25. D'Souza G, Springer G, Gustafson D, et al. COVID-19 symptoms and SARS-CoV-2 infection among people living with HIV in the US: the MACS/WIHS combined cohort study. *HIV Res & Clin Pract*. 2020. 129-39. DOI: 10.1080/25787489.2020.1844521
26. Shalev N, Scherer M, LaSota ED, et al. Clinical Characteristics and Outcomes in People Living With Human Immunodeficiency Virus Hospitalized for Coronavirus Disease 2019. *Clin Infect Dis*. 2020;71:2294–97. DOI: 10.1093/cid/ciaa635
27. Jiménez E, Fontán-Vela M, Valencia J, et al. Characteristics, complications and outcomes among 1549 patients hospitalised with COVID-19 in a secondary hospital in Madrid, Spain: A retrospective case series study. BMJ Open. 2020;10(11):1–10. DOI: 10.1136/bmjopen-2020-042398
28. Goyal P, Choi JJ, Pinheiro LC, et al. Clinical Characteristics of Covid-19 in New York City. *N Engl J Med* [Online]. 2020; 382(24):2372–74. DOI: 10.1056/NEJMc2010419
29. Karim F, Gazy I, Cele S, et al. HIV infection alters SARS-CoV-2 responsive immune parameters but not clinical outcomes in COVID-19 disease. medRxiv, preprint. 2020. Available from: DOI: https://doi.org/10.1101/2020.11.23.20236828.
30. Parker A, Koegelenberg CFN, Moolla MS, et al. High HIV prevalence in an early cohort of hospital admissions with COVID-19 in Cape Town, South Africa. *South African Med J*. 2020;110(10):982–7. DOI: 10.7196/samj.2020.v110i10.15067
31. Etienne N, Karmochkine M, Slama L, et al. HIV infection and COVID-19: risk factors for severe disease. *AIDS*. 2020;34(12):1771–74. DOI: 10.1097/QAD.0000000000002651
32. Hadi YB, Naqvi SFZ, Kupec JT, Sarwari AR. Characteristics and outcomes of COVID-19 in patients with HIV: a multicentre research network study. *AIDS*. 2020;34(13). F3-F8. DOI: 10.1097/QAD.0000000000002666
33. Wang Z, Zheutlin A, Kao YH, et al. Hospitalised COVID-19 patients of the Mount Sinai Health System: A retrospective observational study using the electronic medical records. BMJ Open. 2020;10(10). 1-13. DOI: 10.1136/bmjopen-2020-040441
34. Hassan Z, Hashim MJ, Khan G. Population risk factors for COVID-19 deaths in Nigeria at sub-national level. *Pan Afr Med J*. 2020;35(Supp 2):1–10. DOI: 10.11604/pamj.supp.2020.35.131.25258
35. Bastos L, Pocinho S, Machado A, et al. SARS-CoV-2 infection in HIV patients: we anticipated a worse scenario. *J Int Aids Soc*. 2020;23(7, SI):122.
36. Sigel K, Swartz T, Golden E, et al. Coronavirus 2019 and People Living With Human Immunodeficiency Virus: Outcomes for Hospitalized Patients in New York City. *Clin Infect Dis*. 2020;71(11); 2933-38. DOI: 10.1093/cid/ciaa880.
37. Palmieri L, Vanacore N, Donfrancesco C, et al. Clinical Characteristics of Hospitalized Individuals Dying with COVID-19 by Age Group in Italy. Journals Gerontol - Ser A Biol Sci Med Sci. 2020;75(9):1796–800.
38. Maggiolo F, Zoboli F, Arosio M, et al. SARS-CoV-2 infection in persons living with HIV: A single center prospective cohort. *J Med Virol*. 2021;93(2):1145-49. DOI: 10.1002/jmv.26352.
39. Karmen-Tuohy S, Carlucci PM, Zervou FN, et al. Outcomes Among HIV-Positive Patients Hospitalized With COVID-19. *J Acquir Immune Defic Syndr*. 2020;85(1):6–10. DOI: 10.1097/QAI.0000000000002423.
40. Di Biagio A, Ricci E, Calza L, et al. Factors associated with hospital admission for COVID-19 in HIV patients. *AIDS*. 2020;34(13):1983–85. DOI: 10.1097/QAI.0000000000002423
41. Guo W, Ming F, Dong Y, et al. A Survey for COVID-19 among HIV / AIDS Patients in Two Districts of Wuhan, China A Survey for COVID-19 among HIV / AIDS Patients in Two Districts of Wuhan, China. The Lancet Preprint, 2020. 1-19. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3550029.
42. Argenziano MG, Bruc SL, Slate CL, et al. Characterization and clinical course of 1000 patients with coronavirus disease 2019 in New York: Retrospective case series. BMJ. 2020;369(March).1-9. DOI: 10.1136/bmj.m1996
43. Dandachi D, Geiger G, Montgomery MW, et al. Characteristics, Comorbidities, and Outcomes in a Multicentre Registry of Patients with HIV and Coronavirus Disease- 19, *Clinical Infectious Diseases*,2020, ciaa1339, 1-30. Available from: https://doi.org/10.1093/cid/ciaa1339. DOI: 10.1093/cid/ciaa1339
44. Shekhar R, Barton A, Sheikh AB, Upadhyay S, Salas NM. Coronavirus Disease of 2019 in Patients With Well-Controlled Human Immunodeficiency Virus on Antiretroviral Therapy. *J Acquir Immune Defic Syndr*. 2020;85(1):e1–e4. DOI: 10.1097/QAI.0000000000002415
45. Ho H, Peluso MJ, Margus C, et al. Clinical Outcomes and Immunologic

Characteristics of Coronavirus Disease 2019 in People With Human Immunodeficiency Virus. *J Infect Dis*. 2021; 223(3): 403-08. DOI: 10.1093/infdis/jiaa380
46. Stoeckle K, Johnston CD, Jannat-Khah DP, et al. COVID-19 in hospitalized adults with HIV. Open Forum Infect Dis. 2020;7(8):1–7. DOI: 10.1093/ofid/ofaa327
47. Calza L, Bon I, Borderi M, et al. Covid-19 Outcomes in Patients With Uncontrolled HIV-1 Infection. *JAIDS J Acquir Immune Defic Syndr*. 2021 Enero 1;86(1): e15-e17. DOI: 10.1097/QAI.0000000000002537
48. Ridgway JP, Schmitt J, Friedman E, et al. HIV Care Continuum and COVID-19 Outcomes Among People Living with HIV During the COVID-19 Pandemic, Chicago, IL. *AIDS Behav*. 2020;24(10):2770–72. DOI: 10.1007/s10461-020-02905-2
49. Park LS. COVID-19 in the largest US HIV cohort. In: COVID-19 in the largest US HIV cohort. 23rd International AIDS Conference abstract LBPEC23; 2020.
50. Bhaskaran K, Rentsch CT, MacKenna B, Schultz A, Mehrkar A, Bates C, et al. HIV infection and COVID-19 death: population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFELY platform. Lancet VIH. 2021 ;8(1):e24-e32. DOI: 10.1016/S2352-3018(20)30305-2
51. Calza L, Bon I, Borderi M, Colangeli V, Viale P. No significant effect of covid-19 on immunological and virological parameters in patients with HIV-1. infection. Journal of acquired immune deficiency síndromes, 2020. 1;85(1): e6-e8. DOI: 10.1097/QAI.0000000000002427
52. Chilimuri S, Sun H, Alemam A, Mantri N, Shehi E, Tejada J, et al. Predictors of Mortality in Adults Admitted with COVID-19: Retrospective Cohort Study from New York City. The western journal of emergency medicine. 2020;21(4):779-84. DOI: 10.5811/westjem.2020.6.47919
53. Davies M-A. HIV and risk of COVID-19 death: a population cohort study from the Western Cape Province, South Africa. medRxiv : the preprint server for health sciences 2020: https://DOI.org/10.1101/2020.07.02.20145185.
54. Del Amo J, Polo R, Moreno S, Díaz A, Martínez E, Arribas JR, et al. Incidence and Severity of COVID-19 in HIV-Positive Persons Receiving Antiretroviral Therapy: A Cohort Study. Ann Intern Med. 2020;173(7):536-41. DOI: 10.7326/M20-3689.
55. Gervasoni C, Meraviglia P, Riva A, Giacomelli A, Oreni L, Minisci D, et al. Clinical features and outcomes of HIV patients with coronavirus disease 2019. Clin Infect Dis. 2020;71(16):2276-78. DOI: 10.1093/cid/ciaa579.
56. Huang J, Xie N, Hu X, Yan H, Ding J, Liu P, et al. Epidemiological, virological and serological features of COVID-19 cases in people living with HIV in Wuhan City: A population-based cohort study. Clin Infect Dis. 2020.1-9. DOI: 10.1093/cid/ciaa1186.
57. Inciarte A, Gonzalez-Cordon A, Rojas J, Torres B, de Lazzari E, de la Mora L, et al. Clinical characteristics, risk factors, and incidence of symptomatic COVID-19 in adults living with HIV: a single-center, prospective observational study. AIDS (London, England). 2020. 34(12): 1775–80. DOI: 10.1097/QAD.0000000000002643.
58. Vizcarra P, Pérez-Elías MJ, Quereda C, Moreno A, Vivancos MJ, Dronda F, et al. Description of COVID-19 in HIV-infected individuals: a single-centre, prospective cohort. The lancet HIV. 2020;7(8):e554-e64. DOI: 10.1016/S2352-3018(20)30164-8.
59. Farinacci D, Ciccullo A, Borghetti A, Visconti E, Tamburrini E, Izzi IM, et al. People living with HIV in the CoVid-19 era: a case report. AIDS research and human retroviruses. 2020. AIDS RESEARCH AND HUMAN RETROVIRUSES, Volume 37, Number 4, 2021. DOI:10.1089/AID.2020.0149.
60. Gudipati S, Brar I, Murray S, McKinnon JE, Yared N, Markowitz N. Descriptive Analysis of Patients Living with HIV Affected By COVID-19. J Adquirir Immune Defic Syndr.2020; 85(2): 123–26. DOI: 10.1097/QAI.0000000000002450
61. Lee K.W, Yap SF, Ngeow YF, Lye MS. COVID-19 in People Living with HIV: A Systematic Review and Meta-Analysis. Int. J. Environ. Res. Public Health 2021, 18(7), 1-25. Free PMC article. DOI: 10.3390/ijerph18073554.
62. Beck JM, Rosen MJ, Peavy HH. Pulmonary complications of HIV infection: report of the fourth NHLBI workshop. American journal of respiratory and critical care medicine. 2001;164(11):2120-6. DOI: 10.1164/ajrccm.164.11.2102047
63. Semenzato G. Immunology of interstitial lung diseases: cellular events taking place in the lung of sarcoidosis, hypersensitivity pneumonitis and HIV infection. European Respiratory Journal. 1991;4(1):94-102.
64. Cohen C, Moyes J, Tempia S, Groom M, Walaza S, Pretorius M, et al. Severe influenza-associated respiratory infection in high HIV prevalence setting, South Africa, 2009–2011. Emerging infectious diseases. 2013;19(11):1766-74. DOI: 10.3201/eid1911.130546
65. Gadelha Farias LAB, Gomes Moreira AL, Austregésilo Corrêa E, Landim de Oliveira Lima CA, Lopes IMP, de Holanda PEL, et al. Case Report: Coronavirus Disease and Pulmonary Tuberculosis in Patients with Human Immunodeficiency Virus: Report of Two Cases. Am J Trop Med Hyg; 103(4): 1593–96. DOI: 10.4269/ajtmh.20-0737.
66. Vásquez SJ. Características clínicas y epidemiológicas de la enfermedad por COVID-19 en pacientes con VIH: una revisión sistémica y metaanálisis [Tesis de Master sobre Infección por el virus de la inmunodeficiencia humana- campus ESTHER], Universidad Rey Juan Carlos, Madrid, 2021.
67. Moher D., Shamseer L., Clarke M., Ghersi D., Liberati A., Petticrew M., Shekelle P., Stewart LA Elementos de notificación preferidos para protocolos de revisión sistemática y metanálisis (PRISMA-P) Declaración de 2015. *sist. Rev.* 2015; 4 :1. DOI : https://dx.DOI.org/10.14306/renhyd.20.2.223.