

# HTLV infection in inmates with active tuberculosis in Mato Grosso do Sul, Brazil

## Infecção pelo HTLV em privados de liberdade com tuberculose ativa em Mato Grosso do Sul, Brasil

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### ABSTRACT

Human T-cell lymphotropic virus (HTLV) is a retrovirus with a worldwide presence that may influence tuberculosis (TB) pathogenesis, particularly in populations where both infections are prevalent. This cross-sectional study aimed to estimate the prevalence of HTLV-1/2 infection among inmates with TB in Mato Grosso do Sul (MS) State, Central Brazil. Male individuals with bacteriologically confirmed active TB were recruited from two major closed male penal institutions in MS State: Instituto Penal de Campo Grande (IPCG) and Estabelecimento Penal Jair Ferreira de Carvalho (EPJFC). Serum samples were screened for anti-HTLV-1/2 antibodies using enzyme-linked immunosorbent assay (ELISA), and positive samples were confirmed by HTLV-1/2 Western Blot (WB) assay. A total of 279 inmates participated in the study. Two participants (0.72%; 95% CI 0.18 – 2.84) initially tested positive for anti-HTLV by ELISA. One patient was confirmed to have HTLV-1 infection by WB, along with active syphilis, while the other showed an indeterminate WB result and tested positive for anti-HIV and anti-HCV. Although the overall HTLV prevalence in the sample was relatively low, this study underscores the potential for HTLV and TB co-infection in high-risk populations such as inmates.

**Keywords.** HTLV-1, Tuberculosis, Prevalence, Prisoners.

### RESUMO

O Vírus Linfotrófico de Células T Humana (HTLV) é um retrovírus que apresenta distribuição mundial com potencial para impactar a patogênese da tuberculose (TB), especialmente em populações com alta prevalência de ambas as infecções. Este estudo transversal objetivou descrever a prevalência da infecção por HTLV-1/2 entre Pessoas Privadas de Liberdade (PPL) com TB ativa no estado de Mato Grosso do Sul (MS), Centro-Oeste do Brasil. Foram incluídos indivíduos do sexo masculino com confirmação bacteriológica (TB ativa) de duas instituições penais fechadas, Instituto Penal de Campo Grande (IPCG) e Estabelecimento Penal Jair Ferreira de Carvalho (EPJFC), de Campo Grande, MS. Amostras de soro foram triadas para anticorpos anti-HTLV-1/2 por ensaio imunoenzimático (ELISA) e os resultados reagentes foram submetidos à confirmação por Western Blot (WB). O estudo envolveu 279 indivíduos. Dois (0,72%; IC 95% 0,18-2,84) apresentaram resultado positivo na triagem para anti-HTLV por ELISA. Um caso foi confirmado para HTLV-1, com coinfeção por sífilis ativa, enquanto o outro teve resultado indeterminado por WB e sorologia positiva para anti-HIV e anti-HCV. Embora a prevalência para a infecção pelo HTLV tenha sido relativamente baixa, o estudo destaca o potencial de coinfeção por HTLV e tuberculose em populações de alto risco, como em PPL.

**Palavras-chave.** HTLV-1, Tuberculose, Prevalência, Pessoas Privadas de Liberdade.

## INTRODUCTION

Human T-lymphotropic viruses 1 and 2 (HTLV-1/2) are retroviruses with tropism for T lymphocytes. HTLV-1 has been implicated in adult T-cell leukemia (ATL), HTLV-1-associated myelopathy (HAM), and various inflammatory diseases. This virus is globally distributed and is considered endemic in sub-Saharan Africa, South America, South Japan, the Caribbean islands, and Melanesia<sup>1-3</sup>. In contrast, HTLV-2 does not exhibit a cosmopolitan distribution and is more prevalent among indigenous populations and individuals who use injecting drugs<sup>4</sup>. In Central Brazil, HTLV-1/2 infection has been documented in communities such as Quilombos, individuals living with HIV (PLHIV), and those with *Mycobacterium tuberculosis* (Mtb) infection<sup>5-7</sup>.

Tuberculosis (TB) is a public health concern and a principal cause of morbidity worldwide. Infection is caused by Mtb when aerosol droplets containing the bacillus settle in the lung, which is the leading site of infection<sup>8</sup>. HTLV-1 infection may induce immunological compromise, potentially leading to various co-infections, such as tuberculosis and strongyloidiasis, which can affect the natural course of both infections. Additionally, this virus may cause several clinical manifestations, including dermatitis and rheumatoid arthritis<sup>9,10</sup>. In areas where both Mtb and HTLV-1 are endemic, there is a significant relationship between their co-infection and a higher incidence of tuberculosis in people living with HTLV-1<sup>11-13</sup>.

Furthermore, incarcerated populations are at high risk of sexually transmitted infections (STIs) and tuberculosis disease<sup>14</sup>. In Mato Grosso do Sul (MS) state, HTLV-1 infection and tuberculosis (incidence and prevalence) have already been described in inmates<sup>15,16</sup>. However, the prevalence of HTLV and active Mtb co-infections among prisoners has not been widely investigated.

Therefore, this study aimed to assess the prevalence of HTLV-1/2 infection and identify the main types of HTLV among this population vulnerable to tuberculosis.

## MATERIAL AND METHODS

### Study population

This cross-sectional study was conducted among inmates from two closed penal institutions, Instituto Penal de Campo Grande (IPCG) and Estabelecimento Penal Jair Ferreira de Carvalho (EPJFC), in Campo Grande, the capital of the state of Mato Grosso do Sul, Central Brazil. The study was conducted between March 2014 and March 2017. Male individuals diagnosed with active tuberculosis, defined as bacteriologically confirmed TB by at least one positive smear microscopy or solid culture for Mtb<sup>17</sup>. Participants were interviewed about their socioeconomic and behavioral characteristics, and blood samples were collected and stored at -20 °C until serological analysis<sup>17</sup>.

### Serological tests

The stored serum samples were screened using a commercial enzyme-linked immunosorbent assay (ELISA) kit for the presence of anti-HTLV-1/2 antibodies (GOLD ELISA HTLV-I/II – REM) following the manufacturer's instructions. Positive samples were repeatedly tested and confirmed by HTLV-1/2 Western Blot (WB) assay (MP Diagnostics HTLV BLOT 2.4, Singapore). HTLV infection was defined as repeated

positive ELISA and WB results. The selected samples were also tested by electrochemiluminescence (ECL) for HIV (anti-HIV-1/2), HCV (anti-HCV), HBV (HBsAg, total anti-HBc, and anti-HBs), and ELISA for syphilis infection (anti-*T. pallidum*) as described by Puga et al<sup>17</sup>. ELISA-reactive samples for anti-*T. pallidum* were serially diluted to quantify Venereal Disease Research Laboratory (VDRL) titers. All the samples which tested positive for anti-HCV and anti-HIV antibodies were confirmed for HCV RNA detection using the qPCR assay (Abbott RealTime HCV), and for HIV infection using the Western blot assay (Immunoblot, Bio-Rad).

## Data analysis

The variables were analyzed using the Stata software (version 13.0; Stata Corporation, College Station, TX, USA). Categorical variables were presented as absolute and percentage frequencies, and continuous variables were expressed as means and medians.

## Ethics Statement

This study was approved by the Ethical Committee on Human Research of the Universidade Federal de Mato Grosso do Sul (protocol number CAAE: 67923923.7.0000.0021). At the time of sampling, all participants gave their written informed consent to participate in the study, which was performed according to relevant guidelines and regulations.

## Data availability statement

All relevant and original data presented in the study are included in this article.

## RESULTS

A total of 279 participants were enrolled in the study, comprising 204 (73.12%) individuals from the EPJFC and 75 (26.88%) from the IPCG, the two largest prison institutions in MS. All participants were men, aged 19-71 years, with a median age of 29. Most participants (n = 178) were from Mato Grosso do Sul. 211 (75.63%) participants had completed five or more years of education. Regarding ethnicity, most individuals identified themselves as multiracial (53.96%). 59.86% of participants reported not having a steady partner during the study ([Table 1](#)).

Two individuals (PTB-05 and PTB-263) tested positive for anti-HTLV antibodies by ELISA (0.72%; 95% CI 0.18 – 2.84). PTB-263 was confirmed as HTLV-1 positive by Western blot and reported a history of syphilis. PTB-05 tests exhibited an indeterminate result by Western Blot, displaying bands p24 and GD21. Performing a polymerase chain reaction (PCR) test was impossible due to the unavailability of whole blood and access to the participant to perform a new blood collection. Additionally, PTB-05 tested positive for anti-HIV-1 and anti-HCV antibodies and reported a history of blood transfusion before 1993. PTB-05 was from the IPCG, and PTB-263 was from EPJFC institutions. Both are related to being single, heterosexual, and irregular condom use. Participant PTB-05 discontinued both HIV and TB treatments and subsequently died ([Table 2](#)). The drugs used to treat both infections are free of charge in the Brazilian Public Health System.

**Table 1.** Characteristics of 279 inmates with active TB in the cross-sectional study

Variable	N (Absolute number)	Percentage (%)
<b>Ethnicity</b>		
White	73	26.26%
Black	51	18.35%
Asian	4	1.44%
Mixed race	150	53.96%
<b>Marital Status</b>		
Steady partner	112	40.14%
Without steady partner	167	59.86%
<b>Sexual orientation</b>		
Homosexual	8	2.87%
Heterosexual	267	95.70%
Bisexual	4	1.43%
<b>Education (years)</b>		
≤ Four years	69	24.73%
≥ Five years	210	75.27%
<b>Condom use</b>		
Always	53	19.00%
Sometimes	155	55.56%
Never	71	25.45%
<b>Share needle</b>		
No	266	95.34%
Yes	13	4.66%
<b>Share sharp objects</b>		
No	51	18.28%
Yes	228	81.72%
<b>History of crack use</b>		
No	247	88.53%
Yes	32	11.47%
<b>History of cocaine use</b>		
No	115	41.22%
Yes	164	58.78%
<b>History of marihuana use</b>		
No	54	19.35%
Yes	225	80.65%

*Continues on next page*

Variable	N (Absolute number)	Percentage (%)
<b>History of heroin use</b>		
No	276	98.92%
Yes	3	1.08%
<b>History of STIs</b>		
No	216	77.42%
Yes	63	22.58%
<b>History of blood transfusion</b>		
No	237	84.95%
Yes	42	15.05%
<b>Year of blood transfusion</b>		
After 1993	35	88.33%
Before 1993	7	16.66%
<b>Type of tattoo</b>		
Unprofessional tattoo	176	79.64%
Professional tattoo	45	20.36%
<b>Sex worker</b>		
No	269	96.42%
Yes	10	3.58%
<b>Anti-HCV</b>		
Negative	260	93.19%
Positive	14	5.02%
<b>Anti-HIV</b>		
Negative	260	93.19%
Positive	19	6.81%
<b>HBsAg</b>		
Negative	275	98.57%
Positive	4	1.43%
<b>Anti-<i>T. pallidum</i></b>		
Negative	251	89.96%
Positive	28	10.04%

**Table 2.** Descriptive characteristics of both inmates coinfecting with TB/HTLV of the 279 participants with active TB of the cross-sectional study

Characteristics	PTB-05	PTB-263
Serological HTLV status	Indeterminate	HTLV-1
Age (years)	42	49
Marital status	Single	Single
Gender	Male	Male
Ethnicity	Multiracial	White
Education level	Elementary school	High school
Prison	IPCG	EPJFC
IDU history	No	No
Tattoo	Home tattooing	No
Blood transfusion before 1993	Yes	No
Condom use	Irregular	Irregular
Sexual preference	Heterosexual	Heterosexual
Previous incarceration	Yes	No
Time in prison (months)	192	12
STI history	Yes (HPV)	No
Anti-HIV positive	Yes	No
Anti-HCV positive	Yes	No
HBsAg positive	No	No
Anti-HBs positive	No	No
Active syphilis	No	Yes
TB treatment	Abandonment treatment	Under treatment

IPCG: Instituto Penal de Campo Grande; EPJFC: Estabelecimento Penal Jair Ferreira de Carvalho; IDU: injection drug use; STI: sexually transmitted infection

## DISCUSSION

To our knowledge, this is the first study to investigate the prevalence of HTLV infection among inmates with active TB. Furthermore, the progression from latent tuberculosis infection (LTBI) to active tuberculosis is more commonly observed in individuals with pre-existing conditions, such as cancer, diabetes, immunodeficiency, organ transplantation, and viral infections, including HIV and HTLV-1<sup>8</sup>.

The prevalence of HTLV-1 infection was 0.72% (95% CI 0.18 – 2.84), which is considered a low to medium prevalence<sup>18</sup>. This result is expected since active TB could be viewed as a predictable disease among people living with HTLV-1 (PLwHTLV-1)<sup>8</sup> due to the significant relationship between these co-infections in countries like Brazil, which has a high burden of these pathogens. TB disease may present a chance almost three times greater in people living with HTLV-1 than among individuals without HTLV-1

infection<sup>11</sup>. We could not provide additional insights regarding the prevalence uncovered since no existing literature has assessed this coinfection in this particular population group.

The PTB-05 case underscores the critical importance of adherence to treatment regimens for patients co-infected with TB and HIV. Nonadherence can lead to poor treatment outcomes, including increased mortality<sup>19,20</sup>. The death of PTB-05 after abandoning HIV treatment is a stark reminder of the complexities and necessity of maintaining strict adherence to TB and HIV treatment protocols. Ensuring patients understand the importance of adherence and managing potential complications of combined treatment is essential for improving patient outcomes. Co-infections present significant clinical challenges, as treating one infection can interfere with the treatment of another. The participant reported a history of blood transfusion before 1993, when screening for HTLV-1/2 infection in Brazilian blood banks had not been mandatory yet<sup>21</sup>. Additionally, prisoners frequently exhibit low adherence to treatment regimens, leading to virologic failure<sup>22</sup>.

Participant PTB-05's initial screening test yielded a positive result, yet subsequent WB analysis produced an indeterminate result. WB could show up to 67% of the results as indeterminate; these results are common mainly in individuals co-infected with HIV/HTLV<sup>23-25</sup>. Indeterminate WB results may occur and could necessitate further testing with highly sensitive methods such as PCR to detect the presence of viral genomic material<sup>26</sup>. However, the inability to perform polymerase chain reaction (PCR) testing due to the unavailability of whole blood precluded definitive confirmation of the participant's status.

PTB-263's recurring incarceration indicates a pattern of behavior that makes it challenging to monitor the treatment of these individuals within the correctional system. The instability associated with re-entry and the potential for recidivism can disrupt the continuity of care, which is crucial for effective infection management<sup>27</sup>. Furthermore, incomplete adherence to prescribed antituberculosis therapy, often seen in correctional settings, is a known risk factor for multidrug-resistant TB, increasing the complexity of treatment in such populations<sup>28</sup>.

Some limitations must be considered. Some risky behaviors could have been under-reported during the interviews due to a potential apprehension of stigma, leading to a possible underestimation of the risks among the studied group. Although only two prisons were included in this study – and may not fully represent the current epidemiological panorama of HTLV and TB co-infection in the broader prison population – they are the two largest male prisons in the MS state. Furthermore, the absence of a whole blood sample from PTB-05 with an indeterminate serological status for HTLV made it impossible to confirm the diagnosis of HTLV infection by molecular analyses.

## CONCLUSION

Although the prevalence of HTLV infection identified in this study was relatively low, the presence of positive cases in this context, particularly among individuals with other STIs, highlights the ongoing necessity for healthcare programs that emphasize diagnosis and prevention. Despite the acknowledged impact of HTLV and tuberculosis (TB) in high-risk populations, there exists a substantial gap in the literature concerning their co-infection among incarcerated individuals. This paucity of data accentuates the significance of our findings and highlights the critical need to advance our understanding of HTLV-TB co-infection within this vulnerable group.

## CONFLICT OF INTEREST

The authors declare that there are no conflicting interests.

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## AUTHOR'S CONTRIBUTIONS

Conceptualization: Marco Antonio Moreira Puga, Ana Rita Coimbra Motta-Castro. Methodology: Larissa Melo Bandeira, Marco Antonio Moreira Puga, Maurício Antonio Pompílio. Analyzed the data: Carolina Amianti. Contributed reagents/materials/analysis tools: Ana Rita Coimbra Motta-Castro. Writing – original draft preparation, review, and editing: Larissa Melo Bandeira, Carolina Amianti, Marco Antonio Moreira Puga. Supervision: Ana Rita Coimbra Motta-Castro. All authors have read and agreed to the published version of the manuscript.

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## REFERENCES

1. Paiva A, Casseb J. Origin and prevalence of human T-lymphotropic virus type 1 (HTLV-1) and type 2 (HTLV-2) among indigenous populations in the Americas. *Rev Inst Med Trop Sao Paulo*. 2015;57(1):1-13. <https://doi.org/10.1590/S0036-46652015000100001>
2. Bangham CRM, Araujo A, Yamano Y, Taylor GP. HTLV-1-associated myelopathy/tropical spastic paraparesis. *Nat Rev Dis Primers*. 2015;1:15012. <https://doi.org/10.1038/nrdp.2015.12>
3. Hermine O, Ramos JC, Tobinai K. A review of new findings in adult T-cell leukemia-lymphoma: a focus on current and emerging treatment strategies. *Adv Ther*. 2018;35(2):135-52. <https://doi.org/10.1007/s12325-018-0658-4>
4. Martinez MP, Al-Saleem J, Green PL. Comparative virology of HTLV-1 and HTLV-2. *Retrovirology*. 2019;16(1):21. <https://doi.org/10.1186/s12977-019-0483-0>
5. Nascimento LB, Carneiro MAS, Teles SA, Lopes CLR, Reis NRS, Silva AMC et al. Prevalência da infecção pelo HTLV-1, em remanescentes de quilombos no Brasil Central. *Rev Soc Bras Med Trop*. 2009;42(6):657-60. <https://doi.org/10.1590/s0037-86822009000600009>

6. Kozłowski AG, Carneiro MAS, Matos MAD, Teles SA, Araújo JA, Otsuki K et al. Prevalence and genetic characterisation of HTLV-1 and 2 dual infections in patients with pulmonary tuberculosis in Central-West Brazil. *Mem Inst Oswaldo Cruz*. 2014;109(1):118-21.  
<https://doi.org/10.1590/0074-0276130230>
7. Kozłowski AG, Matos MAD, Carneiro MAS, Lopes CLR, Teles SA, Vicente CP et al. Seroprevalence of HTLV in a population of HIV1-infected patients in Midwestern Brazil. *Rev Inst Med Trop São Paulo*. 2016;58:80.  
<https://doi.org/10.1590/S1678-9946201658080>
8. Keikha M, Karbalaee M. Overview on coinfection of HTLV-1 and tuberculosis: mini-review. *J Clin Tuberc Other Mycobact Dis*. 2021;23:100224.  
<https://doi.org/10.1016/j.jctube.2021.100224>
9. Rosadas C, Taylor GP. HTLV-1 and co-infections. *Front Med*. 2022;9:812016.  
<https://doi.org/10.3389/fmed.2022.812016>
10. Schierhout G, McGregor S, Gessain A, Einsiedel L, Martinello M, Kaldor J. Association between HTLV-1 infection and adverse health outcomes: a systematic review and meta-analysis of epidemiological studies. *Lancet Infect Dis*. 2020;20(1):133-43.  
[https://doi.org/10.1016/S1473-3099\(19\)30402-5](https://doi.org/10.1016/S1473-3099(19)30402-5)
11. Grassi MFR, Santos NP, Lírio M, Kritski AL, Almeida MCC, Santana LP et al. Tuberculosis incidence in a cohort of individuals infected with human T-lymphotropic virus type 1 (HTLV-1) in Salvador, Brazil. *BMC Infect Dis*. 2016;16:491.  
<https://doi.org/10.1186/s12879-016-1428-z>
12. Pedral-Sampaio DB, Martins Netto E, Pedrosa C, Brites C, Duarte M, Harrington W Jr. Co-infection of tuberculosis and HIV/HTLV retroviruses: frequency and prognosis among patients admitted in a Brazilian hospital. *Braz J Infect Dis*. 1997;1(1):31-5. PMID:11107236. Available from:  
<https://pubmed.ncbi.nlm.nih.gov/11107236/>
13. Bastos ML, Santos SB, Souza A, Finkmoore B, Bispo O, Barreto T et al. Influence of HTLV-1 on the clinical, microbiologic and immunologic presentation of tuberculosis. *BMC Infect Dis*. 2012;12:199.  
<https://doi.org/10.1186/1471-2334-12-199>
14. Cords O, Martinez L, Warren JL, O'Marr JM, Walter KS, Cohen T et al. Incidence and prevalence of tuberculosis in incarcerated populations: a systematic review and meta-analysis. *Lancet Public Health*. 2021;6(5):e300-e308.  
[https://doi.org/10.1016/S2468-2667\(21\)00025-6](https://doi.org/10.1016/S2468-2667(21)00025-6)

15. Bandeira LM, Puga MAM, Croda J, Pompílio MA, Amianti C, Rezende GR et al. Human T-lymphotropic virus-1/2 infection in Central Brazil prisons: a multicenter study. *Front Microbiol*. 2022;12:740245. <https://doi.org/10.3389/fmicb.2021.740245>
16. Carbone ASS, Paião DSG, Sgarbi RVE, Lemos EF, Cazanti RF, Ota MM et al. Active and latent tuberculosis in Brazilian correctional facilities: a cross-sectional study. *BMC Infect Dis*. 2015;15:24. <https://doi.org/10.1186/s12879-015-0764-8>
17. Puga MAM, Bandeira LM, Pompilio MA, Rezende GR, Soares LS, Castro VOL et al. Screening for HBV, HCV, HIV and syphilis infections among bacteriologically confirmed tuberculosis prisoners: an urgent action required. *PLoS One*. 2019;14(8):e0221265. <https://doi.org/10.1371/journal.pone.0221265>
18. Gonçalves DU, Proietti FA, Ribas JGR, Araújo MG, Pinheiro SR, Guedes AC et al. Epidemiology, treatment, and prevention of human T-cell leukemia virus type 1-associated diseases. *Clin Microbiol Rev*. 2010;23(3):577-89. <https://doi.org/10.1128/CMR.00063-09>
19. Tshitenge S, Ogunbanjo GA, Citeya A. A mortality review of tuberculosis and HIV co-infected patients in Mahalapye, Botswana: does cotrimoxazole preventive therapy and/or antiretroviral therapy protect against death? *Afr J Prim Health Care Fam Med*. 2018;10(1):e1-e5. <https://doi.org/10.4102/phcfm.v10i1.1765>
20. Yusmaniar Y, Kurniawan AH. Medication adherence to successful tuberculosis treatment outcome among TB/HIV patient at Prof. Dr. Sulianti Saroso Infectious Disease Hospital. *PCPR*. 2020;5(3):98. <https://doi.org/10.15416/pcpr.v5i3.29166>
21. Ministério da Saúde (BR). Portaria nº 1376, de 19 de novembro de 1993. Aprova alterações na Portaria nº 721/GM, de 09.08.89, que aprova Normas Técnicas para coleta, processamento e transfusão de sangue, componentes e derivados, e dá outras providências. *Diário Oficial da União*, Brasília, DF, 02 dez 1993. Seção 1:18405.
22. Tanaka TSO, Cesar GA, Rezende GR, Puga MAM, Weis-Torres SMS, Bandeira LM et al. Molecular epidemiology of HIV-1 among prisoners in Central Brazil and evidence of transmission clusters. *Viruses*. 2022 Jul 28;14(8):1660. <https://doi.org/10.3390/v14081660>
23. Garin B, Gosselin S, Thé G, Gessain A. HTLV-I/II infection in a high viral endemic area of Zaire, Central Africa: comparative evaluation of serology, PCR, and significance of indeterminate western blot pattern. *J Med Virol*. 1994;44(1):104-9. <https://doi.org/10.1002/jmv.1890440119>

24. Jacob F, Santos-Fortuna E, Azevedo RS, Caterino-de-Araujo A. Serological patterns and temporal trends of HTLV-1/2 infection in high-risk populations attending Public Health Units in São Paulo, Brazil. *J Clin Virol*. 2008;42(2):149-55.  
<https://doi.org/10.1016/j.jcv.2008.01.017>
25. Campos KR, Santos FLN, Brito VS, Gonçalves NLS, Araujo THA, Galvão-Castro B et al. Line immunoassay for confirmation and discrimination of human T-cell lymphotropic virus infections in inconclusive Western blot serum samples from Brazil. *J Clin Microbiol*. 2019;58(1):e01384-19.  
<https://doi.org/10.1128/JCM.01384-19>
26. Caterino-de-Araujo A, Barbosa-Stancioli EF, Alonso Neto JB, Aragón MG, Galvão-Castro B, Ishak R et al. Laboratory diagnosis of human T-lymphotropic virus in Brazil: assays, flowcharts, challenges, and perspectives. *Rev Soc Bras Med Trop*. 2021;54:e01752021.  
<https://doi.org/10.1590/0037-8682-0175-2021>
27. Tharshini NK, Ibrahim F, Mohamad MS, Zakaria E. Challenges in re-entry among former inmates: a review. *IJ-ARBSS*. 2018;8(4).  
<https://doi.org/10.6007/ijarbss/v8-i4/4126>
28. Curry International Tuberculosis Center, California Department of Public Health. Drug-resistant tuberculosis: a survival guide for clinicians. 3rd ed. San Francisco: Curry International Tuberculosis Center, University of California; 2016. [accessed 2025 Mar 21]. Available from:  
<https://npin.cdc.gov/publication/drug-resistant-tuberculosis-survival-guide-clinicians-3rd-edition>