The Role of Blood Group in Cancer Risk: Correlations with Site, Age, and Body Mass Index

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ABSTRACT
Background: Cancer is a complicated group of diseases in which cells grow and divide without being controlled. It is still one of the main reasons of death in the world, which presents major public health issues. Blood group links to cancer risk have been getting more and more attention over the past few years, among other things being studied.
Aim of the study: This study aimed to assess the relation between ABO blood groups and the occurrence of different cancer types among the population of Kirkuk city.
Patients and methods: This cross-sectional study was carried out in Kirkuk city from the period 15th October 2023 to 15th May 2024 on cancer patients of Kirkuk's Oncology and Hematology Centre. Data was collected from medical records and patient interviews to examine demographic characteristics, lifestyle factors, medical history, and potential exposures. The study included 398 patients diagnosed with cancer within a specified time frame, selected from medical records of healthcare facilities in the target area.. Blood samples were collected from each participant in the study for determination of blood group and Rh.
Results: The study reveals that breast cancer is the most prevalent cancer, accounting for 45.98% of all cases. The study presents the distribution of cancer patients according to their blood groups, with O positive and A positive blood types accounting for the highest percentage at 33.67%. Other blood types such as B positive, AB positive, O negative, B negative, AB negative, and A negative are represented in smaller percentages ranging from 1.26% to 20.60%. The duration of cancer is examined in relation to blood groups, providing insights into mean durations across different ABO blood types and Rh factors. Blood type A exhibits the longest mean duration at 1.71 years, followed closely by blood type B at 1.74 years, while blood type O presents a slightly shorter mean duration at 1.52 years. In the current study, blood group A is predominantly seen in brain cancer for males (100%), with a considerable presence in digestive system cancers, split nearly evenly between males (41.94%) and females (58.06%). Blood group B appears infrequently but is represented in the digestive system and female reproductive cancers, demonstrating a minor presence compared to other groups. Skin cancer shows a potential link between blood group distribution and family history of the disease, suggesting a genetic predisposition or a significant association worth further investigation.

1. Introduction

Cancer is a complicated group of diseases in which cells grow and divide without being controlled. It is still one of the main reasons of death in the world, which presents major public health issues (1). There has been increasing focus on the association between blood type and cancer risk in recent years, with many studies being conducted (2). A study conducted by a British research group over fifty years ago demonstrated that individuals with stomach cancer had a higher likelihood of having blood group A and a lower likelihood of having blood group O. This study was significant since it was the first attempt to establish a correlation between ABO blood types and the susceptibility to developing cancer (3). The ABO blood type system is well recognized and intensively researched in humans. It has been regarded as a potential indication of both the risk and prognosis of cancer (4). There is ongoing interest in investigating the correlation between ABO blood group and solid malignancies such as pancreatic, stomach, and colon cancers. However, the findings are currently inconclusive. However, these linkages are often weak and are overwhelmed by more influential risk factors such as genetics, lifestyle choices, and the environment (6). The available data regarding the association between ABO blood group and the risk of colorectal cancer is inconclusive. Several studies have indicated a slightly elevated risk for those with blood type A. Nevertheless, these findings remain inconclusive, and the correlation between the variables is still not well comprehended. Additional elements are believed to have a more significant impact on the formation of solid tumors. Further research in this field may provide more

insights into the potential correlations between ABO blood group and the risk of developing solid cancers (7). ABO blood types have a high correlation with an elevated vulnerability to cancer. This is mostly due to interrelated processes such as inflammation, immune response, and blood clotting, which play a crucial role in the genesis and spread of cancer (1). The ABO blood types, initially discovered by Karl Landsteiner in 1901, are of utmost importance in the realm of medicine. The ABO blood types are identified by the presence of carbohydrate moieties that are displayed on the surface of red blood cells and connected to a protein backbone, known as the H antigen (7). Confirmation of the first findings would need the implementation of meticulously designed and impeccably executed prospective cohort studies (1,2). An epidemiological research done in the United States analyzed two large cohorts and found a statistically significant link between self-reported ABO blood types and the risk of pancreatic cancer (8). The inheritance of ABO blood types is determined by genes found on chromosome 9q34. Furthermore, a study using genome-wide association analysis discovered a correlation between specific DNA sequence variants in the ABO region and a heightened susceptibility to pancreatic cancer. These findings further support the notion that ABO blood type is a key indication of the risk of developing pancreatic cancer (9). Multiple research conducted over the last five decades have consistently found a link between ABO blood type and cardiovascular disease (10,11). Recent extensive assessment and statistical analysis have shown that persons with a blood type other than O have approximately double the risk of developing venous thrombosis (12,13). In a further systematic study conducted by the same authors, a less robust nevertheless significant association was identified between non-O blood type and arterial thrombosis. The odds ratio (OR) for myocardial infarction was 1.28, whereas for ischemic stroke it was 1.17 (14). The ABO blood type exerts a substantial influence on the levels of low-density lipoprotein and total serum cholesterol. The primary reason for this correlation may be attributed to the significant impact of the ABO blood type system on hemostasis, particularly on the levels of von Willebrand factor (VWF) and coagulation factor VIII (FVIII) in the plasma. The correlation between ABO blood group types and cancer has been extensively studied for the past five decades, rendering it an intriguing area of research (15). The most significant connection has been established between pancreatic and stomach cancers (16). This study aimed to assess the relation between ABO blood groups and the occurrence of different cancer types among the population of Kirkuk city.

2. Methodology

Patients and Methods

Study Design

This cross-sectional study was carried out in Kirkuk city from the period 15th October 2023 to 15 May 2024 on cancer patients who admitted to Kirkuk's Oncology and Hematology Centre. Study sample was convenient, a Data was collected from medical records and patient interviews to examine demographic characteristics, lifestyle factors, medical history, and potential exposures.

Patients

The study included 398 patients diagnosed with cancer within a specified time frame. Participants were categorized based on age, sex, residence, educational level, socioeconomic status, occupation, blood group, Rh factor, cancer type, family history of cancer, marital status, smoking and alcohol consumption habits, body mass index (BMI), dietary habits, medical conditions, drug and medication history, viral infections, and exposures to chemicals or radiation.

Ethical approval: Approval permission was presented to the director of Kirkuk Health Directorate/Kirkuk Oncology Center according to the document number 671 (including the number and the date in 19/10/2023). An interview was conducted with these patients using a questionnaire form created by the investigator, which included demographic information such as age,

gender, and so on.

Methods

Information regarding participant demographics, including age, sex, residence, educational level, socioeconomic status, and occupation, was extracted from medical records. Patient interviews were conducted to obtain additional details on lifestyle factors such as smoking and alcohol consumption habits, dietary patterns, medical conditions, drug and medication history, viral infections, and exposures to chemicals or radiation.

Blood samples were collected from each participant in the study for determination of blood group and Rh

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics and factors associated with cancer occurrence. Statistical analyses, including chi-square tests and regression models, were conducted to assess the relationship between various factors and cancer occurrence. Computerized statistically analysis was performed using SPSS 26 statistic program. Comparison was carried out using, Chi-square for correlation and for determination of probability value (P-value). The P value $\leq$ 0.05 was considered statistically significant, while for those which its P value was greater than 0.05 considered non-significant statistically.

3. Results and discussion

The study showed that breast cancer constitutes the largest proportion at 183 cases, (45.98%) of the total. Following breast cancer, digestive system cancers account for 79 cases, representing 19.85%. The reproductive system is represented with 24 cases for females (6.03%) and 28 cases for males (7.04%). Respiratory system cancers have 27(6.78%), urinary system cancers have 17(4.27%), and lymphoma cancers(3.52%). Less prevalent cancers include leukemia with 9(2.26%), sarcoma with 7(1.76%), skin cancer with 4 (1.01%), and those with an unknown primary origin with 3(0.75%). While the Brain cancer was the lowest rate in this study, 3(0.75%).

Table 1: Distribution of cancer patients according to site body system

Cancer group		No.	%
Breast cancer		183	45.98%
Digestive system		79	19.85%
Reproductive system	Female	24	6.03%
	Male	28	7.04%
Respiratory system		27	6.78%
Urinary system		17	4.27%
Lymphoma		14	3.52%
Leukemia		9	2.26%
Sarcoma		7	1.76%
Skin		4	1.01%
Unknown primary origin		3	0.75%
Brain		3	0.75%
Total		398	100%

The study reveals that the 48-57 age group experiences the highest cancer cases (31.41%), followed by the 58-67 age group (26.63%). This indicates increased vulnerability to cancer as individuals age. Younger age groups (<18 years) have lower incidence (Table 4.4). The study reveals that brain cancer patients are younger, with a mean age of 40.67 years, followed by skin, breast, and male reproductive system cancer patients. The average age of leukemia patients is 47.67 years, while lymphatic, respiratory, and urinary system cancer patients are 50 years, 60.30, and 57.76 years respectively. Table

2

Table 4. 1: Distributions cancer patients according to age groups

Age groups	No.	%
<18	3	0.75%
18-27	7	1.76%
28-37	21	5.28%
38-47	60	15.08%
48-57	125	31.41%
58-67	106	26.63%
68-77	53	13.32%
78-87	23	5.78%
Total	**398**	**100%**

Figure 1 presents the distribution of cancer patients according to their blood groups, with percentages included for each category. Both O positive and A positive blood types accounts for the highest percentage at 33.67% for each,. Other blood types such as B positive, AB positive, O negative, B negative, AB negative, and A negative are represented in smaller percentages ranging from 1.26% to 20.60%.

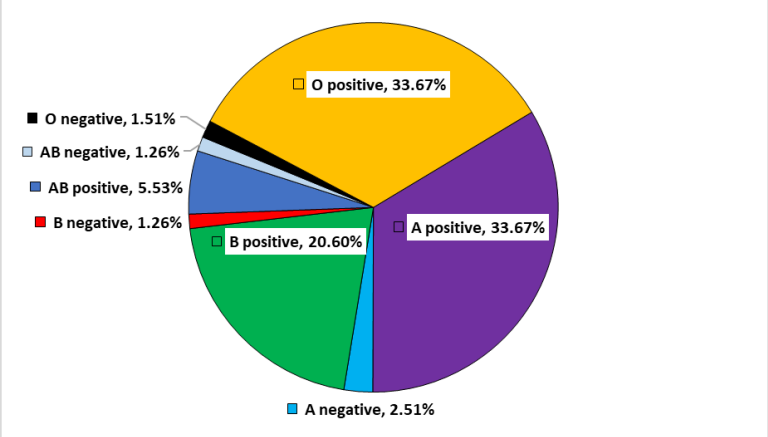

Figure 1: distribution of cancer patients concerning blood groups

In the current study, cholangial carcinoma and esophageal cancer each show a stark division, with cases split evenly at 50% between blood groups A and O for cholangial, and A and B for esophageal. Colon cancer shows a higher incidence in blood group A at 38.89% and O at 36.11%, with lower occurrences in B and AB. Gastric cancer and gallbladder cancer both exhibit a relatively even distribution across A, B, and O. Notably, hepatocellular carcinoma (HCC) presents predominantly in blood group A at 60%. Pancreatic cancer is most common in blood group A at 57.14%, with a lesser spread into B and O. Rectum cancer cases were exclusively found in blood group O at 100%, and tongue cancer occurred only in blood group B. Figure 2

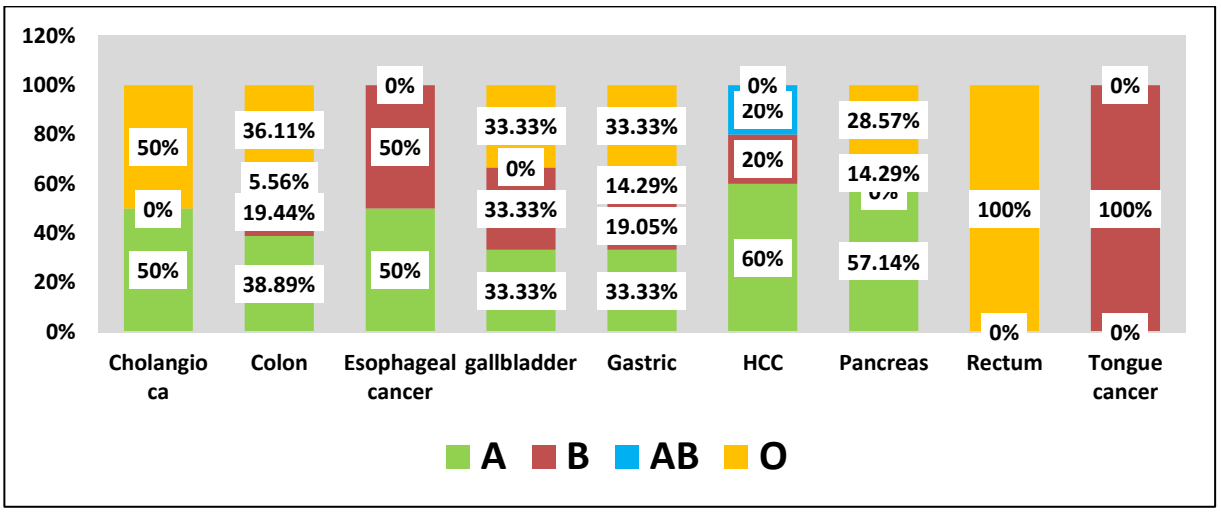

Figure 2: Distribution of patients with digestive system cancers according to their blood groups

In Table 3, the duration of cancer is examined in relation to blood groups, providing insights into mean durations across different ABO blood types and Rh factors, along with corresponding p-values. Interestingly, ABO blood type A exhibits the longest mean duration at 1.71 years, followed closely by blood type B at 1.74 years, while blood type O presents a slightly shorter mean duration at 1.52 years. Blood type AB falls in between with a mean duration of 1.44 years. However, the p-value of 0.035 suggests a statistically significant difference in the duration of cancer among the ABO blood groups. Conversely, when considering Rh factor, both Rh-positive and Rh-negative groups show relatively similar mean durations at 1.64 years and 1.55 years respectively, with a p-value of 0.014 indicating a statistically significant difference between the two groups.

Table 3: Mean of cancer durations across different ABO blood types and Rh factors

Blood group		Duration of Cancer (year)		P-value
		Mean	SD	
ABO	A	1.71	2.62	0.035
	AB	1.44	1.65	
	B	1.74	1.99	
	O	1.52	1.56	
Rh	Positive	1.64	2.13	0.014
	Negative	1.55	1.31	

Table 4 provides an overview of cancer patients' distribution according to body mass index (BMI), presenting mean values and standard deviations for each cancer type across various body systems. The lymphoma cancer patients having the highest mean BMI at 44.83. Respiratory system cancer patients have the lowest mean BMI at 24.66. Breast cancer patients have a high mean BMI of 32.21, while leukemia patients and those with unknown primary origin cancer have relatively high mean BMIs at 29.60 and 27.37, respectively. Other cancer groups show moderate mean BMIs ranging from 25.03 to 29.53. A statistically significant association between cancer type and BMI is suggested..

Table 4: Distribution of cancer patients according to BMI

Cancer group	BMI	
	Mean	SD
Brain	25.03	4.50
Breast cancer	32.21	22.17
Digestive system	27.16	5.25
Female reproductive system	29.53	7.04
Male reproductive system	27.22	5.80
Leukemia	29.60	5.98
lymphoma	44.83	63.63
Respiratory system	24.66	4.52

Sarcoma	26.94	5.67
Skin	27.05	4.24
Unknown primary origin	27.37	5.49
Urinary system	26.96	6.46
P-value	0.044	

In the current study, individuals with blood group AB exhibit the highest mean BMI at 38.40 kg/m², indicating a potentially higher body weight in this group compared to others. Conversely, individuals with blood group B demonstrate a relatively lower mean BMI at 28.43 kg/m². Interestingly, the p-value for blood group A is 0.012, suggesting a statistically significant association between blood group A and BMI, while other blood groups do not show significant associations with BMI. However, the Rh factor does not appear to have a significant association with BMI, as indicated by the p-value of 0.61.

Table 5: Distribution of cancer patients according to their blood groups and the associated body mass index

Blood group of cancer patients	No.	BMI (Kg/m2) Mean ±SD	P-value
A	144	30.02 ± 20.45	0.012
AB	27	38.40 ± 51.28	
B	87	28.43 ± 6.32	
O	140	29.65 ± 12.09	
Rh			
Positive	372	30.06 ± 20.32	0.61
Negative	26	30.79 ± 5.72	

In the current study, for patients under 18 years, all cases belong exclusively to blood group O (100%). As ages progress, there is a more varied distribution: for ages 18-27, blood group O is still predominant at 50%, but groups A and B are also present at 25% each. The prevalence shifts towards blood group A in the 28-37 and 38-47 age brackets, marking the highest incidence at 52.38% and 41.67% respectively. Blood group O then takes precedence again in the 48-57 age group with 42.40%, while group A remains significant across all older age brackets, especially notable at 40% in ages 58-67. The oldest groups (68-77 and 78-87) show a balanced spread among A, B, and O, each contributing significantly to the overall distribution. This data indicated a potential correlation between age, blood type, and the prevalence of certain conditions, with blood group O notably prevalent among the youngest and blood group A prominent in older age. Table 6

Table 6: Distribution of cancer patients according to their blood groups and age

Age (year)	Blood group							
	A		**B**		**AB**		**O**	
	No.	%	No.	%	No.	%	No.	%
<18	0	0%	0	0%	0	0%	3	100%
18-27	2	25%	2	25%	0	0%	4	50%
28-37	11	52.38%	6	28.57%	1	4.76%	3	14.29%
38-47	25	41.67%	12	20.0%	4	6.67%	19	31.67%
48-57	38	30.4%	28	22.4%	6	4.80%	53	42.40%
58-67	42	40.0%	20	19.05%	8	7.62%	35	33.33%
68-77	18	33.96%	12	22.64%	7	13.21%	16	30.19%
78-87	8	34.78%	7	30.43%	1	4.35%	7	30.43%

P-value: 0.41

In the current study, blood group A is predominantly seen in brain cancer for males (100%), with a considerable presence in digestive system cancers, split nearly evenly between males (41.94%) and

females (58.06%). Blood group B, while absent in brain cancer cases, shows a notable occurrence in female lymphoma cases (100%) and male digestive system cancers (40%). Blood group AB appears infrequently but is represented in the digestive system and female reproductive cancers, demonstrating a minor presence compared to other groups. Blood group O is especially prevalent, appearing in 100% of female brain cancer cases and evenly across male and female respiratory system cancers (71.43% and 28.57%, respectively). Table 7

Table 7: Distribution of cancer patients according to their blood groups and sex

Cancer group	Sex	Blood group							
		A		B		AB		O	
		No.	%	No.	%	No.	%	No.	%
Brain	Male	2	100%	0	0%	0	0%	0	0%
	Female	0	0%	0	0%	0	0%	1	100%
Breast cancer	Female	63	100%	42	100%	17	100%	61	100%
Digestive system	Male	13	41.94%	6	40%	2	28.57%	11	42.31%
	Female	18	58.06%	9	60%	5	71.43%	15	57.69%
Female reproductive	Male	0	0%	0	0%	0	0	0%	0
	Female	6	100%	2	100%	1	100%	15	100%
Leukemia	Male	2	50%	1	50%	0	0%	2	66.67%
	Female	2	50%	1	50%	0	0%	1	33.33%
Lymphoma	Male	2	66.67%	0	0%	0	0%	3	60%
	Female	1	33.33%	6	100%	0	0%	2	40%
Male reproductive	Male	6	100%	5	100%	2	100%	15	100%
Respiratory system	Male	9	75%	6	75%	0	0%	5	71.43%
	Female	3	25%	2	25%	0	0%	2	28.57%
Sarcoma	Male	3	42.86%	0	0%	0	0%	0	0%
	Female	4	57.14%	0	0%	0	0%	0	0%
Skin	Male	2	66.67%	0	0%	0	0%	1	100%
	Female	1	33.33%	0	0%	0	0%	0	0%
Unknown primary origin	Male	1	50%	0	0%	0	0%	0	0%
	Female	1	50%	0	0%	0	0%	1	100%
Urinary system	Male	4	80%	5	71.43%	0	0%	3	60%
	Female	1	20%	2	28.57%	0	0%	2	40%

In the current study breast cancer shows a balanced distribution across all blood groups in both urban (A: 35.29%, B: 20.59%, AB: 10.29%, O: 33.82%) and rural areas (A: 31.91%, B: 29.79%, AB: 6.38%, O: 31.91%). Digestive system cancers also present a notable variation, particularly in rural settings with blood group A at 44% and O at 40%. Urban leukemia cases are predominantly in blood groups A and B (40% each), while rural lymphoma cases are primarily in blood group B (75%). Male reproductive system cancers and respiratory system cancers show a strong presence of blood group O in rural areas (71.43% and 75% respectively), contrasting with a more mixed distribution in urban areas. Table 8

Table 8: Distribution of cancer patients according to their blood groups and residence

Cancer types	Residence	Blood group							
		A		B		AB		O	
		No.	%	No.	%	No.	%	No.	%
Brain	Urban	2	66.67%	0	0%	0	0%	1	33.33%
	Rural	0	0%	0	0%	0	0%	0	0%
Breast cancer	Rural	15	31.91%	14	29.79%	3	6.38%	15	31.91%
	Urban	48	35.29%	28	20.59%	14	10.29%	46	33.82%
Digestive system	Rural	11	44%	3	12%	1	4%	10	40%
	Urban	20	37.04%	12	22.22%	6	11.11%	16	29.63%
Female reproductive sys	Rural	3	30%	1	10%	0	0%	6	60%
	Urban	3	21.43%	1	7.14%	1	7.14%	9	64.29%
Leukemia	Rural	2	50%	0	0%	0	0%	2	50%
	Urban	2	40%	2	40%	0	0%	1	20%

Lymphoma	Rural	0	0%	3	75.00%	0	0%	1	25.00%
	Urban	3	30%	3	30%	0	0%	4	40%
Male reproductive	Rural	1	14.29%	1	14.29%	0	0%	5	71.43%
	Urban	5	23.81%	4	19.05%	2	9.52%	10	47.62%
Respiratory system	Rural	6	75.00%	1	12.50%	0	0%	1	12.50%
	Urban	6	31.58%	7	36.84%	0	0%	6	31.58%
Sarcoma	Rural	1	100%	0	0%	0	0%	0	0%
	Urban	6	100%	0	0%	0	0%	0	0%
Skin	Rural	0	0%	0	0%	0	0%	1	100%
	Urban	3	100%	0	0%	0	0%	0	0%
Unknown primary origin	Rural	0	0%	0	0%	0	0%	1	100%
	Urban	2	100%	0	0%	0	0%	0	0%
Urinary system	Rural	3	37.50%	3	37.50%	0	0%	2	25.00%
	Urban	2	22.22%	4	44.44%	0	0%	3	33.33%

Discussion

The study showed that O positive and A positive blood types accounts for the highest percentage at 33.67% for each,. Other blood types such as B positive, AB positive, O negative, B negative, AB negative, and A negative are represented in smaller percentages ranging from 1.26% to 20.60%. The current study reveals distinct distributions of ABO blood groups across various cancer types. Different studies have found different levels of link between blood type and breast cancer. For instance, it has been said that people with the A blood group are more likely to have breast cancer than people with the O blood group (17). Colon cancer, ovarian and breast cancer, liver and pancreatic cancer, prostate cancer, and brain tumors were all looked at in another study. That doesn't mean that other blood types don't get cancer. It just means that people with blood type A are less able to fight it off. Cancer cells seem to have certain type (A) traits that make them hard for people with blood type (A) to spot by their immune systems (18). A lot of research has shown that women with blood type A are more likely to have bad results and the cancer will spread faster. Research shows that women with blood type A are more likely to get breast cancer. This is true even for women who are thought to have a low risk for cancer (19). The study was also agreed with Zaki et al (20) who found that prostate cancer patients with blood group O had slightly more than one-third of total prostate cancer patients. This finding was reported in other studies conducted by Joh et al (21) and Huang et al (22) in China as O blood group had high frequency rates. This was also reported by previous studies from other countries (23,24). It's hard to figure out how the ABO blood group system directly affects the growth of cancer. There are, however, several lines of scientific evidence that could explain the connections that were seen. The ABO gene creates a glycosyltransferase enzyme that has three main forms (A, B, and O) that bind to different types of substrates (1,2). Glycosyltransferases of types A, B, and O attach N-acetylgalactosamine, D-galactose, or no sugar to the H antigen, which serves as the protein backbone (3,4). Blood group proteins are shown on the surface of red blood cells and several other organs in the body. It was discovered that the blood group antigens present on the outer layer of cancer cells differed from those found on normal cells in various types of malignancies. Modifying the expression of blood type antigens on cancer cells' surface can alter their mobility, susceptibility to apoptosis, and evasion from the immune system. These factors can influence the initiation and dissemination of cancer (5,6). Recent research has discovered associations between ABO blood groups and the concentrations of tumor necrosis factor-alpha and soluble ICAM-1, E-selectin, and P-selectin in the circulatory system (11,13). This suggests that blood group antigens could potentially influence the body's inflammatory response. The correlation between long-term inflammation and the formation of cancer has been extensively confirmed, indicating that ABO antigens might possibly impact the chance of developing cancer through this mechanism. Scientists have shown that certain tumor antigens have a similar structure with antigens present in the ABO system. According to the study, cancer patients with blood type A (ABO) had the highest average duration of malignancy, followed by those with blood type B and O. The blood type AB has the lowest duration, with an average lifespan of 1.44 years. Nevertheless, there was a notable disparity in the duration of cancer between ABO blood types. The Rh factor

likewise exhibited comparable average lengths, with a notable distinction between the two groups. The variations in cancer duration across ABO blood types and Rh factors may arise from several biological and physiological causes. ABO blood type antigens have been identified as having a significant impact on immunological function. Blood group antigens are found on the outside of red blood cells and other cells in the body, impacting immune responses and inflammatory processes. Differences in immune responses across various blood types may possibly impact the development and length of cancer (25). Blood group antigens can also influence the tumor microenvironment, including tumor cell interactions with the immune system and surrounding tissues. Differences in blood group antigens may alter the composition and behavior of immune cells within the tumor microenvironment, impacting tumor growth, invasion, and response to treatment. These variations in the tumor microenvironment could contribute to differences in cancer duration among individuals with different blood groups (26). Genetic variables linked to ABO blood types and Rh factors may also play a role in variations in the length of cancer progression. Specific genetic variations associated with blood type antigens or Rh factors may impact the development, progression, and treatment response of cancer. Genetic variants that impact immune function or tumor suppressor genes may be more common in persons with certain blood types, resulting in variances in cancer outcomes (27). The study revealed that persons with blood type AB have the highest average BMI of 38.40 kg/m², suggesting a possible tendency towards increased body weight. Individuals with blood type B exhibit a statistically significant decrease in the average body mass index (BMI), which is measured at 28.43 kg/m². The p-value for blood type A is 0.012, indicating a statistically significant correlation with BMI. Nevertheless, there is no substantial correlation observed with the Rh factor. The results indicate interesting connections between ABO blood types, Rh factor, and body mass index (BMI), which may indicate underlying molecular and physiological systems. Hormonal variables, including insulin and leptin, have essential functions in controlling hunger, energy metabolism, and the storage of fat. ABO blood type variations can impact hormonal signaling pathways that are involved in these processes, thereby altering BMI. Blood type A has been linked to elevated levels of insulin in the bloodstream and reduced levels of adiponectin, a hormone that plays a role in controlling glucose and fatty acid metabolism. This interaction might potentially contribute to the reported correlation with greater BMI (206). Variations in BMI among cancer patients with various blood types may be influenced by differences in food habits and lifestyle behaviors. It has been suggested that some blood groups have developed in reaction to nutritional changes throughout the course of human history. Consequently, individuals with particular blood groups may have preferences or tolerances for specific types of foods. These eating habits, together with other aspects of one's lifestyle, may impact the maintenance of energy balance and the management of body weight (28,29). In the present investigation, blood type A is largely observed in males with brain cancer (100%), and it is also significantly present in digestive system malignancies, with a roughly equal distribution between males (41.94%) and females (58.06%). Blood type B is not found in instances of brain cancer, although it is significantly present in female lymphoma cases (100%) and male digestive system tumors (40%). Blood type AB is relatively rare, yet it is seen in the digestive system and female reproductive tumors, indicating a lesser occurrence compared to other blood groups. Blood type O is highly widespread, being present in all female brain cancer cases and equally distributed among male and female respiratory system malignancies (71.43% and 28.57%, respectively). The present study's analysis of cancer patients categorizes them based on blood group and sex, revealing clear patterns that might provide valuable insights into the connection between genetic markers, such as blood type, and susceptibility to different forms of cancer, as well as variations across genders. The distribution of blood group A is about equal among males and females in cases of digestive system malignancies, indicating that this blood group may be a substantial risk factor for these types of cancers, irrespective of gender. This might be associated with the function of blood type antigens in the immune response or inflammation of the gastrointestinal mucosa (30,31). Conversely, brain cancer cases do not exhibit blood group B, while female lymphoma cases and male digestive system tumors prominently display this blood type. The presence of blood type B in all female lymphoma cases, with a frequency of 100%, is highly interesting. This indicates a potential genetic link between the B antigen and variables that promote the development of lymphoma specifically in

females. The significant prevalence of this blood type in male digestive system malignancies may suggest a susceptibility associated with the B antigen in this population, maybe through mechanisms involving inflammation or immune response(32). The current study's findings on the distribution of cancer patients by blood group across urban and rural settings reveal intriguing patterns that could indicated environmental and genetic interactions influencing cancer prevalence. Such patterns may be crucial for developing targeted public health strategies and understanding regional variations in cancer risk factors. Breast cancer shows a remarkably balanced distribution across all blood groups in both urban and rural areas, with only slight variations between them. In urban areas, the percentages are 35.29% for blood group A, 20.59% for B, 10.29% for AB, and 33.82% for O. In rural settings, the distribution is 31.91% for A, 29.79% for B, 6.38% for AB, and 31.91% for O. This balanced distribution might suggest that for breast cancer, blood type does not play a significant discriminatory role in risk across different environments, which could indicate that other genetic or environmental factors might be more influential in determining risk. For digestive system cancers, there is a notable variation in blood group distribution between urban and rural areas, particularly with a high prevalence of blood group A (44%) and O (40%) in rural settings. This pronounced presence might reflect environmental factors such as diet, exposure to carcinogens, or healthcare access that are differentially distributed between urban and rural areas and interact with genetic predispositions related to blood groups. Urban leukemia cases show a predominance of blood groups A and B, each at 40%, suggesting potential urban-related factors that might influence the development of leukemia in individuals with these blood groups. In contrast, rural lymphoma cases are heavily skewed towards blood group B (75%). This significant concentration could point to specific rural environmental exposures or lifestyle factors that might predispose individuals with blood group B to develop lymphoma. Both male reproductive system cancers and respiratory system cancers exhibit a strong presence of blood group O in rural areas, at 71.43% and 75% respectively, contrasting sharply with more mixed distributions in urban areas. This might suggest that certain aspects of rural living—possibly environmental exposures or lifestyle factors related to agriculture or industrial work—might interact with the blood group O to increase the susceptibility or detection rates of these cancers in rural populations. The current study indicated a potential link between blood group O and a family history of skin cancer, with a statistically significant p-value of 0.046, highlights a noteworthy area for deeper investigation. This finding suggests that individuals with blood group O who have a family history of skin cancer might have a genetic predisposition that increases their risk of developing the disease. If blood group O is linked to an increased skin cancer risk, particularly among those with a family history, it could be due to underlying genetic mechanisms or differences in how these individuals' immune systems interact with cancerous cells (30). Moreover, the variability observed in blood group distribution among patients with other types of cancer (such as brain, breast, digestive system, and leukemia) indicates that the influence of blood groups on cancer risk might be complex, involving interactions with other genetic and environmental factors. This aligns with a research which pointed out the intricate relationships between blood type and cancer risks, underscoring the multifactorial nature of cancer development where multiple genes and lifestyle factors interact (31).

4. Conclusion and future scope

Blood group B appears infrequently but is represented in the digestive system and female reproductive cancers, demonstrating a minor presence compared to other groups. Skin cancer shows a potential link between blood group distribution and family history of the disease, suggesting a genetic predisposition or a significant association worth further investigation. Incorporate blood group information into cancer management protocols to better understand disease progression and prognosis.

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