

## Original Research Article

# Prevalence of Bombay phenotype among Bangladeshi 'O' blood group population

Sheikh Saiful Islam Shaheen<sup>1\*</sup>, Ayesha Khatun<sup>1</sup>, Atiar Rahman<sup>1</sup>,  
Farah Anjum Sonia<sup>1</sup>, Jannatul Fedous<sup>2</sup>

<sup>1</sup>Department of Transfusion Medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

<sup>2</sup>Department of Obstetrics and Gynecology, Nagorpur Upazilla Health Complex, Tangail, Bangladesh

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### \*Correspondence:

Dr. Sheikh Saiful Islam Shaheen,

E-mail: drskshaheen@yahoo.com

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## ABSTRACT

**Background:** The Bombay blood group, a rare type often confused with 'O', poses a critical transfusion risk, requiring specific compatibility with Bombay (Oh) blood. With a lack of data in Bangladesh, this study aimed to establish a comprehensive database for the rare Bombay phenotype, crucial for transfusion safety. Objective was to determine the frequency prevalence of Bombay phenotype among 'O' blood group individuals.

**Methods:** A cross-sectional study conducted at Bangabandhu Sheikh Mujib Medical University from January 2020 to June 2021 involved, aseptic collection of 3 ml venous blood sample, with forward and reverse blood grouping revealing a 'O' phenotype. Utilizing anti-H lectin resolved discrepancies and confirmed the absence of 'H' antigen in individuals with Bombay blood groups. Blood samples of Bombay phenotype individuals showed the following reactions: anti-A (-), anti-B (-), anti-AB (-), anti-H (-), A cells 4+, B cells 4+, O cells 4+.

**Results:** Among 10,000 individuals with apparent blood group 'O', 99.97% were identified as 'O' blood type, while only 0.03% exhibited the rare Bombay blood group. ABO and Rh-D blood group frequencies varied over the study period, with B +ve at the highest (28.31%) and AB -ve at the lowest (0.21% to 0.23%). Overall, O +ve had the highest frequency (97.29%), and Bombay blood group was rare, with 'O' dominating at 99.97%.

**Conclusions:** The study identified a 0.03% prevalence of the Bombay phenotype. Due to its potential confusion with 'O' blood group, transfusing 'O' blood to Bombay individuals carries a substantial risk of severe hemolytic reactions, including fatal consequences.

**Keywords:** ABO blood group system, Blood transfusion, Bombay phenotype

## INTRODUCTION

Four main blood groups routinely identified are A, B, AB, and O. Individuals with blood group 'A' belong to A and H antigens on red cell membrane and antibody B in serum. Similarly, B blood group persons have B and H antigens on the red cell membrane and antibody 'A' in the serum, For AB blood group individuals A, B and H antigens on the red cell membrane and no antibodies in serum For 'O' blood group individual have only H antigens on cell membrane and both anti-A and anti-B in

serum. For Bombay phenotype there was no A, B, or H antigens on the red cell membrane and Anti-A, anti-B, and anti-H are present in the serum. Bombay phenotype has no 'A' or 'B' antigens, classifying it as 'O' blood group as in forward blood grouping similar reaction like 'O' but in reverse grouping agglutination occurs as Bombay phenotype lack 'H' antigen and possess anti-H. So blood group apparently 'O' when a cross-matching is done it shows cross reactivity or incompatibility. Blood group Bombay does not possess A or B antigens it is usually read as 'O' blood group. This blood group is

commonly mistaken as 'O' blood group. In this blood group, no "A" or "B" antigens are identified on red blood cells or in secretions. By definition, that would fit type "O" blood group. In Bombay phenotype, there is a void of A antigen, B antigen as well and H antigen.<sup>1</sup>

In the general population, the prevalence of Bombay blood group is about 1 in 10,000 individuals in India and 1 per 1,00,000 individuals in Europe.<sup>2</sup> However, in some places of Mumbai (formerly Bombay) the prevalence of this phenotype is as high as 0.01%. A high incidence of Bombay phenotype was reported in Orissa of eastern India, among Kutia Kondh tribe.<sup>3</sup> Bombay blood group is one of the rarest blood groups in the world. 1 in every 17600 people in India or 1 in every 250,000 people in the world has this blood group.<sup>4</sup> In Bangladesh first documented Bombay blood group was found among three sisters of the same family (Miah family) in 1990.<sup>5</sup> The serum of individuals with Oh (Bombay) blood type contains strong anti-H in addition to anti-A and Anti-B.<sup>6</sup> Bombay blood group is one of the rarest blood groups in the world. 1 in every 17600 people in India or 1 in every 25,000 people in the world has this blood group.<sup>7</sup>

If someone has blood group A, it means that the person has an antigen of type 'A' and an antibody of type 'B' in his/her blood. People with AB have both antigens A and B in their blood and no antibodies. People with 'O' blood group have antibodies A and B and no antigens. However, what is not generally known is that all these groups have an antigen H in the blood as well. H antigen is present in 99.9% of RBCs in all populations. Therefore, very few people do not have this antigen H in their blood. Instead, they have naturally occurring antibody H, they are people with Bombay blood group. Bombay blood group differs from 'O' blood group by lacking H antigen on RBCs. It could be Rh positive or Rh negative.<sup>8</sup>

In the general population, the prevalence of Bombay blood group is about 1 in 10,000 individuals in India and 1 per 1,00,000 individuals in Europe.<sup>9</sup> However, in some places of Mumbai (formerly Bombay) the prevalence of this phenotype is as high as 0.01%. A high incidence of Bombay phenotype was reported in Orissa of eastern India, among Kutia Kondh tribe.<sup>10</sup> Another study from northwestern Orissa reported an average of 1 in 278 Bombay phenotypes among Bhuyan tribal population.<sup>11</sup> A relatively large number of H-deficient individuals were found on Reunion Island, which is a small French Island 800 km east of Madagascar in the Indian Ocean.<sup>12</sup> The function of the H antigen, apart from being an intermediate substrate in the synthesis of ABO blood group antigens, is not known although it may be involved in cell adhesion.<sup>13</sup>

## METHODS

A descriptive cross-sectional study was conducted from 1 January 2020 to 30 June 2021. A structured questionnaire

was used. Written consent was taken from the participants. The total participants of the study were 10,000. This study was carried out in the department of transfusion medicine, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh. Blood donors and patients having blood group 'O' coming in the department of the transfusion medicine, BSMMU fulfilling inclusion criteria were taken as samples by purposive convenient or non-random or non-probability sampling technique. The participants consented to participate voluntarily in the present study. The data obtained from this study was analyzed for frequencies (absolute) and percentages.

## Methods of detection of Bombay (Oh)

Three (3) ml venous blood sample was collected in a clean dry sterile test tube with all aseptic precaution. Cell and serum were separated accordingly. Forward grouping was done by using anti-A, anti-B, and anti-AB of Tulip Diagnostic Limited (manufacturing company). Reverse grouping was done by using newly prepared A1 cells, B cells, and 'O' cells. In the blood samples that were in forward grouping, there was no agglutination with anti-A, anti-B and anti-AB showed red cell phenotype 'O' but in reverse grouping there was strong agglutination with all cells i.e., A cells, B cell and 'O' cells, at room temperature and at 37°C. Auto control showed no agglutination when these discrepancies were seen, then forward grouping was done by using anti-H lectin (Ulex uropeous) of Lorne Laboratories Limited (manufacturing company). Individuals of Bombay blood group showed no agglutination with anti-H lectin, which means the absence of (H) antigen on the red cell surface. Blood samples of Bombay phenotype individuals showed the following reactions: anti-A (-), anti-B (-), anti-AB (-), anti-H (-), A cells 4+, B cells 4+, O cells 4+.

## Inclusion and exclusion criteria

Inclusion criteria encompassed individuals with verified blood group 'O' who voluntarily participated as either blood donors or patients at the department of transfusion medicine, Bangabandhu Sheikh Mujib Medical University. Exclusion criteria applied to individuals with blood groups other than 'O' and those unwilling or unable to provide voluntary consent for study participation.

## RESULTS

Among 10000 apparent blood group 'O', 9997 (99.97%) were found 'O' blood group and only 3 (0.03%) were Bombay blood group. Frequency of ABO and Rh-D blood groups in the studied respondent. Highest frequency B +ve 2831 (28.31%) and lowest AB -ve 21 (0.21%) from January 2020 to June 2020. From July 2020 to December 2020, it showed the highest frequency of O +ve 3386 (33.86%) and the lowest AB -ve 23 (0.23%). From January 2021 to June 2021 showing the

highest frequency of B +ve 2831 (28.31%) and the lowest AB -ve 21 (0.21%) Frequency of ABO and Rh-D blood groups in the studied respondent from January 2020 to June 2021 showing the highest frequency O +ve 9729 (97.29%) and lowest AB -ve 70 (0.70%). The frequency of Bombay blood groups from January 2020 to June 2021 showed the highest frequency ‘O’ 9997 (99.97%) and lowest Oh (Bombay). Among 10000 of apparent blood group ‘O’, 9997 (99.97%) found ‘O’ blood group and only 3 (0.03%) was Bombay blood group.

**Table 1: Frequency of ABO and Rh-D blood groups in the studied respondent (from January 2020 to June 2020).**

ABO and Rh-D groups	Frequency	Percentage
A -ve	51	0.51
A +ve	1704	17.04
AB -ve	21	0.21
AB +ve	1125	11.25
B -ve	53	0.53
B +ve	2831	28.31
O -ve	76	0.76
O +ve	2601	26.01
<b>Total</b>	<b>8462</b>	<b>84.62</b>

Table 1 presents the frequency distribution of ABO and Rh-D blood groups among the studied respondents from January 2020 to June 2020. The table provides both the actual count (frequency) and the corresponding percentage for each blood group. Notably, the most common blood group among the respondents was B +ve, comprising 28.31% of the sample, while the least common blood group was AB -ve, accounting for only 0.21%.

**Table 2: Frequency of ABO and Rh-D blood groups in the studied respondent (from July 2020 to December 2020).**

ABO and Rh-D groups	Frequency	Percentage
A -ve	77	0.77
A +ve	2267	22.67
AB -ve	23	0.23
AB +ve	941	9.41
B -ve	100	1.00
B +ve	3164	31.64
O -ve	94	0.94
O +ve	3386	33.86
<b>Total</b>	<b>10052</b>	<b>100.52</b>

Table 2 presents the frequency distribution of ABO and Rh-D blood groups among the studied respondents from July 2020 to December 2020. This table includes the actual count (frequency) and corresponding percentages for each blood group, along with a total column. Notably, the most common blood group among the respondents during this period was O +ve, comprising 33.86% of the

sample, while the least common blood group was AB -ve, accounting for only 0.23%.

**Table 3: Frequency of ABO and Rh-D blood groups in the studied respondent (from January 2021 to June 2021).**

ABO and Rh-D groups	Frequency	Percentage
A -ve	89	0.89
A +ve	2532	25.32
AB -ve	26	0.26
AB +ve	1048	10.48
B -ve	131	1.31
B +ve	3481	34.81
O -ve	101	1.01
O +ve	3742	37.42
<b>Total</b>	<b>14314</b>	<b>143.14</b>

Table 3 displays the frequency distribution of ABO and Rh-D blood groups among the studied respondents from January 2021 to June 2021. The table includes the actual count (frequency) and corresponding percentages for each blood group, along with a total column. Notably, O +ve remains the most prevalent blood group during this period, constituting 37.42% of the sample, while AB -ve was the least common, representing only 0.26%.

**Table 4: Frequency of ABO and Rh-D blood groups in the studied respondent (from January 2020 to June 2021).**

ABO and Rh-D groups	Frequency	Percentage
A -ve	217	2.17
A +ve	6503	65.03
AB -ve	70	0.7
AB +ve	3114	31.14
B -ve	284	2.84
B +ve	9476	94.76
O -ve	271	2.71
O +ve	9729	97.29
<b>Total</b>	<b>29664</b>	<b>296.64</b>

Table 4 presents the comprehensive frequency distribution of ABO and Rh-D blood groups among the studied respondents, spanning from January 2020 to June 2021. This table includes the actual count (frequency) and corresponding percentages for each blood group, along with a total column. Remarkably, O +ve remains the most prevalent blood group, constituting 97.29% of the total sample, while AB -ve was the least common, representing only 0.7%.

Table 5 provides data on the frequency of Bombay blood groups within the studied population from January 2020 to June 2021. The table includes the actual count (frequency) and corresponding percentages for each blood group, along with a total column. Remarkably, the majority of the respondents have blood type ‘O’,

accounting for 99.97% of the sample, while the rare Bombay blood group (Oh) represents only 0.03%.

**Table 5: Frequency of Bombay blood groups (January 2020 to June 2021).**

ABO and Rh-D groups	Frequency	Percentage
<b>O</b>	9997	99.97
<b>Bombay (oh)</b>	3	0.03
<b>Total</b>	10000	100

## DISCUSSION

The Bombay phenotype was discovered by Bhende et al in 1952 in India.<sup>5</sup> They observed incompatibility of a case with 'O' blood group with 'O' blood group of several persons. This study shows the prevalence of Bombay phenotype was 0.03%. The prevalence of Bombay phenotype was 1:10,000 in India and 1:10 in Europe and some other studies agreed with this study.<sup>2,6</sup> It is rare in Caucasians with an incidence of 1 in 2,50,000.<sup>11,14</sup> The main therapeutic challenge in the patients with the Bombay blood group is the arrangement of cross-matched blood due to the very low incidence of this blood group in the population. A few cases have been reported where blood was arranged with difficulty from the neighbouring states after a few hours for transfusion in the emergency situation.<sup>15,16</sup>

In our study among 10000 apparent blood groups 'O', 9997 (99.97%) found 'O' blood group and only 3 (0.03%) were Bombay blood group. A report that investigated 26,638 study subjects in a tertiary care hospital in Andhra Pradesh, India showed that 13 of the subjects were Bombay phenotypes (0.048%) and that consanguinity among parents was observed in 10 cases (77%).<sup>17</sup>

The first known female cases of the Bombay phenotype was reported among three sisters of Bangladesh extraction.<sup>18</sup> Although the Bombay phenotype seems mostly confined to south east Asian countries cases have been detected in Sri Lanka, Thailand and Malaysia.<sup>19-21</sup> In our study the most common blood group among the respondents during this period was O +ve, comprising 33.86% of the sample, while the least common blood group was AB -ve, accounting for only 0.23%. They phenotype as blood group 'O' on normal ABO blood grouping, but cross matching shows incompatibility to 'O' blood group.<sup>22</sup> They are Lewis antigen positive (a+).<sup>23</sup>

In our study the majority of the respondents have blood type 'O', accounting for 99.97% of the sample, while the rare Bombay blood group (Oh) represents only 0.03%. Similarly, a prevalence of 0.005% was observed among subjects in the Bangalore part of India.<sup>24</sup> Currently, in our country, the primary method for ABO and Rh typing involves forward grouping in most instances, with reverse grouping being seldom employed. This practice has led to

the failure to diagnose Bombay phenotypes accurately and has resulted in incorrect blood group typing. This situation poses a significant risk of hemolytic transfusion reactions in such cases. Therefore, it is imperative to emphasize the importance of implementing reverse grouping, along with the inclusion of 'O' cells in the reverse grouping process, to address these concerns effectively.

The study's limitations include potential regional bias as it solely focuses on individuals with blood group 'O' in a specific locale, which might limit the generalizability of findings. Additionally, the sample size of 10,000 participants, while substantial, may still pose challenges in representing the rare Bombay blood group adequately.

## CONCLUSION

This study shows the prevalence of Bombay phenotype is 0.03%. Since Bombay blood group often misleads 'O' blood group. If Bombay blood group individual is transfused by 'O' blood, a severe hemolytic transfusion reaction occurs, which may lead to death even.

## Recommendations

To enhance the study's comprehensiveness, future research should consider multicenter collaborations involving diverse populations. This would contribute to a more representative analysis of Bombay blood group prevalence and characteristics.

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