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Prevalence and risk factors associated with blood transfusion reactions among hospitalized patients

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Abstract

Adverse transfusion reactions that may have a range of consequences, from minor to fatal outcomes, remain an important clinical concern. This prospective observational study aimed to identify risk factors and the prevalence of transfusion reactions among patients receiving blood products. The study was carried out in the transfusion units of Allied Hospital in Faisalabad, Pakistan, between April and June of 2025. A total of 100 hospitalized patients were included in the study. Vital signs and clinical observations were recorded before, during, and after the transfusion. To determine correlations between potential risk factors and transfusion outcomes, SPSS was used to analyze the data. Females comprised 59% of the study population, and the most frequent reasons why the patients needed a transfusion were obstetric and gynecological conditions, including postpartum bleeding and pregnancy anemia. The average age of the receivers was 40.0 years. The overall prevalence of adverse transfusion reactions was 27%. The most common reaction was febrile non-hemolytic, followed by allergic reactions. Stored blood showed a significantly higher reaction rate (30%) compared with fresh blood (15%). Isolated blood had resulted in adverse reactions more often. Proper inventory management and storage practices are essential because stored blood is associated with a higher risk of transfusion reactions. The need for the most efficient blood management practices is based on the greater risk of transfusion responses due to preserved blood.

Introduction

Blood transfusion is an essential part of modern medicine, as it is needed to treat hematological diseases, trauma, surgical cases, and obstetric cases. Transfusion is a lifesaving process, but it has its dangers. The recipients can experience mild allergic reactions to severe, even life-threatening reactions [1]. The practice of whole blood transfusion was common in the olden days, but research on transfusion therapy enabled blood to be divided into its various components, such as red blood cells, plasma, and platelets. This change made it possible to utilize resources better, provide more focused therapy, and increase storage [2]. There are still concerns that the lack of a natural physiological balance between components could put patients at risk for problems, especially after heavy transfusion, even though component therapy has improved compatibility and decreased many transfusion-related hazards [3]. Both immunological and non-immunological adverse transfusion responses (ATRs) might manifest as acute hemolysis, allergic reactions, transfusion-associated circulatory overload, transfusion-related acute lung injury, or febrile non-hemolytic transfusion reactions (FNHTR). Infectious complications are still a major problem in low- and middle-income nations, where transfusion-transmissible infections (TTIs), including HIV, HBV, and HCV, still represent a concern, even if they are less common in high-income settings because of strict screening [4, 5].

Hemovigilance systems have been created worldwide to monitor transfusion safety and reduce risk. But in many poorer nations, like Pakistan, where blood banks frequently rely on family replacement contributions rather than voluntary donors, these systems are poorly developed. TTIs and acute transfusion responses are more likely as a result [6]. Research from Asian and African nations has shown that the prevalence of ATRs varies, from less than 1% in wealthy nations to more than 25% in settings with inadequate resources [7].

Blood transfusions are widely used in Pakistan to treat gastrointestinal bleeding, anemia, trauma, cancer, and maternal hemorrhage. There is still little local data on the prevalence, range, and causes of adverse transfusion responses, despite this great clinical demand. Allergic and febrile non-hemolytic reactions are the most frequently reported occurrences in the hospital-based studies from Pakistan that are currently available. Reaction rates typically range from 0.3% to 1.2%. These conclusions, however, are mostly based on retrospective assessments and single-center audits, which are frequently limited by underreporting and the lack of standardized surveillance methods. Additionally, Pakistan does not have a national hemovigilance program, which leads to the absence of systematic data collection and risk evaluation.

Context-specific data are essential because transfusion safety profiles may vary depending on blood storage practices, component preparation methods, patient comorbidities, and transfusion indications. Identifying the prevalence and risk factors associated with adverse transfusion reactions is important for improving transfusion practices, strengthening hemovigilance systems, and enhancing patient safety. Therefore, this study aimed to determine the prevalence and risk factors associated with adverse transfusion reactions among hospitalized patients receiving blood transfusions in Faisalabad, Pakistan.

Materials and Methods

Study design and setting

This prospective observational study was conducted to determine the prevalence and risk factors associated with transfusion reactions among patients receiving blood products. Between April and June of 2025, the study was conducted in the medical wards and transfusion units of tertiary care teaching institutions in Faisalabad, Pakistan. The Institutional Research Ethics Committee of Riphah International University's Ethical Review Committee gave its approval to this study (Reference No. REC/RCR &AHS/25/0329). Every individual who consented to take part in the study provided signed informed consent.

Study population

A non-probability consecutive sampling technique was used to recruit a total of 100 patients receiving blood transfusions during the study period. Until the desired sample size was reached, all eligible patients who fulfilled the inclusion requirements and had at least one transfusion during the study period were included.

Inclusion and exclusion criteria

Patients who were admitted to the medical, surgical, or emergency wards throughout the study period and

received whole blood or any blood component, including red blood cells, plasma, or platelets, if they provided informed consent, were included in the study if they were at least eighteen years old. Patients with incomplete medical records, patients with hematological disorders requiring frequent transfusions such as thalassemia major, and those who refused or withdrew consent were excluded from the study.

Data collection

Data were collected using a structured questionnaire and review of patient medical records. The data contained clinical and demographic characteristics such as diagnosis, comorbidities, and current medicines, and the characteristics of ward or hospital unit, such as age, sex, and the purpose of transfusion, and the number of transfusions, volume of transfusion, and type of blood product administered. Every suspected reaction's clinical presentation, time of onset, management techniques, and patient outcomes were methodically recorded, and patients were continuously watched for any indications of adverse reactions both during and after each transfusion.

Laboratory and clinical monitoring

Trained personnel kept an eye out for any negative responses in any transfusion recipients. Relevant laboratory tests (full blood count, direct Coombs test, repeat crossmatch, and blood culture when appropriate) were carried out in accordance with hospital protocols in cases with suspected responses.

Classification of reactions

In this study, adverse transfusion events were categorized in accordance with worldwide standards, such as those established by the CDC and WHO. These included allergic responses, hemolytic transfusion reactions, anaphylactic reactions, and febrile non-hemolytic transfusion reactions (FNHTR). Transfusion-related acute lung injury (TRALI) and other more serious but less common consequences were also included. The more general category of miscellaneous adverse events also included other significant reactions, including sepsis and iron overload.

Statistical analysis

SPSS version 25 was used for data analysis. Descriptive statistics, including mean, standard deviation, frequencies, and percentages, were used to summarize demographic and clinical characteristics as well as the prevalence of transfusion reactions. Chi-square tests were used to assess associations between categorical variables and transfusion reactions. A single chi-square test of independence was applied to evaluate the association between blood storage duration and transfusion reactions. A p-value of less than 0.05 was considered statistically significant.

Results

Gender and age distribution

Out of the 100 transfusion recipients at Allied Hospital in Faisalabad, 41% were male, and 59% were female (n = 59). Patients were divided into five age categories (**Fig. 1**). The highest proportion of transfusion recipients belonged to the 25–34 years age group (25%), followed by the 45–54 years group (23%) and the 35–44 years group (22%). The 18–24 years and ≥55 years age groups each comprised 15% of the study population. The study population's mean age was 40.01 (**Table 1**).

Table 1: Summary statistics of age among transfusion recipients

Statistic	Value
Sample Size (n)	100 People
Mean Age	40.01 years
Standard Deviation (SD)	11.51 years

Distribution of transfusion reactions

Among the 100 transfusion recipients, 27% developed suspected transfusion reactions, while 73% experienced no adverse reactions. Febrile non-hemolytic transfusion reaction (FNHTR) was the most common reaction, occurring in 10 patients (37.04%), followed by allergic reactions in 9 patients (33.33%). Other reactions included sepsis in 3 patients (11.11%), hemolytic reactions in 2 patients (7.41%), and one patient each with iron overload (3.70%), anaphylaxis (3.70%), and transfusion-related acute lung injury (TRALI) (3.70%).

Transfusion reaction rates by blood product type

The frequency of transfusion reactions was compared among different blood products, including packed red blood cells (PRBCs), platelets, fresh frozen plasma (FFP), and cryoprecipitate. PRBCs showed the highest reaction rate (47.8%), followed

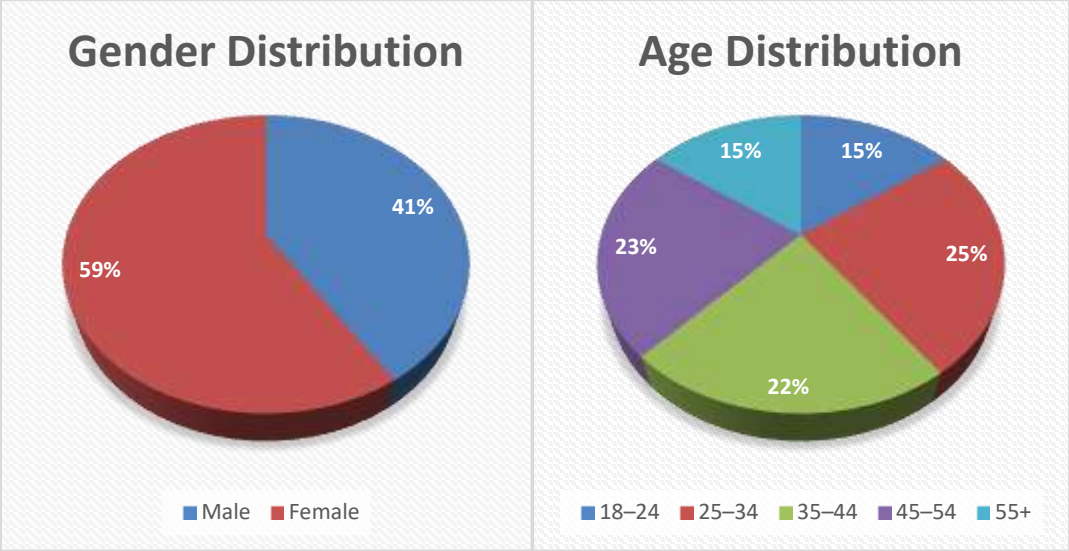

Fig. 1: Transfusion recipients' gender and age distribution

by cryoprecipitate (45.5%), platelets (38.5%), and FFP (35.7%). However, statistical analysis demonstrated no significant association between blood product type and transfusion reactions ($p > 0.05$) (**Table 2** and **Fig. 2**).

Effect of blood storage duration on transfusion reactions

The effect of blood storage duration on transfusion reactions was also evaluated. Transfusion reactions occurred in 3 of 20 patients (15%) receiving fresh blood stored for less than 7 days, compared with 24 of 80 patients (30%) receiving stored blood for more than 14 days. Chi-square analysis demonstrated a statistically significant association between prolonged blood storage and transfusion reactions ($\chi^2 = 4.03$, $p = 0.045$), indicating that stored blood was associated with a higher frequency of adverse transfusion events (**Fig. 3** and **Table 3**).

Table 2: Association between blood product type and transfusion reactions.

Blood Product	Chi-square (χ^2)	Degrees of Freedom (dof)	p-value	Association
Cryoprecipitate	0.12	1	0.73	No
PRBCs	0.34	1	0.56	No
FFP	0.28	1	0.6	No
Platelets	0.4	1	0.53	No

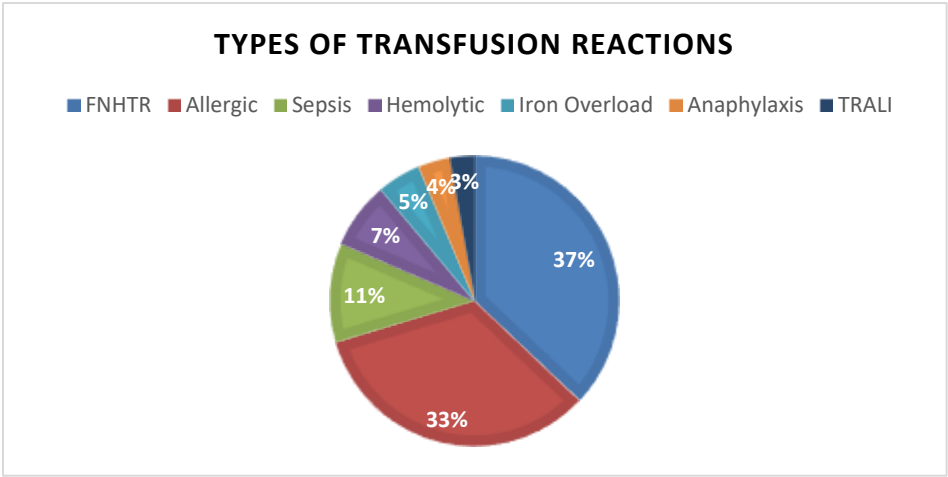

Fig. 2: Distribution of particular types of fusion responses in patients with suspected reactions (n = 27).

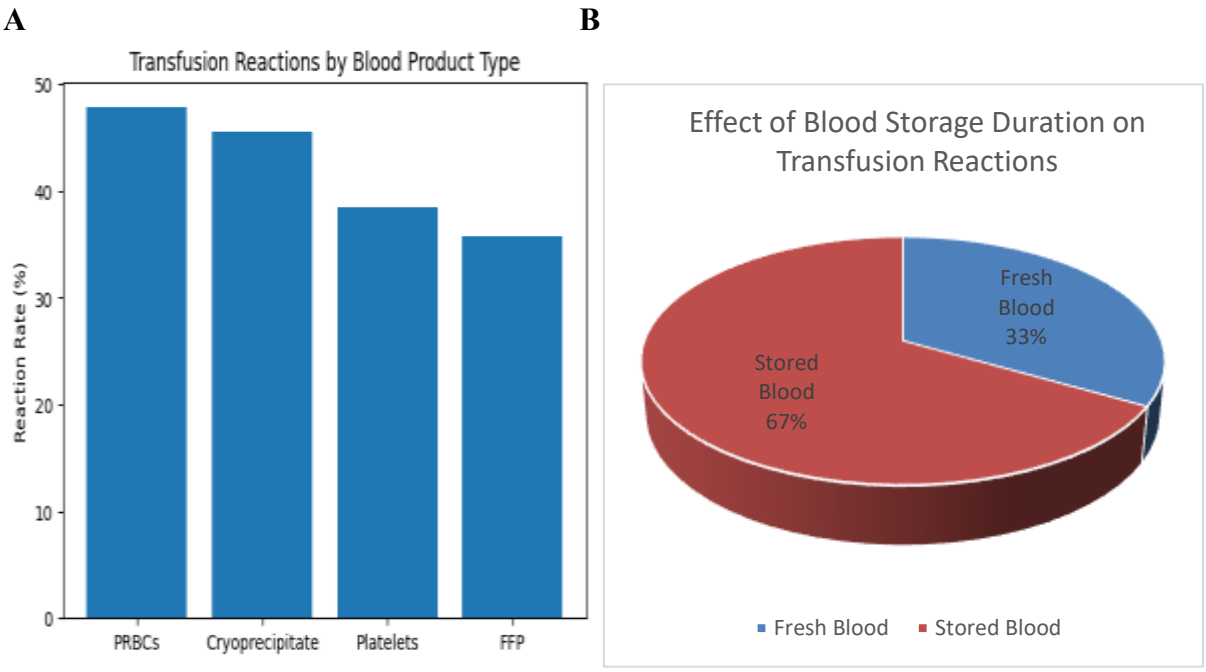

Fig. 3: (A) Transfusion reaction rates by blood product type. (B) Effect of blood storage duration on transfusion reactions.

Table 3: Association Between Blood Storage Type and Transfusion Reactions

Blood Type	No Reaction (n)	Reaction (n)	Total
Fresh Blood	17	3	20
Stored Blood	56	24	80

Note: Chi-square test showed a statistically significant association between blood storage duration and transfusion reactions ($\chi^2 = 4.03$, $p = 0.045$).

Clinical indications for blood transfusion

Gastrointestinal bleeding (16%), anemia (15%), postpartum hemorrhage (14%), trauma (13%), sepsis (12%), and kidney failure (11%) were the most frequent clinical indications for blood transfusion reaction, according to the distribution and frequency of these indications among the population under study. Leukemia (10%) and solid tumors (9%) were additional significant indications. The proportionate contribution of each ailment to the need for transfusions is shown in **Fig. 5**, which sheds light on blood component usage trends and the clinical settings where transfusions are most commonly given.

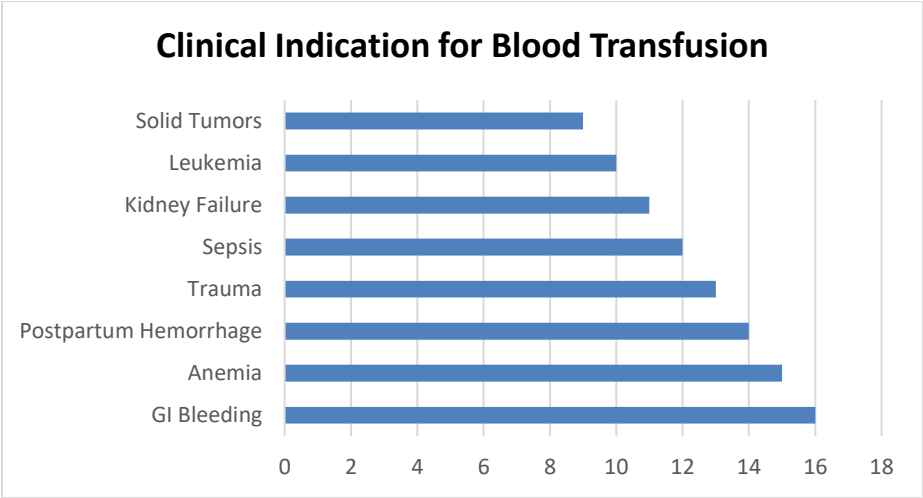

Fig. 5: Distribution of clinical diagnoses among transfusion recipients.

Discussion

This study evaluated the demographics, clinical signs, and transfusion issues of patients receiving transfusions at Allied Hospital in Faisalabad. Among the 100 transfusion recipients, females comprised 59% of the study population, while males accounted for 41%. Due to obstetric causes (such as postpartum hemorrhage and pregnancy-related anemia) [8], gynecological problems, and a higher incidence of iron-deficiency anemia in low- and middle-income countries, women are more prone to require transfusions. These results are in line with Khaskheli et al. (2021), who found that 62% of transfusion cases at a Pakistani tertiary care hospital were female, mostly because of obstetric problems [9]. Hussain et al. (2019) reported that, conversely, the prevalence of males in trauma and emergency was 66% in gender-based transfusion, which proved the huge impact of clinical conditions and disease profile on gender-based transfusion tendencies [10]. The study population (n = 100) was divided into five age groups. The highest proportion of transfusion recipients belonged to the 25–34 years age group, followed by the 45–54 years and 35–44 years age groups. The findings of the current study are aligned with those of Tariq et al. (2024), who reported that transfusion was most required in the 30- to 50-year-old bracket, primarily due to chronic anemia, maternal issues, and surgical operations [11]. Nonetheless, HB Wubet et al. (2025) found that age-related patterns of transfusion varied across clinical environments and disease burden, depending on the type of patients in the trauma and surgical hospitals (mostly older (>60 years) patients) [12].

Also, bleeding through the gastrointestinal tract was the most common clinical indication of transfusion to be used in the current study, as anemia came in second, followed by postpartum bleeding, trauma, sepsis, and kidney failure. Other major contributors were leukemia and solid tumors (**Fig. 5**). This distribution shows how broad the range of acute and chronic diseases in which transfusions are applied is. Regional studies have shown similar trends, with hemorrhagic diseases and anemia continuing to be the most common transfusion justifications [13].

While 73% of patients had transfusions without incident, 27% of patients had suspected transfusion reactions. The higher transfusion reaction rate observed in this study compared with previously reported Pakistani studies may be attributed to the prospective study design with active clinical monitoring, inclusion of mild reactions that are often underreported, and differences in patient populations and surveillance methods. Earlier local studies were mostly retrospective and relied on passive reporting systems, which may underestimate the actual frequency of transfusion reactions. Febrile non-hemolytic transfusion reactions (FNHTR) were the most common adverse events, followed by allergic reactions (**Fig. 2**). According to Rekik et al. (2025), FNHTR and allergic reactions are the most common adverse events (>60%) [14], which is consistent with the prevalence of these conditions. Nevertheless, Tadasa E et al. (2024) reported reduced incidences as a result of universal leukoreduction procedures, indicating that reaction frequencies are directly impacted by institutional transfusion policies [15]. PRBCs and cryoprecipitate showed comparatively higher reaction rates than other blood products; however, statistical analysis did not demonstrate a significant association between blood product type and transfusion reactions. These findings may reflect the limited sample size and differences in exposure among patient groups. These findings are like those of Abbade LP et al. (2021) and Brooks MB et al. (2022), who found that cryoprecipitate and PRBCs increased immunogenicity [16, 17]. However, no statistically significant correlation between the kind of blood product and transfusion reactions was discovered in this investigation. This lack of significance may be due to the very small size of the sample or the fact that there was unevenness in the use of the products between groups of patients. Whaley D et al. (2021), on the other hand, demonstrated that cryoprecipitate was the least reactive due to the improved processing methods [18]. This sort of variation highlights the importance of institutional practices and product preparation approaches in the choice of the reaction rates.

The influence of the time of storage on the transfusion reactions was one of the interesting results of the study. Patients receiving stored blood units (>14 days) experienced a higher frequency of transfusion reactions compared with those receiving fresh blood units (<7 days), which was also statistically significant ($P < 0.05$). This difference indicates that preserved blood tends to induce reactions, which might be due to storage lesions such as red cell membrane damage and accumulation of cytokines. These results are in line with those of Wacka E et al. (2023) and Dziedzic EA et al. (2023), who found that older blood had more

inflammatory responses [19, 20]. Similarly, banked blood was associated with increased cytokine-mediated transfusion reactions by Goetzl EJ et al. (2024) and Soleimani Mamalo A et al. (2025) [21, 22]. The RECESS trial, however, did not find a significant difference, indicating that clinical context and population type may have an impact on results [23]. Although descriptive differences in reaction frequencies were observed among blood products, statistical analysis did not demonstrate a significant association between blood product type and transfusion reactions ($p > 0.05$) (**Table 2**). When premedication and immunological profile were taken into account, Chow TG et al. (2022) found substantial correlations, indicating that product type may still have an indirect impact when patient factors are taken into account [24]. A statistically significant association was observed between prolonged blood storage duration and transfusion reactions ($\chi^2 = 4.03$, $p = 0.045$) (**Table 3**).

Overall, this study demonstrates that transfusion responses were somewhat frequent, with allergic reactions and FNHTR being the most common adverse outcomes. Storage length seemed to be the more significant factor linked to transfusion responses in this cohort, despite descriptive differences between blood product types. To reduce adverse events and improve patient outcomes, such data points to the need to maintain hemovigilance, implement careful blood storage practices, and institutional-specific transfusion safety practices.

CONCLUSION

This study evaluated the prevalence of blood transfusion reactions and the risk factors among patients in the hospital setting at Allied Hospital in Faisalabad. The outcomes revealed that the most prevalent causes of transfusion were anemia, gastrointestinal bleeding, and postpartum bleeding. Other life-threatening outcomes like sepsis, hemolytic reactions, anaphylaxis, and TRALI were less common yet had clinical significance. The percentage of patients who responded to transfusion was high (27%), with febrile non-hemolytic and allergic reactions the most prevalent. The most typical reaction of the blood products considered was PRBCs and cryoprecipitate, and the utilization of preserved blood was significantly linked with higher rates of reaction compared to fresh blood. However, the type of blood product and transfusion reactions did not have a statistically significant relationship, as assessed by chi-square. These results imply that storage-related modifications as well as patient-related factors are important for transfusion safety. The general results of the study highlight the estimates of the problem of transfusion in clinical practice and the need for strict hemovigilance, ideal storage practices, and individualized patient care in transfusion regimens. The study was based on 100 patients from one center, so the findings may not apply broadly, and its design does not allow cause-and-effect conclusions; some reactions might also have been missed. Better monitoring, greater use of fresh blood, improved storage and donor screening, along with leukoreduction and staff training, can help make transfusions safer.

This study has certain limitations. The sample size was relatively small, and data were collected from a single center, which may limit the generalizability of the findings. In addition, patients requiring frequent transfusions, such as those with thalassemia major, were excluded from the study, although these patients are considered at higher risk for transfusion reactions.

Acknowledgement

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Ethical statement and participation consent

The study was approved by the Ethical Review Committee of the Institutional Research Ethics Committee of Riphah International University (Reference No. REC/RCR &AHS/25/0329). Informed written consent was obtained from all participants who agreed to participate before their inclusion in the study.

Conflict of interest

The authors declare no conflict of interest.

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