

## Health conditions influence in virologic outcomes in a population living with HIV: a retrospective observational study

*Influência das condições de saúde nos desfechos virológicos em uma população vivendo com HIV: um estudo observacional retrospectivo*

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### ABSTRACT

**Objective:** To correlate health conditions, linking the primary health care and municipal Human Development Index with the virological outcomes of HIV treatment, in a population over 13 years old, in the region of Vale do Jequitinhonha, north of Minas Gerais. **Methods:** A retrospective review of 239 medical records, from 1995 to 2020 was performed in a regional reference service. The risk for an unfavorable HIV PCR blood test result was initially estimated by a chi square test, simple logistic regression, Pearson's and Spearman's correlations, considering a 95% significance level. Subsequently, multivariate analysis was performed to build a decision tree for a risk profile of treatment failure. **Results:** 92 users had a weak link with primary health care and 12 presented treatment failure. Conditions that reduced the risk of a favorable treatment response were systemic arterial hypertension (OR=0.13; 95%CI=0.13-0.47), psychosocial conditions (OR=0.06; 95%CI=0.00-0.32), visceral leishmaniasis (OR=0.07; 95%CI=0.01-0.58), and CD4 T lymphocytes level under 350 cells/mm<sup>3</sup> (OR=0.10; 95%CI=0.02-0.39). Positive correlation ( $p<0.05$ ) was observed between the Human Development Index and treatment failures (COR=0.5; 95%CI=0.1-0.7). **Conclusion:** Systemic arterial hypertension and CD4 T lymphocyte levels under 350 cells/mm<sup>3</sup> were the most relevant conditions in a decision tree model for a profile for treatment failure risk.

**Keywords:** HIV; AIDS; Chronic disease; Coinfection; Primary health care.

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## RESUMO

**Objetivo:** Correlacionar as condições de saúde, o vínculo com a atenção primária à saúde e o Índice de Desenvolvimento Humano municipal com os desfechos virológicos do tratamento do HIV, em uma população acima de 13 anos, na região do Vale do Jequitinhonha, norte de Minas Gerais. **Métodos:** Estudo retrospectivo de 239 prontuários, de 1995 a 2020, em um serviço de referência regional. O risco para um resultado desfavorável do HIV PCR sérico foi inicialmente estimado pelo teste qui-quadrado, regressão logística simples e correlações de Pearson e Spearman, considerando nível de significância de 95%. Posteriormente, a análise multivariada foi realizada para construir uma árvore de decisão para um perfil de risco de falha terapêutica. Resultados: 92 usuários apresentavam vínculo fraco com a atenção primária à saúde e 12 estavam em falha terapêutica. As condições que reduziram as chances de resposta favorável ao tratamento foram hipertensão arterial sistêmica (OR=0,13; IC95%=0,13-0,47), condições psicossociais (OR=0,06; IC95%=0,00-0,32), leishmaniose visceral (OR=0,07; IC95%=0,01-0,58) e nível de linfócitos T CD4 abaixo de 350 células/mm<sup>3</sup> (OR=0,10; IC95%=0,02-0,39). A correlação positiva ( $p<0,05$ ) foi observada entre Índice de Desenvolvimento Humano e falhas no tratamento (COR=0,5; IC95%=0,1-0,7). **Conclusão:** Hipertensão arterial sistêmica e nível de linfócitos T CD4 abaixo de 350 células/mm<sup>3</sup> foram as condições mais relevantes no modelo de árvore de decisão para um perfil de risco de falha terapêutica.

**Palavras-chave:** HIV; AIDS; Doença crônica; Coinfecção; Atenção primária à saúde.

## INTRODUCTION

HIV continuous care can be understood as the care process for people living with HIV, occurring from the moment there is a timely diagnosis and the connection to a health service, to retention in that service, the initiation of antiretroviral treatment, maintaining good adherence, and the suppression of the viral load, attempting to sustain a similar quality of life as that of a person who does not have the virus. The health care network for people with HIV was created to overcome the fragmentation of health services, which is usually manifested in the absence of coordination between levels of care, multiplication of services, low infrastructure and inappropriate locations, the lack of or difficulty in service access, discontinuity of actions and inconsistency between the services offered and the population's needs<sup>1</sup>.

In the last years, the HIV epidemic has shown a reduction in morbidity and mortality; however, chronic diseases have been more prevalent in this group of people. This new scenario also gives the HIV infection a chronic disease status. Cardiovascular diseases, Systemic Arterial

Hypertension (SAH) and diabetes have become more prevalent in this group. Thus, HIV services need to develop multidisciplinary and continuous care, involving other services, like Primary Health Care (PHC), to guarantee the quality of care<sup>1</sup>. A significant part of HIV specialized services are operating at maximum capacity, meeting the demand without organized flows, and acting in isolation, in a non-collaborative way with the care network<sup>1</sup>.

It is estimated that at least half of HIV patients (50.6%), have other comorbidities, with SAH being the most prevalent (13%), followed by depression (12.5%), hypercholesterolemia (10.83%) and diabetes and prediabetes (10.6%)<sup>2</sup>.

People at greater risk of being infected by the virus are also at greater risk of being infected by other pathogens, including hepatitis B and C virus. These pathogens are transmitted through similar routes, such as injection drug use, sexual contact or from mother to child during pregnancy or birth. The HIV-HBV, HIV-HCV and HIV-HBV-HCV co-infection prevalence has already been estimated at 2.95%, 18.14% and 2.53% respectively<sup>3</sup>. Both scenarios

involving HIV associated with chronic communicable and non-communicable diseases can interfere in HIV health care and can influence adherence to treatment, HIV progression to AIDS and virus transmission.

Even a low rate of first line treatment failures has a devastating impact for long-term outcomes. Treatment failure also presents a financial and human resource burden on the health care infrastructure<sup>4</sup>. The relationship between PHC coverage and low AIDS rates has already been observed in other studies<sup>5</sup>. The discussion of factors that impact HIV treatment outcomes in less developed countries has historically been neglected, even though, in these countries, it is even more crucial since it leads to key points for interventions.

This study aims to correlate health conditions, linking the PHC and municipal Human Development Index (HDI) with the virological outcomes of HIV treatment in a population over 13 years old, in the region of Vale do Jequitinhonha, north of Minas Gerais, Brazil.

## METHODS

### STUDY POPULATION

This is an observational, retrospective, descriptive and exploratory study, through the analysis of the medical records of all patients seen by the regional and public HIV clinic in the Vale do Jequitinhonha region, Minas Gerais, Brazil. This clinic is a reference for 28 municipalities from 3 different regions. It operates in a lower economic and human development area than other parts of the state. Its Gross Domestic Product (GDP) represents only 2.0% of Minas Gerais GDP and there is a moderate variation (0.151) in Municipal IDH<sup>6</sup>.

All medical records of all of the HIV population being followed up at the clinic and living in the coverage area were included. Data collection was performed from 10/01/2020 to 12/31/2020. This was the period required for the evaluation of all active medical records with a diagnosis between 1995, the year in which the clinic began its activities, and the end of 2020. Medical records without searched information were excluded. A specific instrument was built for data collection, based on information usually collected during consultations and on the layers of the Social Determination of Health Model<sup>7</sup>. Thus, this instrument was organized in layers, which started with individual characteristics, such as age and sex, went through intermediate characteristics, such as behaviors and living and work conditions, and ended with a distal layer, which included economic conditions. A history of coinfections, chronic diseases, psychosocial conditions, HIV PCR results, CD4 T lymphocyte levels, municipality origin and the link to the PHC was also registered. Patients

were not identified by name to protect confidentiality. Weak PCH links were marked when medical records registered reasons for visits that were not related to HIV care, following the International Classification of Primary Care.<sup>7</sup> It is important to highlight that this data collection instrument was built for this study and was not validated, which can be considered a limitation. The study was guided by the STROBE statement (Strengthening the Reporting of Observational Studies in Epidemiology)<sup>9</sup>, and GATHER statement (Guidelines for Accurate and Transparent Health Estimates Reporting)<sup>10</sup>.

All computations were done using the “R”<sup>11</sup> version 4.0.3. The QGIS<sup>12</sup> version 3.16 was used for spatial information. Institutional review board approval was obtained at the Vales do Jequitinhonha Federal University, Diamantina; Vales do Jequitinhonha Federal University Local Ethics Committee; Diamantina Municipal Health Department; and the National Ethics Committee (opinion number 4.267.116, CAAE 36223420.8.0000.5108). The study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

### PREVALENT HEALTH CONDITIONS AND HIV INFECTION CONTROL

Prevalent health conditions and the PHC link in the study population was estimated and a 95% confidence interval was calculated. To verify the association between factors and treatment outcomes, the chi square test was used, considering a 95% significance level ( $\alpha=0.05$ ). Simple logistic regression analyses were also performed to predict the risk (OR) treatment failure. Patients were considered to be in treatment failure when diagnosed more than 6 months ago and when HIV PCR results were between 200 and 500 copies/ml in the last 2 tests, or above 500 copies/ml in the last test done, following the national protocol for HIV comprehensive care<sup>1</sup>.

### MOST PREVALENT COINFECTIONS AND HDI

Municipality HDI was obtained from the national demographic database<sup>7</sup>. Spatial correlation (COR) was used to correlate the number of treatment failures and the municipality HDI of the patient's origin. Most prevalent coinfections were also correlated to municipality HDI. The Shapiro Wilk test was performed to access normal distribution. Pearson's and Spearman's correlations were used for parametric and non-parametric data. For spatial autocorrelation of these variables, the Moran's index (MI) was performed.

After analyzing the data by the bivariate statistical analysis described above, statistical exploration by multivariate analysis was chosen, using the decision tree, and considering the chances of treatment failure as an

outcome. This analysis was carried out due to the volume of information collected and with the proposal of selecting the DSS that can explain the outcomes more objectively. It follows the proposal performed in other similar studies<sup>13</sup>.

## RESULTS

During the study, 244 medical records were identified in service files. Of these, 5 medical records were excluded because they did not have researched information. After the inclusion and exclusion criteria, 239 medical records were considered in this study. Regarding sociodemographic characteristics, most patients (70.29%) were brown, male (62.34%), single (48.95%) and heterosexual (71.55%). About half of the population had a job with income (50.9%) and only literacy as schooling (50.21%). The mean age of the patients was 44.13 years (Table 1).

### THE IMPACT OF HEALTH CONDITIONS AND PRIMARY HEALTH CARE LINK ON HIV CLINICAL CONTROL

Toxoplasmosis (PR,31.4), hepatitis A (PR,18.0), cytomegalovirus (PR,18.4) and syphilis (PR,14.6) were the most common co-infections. Tuberculosis was the eighth most common co-infection (PR,4.2). 146 users had a chronic non-transmissible disease (PR,61.1). SAH was the most prevalent chronic disease (PR,18.0), followed by renal disease (PR,14.2) and diabetes mellitus or pre-diabetes (PR,11.3). Chronic renal failure, observed in 30 patients, was the most common renal disease. Despite this, it was usually at a mild degree in this study population. 88 users had some psychosocial assistance need (PR,36.8). 12 users (PR,5.0) were in treatment failure. |The chi square test indicated a statistical significance ( $p < 0.05$ ) between treatment outcomes and SAH, visceral leishmaniasis, the CD4 T lymphocyte values and psychosocial conditions (Table 2).

A weak link with the PHC was observed in 92 patients (PR,38.5). As described in the methodology section, this weak link with the PHC was considered when medical records registered reasons for visits at the HIV clinic that were not related to HIV care, but related to PHC routine care, following the International Classification of Primary Care<sup>8</sup>. This study did not find a statistical significance between the PHC link and treatment outcomes ( $p > 0.05$ ) (Table 2). Despite this, when users were attended by the HIV service, for demands not directly related to HIV monitoring, the main reasons for visits were chronic disease control (17.6%) or psychosocial assistance (10.9%) (Table 3).

Simple logistic regression identified that the health conditions significantly ( $p < 0,05$ ) reduced chances of a favorable HIV PCR result, as treatment response control were SAH (OR=0.13; 95%CI=0.13-0.47), psychosocial conditions (OR=0.06; 95%CI=0.00-0.32), visceral leishmaniasis (OR=0.07; 95%CI=0.01-0.58), and a CD4 T lymphocytes level under 350 cells/mm<sup>3</sup> (OR=0.10; 95%CI=0.02-0.39) (Table 4).

**Table 1.** Prevalence of sociodemographic characteristics in HIV individuals, in Vale do Jequitinhonha, from October to December 2020.

Characteristic	All Population (n=239)	
	Number	Prevalence
<b>Age, median (1st-3rd)</b>		
<b>Ethnicity</b>		
Yellow	2	0.84
White	42	17.57
Brown	168	70.29
Black	27	11.3
<b>Sex</b>		
Male	149	62.3
Female	90	37.6
<b>Sexual orientation</b>		
Bisexual	12	5.02
Heterosexual	171	71.55
Homosexual	52	21.76
Transexual	4	1.67
<b>Marital status</b>		
Married or stable union	74	30.96
Divorced	20	8.37
Single	117	48.95
Widower	28	11.71
<b>Occupation</b>		
Retired	24	10.04
Unemployed	27	11.3
Home caregiver	36	15.06
Employed	136	56.9
Student	16	6.69
<b>Schooling</b>		
Illiterate	13	5.44
No schooling, can read	120	50.21
Elementary School	30	12.55
High school	51	21.34
Undergraduate University degree	23	9.62
Graduate studies	2	0.84

**Note:** Prevalence values are presented in percentages. CI = Confidence interval. (1<sup>st</sup>-3<sup>rd</sup>) = interquartile range between 1<sup>st</sup> and 3<sup>rd</sup> quartiles.

### SPATIAL CORRELATION OF THE MOST COMMON CONDITIONS AND HDI

A positive correlation ( $p < 0.05$ ) was observed for HDI and treatment failures (COR=0.5; 95%CI=0.1-0.7), for HDI and hepatitis A (COR=0.4; 95%CI=0.1-0.8) and HDI and toxoplasmosis (Figure 1).

The Moran index did not show a statistical significance ( $p > 0.05$ ) for coinfections or treatment failure. Thus, the number of cases of these coinfections in one municipality does not seem to be influenced by neighboring municipalities (Table 5).

**Table 2.** Coinfections, Comorbidities and Primary Health Care link in HIV Individuals and the correlation to HIV PCR results in Vale do Jequitinhonha, from October to December 2020.

Health Condition	All Individuals n=239	Prevalence	Unfavorable HIV PCR result n=12	<i>p</i>
<b>Confections</b>	169	70.71	5	0.05
Toxoplasmosis	75	31.38	2	0.42
Cytomegalovirus	44	18.41	1	0.59
Hepatitis A	43	17.99	1	0.61
Syphilis	35	14.64	1	0.83
Candidiasis	17	7.11	1	1
Hepatitis B	11	4.6	0	0.94
Herpes zoster	11	4.6	0	0.94
Tuberculosis	10	4.18	0	1
Human papillomavirus	9	3.76	0	1
Epstein–Barr virus	7	2.92	0	1
Herpes simplex	6	2.51	0	1
Visceral leishmaniasis	6	2.51	2	0.02
Hepatitis C	5	2.09	0	1
Bacterial urethritis	4	1.67	0	1
Meningitis	4	1.67	0	1
Chagas disease	4	1.67	1	0.35
Dengue	3	1.25	0	1
<b>Chronic diseases</b>	146	61.1	7	1
Systemic arterial hypertension	43	17.99	7	0.00
Renal disease	34	14.22	0	0.30
Diabetes mellitus or pre-diabetes	27	11.3	0	0.42
Neurological disease	26	10.88	2	0.85
Dyslipidemia	24	10.04	1	1
Orthopedics	23	9.62	2	0.73
Hepatic	15	6.28	1	1
Thyroid disorder	13	5.39	1	1
Cancers	8	3.35	0	0.99
Obesity	8	3.35	0	1
Other Cardiovascular Diseases	7	2.93	0	1
<b>Psychosocial demand</b>	88	36.82	11	0.00
<b>No Primary Health Care use</b>	92	38.49	6	0.59
<b>CD4&lt;350 cells/mm<sup>3</sup></b>	55	23.01	9	0.00
<b>Treatment failure</b>	12	5.02	12	-

Note: *p* = *p*-value by chi square test \*Confidence interval.

The decision tree analysis considering virological control of HIV as an outcome showed that if an individual does not have a CD4+ count below 350 cells/mm<sup>3</sup>, there is a 100% chance of good virological control. If an individual

has a CD4+ count below 350 cells/mm<sup>3</sup> and still has high blood pressure, there is a 50% chance of having a detectable viral load. This chance is around 10% if this individual does not have SAH (Figure 2).

**Table 3.** Reasons not directly related to HIV/AIDS monitoring received at the HIV clinic, in Vale do Jequitinhonha, from 1995 to 2020.

Reason	All Individuals (n=239)
Chronic disease control, n(%)	42(17.6)
Psychosocial assistance, n(%)	26(10.9)
Women's health, n(%)	7(2.9)
Orthopedic care, n(%)	7(2.9)
Acute upper respiratory infection, n(%)	7(2.9)
Sexual disorder, n(%)	2(0.8)
Scabies, n(%)	2(0.8)
Request for specialty referral, n(%)	2(0.8)
Cholelithiasis, n(%)	1(0.4)
Chronic constipation, n(%)	1(0.4)
Hemorrhoidal disease, n(%)	1(0.4)
Uncomplicated urinary tract infection, n(%)	1(0.4)
Medical report to start physical activity, n(%)	1(0.4)
Prostate cancer screening, n(%)	1(0.4)

**Table 4.** Simple Logistic Regression Analyses of Factors Associated with Favorable HIV PCR result in a HIV Clinic, Vale do Jequitinhonha, from October to December 2020.

Factor	<i>p</i>	OR	CI
Systemic arterial hypertension			
Yes	0.00	0.13	0.03 - 0.47
No	0.00	46.50	19.74-150.92
Psychosocial assistance demand			
Yes	0.01	0.06	0.00 - 0.32
No	0.00	146.00	32.80- 2568.36
Visceral leishmaniasis			
Yes	0.00	0.07	0.01-0.58
No	0.00	27.25	4.41-60.22
CD4<350 cells/mm <sup>3</sup>			
Yes	0.00	0.10	0.02-0.39
No	0.00	59.67	22.71-241.44

**Note:** *p* = *p*-value by Simple Logistic Regression; OR = Odds ratio; CI = Confidence interval.

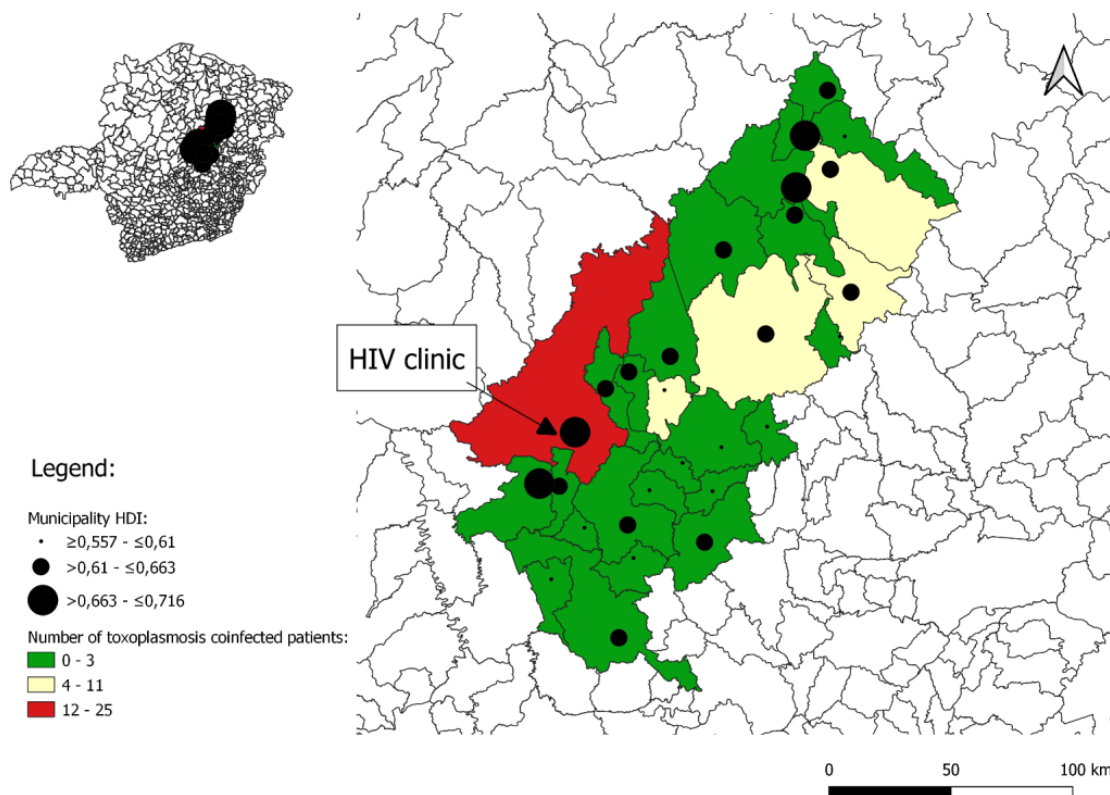
## DISCUSSION

The findings of this study suggested that health conditions related to virological outcomes of HIV are illnesses related to psychosocial issues, low CD4 T lymphocyte levels, visceral leishmaniasis and SAH. These health conditions increase the chances of an unfavorable outcome of HIV treatment. A higher municipal HDI was another factor positively correlated with the unfavorable treatment outcomes. In this study, the link with the PHC was not correlated with the virological outcomes.

Psychosocial conditions as factors that increase chances for treatment failure reinforces the importance of having a complete professional team, including psychologists and social assistance workers. Living with HIV/AIDS has an

impact on various dimensions of an individual's life. Socially constructed stigmas and efforts to keep the diagnosis a secret can contribute to mental disorders. Family support and discrimination are factors that interfere in living with the disease<sup>14</sup>. Family support is especially important in individuals coping with physical or cognitive deficiency. In these cases, social assistance can be decisive for treatment success. The impact of living with HIV on mental health and social support may not be well monitored if there is a lack of professionals.

The existence of chronic non-transmissible diseases in more than half of the users reinforces the importance of follow-ups not being exclusively in a regional health care service. During the study, several medical records reported high blood pressure values in hypertensive patients. Despite



Note: Artwork created using Qgis<sup>12</sup>.

Figure 1. Municipality HDI and number of toxoplasmosis coinfected patients in a HIV Clinic region, Vale do Jequitinhonha, from October to December 2020.

Table 5. Correlation between Municipality HDI and Number of Co-infected individuals in a HIV Clinic, Vale do Jequitinhonha, from October to December 2020.

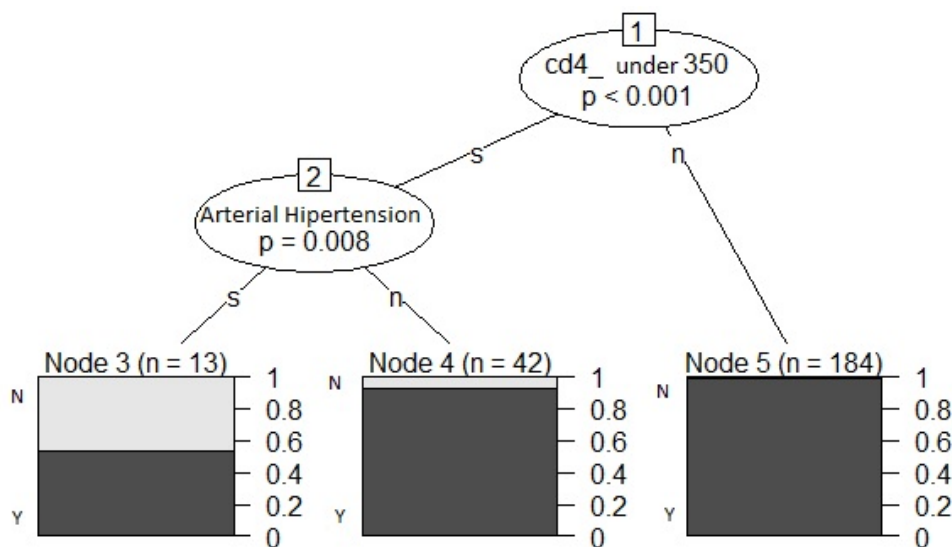
Coinfection	<i>p</i>	Correlation* (95%CI)	<i>p</i>	Moran Index
Toxoplasmosis	0.02	0.44(0.09-0.78)	0.48	-0.03
Hepatitis A	0.02	0.43(0.09- 0.77)	0.41	-0.01
Cytomegalovirus	0.16	0.27(-0.11-0.65)	0.65	-0.06
Tuberculosis	0.05	0.37(0.02-0.72)	0.29	0.02
Visceral leishmaniasis	0.20	0.25(-0.15-0.64)	0.38	-0.00

Note: *p* = *p*-value; CI = Confidence interval; \*Spearman correlation was used for non-parametric data, by Shapiro-Wilk test.

this fact, this research did not consider the control of blood pressure levels and adherence to SAH treatment in HIV patients. Prevalence studies for SAH in HIV patients are variable. Although some authors have found an association between SAH and a longer use of antiretrovirals drugs, other studies indicate the same risk factors as the general population<sup>15</sup>. Having SAH as a factor for unfavorable HIV outcomes suggests that individuals living with both diseases may have more difficulty in adhering to HIV treatments. Psychosocial illnesses as a factor associated to adherence to HIV treatments, observed in this study, can

also be associated to unhealthy lifestyles involved in the genesis of SAH. Some authors consider that patients who are not following therapy find it more difficult to have healthy lifestyle habits, like not smoking<sup>16</sup>.

The main reason not directly related to HIV/AIDS monitoring received at the studied health care service was other chronic disease control. This suggests that users are only using this health care service for medical follow-up. Considering that many patients are not from Diamantina and many chronic diseases need to be more often monitored, it is likely that these users are not being fully followed.



**Note:** N = Percentage of individuals without control, despite treatment; Y = Percentage of individuals controlled with treatment. Artwork created using R<sup>11</sup>.

**Figure 2.** Decision tree for HIV virological control considering health conditions, Vale do Jequitinhonha, from October to December 2020.

The PHC can reduce geographical barriers by acting closer to people’s homes, so the expansion of the PHC associated with public policies may contribute to low rates of HIV<sup>17</sup>. Although this study did not find a statistical significance between PHC attendance and HIV control outcomes, attending secondary health care services for PHC routines, such as for the renewal of an antihypertensive prescription, especially if this person is transported from another municipality, implies an unnecessary cost to the national health care system.

The evolution of antiretroviral treatments throughout the years brought different levels of complexity for HIV health care. In the past, patients were diagnosed in advanced stages of immunodeficiency, with few and complex therapeutic options, and had high morbidity and mortality rates. More recently, the management of stable HIV patients, using simplified treatment schemes, has been observed which are similar to other chronic disease patients. In an equity perspective, different health care levels require different intervention strategies<sup>18</sup>.

The PHC usually acts in promoting health, as well as in preventing and treating diseases, considering a person’s uniqueness and integrality. However, HIV health care is characterized by being almost restricted to specialized services. A significant part of these specialized services is operating at maximum capacity, meeting the demand without organized flows and acting in a non-collaborative network care<sup>3</sup>. People are not receiving the services they need to stay healthy. Actions must involve improving access to health services and reducing discrimination<sup>19</sup>.

A low CD4 T lymphocyte level as a health condition related to unfavorable HIV PCR control was expected, since AIDS is expected as the natural course of HIV. However,

visceral leishmaniasis proved to be the coinfection with the highest impact for individuals dealing with unfavorable HIV control. Secondary prophylaxis is recommended in the country for all patients with low immune response who have ever had visceral leishmaniasis<sup>1</sup>.

Higher municipal HDI as a factor that increases the number of treatment failures may suggest that unequal distribution of resources and services across different locations, such as healthcare, welfare, public services, household income and infrastructures, can have less impact in the prevalence of HIV coinfections than is usually expected. An individual’s behaviors, such as sexual and dietary habits and work conditions as a risk for coinfections, should be explored not only in the poorest socioeconomic groups. Treatment adherence can be improved in higher socioeconomic regions. Future studies in private health services can complement these results.

The municipal HDI also had a positive correlation with numbers of cases of toxoplasmosis and hepatitis A. However, these numbers may have been influenced by a deficient offer of serological tests in some locations. Hence, this result may be underestimated.

Despite the possibility of sexual transmission of toxoplasmosis, this is usually related to dietary habits and sanitary conditions. Rural areas may have more seropositive tests for *T. gondii*, which may be due to the higher likelihood of handling soil<sup>20</sup>. Living or working in rural areas is a known situation in the study area. Toxoplasmosis infections are opportunistic and may be reactivations in immunocompromised individuals<sup>1</sup>. Special attention should be dedicated to educational measures in higher HDI areas.



Available rapid tests are usually directed to Hepatitis B and C, although the hepatitis A test needs a laboratory environment. Men who have sex with men are at increased risk of acquiring hepatitis A through sexual transmission due to behaviors involving oral-anal contact<sup>21</sup>. Low testing for hepatitis A is common in specialized services. The hepatitis A vaccine is recommended for people living with HIV who have associated liver diseases and who have a negative hepatitis A antibody test<sup>1</sup>. Failure to carry this out may compromise the vaccine indication.

In addition to the spatial correlations involving the health conditions studied and individuals' origin HDI, attempts were made to correlate the same conditions and the Socioeconomic Index of the Geographical Context for Health Studies (GeoSES) in its 6 dimensions (education, poverty, wealth, income, segregation and deprivation of resources and services), but there were no significant results. There were still attempts to correlate it with the GINI index, and there were also no significant results for inequalities in income distribution on HIV outcomes.

The difficulty of offering complementary serological tests hinders coinfection monitoring and is another limitation in this study. More efforts for a timely diagnosis of HIV and co-infections must be made. The low number of treatment failures may have compromised the analyses. Despite this, though it is a low number, it may represent a devastating impact on individual and collective quality of life in the near future.

Considering the results of the decision tree model for HIV virological control contemplating health conditions, the CD4+ count associated with the presence of SAH may be a criterion for a more regular follow-up appointment protocol. Considering the protocol in force that suggests biannual follow-up consultations for this public<sup>1</sup>, reducing this interval could be reasonable if the CD4+ count is under 350 cels/mm<sup>3</sup> in hypertensive individuals. The involvement of the PHC in HIV treatment supervision interspersed with the HIV clinic is essential. Faced with a situation of scarcity of resources, common in public services, the CD4+ count could also be considered as a predictor that helps provide two pieces of information in a single exam: the virological status and the immunological status.

Individuals living with HIV and having SAH and AIDS are at greater risk of unfavorable treatment outcomes and should be monitored more intensely by a multidisciplinary team. No correlation was observed between the link with the PHC and virological treatment outcomes, however this multidisciplinary team must work in network with the PHC due the risk of these two conditions having the potential to make person-centered care a more complex process.

Psychosocial conditions and visceral leishmaniasis were significant in treatment outcomes in the initial bivariate analysis, but were not the conditions with the greatest

impact on virological outcomes in the multivariate analysis. The correlation between municipalities with higher HDI and higher rates of unfavorable virological outcomes highlights the need to monitor HIV patients regardless of socioeconomic conditions.

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## AUTHOR'S CONTRIBUTION

PRC. Görgens proposed the theme developed and the design of the study; carried out the bibliographical survey, the empirical research and the elaboration of the first draft of the manuscript; participated in the theoretical discussion, revision of the text and elaboration of the final version of the manuscript. DB. de Oliveira participated in the theoretical discussion, revision of the text and preparation of the final version of the manuscript. All authors discussed, read and approved the final version of the manuscript.

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