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Helminth-HIV Co-infection in the Osh Region, Kyrgyzstan: A prospective cohort Study on Public Health Challenges and Intervention Strategies

Satybaldyev Mederbek Myrzaevich[1], Kutmanova Ainura Z. [2], Timur Dautov[3]

[1]Affiliation: Head of the Infectious Diseases department of Osh City Clinical Hospital, International medical faculty, Department of Public health, Osh state university, Osh City, Kyrgyzstan

[2]Affiliation: Head of Infectious Diseases Department, International Higher School of Medicine (IHSM), Bishkek, Kyrgyzstan

[3]Affiliation: International medical faculty, Department of Public health, Osh state university, Osh City, Kyrgyzstan

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ABSTRACT

Background: HIV related immune suppression is a growing public health issue especially if it has implications on immune function. HIV induced immunosuppression makes people more vulnerable to other opportunistic infections such as helminthiasis. In the areas with high prevalence of parasitic diseases for example the south of Kyrgyzstan co-infection with helminths can worsen immune dysfunction and may rapiden the progression of HIV disease. There is increasing evidence of a link between HIV-helminth co-infection and lower CD4+ cell counts, therefore it is crucial to explore the clinical implications of this relationship in detail.

Objective: To examine the clinical symptoms of helminthiasis in persons living with HIV (PLHIV) and its effect on CD4+ cell counts to guide the formulation of evidence-based treatment and intervention strategies.

Methods: A prospective cohort study was conducted between 2018 and 2024, 157 PLHIV with gastrointestinal symptoms including chronic or intermittent abdominal discomfort, diarrhea of unclear etiology, unexplained weight loss, and dyspeptic manifestations were enrolled. Parasitological diagnosis was done by fecal analysis, Kato-Katz technique was used to quantitate helminth eggs and light microscopy for oocysts, cysts, eggs and larvae of intestinal parasites. Statistical analyses were done using R-Studio, with descriptive statistics, hypothesis testing (χ^2 test, Fisher's exact test, and t-test), and regression modeling to analyze the relationship between helminthiasis and CD4+ cell depletion.

Results: The aim of this study was to offer a comprehensive investigation of the prevalence and severity of helminthiasis among PLHIV, the relationship between immune suppression and helminthiasis, and the potential role of helminthiasis in disease progression. These findings will help in identifying the need for routine anthelmintic treatment, as advised by the WHO in the endemic areas.

Conclusion: It is crucial to have a better understanding of the interaction between HIV and helminth co-infections in order to improve diagnostic protocols and therapeutic interventions. The findings from this study will provide a quantitative and qualitative basis for the development of specific deworming guidelines and public health measures that can lead to better clinical outcomes for people living with HIV in Kyrgyz Republic

Keywords: *HIV-helminth co-infection, Immunosuppression, Parasitic infections in PLHIV, Public health intervention, Kyrgyzstan*

1. INTRODUCTION

The proliferation of HIV infection presents significant worldwide challenges. HIV infection compromises the immune system, resulting in a debilitated body and heightened susceptibility to several illnesses, including parasite infestations [1]. In recent years, there has been a rise in individuals with prolonged HIV infection and advanced disease stages, with changed subtypes, which facilitates the emergence of secondary infections. Parasitic infestations are more pertinent owing to their extensive prevalence and the many adverse consequences on the body [2]. Helminthiasis may manifest with diverse symptoms contingent upon the stage of HIV infection. Helminthiasis-induced immunosuppression results in a transient

condition of immunodeficiency. Unregulated proliferation of parasites transpires in individuals with immunosuppression, such as those infected with HIV. The chronic and enduring immunodeficiency associated with HIV infection renders the body susceptible to parasitic and pathogenic agents [3].

During the first phases of HIV infection, symptoms may be subtle; however, in the advanced stages, when the immune system is considerably compromised, the clinical manifestations may become more severe and varied. The symptoms of helminthiasis in individuals infected with HIV are more apparent and severe compared to those without HIV infection. As a hyperendemic zone, the southern part of Kyrgyzstan has a high prevalence of parasitic diseases and therefore screening and ongoing monitoring of people living with HIV (PLHIV) is important for the early diagnosis and treatment of helminthiasis. It is important to study helminthiasis clinical and laboratory symptoms at various phases of HIV infection for enhancing the diagnostic methods, optimizing treatment regimens and enhancing preventive measures for the susceptible groups [4].

In the endemic areas the World Health Organization (WHO) recommend periodic mass deworming every 6–12 months for at risk populations irrespective of individual diagnostic confirmation. There is emerging evidence that HIV helminth co infection may lead to further decline in CD4+ cell counts and thus to exacerbate immunosuppression and possibly influence disease progression. However, the specific implications of this interaction within the Kyrgyz context have not been fully investigated. This study was conducted to fill this gap by determining the effects of HIV helminth co infection on clinical outcomes and to determine the possible need for routine deworming interventions given the epidemiological landscape of Kyrgyzstan [5].

This study aims to determine how helminthiasis in HIV-positive people (PLHIV) affects CD4+ cell counts and its course and symptoms. This study examines the relationship between parasite infestations and immunological suppression during HIV infection to better understand how helminth co-infections affect disease progression and health. Furthermore, particularly in hyperendemic regions like southern Kyrgyzstan, this study seeks to evaluate the necessity of consistent deworming treatments and other preventive actions. The outcomes will support the development of evidence-based public health, therapeutic, and diagnostic strategies fit for the national epidemiological context. Our work finally aims to help legislators and healthcare professionals in maximizing treatment processes for PLHIV thus improving clinical outcomes and reducing the burden of co-infections in vulnerable populations.

2. RESEARCH METHODS

2.1 Study Design and Population:

A prospective cohort study was conducted from 2018 to 2024, involving 157 individuals living with HIV (PLHIV) who presented with gastrointestinal symptoms. Patients were recruited based on clinical indications, including chronic or recurrent abdominal pain, episodes of diarrhea of unclear etiology, unexplained weight loss, flatulence, and dyspeptic symptoms.

2.2 Laboratory Testing Methods:

To diagnose parasitic infections, a comprehensive parasitological examination of fecal samples was performed using the following techniques:

1.2.1 Kato-Katz Method: A quantitative approach for detecting helminth eggs, particularly useful for diagnosing intestinal parasites such as trematodes and nematodes.

1.2.2 Light Microscopy: Examination of native and stained preparations to identify oocysts, cysts, eggs, and larvae of parasitic organisms.

2.3 Statistical Analysis:

All statistical analyses were conducted using R Studio software. Descriptive statistics, including mean values, medians, and percentage distributions, were utilized to summarize the data. Hypothesis testing was performed using statistical tests such as the chi-square test (χ^2), Fisher's exact test, and t-tests. Additionally, regression analysis methods were employed to assess the relationship between parasitic infections and clinical manifestations in PLHIV.

2.4 Ethical consideration:

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki [6]. Due to the prospective nature of the study, informed consent was waived by the institutional ethics committees. All patient information was anonymized during data collection and analysis to prevent any identification of individuals. Informed consent was waived due to the retrospective nature of the study.

3. RESULTS

3.1 Demographic characteristics of PLHIV

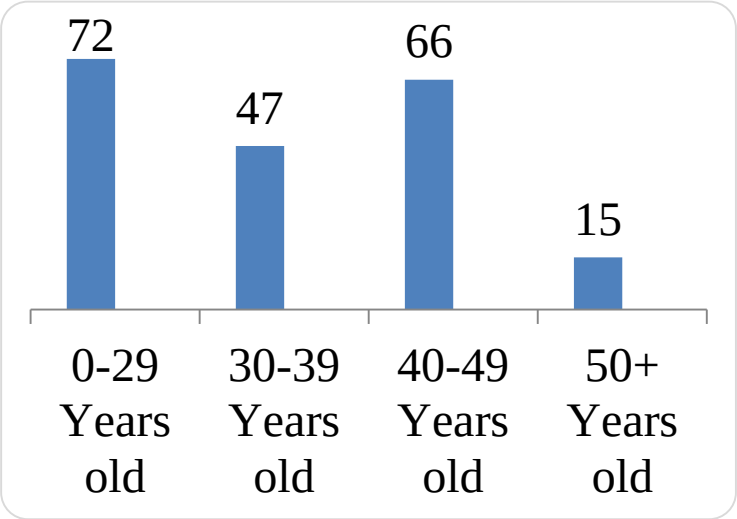

Figure 1. Age distribution of PLHIV at the time of the survey (n=157), represented as a percentage.

Stratified by helminthiasis, this table shows the distribution of HIV infected people across many age groups. In all, 157 patients were reviewed (N=157), 77 with helminthiasis and 80 without parasitic diseases. The greatest frequency of helminthiasis was seen among the patients 0–29 years of age; 56% of patients in this age group were positive for helminthiasis, while only 16% of those without helminthiasis were positive. This difference may be due to higher exposure risks in the younger populations, which may be a function of behavioral patterns, hygiene practices and environmental factors.

In contrast, the prevalence of helminthiasis declined in patients aged 30 years and older. This trend may indicate a reduced risk of parasitic infections with increasing age, possibly due to greater awareness of preventive measures, improved personal hygiene, or lifestyle modifications. Statistical analysis confirmed that age and the chance of parasite infection in PLHIV had a pretty strong connection ($p<0.001$), i.e., the variances in helminthiasis frequency among age groups were quite significant. These findings underline the importance of age as the key factor influencing helminthiasis susceptibility in HIV-infected individuals as younger patients have substantially higher risk.

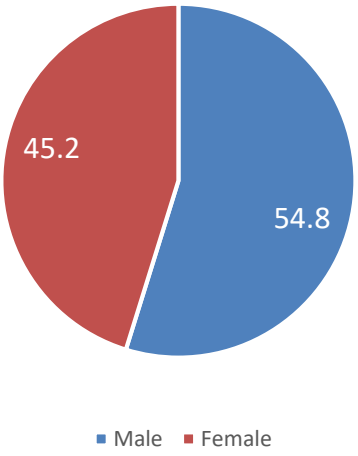

Figure 2: Gender distribution of people living with HIV (PLHIV) (n=157) and prevalence of parasitosis. Parasitosis was detected in 54.8% of male PLHIV cases, indicating a higher burden of infection in this subgroup.

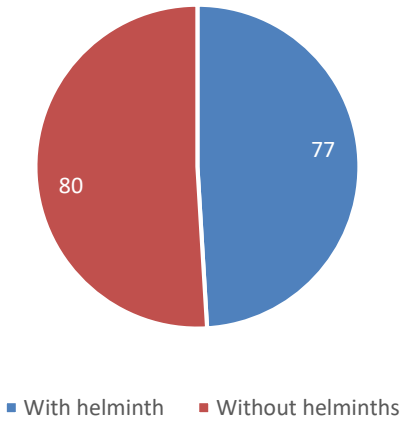

Figure 3: Parasitological study results among PLHIV (n=157), showing the prevalence and distribution of parasitic infections in the study population (%).

3.2 Prevalence and Parasitological Findings in Persons Living with HIV: A Comprehensive Analysis of Parasitic Infections

A detailed parasitological research conducted among 157 persons living with HIV (PLHIV) identified parasitic diseases in 77 people, accounting for 49% of the total sample. The results highlight an important burden of parasitosis within this community, underlining the influence of immunosuppression on susceptibility to parasitic diseases. A broad spectrum of parasitic pathogens, including both helminths and protozoal diseases, were found among afflicted people. Diverse environmental exposures, immunological states, and potential geographical endemicity of parasitic diseases influenced the distribution and prevalence of specific parasite species among confirmed patients. The fact that over half of the investigated cohort had parasitosis highlights the need of consistent screening and focused treatment plans for PLHIV, especially in areas where parasitic infestations are somewhat common. The entire breakdown of the detected parasite species and their distribution among individuals with parasitic disorders are followed:

3.2.1 Ascaris lumbricoides – 37 (48,1%)

3.2.2 Giardia intestinalis – 28 (36,4%)

3.2.3 Lumbricoides + Enterobius vermicularis – 12 (15,5%)

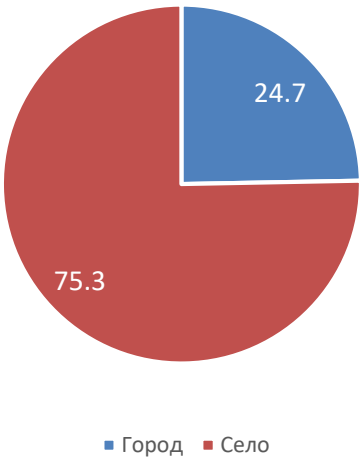

Figure 4: Distribution of PLHIV with parasitosis by place of residence (n=77, %). The prevalence of parasitosis among people living with HIV (PLHIV) is significantly higher in rural areas, accounting for 75.3% of cases, highlighting potential environmental and socio-economic risk factors.

Table1: Distribution of Clinical Symptoms Among All Examined PLHIV, PLHIV with Parasitic Infections, and PLHIV Without Parasitic Infections, with Corresponding p-values

Clinical symptoms	All examined PLHIV *n = 157 (%)*	PLHIV with parasitosis *n = 77 (%)*	PLHIV without parasitosis *n = 80 (%)*	p-value2
Fever	85 (54)	57 (74)	28 (35)	<0.001
Diarrhea	74 (34)	52 (68)	22 (28)	0.004
Cough	137 (87)	73 (95)	64 (80)	0.005
Dry mouth	102 (64,9)	75 (97)	27 (34)	>0.9
Abdominal pain	98 (62.4)	77 (100)	21 (26)	0.003
Headaches	147 (94)	67 (87)	80 (100)	<0.001
Vertigo	116 (74)	45 (58)	71 (89)	<0.001
Nausea	88 (56)	70 (90)	18(22)	0.10
Poor appetite	81(52)	73(94)	8 (10)	0.003
Vomiting	93 (72)	75 (97)	18 (23)	<0.001
Dryness	148 (94)	70 (91)	78 (98)	0.094
Arthralgia	113 (72)	55 (71)	58 (73)	0.9

3.3 Clinical symptoms of PLHIV with parasitosis and Correlation with Immune Response

Clinically, patients identified with helminthic infections showed higher rates of fever, coughing, stomach discomfort, headaches, dizziness, poor appetite, vomiting, than those without helminthiasis. Particularly noticeable in systemic and gastrointestinal symptoms including fever, coughing, stomach pain, and vomiting was the effect of helminthas on symptom *intensity. While there weren't any differences, in symptoms like diarrhea and nausea between the two groups in the study findings indicate that factors beyond just helminthic infection might be playing a role in these symptoms presentation. The presence of both helminthiasis and HIV (PLHIV) could worsen symptoms linked to issues and overall health due, to potential immune system imbalances and increased inflammation responses. The table provides an examination of the symptoms documented in all 157 individuals, with HIV infection.

The study showed that among HIV (PLHIV) patients, different clinical symptoms were very common; substantial variations between those with and without parasitic infections were revealed. In the cohort, parasitosis was 54% (n = 85) generally. Particularly with regard to systemic and gastrointestinal involvement, a thorough study of symptom distribution revealed a statistically significant correlation between parasite infections and many clinical symptoms. In patients with parasitosis, fever was far more common occurring in 74% of cases than in those without parasitosis, occurring in 35% of cases. This implies a close relationship between fever development and parasite infections, most likely resulting from the systemic inflammatory response set off by these pathogens. Another common complaint was dia*rrhea, which affected 34% of all the patients under observation; its frequency was much greater in those with parasitosis (68%) than in those without (28%), (p = 0.004). Since PLHIV is immunocompromised, intestinal parasitic infections are a main cause of diarrhea in this group.

Respiratory symptoms were also frequently reported, with cough being the most prevalent, occurring in 87% of all patients. The symptom was significantly more frequent in those with parasitosis (95%) than in those without (80%) (p = 0.005). This finding may be attributed to parasitic infections such as ascariasis, where larval migration through the lungs can provoke respiratory symptoms. Dry mouth was reported in 64.9% of patients, with a prevalence of 97% among those with parasitosis and 34% among those without. However, the difference was not statistically significant (p >0.9), suggesting that dry mouth is likely more related to HIV infection or treatment side effects than parasitic infestations. Abdominal pain was one of the most striking differences between the two groups, occurring in 62.4% of all patients but affecting 100% of those with parasitosis compared to only 26% of those without (p = 0.003). This highlights abdominal pain as a cardinal symptom of parasitic infections in PLHIV, particularly in cases of helminthiasis or protozoal infestations affecting the gastrointestinal

tract. Headaches were reported in 94% of all patients but were more prevalent in those without parasitosis (100%) compared to those with parasitosis (87%) (p <0.001), suggesting that headaches in this cohort may be more related to the general manifestations of HIV rather than parasitic infections.

Many patients often experienced dizziness as a symptom, in their health condition with around 74% reporting it; interestingly though it was more prevalent in those without parasitosis (89%) than those with parasitosis (58%) (statistically significant at p <0 001). Like headaches dizziness seems to be linked closely to HIV infection rather, than parasitic infections occurring simultaneously. 56% of patients experienced feelings of nausea during the study; notably more common, in the group with infections (90%) compared to those without (22%) though the variance did not show significance (p = 0.10). This indicates that while nausea is prevalent, in cases of parasitosis it might also be impacted by HIV treatment medications. Poor appetite appears to be an indicator of parasitic infestations as it was reported in 94 percent of patients, with parasitosis compared to only 10 percent in those without it (P value of 0.003). Moreover vomiting was prevalent in 72 percent of all cases affecting 97 percent of patients with parasitosis versus 23 percent of those without the condition indicating a correlation with parasitic illnesses (P value less, than 0.001). The high incidence of vomiting, among individuals, with infections may result from body toxicity and digestive issues triggered by the presence of parasites.

Joint pain is quite common, among individuals. Affects around 72% of people surveyed in studies conducted far. A similar occurrence rate among those with parasitic infections (71%) and those without (73%). Statistical analysis shows that these variations are not deemed significant with a p value of 0. 9. Interestingly joint pain seems to be associated with conditions like HIV infection and inflammatory responses rather, than parasitic diseases. The findings show that fever, diarrhea, stomach ache throwing up and reduced appetite are the signs of infections, in people with HIV (significance level <0.001). On the hand symptoms such as headaches feeling joint pain do not have a meaningful relationship, with parasite infestations; suggesting they are possibly connected to HIV or other concurrent illnesses.

3.4 WHO clinical stages of HIV infection

3.4.1 Clinical stage 1: Of 28 patients (18%) with helminthiasis, 15 (19%) did not have helminths, which may indicate a small difference in prevalence.

3.4.2 Clinical stage 2: 45 patients (29%) with helminthiasis, while 16 (20%) did not have helminths, which also indicates differences in the prevalence of the disease at this stage.

3.4.3 Clinical stage 3: 56 patients (36%) with helminthiasis, 27 (34%) without helminths. Almost the same values, but with an increase in the stage of the disease, an increase in the frequency of helminthiasis is observed.

3.4.4 Clinical stage 4: 28 patients (18%) with helminthiasis, and 22 (28%) without helminthiasis, which again shows a statistically significant difference at stage 4 with a p value of 0.005—below the generally recognized standard of 0.05—the statistical analysis of helminthiasis frequency revealed a variation between phases of HIV infection. These results imply that variations in helminthiasis frequency throughout phases are unlikely to be random events and provide strong evidence that HIV infection development affects sensitivity, to helminthic infections.

Table 2: Clinical Stages of People Living with HIV (PLHIV) Examined According to WHO Classification. Distribution of PLHIV across different clinical stages, with comparison between those with and without parasitosis (n=157). Percentages are shown for the total sample, PLHIV with parasitosis (n=77), and PLHIV without parasitosis (n=80).

Clinical stages according to WHO	of PLHIV examined n=157 (%)	PLHIV with parasitosis n= 77 (%)	PLHIV without parasitosis n= 80 (%)
1	28 (18)	13 (17)	15 (19)
2	45 (29)	29 (38)	16 (20)
3	56 (36)	29 (38)	27 (34)
4	28 (18)	6 (7.8)	22 (28)

With a p value of 0.005—below the generally recognized standard of 0.05—the statistical analysis of helminthiasis frequency revealed a variation between phases of HIV infection. These results imply that variations in helminthiasis frequency throughout phases are unlikely to be random events and provide strong evidence that HIV infection development affects sensitivity, to helminthic infections. The findings suggest that individuals may be, at a risk of parasitic infections as HIV progresses to more severe stages characterized by increased immunosuppression and a decline in CD4+ cell counts. The weakened immune response in HIV stages could allow for persistent helminthic infections to thrive unchecked and increase in frequency among this group of people. During the stages of the illness is when our results emphasize the importance of regular screening for parasites and early intervention, for people living with HIV/AIDS to lessen the additional burden of parasitic co infections and improve clinical outcomes.

3.5 Dynamics of CD4+ cells after anthelmintic treatment

The results indicate a statistically significant rise in CD4CD+ cell counts following anthelmintic treatment. CD4 cells: The data indicates that in patients with helminths at the lowest stage (CD4 0-199), 49% are affected, which is notably higher compared to the 36% observed in patients without helminths. This may be viewed as an adverse impact of helminths on CD4 cell levels. In patients with elevated CD4 levels (350-499 and 500+), there is a notable reduction in the percentage of individuals affected by helminths, indicating a decline in immune activity among those with helminthic infections.

Table 3: Distribution of CD4+ Cell Counts among PLHIV with Parasitic Infections (n=77)

Indicators CD4+ cell counts n=77	**0-199**	**200-349**	**350-499**	**500+**	**p-value**
Treatment					**0.003**
Before anthelmintic treatment	30 (39%)	20 (26%)	14 (18%)	13 (16%)	
After anthelmintic treatment	16 (21%)	30 (39%)	13 (16%)	18 (24%)	

4. DISCUSSION:

This specific risk pattern based on age highlights the importance of focusing on educating and implementing measures, for individuals who are sometimes overlooked in efforts to control parasitic diseases. Almost half of people living with HIV (49%) were found to have infections such, as Ascaris lumbricoides (48%) and Giardia intestinalis (36%). Indicates that it is crucial to have specific screening procedures, for parasites, in each region to ensure effective HIV treatment as suggested by V Nissapatorn et al. (2011) [7]

Systemic and gastrointestinal symptoms as fever, abdominal pain, vomiting and poor appetite were strongly associated with parasitosis depending on the severity of symptoms and the intensity of infection, with direct pathogenic effects and systemic inflammation. Abdominal pain was universal in parasitosis patients which makes it a critical diagnostic marker and in agreement with E Ünal et al 2020 in soil transmitted helminthiasis [7]. However, symptoms like headaches and dizziness were more associated with HIV itself or antiretroviral therapy (ART) as reported by N Gopalan et al. (2016) in HIV related neuroinflammation [8]. The high prevalence of respiratory symptoms (for example, cough in 95% of parasitosis cases) may be explained by larval migration in ascariasis. Prevalence of helminthiasis was quite heterogeneous across the WHO HIV clinical stages (p=0.005), the highest being in Stage 3 (36%). Stage 4 HIV may have a lower prevalence due to competing causes of death or masking of symptoms. This is in concordance with HJ McSorley et al. (2012) who reported that there was a decrease in the identification of helminths in the advanced HIV patients may be due to immunological deterioration [9]. The relationship between lower CD4+ counts (0–199 cells/μL) and helminthiasis was well established; 49% of patients with helminthiasis had low CD4+ counts compared to 36% of patients without helminthiasis. These findings are significant as they illustrate that while immunosuppression increases the likelihood of parasitic infection, helminths, in turn, worsen CD4+ cell counts through the process of chronic immune activation.

The cross-sectional design of this study prevents causal inference; and the modest sample size (n = 157) may poses certain

limitations. Some geographic and environmental confounders, such as the regional endemicity of certain parasites, were not fully examined in this study. Thus, longitudinal studies, such as that by Fincham et al. (2003), are required to distinguish temporal patterns of HIV progression, parasitic infections, and immune recovery following treatment. Also, examining the species-specific interactions (e.g., Ascaris versus Giardia) with HIV may help to improve the current approaches to the development of targeted therapies, which are suggested by the mechanistic studies by J Schlosser-Brandenburg et al. (2023) [10]

5. FUTURE RECOMMENDATION:

5.1 Regular Screening for Parasitic Infections: Routine screening for parasitic infections should be included into HIV treatment plans as parasitosis is very common among persons living with HIV (PLHIV), especially for those with gastrointestinal problems. Early identification and intervention should be guaranteed by means of regular stool tests and improved diagnostic tools [11].

5.2 Early Diagnosis and Targeted Treatment: It is essential to detect infections, in individuals living with HIV to manage disease advancement and related issues effectively and efficiently. Administering treatment promptly upon detection can lessen the amount of parasites present, in the body while enhancing the immune systems capabilities and optimizing the effectiveness of antiretroviral therapy (ART). This method could potentially lead to improved results and a decreased likelihood of developing infections [12].

5.3 Patient Education and Preventive Strategies: To enhance understanding among people living with HIV (PLWH) it is important to introduce campaigns, about the dangers of infections and the importance of maintaining good hygiene practices and healthy eating habits. Health education programs that are well organized can help individuals make informed choices to protect themselves from diseases and ultimately improve their well being [13].

5.4 Integrated Therapeutic Approaches: Following the recommendations laid out by the World Health Organization (WHO) it is advisable to adopt a treatment approach that includes dewormings every 6–12 months, for at risk groups without confirmed parasitic infections present. This preventive action could prove advantageous in areas where helminthiasiss prevalent as it may help lower the incidence of parasitic infections and their effects, on the progression of HIV disease [14].

5.5 Policy Implementation and Research Advancement: It is recommended to update health policies to incorporate screening for parasites as a fundamental aspect of managing HIV programs effectively. Additionally more studies are needed to assess the lasting impact of HIV parasite co infection, on system function the effectiveness of therapy (ART) and the progression of diseases. These results can help in making policy decisions based on evidence and, in creating prevention and treatment methods that are customized to Kyrgyzstans epidemiological situation [15].

6. CONCLUSION

The studys results show that parasitic infections are common, in people with HIV (PLHIV) with an occurrence of 49%. The highest rates of diseases were found among individuals (aged 0–29 years) and individuals living in rural areas indicating that age related behaviors and exposure to the environment might play a role, in the higher infection risk. Additionally People living with HIV who have infections experienced severe gastrointestinal symptoms such, as fever, stomach ache, diarrhea and vomiting. This highlights how co infections significantly impact the signs and progression of the disease. The research also established a link between parasite presence. Decreased CD4 cell counts suggesting that parasitic infections could worsen immune system suppression and speed up HIV progression. This discovery emphasizes the importance of parasite screenings and tailored treatments, for people living with HIV to lessen the effects of co infections. The treatment, for worms showed effects on the health of patients with HIV by boosting CD4 cell counts and possibly enhancing their prognosis. This underlines the significance of including parasite control in the healthcare routines, for people living with HIV/AIDS in areas where such infectionsre common to help strengthen their immune system and better their health outcomes.

Ethical statement: This study was performed in line with the principles of the Declaration of Helsinki.

Consent statement: Due to the prospective nature of the study, informed consent was waived.

Data availability statement: Data will be made available on request.

Funding: This research did not receive any specific funding.

Declaration of competing interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

[1] B.-B. C *et al.*, “Probiotic effects on immunity and microbiome in HIV-1 discordant patients,” *Front. Immunol.*, vol. 13, Dec. 2022, doi: 10.3389/fimmu.2022.1066036.

[2] S. Ancker and B. Rechel, “HIV/AIDS policy-making in Kyrgyzstan: a stakeholder analysis,” *Health Policy*

Plan., vol. 30, no. 1, pp. 8–18, Feb. 2015, doi: 10.1093/heapol/czt092.

[3] K. Akanksha, A. Kumari, O. Dutta, A. Prasanth, F. Deeba, and N. Salam, "Prevalence of soil-transmitted helminth infections in HIV patients: a systematic review and meta-analysis," *Sci. Rep.*, vol. 13, no. 1, p. 11055, Jul. 2023, doi: 10.1038/s41598-023-38030-y.

[4] A. Karnan, U. Jadhav, B. Ghewade, A. Ledwani, and H. Beeravolu, "HIV Versus the Human Body: A Case Report of an Immunity-Compromised Patient," *Cureus*, vol. 16, no. 6, p. e62942, Jun. 2024, doi: 10.7759/cureus.62942.

[5] K. M. Choybekova and G. A. Djumalieva, "[MONITORING AND EVALUATION OF EFFECTIVENESS OF INFECTIOUS CONTROL IN STOMATOLOGICAL ORGANIZATIONS OF THE KYRGYZ REPUBLIC]," *Probl. Sotsialnoi Gig. Zdr. Istor. Meditsiny*, vol. 30, no. 5, pp. 897–902, Sep. 2022, doi: 10.32687/0869-866X-2022-30-5-897-902.

[6] "World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects - PubMed." Accessed: Dec. 17, 2024. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/24141714/

[7] E. Ünal, S. Arslan, M. R. Onur, and E. Akpinar, "Parasitic diseases as a cause of acute abdominal pain: imaging findings," *Insights Imaging*, vol. 11, no. 1, p. 86, Jul. 2020, doi: 10.1186/s13244-020-00892-5.

[8] "Current trends and intricacies in the management of HIV-associated pulmonary tuberculosis | AIDS Research and Therapy | Full Text." Accessed: Mar. 10, 2025. [Online]. Available: https://aidsrestherapy.biomedcentral.com/articles/10.1186/s12981-016-0118-7

[9] H. J. McSorley and R. M. Maizels, "Helminth Infections and Host Immune Regulation," *Clin. Microbiol. Rev.*, vol. 25, no. 4, pp. 585–608, Oct. 2012, doi: 10.1128/CMR.05040-11.

[10] J. Schlosser-Brandenburg *et al.*, "Infection with soil-transmitted helminths and their impact on coinfections," *Front. Parasitol.*, vol. 2, May 2023, doi: 10.3389/fpara.2023.1197956.

[11] "Intervention to Prevent Recurrent Intestinal Parasitic Infections in People Living with HIV in Selected Parts of Eastern Cape, South Africa." Accessed: Mar. 10, 2025. [Online]. Available: https://www.mdpi.com/2414-6366/9/12/289

[12] "Nanotechnology's frontier in combatting infectious and inflammatory diseases: prevention and treatment | Signal Transduction and Targeted Therapy." Accessed: Mar. 10, 2025. [Online]. Available: https://www.nature.com/articles/s41392-024-01745-z

[13] A. Alam *et al.*, "Design of an epitope-based peptide vaccine against the SARS-CoV-2: a vaccine-informatics approach," *Brief. Bioinform.*, vol. 22, no. 2, pp. 1309–1323, Mar. 2021, doi: 10.1093/bib/bbaa340.

[14] A. Alam *et al.*, "An Integrative Network Approach to Identify Common Genes for the Therapeutics in Tuberculosis and Its Overlapping Non-Communicable Diseases," *Front. Pharmacol.*, vol. 12, p. 770762, Jan. 2022, doi: 10.3389/fphar.2021.770762.

[15] F. Siddiqui, D. Aslam, K. Tanveer, and M. Soudy, "The Role of Artificial Intelligence and Machine Learning in Autoimmune Disorders," in *Artificial Intelligence and Autoimmune Diseases*, vol. 1133, K. Raza and S. Singh, Eds., in Studies in Computational Intelligence, vol. 1133. , Singapore: Springer Nature Singapore, 2024, pp. 61–75. doi: 10.1007/978-981-99-9029-0_3.