



Detection of HTLV-1 and -2 infections in relation to the immune factor soluble HLA-G in adult Iraqi lymphoma patients

A. R. H. Al Rawi, Z. A. Hamid, A. S. Najj

University of Baghdad, Baghdad, Iraq

Article info

Received 06.07.2025

Received in revised form

17.08.2025

Accepted 09.09.2025

Collage of Medicine,
University of Baghdad,
Baghdad-Iraq. E-mail:
mzahraa798@gmail.com

Al Rawi, A. R. H., Hamid, Z. A., & Najj, A. S. (2025). Detection of HTLV-1 and -2 infections in relation to the immune factor soluble HLA-G in adult Iraqi lymphoma patients. *Regulatory Mechanisms in Biosystems*, 16(3), e25153. doi:10.15421/0225153

The objective of this article is to determine the expression of sHLA-G antigen in HTLV-1 and HTLV-2 lymphoma cases and to confirm positive infection cases of HTLV-1 and distinguish random cases from negative by using the real-time polymerase chain reaction (RT-PCR) technique. This cross-sectional study involved 180 lymphoma patients recruited from the Blood and Bone Marrow Transplantation Center at the Teaching Hospital, Medical City, Baghdad, National Center for Blood Diseases, Al-Mustansiriya University, and Al-Imamain Al-Kadhimain Medical City. A minority of the participants were ELISA positive to HTLV-1. The same is true for the TaqMan probe RT-PCR result, the mean levels of HLA-G did not differ significantly between lymphoma participants who were HTLV-1 positive and those who were HTLV-1 negative. All lymphoma participants in this study were HTLV-2 negative. In this study, lymphoma patients were less predominantly affected by HTLV-1 and HTLV-2 infection. Therefore, it is important to implement screening protocols to control the transmission and complication of this virus in lymphoma patients. Further research will be necessary, involving all provinces of Iraq, to reveal the exact number of virus infections.

Keywords: Lymphoma; HTLV-1; HTLV-2; soluble human leukocyte antigen-G; TaqMan probe RT-PCR.

Introduction

Lymphoma is a cancer in the lymphatic cells of the immune system. There are many different subtypes and clinical manifestations of lymphoma, a complex group of hematological cancers that originate in the lymphocytes. Various types of lymphomas exhibit distinct clinical and pathological manifestations. The two primary types are Hodgkin lymphoma (HL) and non-Hodgkin lymphoma (NHL) (Mohson & Al-Hilli, 2016; Xavier et al., 2025).

Human T-lymphotropic virus type 1 (HTLV-1) is a retrovirus that affects around 5 to 10 million people globally. It is linked to serious diseases such as adult T-cell leukemia/lymphoma (ATL) and HTLV-1-associated myelopathy/tropical spastic paraparesis (HAM/TSP). Despite its notable health burden, HTLV-1 is often overlooked, with limited public health efforts to curb its spread and mitigate its impacts. HTLV-1 consists of a positive single-stranded RNA genome that is integrated into the host DNA as a provirus upon infection. The virus spreads mainly through sexual contact, from mother to child, and through blood transfusions (Branda et al., 2025). The estimated prevalence of HTLV-1 at 5–10 million people worldwide could be higher due to underreporting in regions lacking comprehensive epidemiological data (Al-Jubouri & Abdullah, 2025).

Human T-cell lymphotropic virus type 2 (HTLV-2) is a retrovirus closely related to HTLV-1, both classified under the *Deltaretrovirus* genus. Unlike HTLV-1, which is linked to several diseases, HTLV-2 is usually considered non-pathogenic, though it has been associated with minor neurological symptoms and benign lymphoproliferation in some cases. HTLV-2 is endemic among certain groups, including Amerindian tribes and intravenous drug users, and is transmitted through mechanisms similar to those of HTLV-1. HTLV-2 has a direct connection to some type of lymphoma, such as cutaneous T-cell lymphoma, in people who are also infected with HIV. Overall, HTLV-2 is much less pathogenic, though it has been associated with a few cases of atypical hairy-cell leukemia and neurological disease (Branda et al., 2025).

Currently, there is no vaccine available that can prevent HTLV infection. To develop rules to prevent the spread of HTLV-1, it is essential to gather real-world data. Antiretrovirals are ineffective against proven infections, and the consequences can be severe. There-

fore, HTLV-1 infection prevention is crucial in lymphoma patients (Rosadas et al., 2022).

The term HLA refers to the human leukocyte antigen system, which is controlled by genes on the short arm of chromosome six (Zeiny, 2016). Human leukocyte antigen (HLA) is human immune-genetic system characterized by polymorphism (Abbas, 2016). Soluble human leukocyte antigen-G (sHLA-G) is a non-classical HLA class I molecule with immunomodulatory properties, playing a significant role in viral infections by facilitating immune tolerance and potentially aiding in immune evasion by pathogens. Elevated levels of sHLA-G have been observed in various viral infections, suggesting its involvement in the pathogenesis and progression of these diseases (Abbas, 2016; Zeiny, 2016).

This research was done to find out how common HTLV-1 and -2 infections are and what risk factors are linked to them. It also examined the risk of contracting other blood-borne viruses simultaneously, as HTLV-1 and HTLV-2 are spreading worldwide.

Materials and methods

This is a cross-sectional study of 180 adult lymphoma patients selected according to the inclusion and exclusion criteria (98 males and 82 females) were admitted to the Blood and Bone Marrow Transplantation Center at the Teaching Hospital at Medical City in Baghdad, National Center for Blood Diseases / Al-Mustansiriya University, Al-Imamain Al-Kadhimain Medical City between November 2024 and March 2025. The patient ranged in age from 18 to 83 years.

This study was approved by the Ethics Committee of the Department of Microbiology, College of Medicine, University of Baghdad (Institutional Review Board-Reference Number 0251–3/7/2025). All participants gave informed consent prior to blood sample collection. Baseline data, including the type of lymphoma as well as sociodemographic information, were gathered for each patient. A blood sample of 5 mL were collected from each patient using accepted medical techniques. Each blood sample was then collected in a gel separation tube and centrifuged at 3000 rpm for 20 minutes. The resulting serum was stored at –20 °C until the examination. Enzyme-linked immunosorbent assay (Cat. No: SL2421H4, Reed Biotech) was used to qualitatively determine the Human T-lymphotropic virus IgG in the serum

sample and (Cat. No: RE3072H, Solarbio) to quantify HLA-G in the serum sample. The manufacturer's instructions were fully followed throughout the testing process. Two wells served as negative control, two wells as positive control and one empty well as blank control. Negative and positive controls in a volume of 50 µL were added to the negative and positive control wells, respectively. In sample wells, 40 µL of sample dilution buffer and 10 µL of sample were added. This was incubated for 30 min at 37°C and then sealed with the closure plate membrane. 50 µL HRP-conjugate reagent was added to each well except the blank control well. Absorbance optical density was read at 450 nm using a Microtiter Plate Reader. Other kits are used to determine the quantity of HLA-G in the patients' serum.

The micro ELISA plate provided in this kit had been pre-coated with an antibody specific to Human MHCG/HLA-G. Samples (or standards) were added to the micro ELISA plate wells and combined with the specific antibody. Then a biotinylated detection antibody specific for human MHCG/HLA-G and avidin-horseradish peroxidase (HRP) conjugate was added successively to each microplate well and incubated. The substrate solution was added to each well. Only those wells that contain human MHCG/HLA-G, biotinylated detection antibody, and avidin-HRP conjugate will appear blue. The optical density (OD) was measured at a wavelength of 450 nm. The concentration of human MHCG/HLA-G in the sample was calculated by comparing the OD of the sample to the standard curve.

Patient results were obtained for verification by a definitive diagnosis test using the TaqMan probe-based real-time fluorescence PCR technique after genome extraction with the RNA Viral Genome Extraction Kit (Cat. No: R2000, Shanghai Keshun Science and Technology Co., Ltd). After that, we used the TaqMan probe-based real-time fluorescence PCR technique to detect two types of virus, HTLV-1 and -2, we used (human T-lymphotropic 1 (HTLV-1) nucleic acid detection kit, Cat. No: KS52112-48 and 5-human T-lymphotropic virus 2 (HTLV-2) nucleic acid detection kit (Cat. No: KS51112T), Shanghai Keshun Science and Technology Co., Ltd. This kit uses TaqMan probe real-time fluorescent PCR technology to design specific primers for the highly conserved region of human T-cell-lymphotropic virus type 1 and 2.

A one-step fluorescent RT-PCR technique was used to amplify and detect the nucleic acid of HTLV-1 and -2 *in vitro*. In the case that the nucleic acid template of HTLV-1 and -2 was included in the reaction system, PCR reaction was carried out, and the fluorescence signal was released. The signal intensity of the corresponding channel in the PCR process was monitored and output in real time by the instrument and the qualitative analysis of the detection results were realized. The diagnosis of HBV, HCV, and HIV was conducted as part of a routine test for lymphoma patients by reverse transcriptase-polymerase chain reaction.

Data analysis using the Statistical Package for the Social Sciences 27 (SPSS) was conducted for descriptive statistics and performing T-test for the comparison between the two continuous groups, and for the normality test for continuous variable, as well the comparison between groups. The data that exhibited a normal distribution presented as mean and standard deviation; Fisher's exact test was used for categorical variables due to small observations in some cells while the chi-square was utilized for variables with sufficient observation in each cell.

Results

The 180 patients were distributed as 66 (36.7%) patients with Hodgkin lymphoma (HL), while 114 (63.3%) had non-Hodgkin lymphoma (NHL). Of the total number of patients, 98 (54.4%) were male while 82 (45.6%) were female. The majority of lymphoma participants were married, at 88.3%, while there were only 21 singles (11.7%). 92.8% (167 patients) were non-smokers while only 7.2% (13 patients) were smokers. A minority of lymphoma participants were blood recipients, 13.3% (24 patients), while the majority of them were not blood recipients. The minimum and maximum patient ages for both Non-Hodgkin and Hodgkin lymphoma are summarized in Table 1.

Table 1

Age distribution in non-Hodgkin and Hodgkin lymphoma patients

	NHL	HL	P-value
Mean ± SD	46.91 ± 19.89	44.57 ± 14.02	> 0.05
Minimum	18	18	
Maximum	83	75	
≤ 40	37	39	> 0.001
> 40	77	27	

Only 10% (18 patients) of overall lymphoma participants were infected with the hepatitis B virus (HBV) virus and the majority 90% (162 patients) were not infected.

Only 5.6% (10 patients) of overall lymphoma participants were infected with the hepatitis C virus (HCV) virus and 94.4% (170 participants) were not infected.

Only 8.9% of overall lymphoma participants were infected with human T-lymphotropic virus type 1 (HTLV-1) virus while 91.1% (164 participants) were not infected (RT-PCR – reverse transcription polymerase chain reaction were used in the diagnosis).

The result of the ELISA shows a significant P-value = 0.001 association. The result of RT-PCR confirms all positive cases of ELISA, the majority of negative ELISA, and the majority of suspected participants (Table 2).

Table 2

IgG of HTLV-1 (ELISA) according to HTLV-1 (RT-PCR) crosstabulation

IgG of HTLV-1 (ELISA)	HTLV-1 (RT-PCR)		Total
	positive	negative	
Positive	9	0	9
Negative	1	161	162
Suspected	6	3	9
Total	16	164	180

All participants with lymphoma were negative for HTLV-2.

The molecular genotypes were shown in Table 3.

Table 3

Molecular genotyping result of HTLV-1

No.	Genotype	Cycling A. Green	Cycling A. Yellow	Number of cases
1	Control positive	Reaction	Reaction	1
2	Control negative	Reaction	Reaction	1
3	Negative	No reaction	Reaction	13
4	Positive	Reaction	Reaction	16

Table 4 shows that the mean levels were lower in the group of lymphoma patients who were HTLV-1 positive than those who were negative; this difference failed to reach significance.

Table 4

HLA-G according to HTLV-1 antigens

HTLV-1, HLA-G group	N	Mean	Std. deviation	P-value
Positive	16	0.634	0.230	0.283
Negative	164	0.701	0.244	

Table 5 shows that males with lymphoma who were HTLV-1 negative show significantly higher levels of HLA-G than females, 0.74 ± 0.26 vs 0.66 ± 0.22 (P < 0.04).

Table 5

HLA-G according to HTLV-1 antigens based on gender

Group	HLA-G mean ± SD, ng/mL	P-value		
		HTLV-1 positive female	HTLV-1 negative male	HTLV-1 negative female
HTLV-1 positive male	0.59 ± 0.25	0.26	0.05	0.36
HTLV-1 positive female	0.73 ± 0.16	–	0.97	0.50
HTLV-1 negative male	0.74 ± 0.26	–	–	0.04
HTLV-1 negative female	0.66 ± 0.22	–	–	–

Table 6 shows the distribution of NHL stages according to HTLV-1 RT-PCR results with the most cases of HTLV-1 in stage 3, with 4 participants while the fewest cases were in stage 2 with no

participants. Also, there is a weak negative non-significant correlation between the stages of NHL and HTLV-1 RT-PCR result $r = -0.050$, $P\text{-value} = 0.599$.

Table 6
Correlation between stages
of non-Hodgkin lymphoma and HTLV-1 RT-PCR

Stage of lymphoma	HTLV-1 (RT-PCR)		Total
	positive	negative	
Stage 1	1	13	14
Stage 2	0	16	16
Stage 3	4	29	33
Stage 4	3	37	40
Total	8	95	103

Table 7 shows the distribution of HL stages according to HTLV-1 RT-PCR results, which showed that the most cases of HTLV-1 were in stage 4, with 3 participants, while the fewest were in stage 3, with only one participant. Additionally, a weak, non-significant correlation was observed between the stages of HL and the HTLV-1 RT-PCR result ($r = 0.114$, $P\text{-value} = 0.362$).

Table 7
Correlation between stages
of Hodgkin lymphoma and HTLV-1 RT-PCR

Stage of lymphoma	HTLV1 (RT-PCR)		Total
	positive	negative	
Stage 1	2	4	6
Stage 2	2	14	16
Stage 3	1	20	21
Stage 4	3	20	23
Total	8	58	66

Discussion

The present study demonstrated the presence of HTLV-1 in a subset of adult Iraqi patients with non-Hodgkin lymphoma (NHL), while HTLV-2 was not detected in any cases. These findings suggest a potential association between HTLV-1 infection and the pathogenesis of NHL in this population. The absence of HTLV-1 in patients with Hodgkin lymphoma (HL) is consistent with previous reports indicating that adult T-cell leukemia/lymphoma (ATLL) and other T-cell lymphomas are the primary neoplastic conditions linked to HTLV-1 infection (Zargari et al., 2020).

Saber et al. (2023) indicate that non-Hodgkin lymphoma (NHL) is more prevalent than Hodgkin lymphoma (HL) across various regions, with distinct histological subtypes dominating in different areas. However, NHL is more prevalent than HL in Iraq, which could be due to a combination of regional epidemiological patterns, environmental factors, and demographic influences. Factors such as obesity, sedentary lifestyle, and tobacco use are associated with increased NHL risk (Huang et al., 2024). HL is less prevalent than NHL due to several factors, including its distinct epidemiological characteristics and the influence of environmental and immunological factors on NHL. The incidence of HL is stable and relatively low, with rates around 3.0 per 100,000 in males and 1.8 per 100,000 in females in the United Kingdom (Cerhan et al., 2024).

Males present with higher prevalence than females, which is consistent with Radkiewicz et al. (2023), and with a cohort study involving 7,735 patients with NHL, in which the gender distribution was relatively balanced, with 3,386 women and 4,349 men, indicating a slight male predominance. Also a study from Bobo-Dioulasso reported a sex ratio of 3.4, suggesting a significant male predominance among 44 lymphoma patients (Traoré et al., 2020), while in HL, a study found that 53.5% of hospitalized patients were male, while 46.5% were female, as indicated by Aslani et al. (2020). This variability highlights the complexity of gender influences in lymphoma epidemiology. However, it is essential to consider that these findings may not be universally applicable across all populations and types of lymphoma. The result of the current study about association with marital status and sex might be attributed to unmarried individuals

(especially singles / widowed) delaying seeking care, leading to underdiagnoses (Al-Marzouqi et al., 2025). Married patients might be diagnosed with lymphoma earlier due to encouragement from spouses to seek treatment while this category of patients often has better survival outcomes due to social support, financial resources, and caregiving assistance. Furthermore, in some regions, being married is culturally expected, leading to a higher prevalence of married individuals in the general population. These cultural norms and societal expectations can influence marriage rates and healthcare-seeking behavior (Mursi et al., 2006).

The majority of participants in this study were non-smokers because smoking reduces chemotherapy efficacy (e.g., anthracyclines) and increases toxicity. However there is some evidence that the risk of death among former smokers may decrease with time since quitting smoking (Geyer et al., 2010).

A minority of lymphoma participants are blood recipients, 13.3% (24 patients), while the majority of them were non blood recipients.

Regarding blood transfusion, the majority of participants had no history of receiving transfusions. This finding aligns with previous studies which have also found no significant correlation between blood transfusion and lymphoma (Cerhan et al., 2019). This study suggests that the lack of association may be due to rigorous blood screening protocols and thorough assessments of donors' physiological and behavioral health prior to donation (Cerhan et al., 2019).

There was no statistically significant difference in age between patients with NHL and those with HL. The mean age \pm standard deviation (SD) for NHL patients was 46.91 ± 19.89 years, ranging from 18 to 83 years. For HL patients, the mean age \pm SD was 44.57 ± 14.02 years, with ages ranging from 18 to 75 years, as presented in Table 1.

A significant age-related trend was observed: most NHL patients were over 40, while the majority of HL patients were 40 or younger. Adolescent and young adult lymphoma patients often present with more severe illness, partly due to late diagnosis and healthcare disparities (Jain et al., 2023). A Romanian study reported a mean age of 37 for lymphoma diagnosis among HIV-positive individuals. Overall, lymphoma prevalence increases with age, especially for NHL, which is more frequently diagnosed in individuals over 55 (Padurariu-Covit et al., 2024).

HBV and HCV infections have been associated with an increased risk of lymphoma. In the present study, the majority of lymphoma patients tested PCR-negative for HBV, consistent with findings reported in Wan et al. (2023). Additionally, the number of HL patients who tested PCR-positive for HBV and HCV was lower compared to NHL patients.

As shown in Tables 2 and 3, the majority of lymphoma patients tested negative for HTLV-1. This finding suggests that the development of T-cell malignancies can occur independently of HTLV-1 infection, as these cases often present with distinct phenotypic and karyotypic features. The low prevalence of HTLV-1 in certain populations highlights the importance of targeted screening, particularly among individuals from endemic regions, to identify those at risk for adult T-cell leukemia/lymphoma (ATLL). The presence of HTLV-1-negative cases underscores the complexity of lymphoma pathogenesis and indicates that additional viral, genetic, or environmental factors may contribute to the development of T-cell malignancies (Mendoza et al., 2023).

As shown in Table 4, all participants were negative for HTLV-2, consistent with its limited association with hematologic malignancies and predominance for infecting CD8⁺ T-cells, which are less prone to oncogenic transformation than CD4⁺ T-cells (Rende et al., 2011). Unlike the HTLV-1 Tax protein, which promotes T-cell transformation and proliferation, the HTLV-2 Tax-2 protein lacks essential oncogenic motifs, possibly explaining the higher prevalence of HTLV-1 in this study. RT-PCR proved the most effective method for detecting HTLV-1, enabling precise quantification of viral mRNA variants and offering high amplification efficiency with a broad dynamic range, making it ideal for comprehensive viral analysis (Li & Green 2007).

Mean HLA-G levels were lower in HTLV-1-positive lymphoma patients compared with HTLV-1-negative patients. HLA-G promotes immune tolerance in malignancies, facilitating tumor immune evasion (Alkhouly et al., 2013). In HTLV-1-positive individuals, immune compromise, NK cell deficiencies (Diepstra et al., 2008) and certain HLA-G polymorphisms (Bielska et al., 2015) may contribute to reduced expression. Although lower HLA-G is associated with poorer survival in lymphoma (Jesonek-Kupnicka et al., 2016), it may also enhance anti-tumor immunity, underscoring the complex interplay between viral infection, immune regulation, and cancer.

Table 5 demonstrates that HLA-G levels are significantly lower in HTLV-1-positive males than in HTLV-1-negative females. This difference may reflect sex-based immune disparities, as males typically exhibit weaker immune regulation and lower levels of molecules such as HLA-G. HLA-G polymorphisms may further reduce its expression in HTLV-1-positive males due to sex-specific genetic-immune interactions (Bielska et al., 2015).

HLA-G's immunosuppressive function enables tumor cells to evade immune surveillance. In HTLV-1 infection, HLA-G may facilitate viral persistence by inhibiting T cell responses, an effect potentially amplified in males due to their immune profile. This interaction could worsen immune dysregulation in male lymphoma patients (Haddad et al., 2010). Conversely, females – particularly when HTLV-1-negative – may benefit from a stronger immune response, supporting better outcomes. These findings highlight the complexity of sex-immune interactions in disease progression (Vallinoto et al., 2019).

The first part of Table 5 reiterates that HTLV-1-positive males have lower HLA-G levels than HTLV-1-negative females, consistent with sex-based immune variation and HLA-G polymorphism effects (Bielska et al., 2015). The immunosuppressive role of HLA-G may be more critical in males with HTLV-1, aiding viral persistence and increasing immune dysregulation in lymphoma (Bielska et al., 2015). The comparatively robust immunity of females in the absence of HTLV-1 may improve prognosis (Vallinoto et al., 2019). The second part of Table 5 shows that HLA-G levels are significantly higher in HTLV-1-negative males than in their female counterparts. This may be influenced by testosterone, which can enhance HLA-G expression, whereas estrogen may downregulate it. Additionally, certain HLA-G gene variants in males may favor higher expression (Khaleel et al., 2021). Elevated HLA-G in males might promote immune tolerance, aiding tumor immune evasion as a compensatory mechanism (Khaleel et al., 2021). Despite lower HLA-G levels, females may possess other immune advantages – such as more effective responses to infection and malignancy – potentially influencing clinical outcomes.

A previous study consistent with the present findings (Table 6) reported no significant correlation between HTLV-1 and lymphoma ($P = 0.599$) (Choksi et al., 2009). Although HTLV-1 is not directly implicated in lymphomagenesis, its presence in B-cell non-Hodgkin lymphoma (NHL) patients has been associated with poorer survival, suggesting an indirect role in disease progression via immune modulation. In Gabon, certain NHL cases were linked to HTLV-1, but the overall association remained weak, highlighting regional variability (Delaporte et al., 1993). Conversely, a study from Jamaica and Trinidad reported a higher incidence of NHL among HTLV-1-infected individuals, particularly in younger patients, with a pronounced increase in T-cell NHL cases (Gupta et al., 2022).

Table 7 presents the distribution of Hodgkin lymphoma (HL) stages according to HTLV-1 RT-PCR results, indicating that most HTLV-1-positive cases were in stage 4 ($n = 3$), while the fewest were in stage 3 ($n = 1$). A weak, non-significant correlation was found between HL stage and HTLV-1 status ($r = 0.114$, $P = 0.362$). Consistent with these findings, a study has reported no significant association between HTLV-1 infection and HL, underscoring the importance of precise diagnosis and staging to distinguish HL from other HTLV-1-related lymphoproliferative disorders (Ghesquière, 2023). However, research conducted in HTLV-1-endemic regions has identified rare HTLV-1-associated malignant lymphomas, including isolated cases of Hodgkin's disease, suggesting a possible but inconclusive

relationship. The virus primarily targets CD4⁺ T cells, which are critical for immune regulation, and its pathogenic potential is modulated by the host's immunological status (Nakahata et al., 2023).

Conclusions

The prevalence of HTLV-1 and HTLV-2 infections among lymphoma patients was relatively low, indicating that these retroviral infections are not predominant within this patient cohort. Nonetheless, the potential clinical implications of HTLV infection in immunocompromised individuals warrant the implementation of routine screening protocols to facilitate early detection, prevent viral transmission, and minimize associated complications in lymphoma patients. Furthermore, large-scale epidemiological studies encompassing all provinces of Iraq are essential to obtain a comprehensive estimate of the true prevalence and geographic distribution of HTLV-1 and HTLV-2 infections, thereby enabling the development of targeted public health strategies.

The authors represent their thanks to College of Medicine, University of Baghdad, Baghdad, Iraq for their help to complete this research.

No conflict of interest.

References

- Abbas, A. A. H. (2016). HLA diversity in Iraqi population: Molecular typing. *Journal of the Faculty of Medicine Baghdad*, 58(2), 176–179.
- Al-jubouri, Z., & Abdullah, S. F. (2025). Active human T-lymphotropic virus type-1 antigenemia in a sample of Iraqi patients on maintenance hemodialysis. *Al-Kindy College Medical Journal*, 21(1), 58–64.
- Alkhouly, N., Shehata, I., Ahmed, M. B., Shehata, H., Hassan, S., & Ibrahim, T. (2013). HLA-G expression in acute lymphoblastic leukemia: A significant prognostic tumor biomarker. *Medical Oncology*, 30, 460.
- Al-Marzouqi, Z., Al-Jabri, N. S., Al-Dhoani, A., & Al-Risi, I. (2025). Barriers of breast self-examination among Omani women. *Advances in Biomedical and Health Sciences*, 4(3), 109–118.
- Aslani, A., Morsali, S., Mousavi, S. E., Choupani, S., Yekta, Z., & Nejadghadiri, S. A. (2024). Adult Hodgkin lymphoma incidence trends in the United States from 2000 to 2020. *Scientific Reports*, 14, 20500.
- Bielska, M., Bojo, M., Klimkiewicz-Wojciechowska, G., Jesonek-Kupnicka, D., Borowiec, M., Kalinka-Warzocha, E., Prochorec-Sobieszek, M., Robak, T., Warzocha, K., Młynarski, W., & Lech-Maranda, E. (2015). Human leukocyte antigen-G polymorphisms influence the clinical outcome in diffuse large B-cell lymphoma. *Genes, Chromosomes and Cancer*, 54(3), 185–193.
- Branda, F., Romano, C., Pavia, G., Bilotta, V., Locci, C., Azzena, I., Deplano, I., Pascale, N., Perra, M., Giovanetti, M., Ciccozzi, A., De Vito, A., Quirino, A., Marascio, N., Matera, G., Madeddu, G., Casu, M., Sanna, D., Ceccarelli, G., ... Scarpa, F. (2025). Human T-lymphotropic virus (HTLV): Epidemiology, genetic, pathogenesis, and future challenges. *Viruses*, 17(5), 664.
- Cerhan, J. R., Kane, E., Vajdic, C. M., Linet, M. S., Monnereau, A., Bernstein, L., de Sanjose, S., Chiu, B. C.-H., Spinelli, J. J., Dal Maso, L., Zhang, Y., Larrabee, B. R., Cozen, W., Smith, A. G., Clavel, J., Serraino, D., Zheng, T., Holly, E. A., Weisenberger, D. D., ... Bracci, P. M. (2019). Blood transfusion history and risk of non-Hodgkin lymphoma: An InterLymph pooled analysis. *Cancer Causes and Control*, 30(8), 889–900.
- Cerhan, J. R., Maurer, M. J., Link, B. K., Feldman, A. L., Habermann, T. M., Jaye, D. L., Burack, W. R., McDonnell, T. J., Vega, F., Chapman, J. R., Syrbu, S., Vij, K. R., Inghirami, G., Leonard, J. P., Bernal-Mizrachi, L., Farooq, U., Witzig, T. E., Weiner, G. J., Wang, Y., ... Flowers, C. R. (2024). The lymphoma epidemiology of outcomes cohort study: Design, baseline characteristics, and early outcomes. *American Journal of Hematology*, 99(3), 408–421.
- Choksi, M., Joseph, A. J., Simon, E., Shah, A., Ramachandran, J., & Ramakrishna, B. S. (2009). The association of HTLV-1 infection, persistent intestinal infection with *Strongyloides stercoralis* and gastrointestinal lymphoma. *BMJ Case Reports*, 2009, 733–745.
- Delaporte, E., Klotz, F., Peeters, M., Martin-Prevel, Y., Bedjabaga, L., Larouzé, B., Nguembi-Mbina, C., Walter, A., & Piot, P. (1993). Non-Hodgkin lymphoma in Gabon and its relation to HTLV-I. *International Journal of Cancer*, 53(1), 48–50.
- Diepstra, A., Poppema, S., Boot, M., Visser, L., Nolte, I. M., Niens, M., Te Meerman, G. J., & Van Den Berg, A. (2008). HLA-G protein expression as a potential immune escape mechanism in classical Hodgkin's lymphoma. *Tissue Antigens*, 71(3), 219–226.

- Geyer, S. M., Morton, L. M., Habermann, T. M., Allmer, C., Davis, S., Cozen, W., Severson, R. K., Lynch, C. F., Wang, S. S., Maurer, M. J., Hartge, P., & Cerhan, J. R. (2010). Smoking, alcohol use, obesity, and overall survival from non-Hodgkin lymphoma. *Cancer*, 116(12), 2993–3000.
- Ghesquière, H. (2023). Diagnostic et bilan préthérapeutique du lymphome de Hodgkin [Diagnosis and staging of Hodgkin lymphoma]. *La Revue du Praticien*, 73(6), 617–620.
- Gupta, V. K., El-Jawahri, A., Orkev, G., Johnson, M. H., Weinberg, J., Goodrich, C., Janakiram, M., & Sloan, J. M. (2022). Impact of human T cell lymphotropic virus type 1 and 2 infection on survival following stem cell transplantation. *Transplantation and Cellular Therapy*, 28(5), 276.e1–276.e5.
- Haddad, R., Cilião Alves, D. C., Rocha Jr., M. C., Azevedo, R., do Socorro Pombo-de-Oliveira, M., Takayanagi, O. M., Donadi, E. A., Covas, D. T., & Kashima, S. (2011). HLA-G 14-bp insertion/deletion polymorphism is a risk factor for HTLV-1 infection. *AIDS Research and Human Retroviruses*, 27(3), 283–288.
- Huang, J., Chan, S. C., Lok, V., Zhang, L., Lucero-Priso, D. E., Xu, W., Zheng, Z., Elcarte, E., Withers, M., & Wong, M. C. S. (2024). Global burden, risk factors, and trends of non-Hodgkin lymphoma: A worldwide analysis of cancer registries. *Cancer Medicine*, 13(5), e7056.
- Jain, T., Ji, X., DeGroot, N., Coxhead, C., Mertens, A., & Castellino, S. (2023). 181 evaluating the association of age with acuity and severity of illness at initial clinical presentation in patients with leukemia and lymphoma. *Journal of Clinical and Translational Science*, 7(S1), 56.
- Jesionek-Kupnicka, D., Bojo, M., Prochorec-Sobieszek, M., Szumera-Ciećkiewicz, A., Jabłońska, J., Kalinka-Warzocho, E., Kordek, R., Młynarski, W., Robak, T., Warzocho, K., & Lech-Maranda, E. (2015). HLA-G and MHC class II protein expression in diffuse large B-cell lymphoma. *Archivum Immunologiae et Therapiae Experimentalis*, 64(3), 225–240.
- Khaleel, Z. K., Al-Hadithi, H. S., Khalaf, A. A., & Habib, O. S. (2021). The role of soluble HLA-G serum level in therapeutic response of chronic myeloid leukemia patients. *Indian Journal of Forensic Medicine and Toxicology*, 16(1), 1305–1311.
- Li, M., & Green, P. L. (2007). Detection and quantitation of HTLV-1 and HTLV-2 mRNA species by real-time RT-PCR. *Journal of Virological Methods*, 142(1–2), 159–168.
- Mendoza, C. D., Rando, A., Miró, E., Pena, M. J., Rodríguez-Avial, I., Ortega, D., González-Praetorius, A., Reina, G., Pintos, I., Pozuelo, M. J., Soriano, V., Calderón, E., Rodríguez-Iglesias, M., Montiel, N., Trujillo, T., Viciano, I., Cabezas, T., Lozano, A., Fernández-Fuertes, E., ... de Mendoza, C. (2023). Adult T-cell leukemia/lymphoma in HTLV-1 non-endemic regions. *Journal of Clinical Virology*, 167, 105578.
- Mohson, K. I., & Al-Hilli, M. (2016). Role of ultrasound and computed tomography in assessment of abdominal lymphadenopathy and splenomegaly in lymphomas. *Journal of the Faculty of Medicine Baghdad*, 57(4), 279–282.
- Mursi, S. S. (2018). Socio-cultural determinants of health-seeking behavior for reproductive health care among women (15–49 years) in Sharq-Alneel locality in Sudan. Al Neelain University, Khartoum.
- Nakahata, S., Enriquez-Vera, D., Jahan, M. I., Sugata, K., & Satou, Y. (2023). Understanding the immunopathology of HTLV-1-associated adult T-cell leukemia/lymphoma: A comprehensive review. *Biomolecules*, 13(10), 1543.
- Padurariu-Covit, M.-D., Chiscop, I., Fotea, S., Arbune, A.-A., Niculet, E., & Arbune, M. (2024). Lymphomas and human immunodeficiency virus: Insights from a 15-year retrospective Romanian study. *Preprints*, 2024(12), 349.
- Radkiewicz, C., Bruchfeld, J. B., Weibull, C. E., Jeppesen, M. L., Frederiksen, H., Lambe, M., Jakobsen, L., El-Galaly, T. C., Smedby, K. E., & Wåsterlid, T. (2022). Sex differences in lymphoma incidence and mortality by subtype: A population-based study. *American Journal of Hematology*, 98(1), 23–30.
- Rende, F., Cavallari, I., Romanelli, M. G., Diani, E., Bertazzoni, U., & Ciminale, V. (2012). Comparison of the genetic organization, expression strategies and oncogenic potential of HTLV-1 and HTLV-2. *Leukemia Research and Treatment*, 2012, 876153.
- Rosadas, C., Assone, T., Sereno, L., Miranda, A. E., Mayorga-Sagastume, R., Freitas, M. A., Taylor, G. P., & Ishak, R. (2022). “We need to translate research into meaningful HTLV health policies and programs”: Webinar HTLV World Day 2021. *Frontiers in Public Health*, 10, 883080.
- Saber, Z. M., Alkhuzai, A., & Khaleel Alsaad, M. A. (2023). Histological pattern of non-Hodgkin lymphoma of Iraqi patients in Al-Amal hospital. *Journal of Wildlife and Biodiversity*, 7(S), 166–179.
- Traoré, C., Sanou, A., Somé, R. O., Sawadogo, S., Kouliadi, J., Konsegré, V., ... Kafando, E. (2020). Les lymphomes chez l’adolescent et l’Adulte au Centre Hospitalier Universitaire de Bobo-Dioulasso: À propos de 44 Cas. *Health Sciences and Disease*, 21(10), 2336.
- Vallinoto, A. C. R., Cayres-Vallinoto, I., Freitas Queiroz, M. A., Ishak, M. de O. G., & Ishak, R. (2019). Influence of immunogenetic biomarkers in the clinical outcome of HTLV-1 infected persons. *Viruses*, 11(11), 974.
- Wan, X., Young, K. H., & Bai, O. (2023). HBV-associated DLBCL of poor prognosis: Advance in pathogenesis, immunity and therapy. *Frontiers in Immunology*, 14, 1216610.
- Xavier, A. C., Attarbaschi, A., Gratzinger, D., & Balagué, O. (2024). Dedicated diagnostic approaches for mature B-cell non-Hodgkin lymphomas occurring in children, adolescents, and young adults. *Histopathology*, 86(1), 17–37.
- Zargari, R., Mahdifar, M., Mohammadi, A., Vahidi, Z., Hassanshahi, G., & Rafatpanah, H. (2020). The role of chemokines in the pathogenesis of HTLV-1. *Frontiers in Microbiology*, 11, 421.
- Zeyni, S. M. (2016). The correlation between HLA class II and β -thalassemia major in Al-Karama Teaching Hospital. *Journal of the Faculty of Medicine Baghdad*, 58(4), 366–370.