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# Exploring the Impact of ABO Blood Groups on BKV, CMV, and EBV Nephropathy among Haemodialysis Patients in Erbil City: A Cross-Sectional Analysis

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**Annotation:** Patients who have had an ABO-incompatible kidney transplant have a higher risk of contracting BKV infection. Patients on hemodialysis are still at serious risk for contracting Cytomegalovirus (CMV) infection. Patients who are immunocompromised, including those receiving hemodialysis, are at serious risk from Epstein-Barr virus (EBV). The current study aims at examine the connection between blood group and BKV, CMV, and EBV viral cases and controls.

This cross-sectional study was conducted in Erbil City, Kurdistan Region, Iraq, utilizing data that was routinely collected at the central laboratory and at the level of tertiary care centers. The investigation took place between November 1, 2024, and January 30, 2025. Hundred twenty hemodialysis patients and 120 control group members participated.

Information included gender, Age, Blood group, BKV, CMV, and EBV viral infection as determined by PCR and ELISA (IgM and IgG) were taken out electronically from medical records and laboratory databases at tertiary care centres and the central laboratory/Erbil, Iraq.

The age distributions of the hemodialysis patients and the control group did not appear to differ significantly (P>0.05). No significant differences (P>0.05) in gender distribution were observed. Significant differences between the control group and the hemodialysis group were found in the frequency of ABO blood groups and Rh factor. Significant variations (P<0.05) in the distribution of Rh factor and ABO blood groups between hemodialysis patients infected with Cytomegalovirus (CMV) and control groups, this was also applicable to EBV. Significant differences (P <0.05) in the frequency of ABO blood groups with Rh factor among hemodialysis patients with BK virus (BKV) infection. Male participants with blood group O are more susceptible to haemodialysis. Patients with Cytomegalovirus positive are mostly have blood groups O positive A +ve and B +ve. Patients who were A+ve were more susceptible to get BK and EBV.

**Keywords:** ABO, BK, CMV, EBV, Hemodialysis.

## Introduction:

Patients on hemodialysis and immunocompromised patients remain to be at great danger for getting BK virus (BKV) Nephropathy. Patients who were an ABO-incompatible renal transplant have a greater risk of getting BKV infection, based on new researches, that highlights the significance of near surveillance in these [1].

Moreover, it has been established that reactions between BKV and other viruses, such as Torque

Teno Virus (TTV), has impact on post-transplant graft task, representing a complicated interaction which might disturb nephropathy consequences. Understanding these interactions is crucial for making effective management strategies for BKV nephropathy in hemodialysis patients [2].

Patients who are on hemodialysis are at risk for infected with cytomegalovirus (CMV) infection. Latest study has observed into ways to cease CMV from reactivating, like utilized double-specific T cells prepared from stem cell grafts, that have revealed ability in dropping the viral load and associated issues [3].

Additionally, investigations about the kinetics of Cytomegalovirus DNA in blood specimens have shed light on the greatest periods for observing and management to decrease the threat of nephropathy. These outcomes highlight how critical customized Cytomegalovirus control plans are for hemodialysis patients [4].

Patients who are immunocompromised, comprising those getting hemodialysis, are at risk for Epstein-Barr virus (EBV). In order to evade problems such as post-transplant lymphoproliferative disorder (PTLD), it is critical to observe the EBV burden, rendering to new research about the existence and impacts of EBV infections in hematological illnesses. Similarly, studies has focused on how EBV reacts with other viruses, such as CMV, giving visions into the dynamics of co-infection and how it impacts graft job. Evolving thorough treatment plans for EBV-related nephropathy in hemodialysis patient needs comprehending of these correlations [5].

Hemodialysis patients' susceptibility to and harshness of viral nephropathy are affected by the ABO blood type system. Patients getting renal transplants which are ABO-incompatible are possible to grow BK virus nephropathy, based on recent research. Moreover, studies on infection risks subsequent ABO-incompatible renal transplantation specify that though the entire infection burden is considerable, it couldn't be all that dissimilar from that of ABO-compatible transplants, although cautiousness is still required . Evolving adjusted care plans that take into account both virus risks and ABO blood group-related vulnerabilities wants comprehending of these relations [6].

**Rationale for the Study**

The complicated reactions among EBV, CMV, BKV and blood types within the patients with hemodialysis stay hugely unknown in spite of the plentiful of research. The present study aimed at explaining this association, paying unusual care to the this reaction. Comprehending these associations is critical to making enhanced renal infection diagnosis and treatment [7].

**Aim of the Study**

The purpose of this study is to determine how blood group and hemodialysis patients are related to the BKV, CMV, and EBV viruses. More precisely, it seeks to:

1. Examine the connection between blood group and BKV, CMV, and EBV viral cases and controls [8].

2. To assess how age and sex affect blood group, BKV, CMV, and EBV virus in hemodialysis patients [9].

3. To investigate if hemodialysis patients' blood groups may be related [10].

4. ABO with Rh frequency in hemodialysis patients infected with BKV, CMV, and EBV [11].

**Methodology**

**Study Design and Participants**

This cross-sectional study was conducted in Erbil City, Kurdistan Region, Iraq, utilizing data that was routinely collected at the central laboratory and at the level of tertiary care centers. The investigation mmttook place between November 1, 2024, and January 30, 2025. Hundred twenty hemodialysis patients and 120 control group members participated [12].

### Inclusion Criteria

Participants between the ages of 40 and 65 who have had given their informed consent for a routine test that included either hemodialysis patients or renal health monitoring were included.

### Exclusion Criteria

Pregnancy, recent surgery within the previous six months, active cancers, or ongoing cancer treatments were all excluded from the current study. Furthermore, medications that are known to disrupt research, missing important information, or insufficient laboratory data were also excluded from the present study.

### Data Collection

### Data Source

The data were obtained from electronic medical records and laboratory databases at tertiary care centres and the central laboratory/Erbil, Iraq. The dataset contained routinely collected clinical and serological parameters.

### Collected Variables

The following information were taken out:

- ✓ Demographic Information: Gender, Age, and Blood group
- ✓ BKV, CMV, and EBV viral infection as determined by PCR and ELISA (IgM and IgG).

### Data Anonymization

To ensure confidentiality, personal identifiers were removed, and a unique study identification number was assigned to each participant. The data were stored in a secure manner, with access limited to authorized research personnel.

### Statistical Analysis

Graph-Pad Prism version 9.0 was utilized to conduct all the statistical analysis.

### Quality Assurance

- ✓ The laboratory conducted all serological analyses in accordance with established procedures..
- ✓ Three independent reviewers extracted the data to guarantee its accuracy.
- ✓ Every piece of equipment utilized in the lab for the tests was regularly calibrated.

### Results and Discussion:

Figure 1 displays there were no substantial changes in mean ages between the hemodialysis group and the control group, according to the data presented. The mean age of the hemodialysis group was 58.47 ± 8.89 years, whereas the control group was 58 ± 2.92 years. The hemodialysis group has a little greater mean age than the other group, although this difference was negligible. Although the hemodialysis group's wider age range, as shown by a higher standard deviation (8.89 vs. 2.92), suggests greater age variability, there was no indication that the two groups' average ages differ significantly. According to the statistics presented, the age distributions of the hemodialysis patients and the control group did not appear to differ significantly. Similar results from other studies were in line with our research that shown that, although individual characteristics may vary, age itself frequently does not significantly differ between these groups [13].

The bar graph illustrates the mean age of control individuals ($58.02 \pm 8.92$ years) and hemodialysis patients ($58.47 \pm 8.89$ years). Statistical analysis indicates no significant difference between the groups, as denoted by “ns” (not significant), suggesting comparable age distributions across both cohorts in this study (Figure 1)

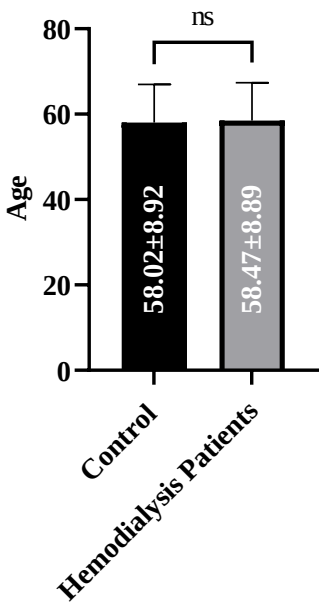


**Figure 1. Comparison of Age Between Control Group and Hemodialysis Patients**

Figure 2 shows that in a comparison between male and female participants in both the control and hemodialysis groups, no significant differences in gender distribution were observed. Both groups displayed an equal image of female and males, and alike sex percentages in hemodialysis group and control group. The means of age groups for the research population and other sociodemographic features didn't appear to be significantly affected by the gender. Whereas gender might affect some clinical results, like issues of dialysis or the development of kidney infections, before study has revealed that the demographic distribution of female and male patients in these groups was generally the same [14].

This suggests that significant variances between hemodialysis and control groups cannot be clarified only by gender, and which any noticed variations in health outcomes are likely to be clarified by other issues like comorbidities or management plans than gender differences[15].

The bar graph presents the gender distribution among control and hemodialysis patient groups, with each subgroup comprising 60 individuals. The equal representation of both males and females across the two cohorts ensures gender-based comparability, supporting balanced demographic analysis in subsequent clinical or statistical evaluations

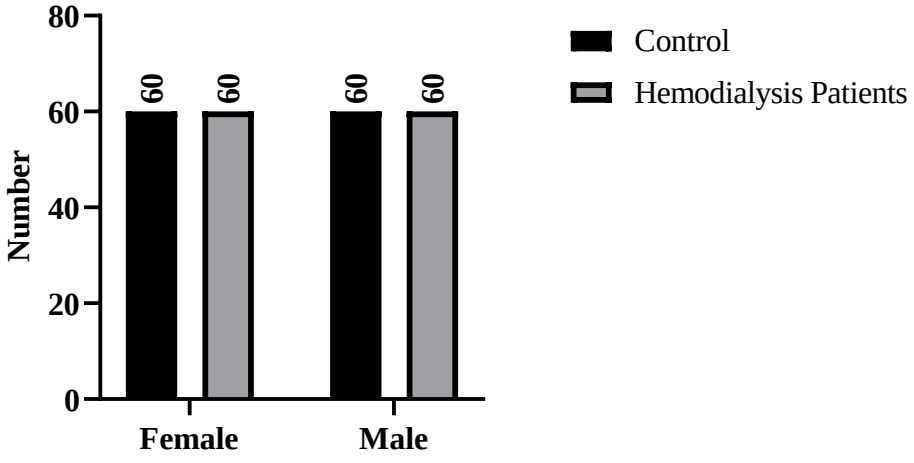


**Figure 2. Distribution of Female and Male Participants in Control and Hemodialysis Patient Groups**

Significant variances between hemodialysis and control group were detected in the occurrence of ABO blood types and Rh factor, as showed in Figure 3. The distribution of ABO blood types and Rh factor in hemodialysis patients differ somehow from that of control group. Specially, it was detected that blood groups B and A were more common among control, while blood group O , for instance , was higher among hemodialysis group. Moreover, the control group showed higher rates of Rh-negative participants than hemodialysis group, that revealed greater percentage of Rh-positive individuals [16].

These differences suggest that there might be underlying reasons for these differences in distribution of blood groups among the two groups, like genetic reasons or demographic features. The occurrence of ABO-blood groups and Rh-factor could be varied within different patients, particularly, among those who had chronic diseases like kidney infections, based on earlier study that denoted these results. This highlights how important is to take genetic and environmental factors into account whereas investigating the demographic features of hemodialysis patients [17].

The bar graph illustrates the distribution of ABO and Rh blood groups among control and hemodialysis patient groups. $A^+$ and $O^+$ are the most prevalent in both groups, with higher frequencies in patients (42 and 41 cases, respectively). Notably, $A^-$, $AB^-$, and $B^-$ groups appear more frequently in the patient cohort, suggesting a potential association between specific blood types and susceptibility to hemodialysis-related conditions (Figure 3)

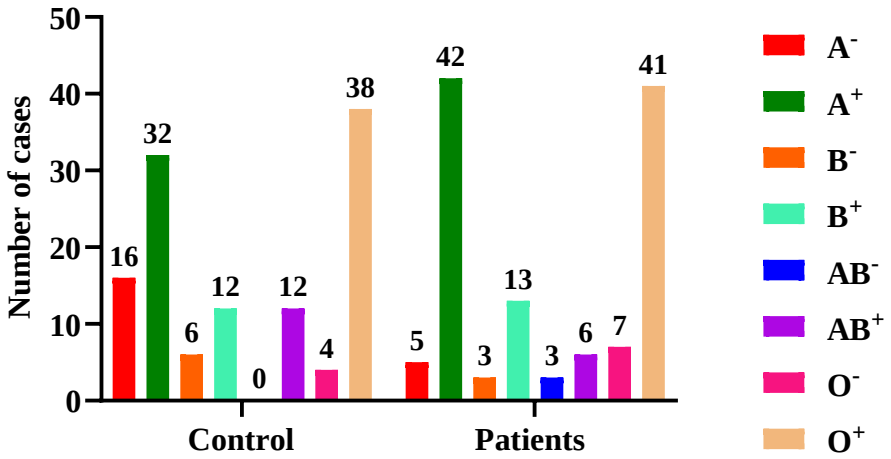


**Figure 3: Frequency of ABO with Rh in control and haemodialysis patients.**

In matching the occurrence of ABO-blood groups and RH-Factor among hemodialysis patients by gender, Figure 4 shows that there was detectable differences from control group. Male patients among hemodialysis group had greater occurrence of blood group O, while female patients revealed greater occurrence of blood group A and B. Furthermore, a higher proportion of Rh-positive people was denoted among male and female participants, signifying a great difference in the distribution of Rh-factor among female and male haemodialysis patients [18].

The ABO and Rh-factor circulation were more equally stable in the control group, with no with no obvious gender-based differences, when these outcomes compared with the control group. These outcomes associated with previous research that detected gender-based variances among blood group occurrences within participants with chronic diseases including kidney disease, specially researches by Suryawanshi *et al*. and Mehmood *et al*. exhibited that blood types distributions, comprising Rh-factor, could be varied among female and male hemodialysis patients, that might be happened by hormonal, environmental or genetic influences. The documented variances among hemodialysis group imply the probable impact of gender on these patients' demographic features [19].

This bar graph displays the distribution of ABO and Rh blood groups among female and male

hemodialysis patients. $A^+$ and $O^+$ blood groups are predominant in both sexes, with $O^+$ slightly higher in males (25 cases) than females (16 cases). Other blood groups show relatively low and evenly distributed frequencies, indicating gender-based similarities in blood group prevalence among the patient cohort (Figure 4).

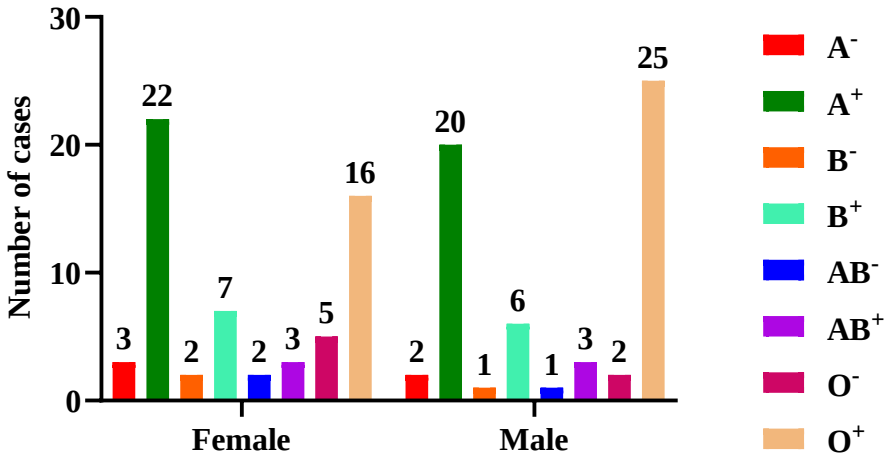


**Figure 4: Frequency of ABO with Rh in hemodialysis patients according to the gender.**

The current study has showed prominent variances in the distribution of Rh-factor and ABO-blood types between haemodialysis patients infected with Cytomegalovirus (CMV) and control group (Figures 5 A, B). Particularly, matched to other blood groups, CMV-positive patients were significantly more likely to have blood groups B +ve, O +ve, A+ve [20].

These findings were close to research revealing that blood groups which are non-O and Rh-+ve were associated to an elevated risks of viral infections, like Cytomegalovirus. Furthermore, there was no mentionable correlation between CMV-positivity and blood groups in a research of thalassemia patients, implying that genetic variables might affect an individuals' susceptibility to infection with CMV [21].

These results denoted how important it was to take blood group and Rh factor into account whent measuring the danger of infection in hemodialysis patients. Moreover, Pandey and Agrawal found that hemodialysis patients ABO-blood types distribution was greatly varied from the general population, that might have an influence on the occurrence of CMV-infection in this demographic [22].

The two bar graphs compare the distribution of ABO and Rh blood groups among virus-negative and virus-positive hemodialysis patients.

In the first graph, virus-negative patients display a more varied distribution across all blood groups, with $A^+$ (25 cases) and $O^+$ (21 cases) being the most frequent. In contrast, the second graph shows that all virus-positive patients belong exclusively to Rh-positive groups, with $A^+$ (42 cases) and $O^+$ (41 cases) dominating, while no cases were observed in Rh-negative groups. This suggests a potential link between Rh positivity and susceptibility to viral infections in hemodialysis patients, warranting further investigation into immunohematological predispositions (Figure 5)

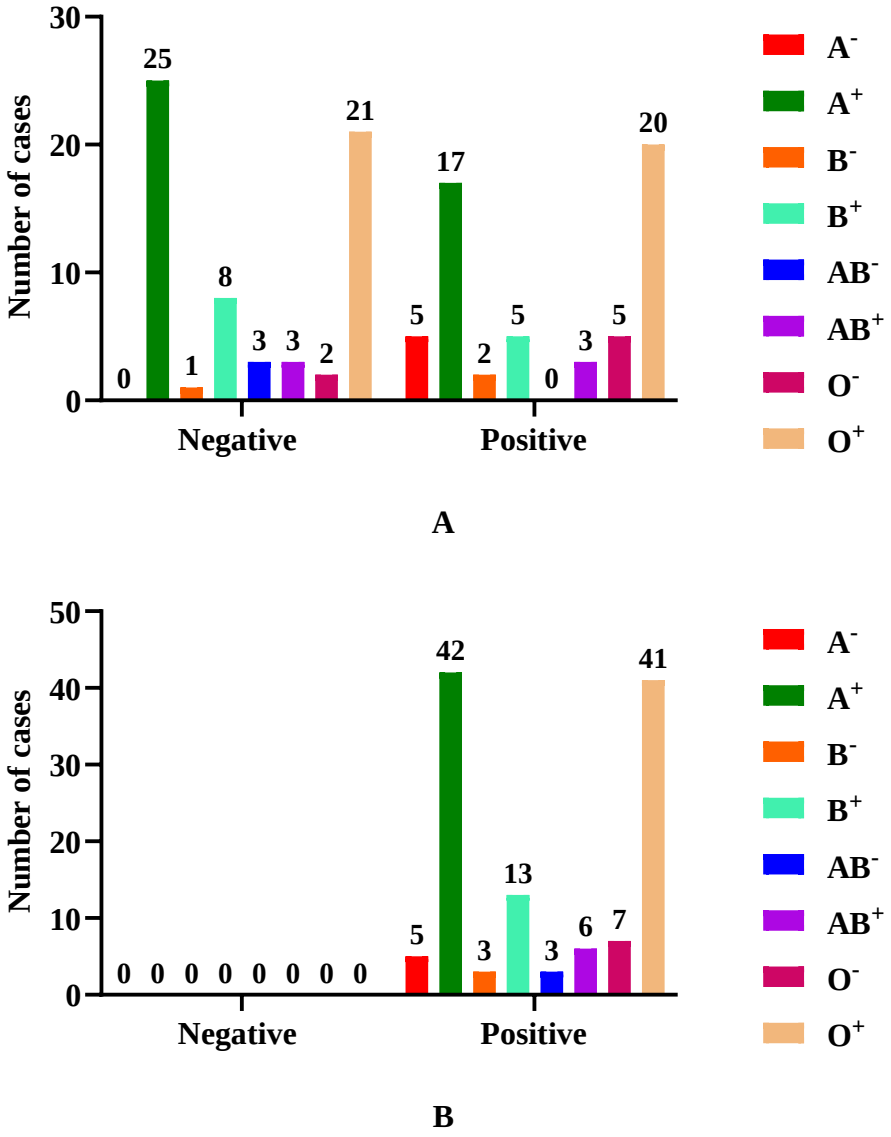


**Figure 5: Frequency of ABO with Rh among hemodialysis patients with CMV: A: negative and positive IgM, B: negative and positive IgG.**

In figures 6 A and 6B when matching the IgG and IgM antibodies, there were remarkable differences in the frequency of ABO and Rh-factor among hemodialysis patients that infected with EBV. The Rh-factor and ABO-Blood groups were distributed as following among the patients with anti-EBV-IgM positive: O+ve (20 patients), A +ve (28 patients), and B +ve (10 patients), it is backing up the findings from other study that detected variances in the occurrence of viral infection by blood types [23].

In oppositions, the ratio of O +ve (15patients), A +ve (15 patients) and B +ve (3 patients) within patients with anti-EBV IgG positive supported results of immune system differences in patients with continuous infection. Based on study on viral infections and immunological responds, EBV-infection might have an affect on the distribution of blood types in this population, as these results indicated that there was a significant variance in the occurrence of ABO-blood types and Rh-factors based on EBV-antibody status [24].

The two bar graphs illustrate the distribution of ABO and Rh blood groups among virus-negative and virus-positive hemodialysis patients for different viral infections. In both graphs, $A^+$ and $O^+$ blood groups are the most frequently observed among virus-positive patients, particularly $O^+$ (32 and 15 cases), suggesting a stronger association with viral susceptibility. Conversely, virus-negative groups show a more dispersed distribution, with $A^+$ (19–28 cases) and $O^+$ (9–26 cases)

still dominant but less concentrated. The consistent absence or low frequency of Rh-negative groups across both infection statuses further supports a potential immunological link between Rh positivity and viral infections. These patterns highlight the need for expanded studies investigating how blood group antigens may influence viral susceptibility and outcomes in hemodialysis populations (Figure 6, A-B).

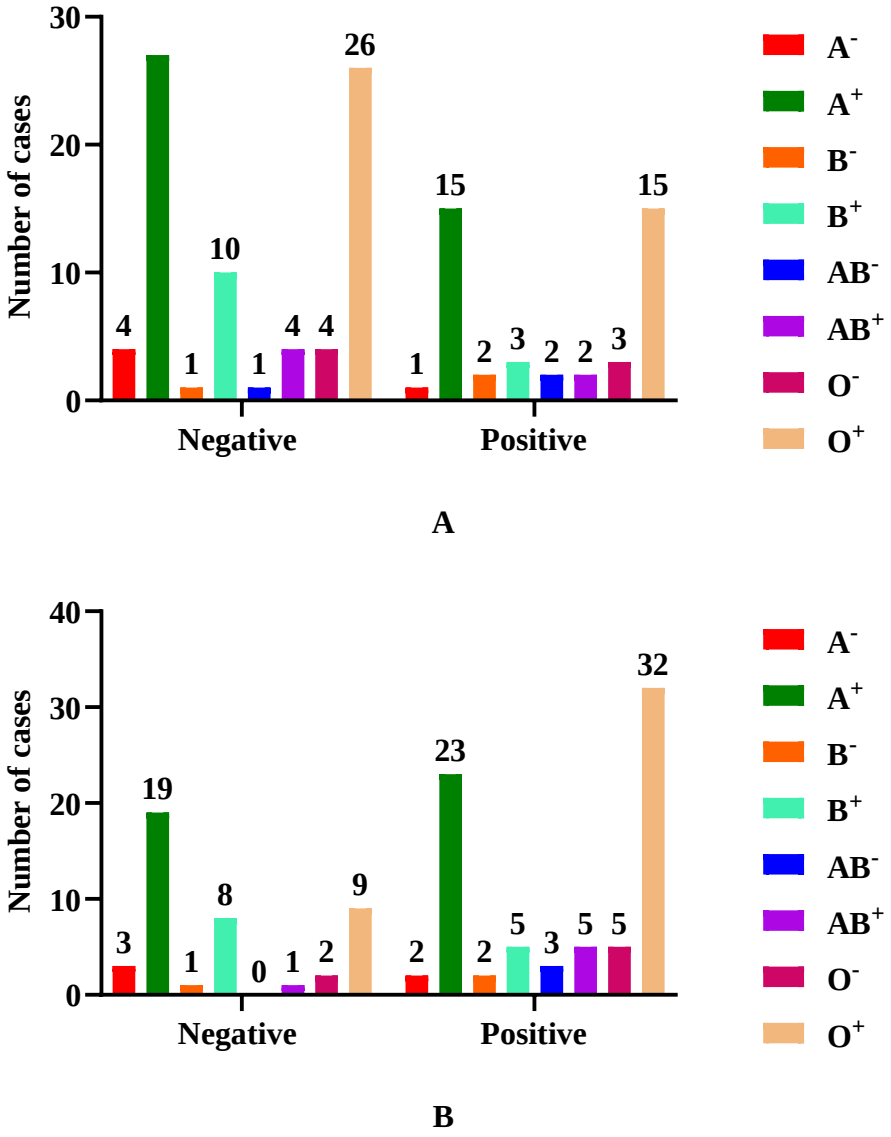


**Figure 6: Frequency of ABO with Rh among hemodialysis patients with EBV: A: negative and positive IgM, B: negative and positive IgG.**

The distribution of Rh-factor and ABO- blood types in patients infected with anti-BKV IgM positive was as following: O +ve (21 patients), A +ve (22 patients), and B +ve (6 patients). This was close with previous study that suggest viral infections could affect blood types incidences in immunocompromised populations [25].

Figure seven shows the significant variations in the incidence of Rh-factor and ABO-blood types in hemodialysis patients with BKV infection, particularly when matching IgG and IgM antibodies status. Nevertheless, when matching IgG and IgM status anti-BKV-IgG positive revealed the following incidences: O +ve (20 patients), A +ve (20 patients), and B +ve (7 patients), showing a minor variation in the ABO distribution [26].

In accordance with results with researchers testing the impacts of viral infection on blood types occurrences in hemodialysis patients, these findings suggest that though the variances between

IgG and IgM positive groups were not significant, BKV infection might still be occurred in modifying blood types distributions in this group[27].

The two bar graphs demonstrate ABO and Rh blood group distributions among virus-negative and virus-positive hemodialysis patients. In both datasets, $A^+$ and $O^+$ remain the most prevalent blood types regardless of infection status. However, virus-positive groups tend to show reduced overall diversity in blood group representation, with notable drops in $A^+$ (from 32 to 10) and increases in specific Rh-positive blood types like $B^+$ and $AB^+$. Conversely, virus-negative individuals display broader variation across blood groups. These findings reinforce patterns observed in earlier graphs, suggesting that certain Rh-positive ABO groups, particularly $O^+$ and $B^+$, may confer increased susceptibility to viral infections in immunocompromised hemodialysis populations. Further immunohematological studies are warranted to explore these associations and their mechanistic underpinnings (Figure 7, A-B)

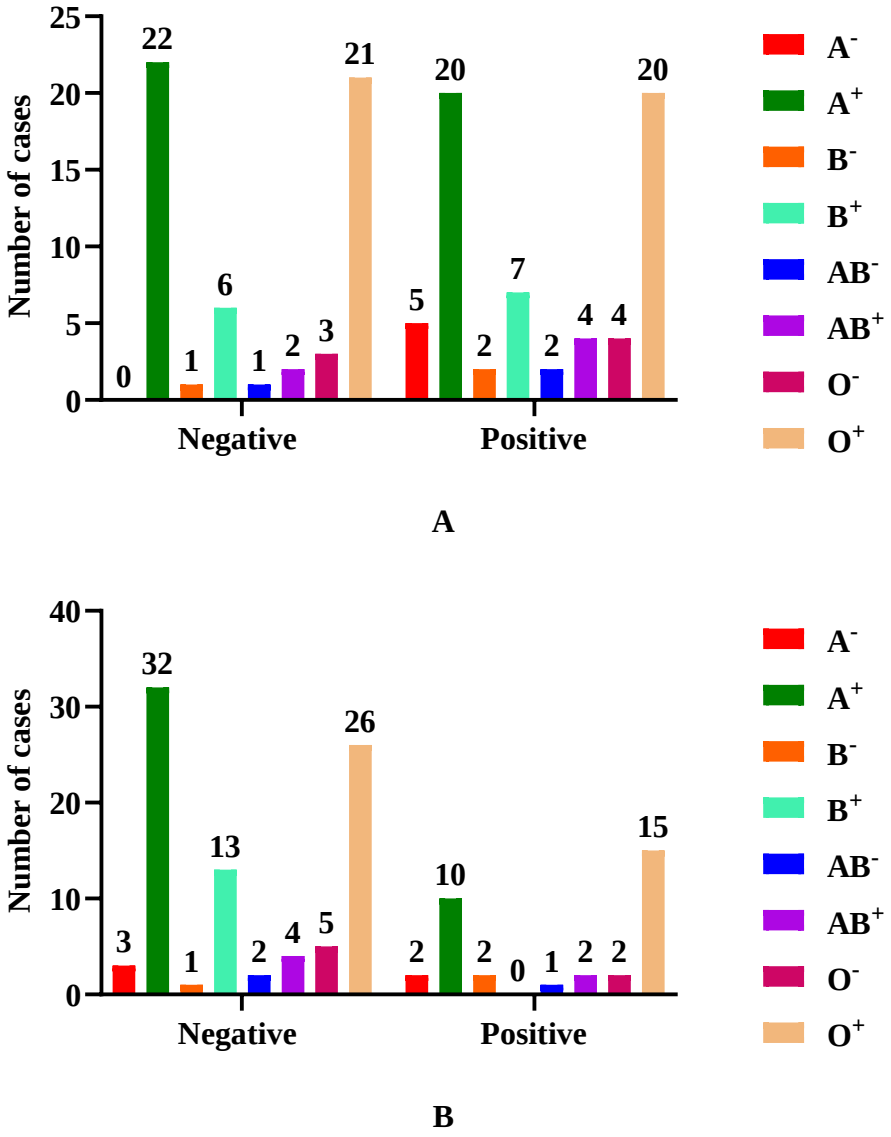


**Figure 7: Frequency of ABO with Rh among hemodialysis patients with BKV: A: negative and positive IgM, B: negative and positive IgG.**

**Conclusions:**

This cross-sectional study underscores the significant associations between ABO blood groups, Rh factors, and the prevalence of BKV, CMV, and EBV infections among hemodialysis patients in Erbil City. The findings reveal that male patients with blood group O and Rh-positive status are

particularly more susceptible to hemodialysis, and that CMV and EBV infections are notably higher among individuals with blood groups $O^+$, $A^+$, and $B^+$. Additionally, $A^+$ individuals exhibit heightened susceptibility to BKV infection. These results align with prior research suggesting a potential immunohematological link in viral vulnerability among immunocompromised populations, including those undergoing renal replacement therapy. The implications of this study are twofold: first, blood group profiling could enhance individualized infection risk assessment and preventative strategies for hemodialysis patients; second, Rh factor distribution should be considered in clinical monitoring to anticipate viral comorbidities. However, the biological mechanisms underlying these associations remain poorly understood. Therefore, future studies should aim to explore the immunogenetic pathways linking ABO and Rh systems with viral pathogenesis. Multi-center longitudinal studies with larger sample sizes, integrated with molecular virology and immunogenomics, would be instrumental in clarifying causality and guiding precision nephrology practices. Moreover, investigating the interplay of blood group antigens with antiviral immune responses could contribute to novel therapeutic strategies for managing viral nephropathy in dialysis-dependent populations.

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