***Systematic Review***

**Determination of the Prevalence of Blood Transfusion Among Children With Different ABO and Rhesus Blood Group Systems: A Systematic Review and Meta-Analysis of Published Literature**

**ABSTRACT**

**Background**: Blood transfusion is a common medical intervention in pediatric patients. However, the prevalence of blood transfusion amongst children with different ABO/Rhesus blood group types have been not well established and documented due to lack of data and paucity knowledge.

**Objective**: The current study is aimed at conducting a systematic review of published literature to determine the prevalence of blood transfusion amongst children with different ABO/Rhesus blood group systems .

**Methods:** A comprehensive literature search was conducted using different search engines, including PubMed, Scopus, and Web of Science, Google Scholar, Embase, Cochrane Library, CINAHL, PsycINFO, ScienceDirect, ProQuest etc. Out of 400 articles retrieved, 300 articles were selected for inclusion in this review.

**Results**: The results of this review showed that the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types varied widely. Children with blood group types such as O+,B+,A+ and AB+ were more likely to receive blood transfusion, while those with blood group A=, B=, AB= , and O= types were less likely to receive blood transfusion .

**Conclusion**: This systematic review highlights the importance of considering ABO/Rhesus blood types in pediatric patients requiring blood transfusions. Further studies are needed to fully understand the benefits of blood transfusions in children population .

**Keywords: blood transfusion, ABO/Rh blood types, population,** **ProQuest**

1. **INTRODUCTION**

Blood transfusion is a common modern medical practice and therapeutic intervention that have been used globally in many clinical settings for many years. It has been defined as the process of removing and preparing safe blood in the form of red blood cells/plasma or any blood products from a “healthy individual called donor” to put another individual called “recipient” that may be used in order to increase the supply of oxygen to the tissues ,when the hemoglobin concentration is low and / or the oxygen carrying capacity of the blood is reduced ,in the presence of inadequate physiological mechanism of compensation **[ WHO,2022 ].** In pediatrics medicine, It is defined as the process of transferring safe and prepared blood or its components to recipients who are usually neonates and children under special guidelines developed and adopted for this purposed **[WHO,2022]**.However, the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types are not well established and available documented data are conflicting.Therefore, understanding the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types,is not only very crucial for optimizing patient care but minimizing morbidity and mortality **[Bassey,2025].** Although few studies have investigated the prevalence of blood transfusion amongst children with different ABO/Rh blood types such data are older, inconsistent and contradicts recent literatures. For instance, a study by **[Kumar *et al.,* 2018]** found that children with type O positive blood group were more likely to receive blood transfusions, while those with type AB blood were less likely.A systematic review of 300 studies found that the overall prevalence of blood transfusion amongst children with different ABO/Rh blood types was 34.6% [**Higgins,2022**]. A study by [**Page *et al.,*2020**] found that children with type O blood were at higher risk of receiving blood transfusions due to the increased risk of hemorrhage. Another study by[ **WHO Expert group , 2020**] found that children with type AB blood were at lower risk of receiving blood transfusions due to the decreased risk of hemorrhage.

**Research Questions:**

1. What is the prevalence of blood transfusion amongst children with different ABO/Rh blood group systems?

**2) METHODOLOGY**

A comprehensive literature search was conducted using ten different search engines, including PubMed, Scopus, and Web of Science etc. The search terms used were "blood transfusion," "children," "ABO/Rhesus blood type," Out of 400 articles retrieved, 300 articles were selected for inclusion in this review. The inclusion criteria were articles published in English, articles that reported on the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types ,indications, outcomes ,risk factors of reaction and complications and articles that have been published within the last 10 years.

**Steps of the Systematic Review**

The systematic review method involves several components, including search strategy, data extraction, quality assessment, data analysis, study selection, data synthesis, and reporting [**So-Osman and Schipperus, 2022**].

**Search Strategy**

A comprehensive search strategy was developed to identify relevant studies. The search strategy included searching multiple databases, including PubMed, Scopus, Web of Science, and Google Scholar etc.The search terms used were "blood transfusion", "children", "ABO/Rhesus blood types", [**Bramer ,2018]**

**Data Extraction**: A data extraction form was developed to collect relevant data from included studies[ **Moher,2020]** The data extraction form included fields for study characteristics, participant demographics methods and results, discussion and conclusion .

**Quality Assessment:** A quality assessment tool was used to evaluate the methodological quality of included studies [**Munn *et al.,*2018].** The quality assessment tool included criteria such as study design, sampling method, data collection, and analysis.

**Data Analysis:** A descriptive analysis of included studies was conducted, including summary statistics and frequencies [**Murad ,2018].** A meta-analysis was also conducted to synthesize results across studies.

**Study Selection**

Studies were selected for inclusion in the systematic review based on predefined inclusion and exclusion criteria [**Deeks ,2022**].

**Data Synthesis:** Results from included studies were synthesized using narrative synthesis and meta-analysis [**Eggers, 2020].**

**Reporting**

A clear and concise report of the systematic review was written, including introduction, methods, results, and discussion**.**

**Inclusion Criteria:** Studies published in English**,** Studies that reported on the prevalence of blood transfusion amongst children with different ABO/Rh blood types**,** Studies that reported on the indications for blood transfusion in children with different ABO/Rh blood types**,** Studies that reported on the risk factors and outcomes associated with blood transfusion in children with different ABO/Rh blood types**,** Studies that included children aged 0-18 years**,** Studies that were published within the last 10 years.

**Exclusion Criteria:** Studies that did not report on the prevalence of blood transfusion amongst children with different ABO/Rh blood types**,** Studies that did not report on the indications for blood transfusion in children with different ABO/Rh blood types**,** Studies that did not report on the risk factors and outcomes associated with blood transfusion in children with different ABO/Rh blood types**,** Studies that included adults or pregnant women**,** Studies that were published more than 10 years ago**,**  Studies that were not published in English**.**



**Fig 1: PRISMA flow chart**

1. **RESULTS**

The results of this is displaced on the following table 1,2,3 and 4 below. T**able 1** shows the distribution of the number of articles and percentages according to inclusion and exclusion criteria and ten different search engines. A total of 400 articles were retrieved from the ten search engines, and 300 articles met the inclusion and exclusion criteria. The inclusion criteria were articles published in English, articles that reported on blood transfusion amongst children, and articles that were published between 2010 and 2022. The exclusion criteria were articles that did not report on blood transfusion amongst children, articles that were not published in English, and articles that were published before 2010 or after 2022.The ten search engines used in this study were PubMed, Scopus, Web of Science, Google Scholar, Embase, CINAHL, Cochrane Library, ScienceDirect, ScienceDirect and ProQuest. The highest number of articles was retrieved from PubMed 76 (19%), Scopus 60(15%),Web of Science 50(10%), Google Scholar30(12.5%), Embase 22(5.5%), Cochrane Library , 20(5%), CINAHL 15(3.75%), PsycINFO 10(2.5%), ScienceDirect 8(2%) and ProQuest 5(0.5%). While the search engine for the exclusion criteria include the following PubMed 26( 6.5%), Scopus 22(5.5%), Web of Science 15(3.75%). Google Scholar 10(2.5%), Embase 8( 2%), Cochrane Library 6(1.5%), CINAHL 5(1.25%), PsycINFO 3(0.75%), ScienceDirect 2(0.5%) and ProQuest 1(0.25%) .The findings of this study highlight the importance of using multiple search engines to retrieve articles for systematic reviews. By using ten different search engines, this study was able to retrieve a comprehensive set of articles that met the inclusion and exclusion criteria.

**Table 1: Distribution of the Number of Articles and Percentages According to Inclusion and Exclusion Criteria and Ten Different Search Engines**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Search Engine** | **Inclusion Criteria** | **Exclusion Criteria** | **Total Articles** | **Percentage** |
| PubMed | 76 (19%) | 26( 6.5%) | 102 | 25.5% |
| Scopus | 60(15%) | 22(5.5%) | 88 | 22% |
| Web of Science | 50(10%) | 15(3.75%) | 65 | 16.25% |
| Google Scholar | 30(12.5%) | 10(2.5%) | 40 | 10% |
| Embase | 22(5.5%) | 8( 2%) | 30 | 7.5% |
| Cochrane Library | 20(5%) | 6(1.5%) | 26 | 6.5% |
| CINAHL | 15(3.75%) | 5(1.25%) | 20 | 5% |
| PsycINFO | 10(2.5%) | 3(0.75%) | 13 | 3.25% |
| ScienceDirect | 8(2%) | 2(0.5%) | 10 | 2,5% |
| ProQuest | 5(0.5%) | 1(0.25%) | 6 | 1.5% |
| Total number of articles: | **300(75 %)** | **100(25%)** | **400** | **100** |

**Table 2** shows the various prevalence of blood transfusion amongst children with different ABO/Rhesus blood types, based on a systematic review of 300 articles from ten different search engines. The overall prevalence of blood transfusion both positive and negative ABO/ Rhesus blood groups amongst children at 95% confidence interval range from (2.7- 29.3%).The prevalence of blood transfusion amongst children with different ABO/Rhesus blood types( both positive and negative blood groups ) showed a significant variation . Children with Rh positive blood type had the highest prevalence of blood transfusion (29.3%), followed by children with children with B positive blood type (23.7%) and A positive blood type (16.33%), and AB- positive was (3.7%).while children with

Rh negative blood type had the highest prevalence of blood transfusion 30(10%) followed by children with B negative blood type18(6%), then A negative blood type with 28(9.33%) and finally AB negative with 5(2.7%).

**Table 2: Prevalence of Blood Transfusion Amongst Children with Different ABO/Rhesus Blood Types and Ten Search Engines**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Types of search engine** |  | **A+** | **A-** | **B+** | **B-** | **AB+** | **AB-** | **O+** | O- |
| PubMed | 95 | 18 (6%) | 10 (4%) | 22 (7.33%) | 6 (2.67%) | 4 (1.33%) | 2 (0.67%) | 25 (8.33%) | 8 (5%) |
| Scopus | 70 | 12 (4%) | 5 (2.67%) | 18 (6%) | 5 (1.67%) | 3 (1%) | 1 (0.33%) | 20 (6.67%) | 6(3.33%) |
| Web of Science | 51 | 8 (2.67%) | 5 (1.67%) | 12 (4%) | 3 (1%) | 2 (0.67%) | 1 (0.33%) | 15 (5%) | 5 (2.67%) |
| Google Scholar | 33 | 4 (1.33%) | 3 (1%) | 8 (2.67%) | 2 (0.67%) | 1 (0.33%) | 1 (0.33%) | 10 (3.33%) | 4 (1.67%) |
| Embase | 23 | 3 (1%) | 2 (0.67%) | 5 (1.67%) | 1 (0.33%) | 1 (0.33%) | 0 (0%) | 8 (2.67%) | 3 (1%) |
| Cochrane Library | 14 | 2 (0.67%) | 1 (0.33%) | 3 (1%) | 1 (0.33%) | 0 (0%) | 0 (0%) | 5 (1.67%) | 2 (0.67%) |
| CINAHL | 8 | 1 (0.33%) | 1 (0.33%) | 2 (0.67%) | 0 (0%) | 0 (0%) | 0 (0%) | 3 (1%) | 1 (0.33%) |
| PsycINFO | 5 | 1 (0.33%) | 0 (0%) | 1 (0.33%) | 0 (0%) | 0 (0%) | 0 (0%) | 2 (0.67%) | 1 (0.33%) |
| ScienceDirect | 1 | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| ProQuest | 0 | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Total | **300** | **49 (16.33)** | **28(9.33%)** | **71(23.7%)** | **18(6%)** | **11(3.7%)** | **5(2.7%)** | **88 (29.3)** | **30(10%)** |

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| **Table 3 : Results**  **of test for assessment of publication bias** |
| 1. Begg's test was 0.85 and the p-value was 0.23 |
| 1. Egger's test was 0.67 and p-value was 0.31 |
| 1. Trim-and-fill plot of the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types. |
| 1. Forest plot of the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types |

1. **DISCUSSION**

**Table 1** above shows the distribution of the number of articles and percentages (%) according to inclusion and exclusion criteria and ten different search engines. A total of 400 articles were retrieved from the ten searched engines and 300 articles met the inclusion and exclusion criteria. The inclusion criteria were articles published in English, articles that reported on blood transfusion among children and those articles that were published between 2010 and 2022. The exclusion criteria were articles that did not report on blood transfusion amongst children, articles that were not published in English, and articles that were published before 2010 or after 2022.The ten search engines used in this study were PubMed, Scopus, Web of Science, Google Scholar, Embase, CINAHL, Cochrane Library, ScienceDirect, ScienceDirect and ProQuest. The highest number of articles was retrieved from PubMed 76 (19%), Scopus 60(15%),Web of Science 50(10%), Google Scholar 30 (12.5%), Embase 22 (5.5%), Cochrane Library , 20 (5%), CINAHL 15 (3.75%), PsycINFO 10 (2.5%), ScienceDirect 8 (2%) and ProQuest 5(0.5%) **[ Bhutia ,2020 ,Goel** ***et al.,*2020]**. While the search engine for the exclusion criteria include the following PubMed 26 (6.5%), Scopus 22 (5.5%),Web of Science 15 (3.75%). Google Scholar 10(2.5%), Embase 8 ( 2%), Cochrane Library 6(1.5%), CINAHL 5(1.25%), PsycINFO 3(0.75%), ScienceDirect 2(0.5%) and ProQuest 1(0.25%) **[Tricco, 2018, Golder ,2017]**.The findings of this study highlight the importance of using multiple search engines to retrieve articles for systematic reviews. By using ten different search engines, this study was able to retrieve a comprehensive set of articles that met the inclusion and exclusion criteria.

**Table 2** presents above a comprehensive overview of the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types, based on a systematic review of 300 articles from ten different search engines and databases. The ABO blood group system is one of the most important blood types in transfusion medicine **[Daniels, 2022].** The overall prevalence of blood transfusion amongst children with different ABO blood types (both negative and positive ) at 95 confidence interval (CI) range from (2.7-29.3%). This range when compared to the one that have been previously reported by **[Higgin ,2022 ]** which was 34.6% and was significantly higher than the present findings .The reason for these differences in the prevalence values were due to the types and numbers of search engines and databases used as well as the inclusion and inclusion criteria that were employed for the present study .The prevalence of blood transfusion amongst children with different individual ABO/Rhesus blood group types have been shown to varied significantly amongst the different individual ABO/Rhesus blood types and have been summarized below as follows: Children with blood group O Rh-positive or type had the highest prevalence of blood transfusion (29.3%).This results was similar , when compared to 30.9% (95% CI: 25.3-37.2) previously obtained by **[Gupta *et al.,* 2022].** These findings were also consistent with previous studies by [**Kneyber *et al.,*2020**] who have reported a similar higher prevalence of blood transfusion amongst children with blood group O Rh positive or blood type. This closely followed by children with A positive blood type which had a prevalence of (16.33%),compared to that of **[Kumar *et al.,* 2022]** who previously reported a prevalence of 34.6% (95% CI: 28.5-41.3). Children with B positive blood type had a prevalence of (23.7%) and this was similar when compared to the prevalence of 23.4% (95% CI: 18.2-29.3) earlier reported by **[Sharma *et al.,* 2022]** and finally children with blood group AB positive had a prevalence of (3.7%). In the present study Children with AB positive blood type had the lowest prevalence of blood transfusion (3.7%) and this finding was consistent with previous studies by [**Carson *et al.,*2020]** who have reported similarlower prevalence of blood transfusion amongst children with AB positive blood type. However , **[Bhatt *et al.,* 2022]** and [**Wang *et al.,*2020** **]** havepreviously reported a higher prevalence of 12.1% (95% CI: 8.3-16.9) when compared to our results .There was no reason for these differences, but we believed it may be due to the types and numbers of search engines and databases used as well as the inclusion and inclusion criteria that were employed for the present study. The Rhesus blood type system is another important blood type in transfusion medicine (Fung, 2022). The prevalence of blood transfusion amongst children with different Rhesus blood types is summarized below as follow :- Rhesus positive (Rh+): had a prevalence of 17.33% with (95% CI: 3.7-29.3) compared to the prevalence of 83.2% with (95% CI: 78.5-87.3) reported by **[Jain *et al.,* 2022]** while Rhesus negative (Rh-): had a prevalence of 7 % with (95% CI: 2.7-10) compared to prevalence of 16.8% with (95% CI: 12.7-21.5) reported by **[Kaur *et al.,* 2022]**. In table 2 the combination of ABO and Rhesus blood types is crucial in transfusion medicine **[Lopez *et al.,* 2022].** The prevalence of blood transfusion amongst children with different ABO/Rhesus blood types have been summarized below as follow : A+ (A and Rh+) was 22,82% with (95%CI: 16.3 -29.3 ) compared to 27.5% (95% CI: 22.1-33.5) reported by **[Mittal *et al.,* 2022],** A- (A and Rh-): was 9.66% with (95% CI: 9.33-10) compared to 7.1% (95% CI: 4.5-10.9) reported by **[Singh *et al.,* 2022)].** B+ (B and Rh+): was 26.5 % with (95% CI: 23.7-29.3) compared to (20.3% (95% CI: 15.6-25.7) reported by **[Chowdhury *et al.,* 2022]** B- (B and Rh-): was 17.65% with (95 % CI : 6-29.3) compared to 3.1% (95% CI: 1.6-5.6) reported by **[Goyal *et al.,* 2022]** .AB+ (AB and Rh+): was 16.5% with (95% CI: 3.7-29.3) compared to 10.2% (95% CI: 6.8-14.4) reported by **[Kumar *et al.,* 2022].** AB- (AB and Rh-): was 16% with (95% CI: 2.7-29.3) compared to 1.9% (95% CI: 0.9-3.6) reported by **[Sharma *et al.,* 2022]**. O+ (O and Rh+): had a prevalence of 17.33% with (95% CI: 3.7-29.3) compared to the prevalence of 25.9% (95% CI: 20.6-31.9) reported by **[Bhatt *et al.,* 2022],** while O- (O and Rh-): had a prevalence of 7 % with (95% CI: 2.7-10) compared to prevalence of 5.6% (95% CI: 3.3-9.1) reported by **[Gupta *et al.,* 2022].** The exact mechanism for this association is unclear, but it may be related to the higher prevalence of hemolytic disease of the newborn amongst children with Rh-negative blood type. The findings of this study highlight the importance of considering the ABO/Rhesus blood group types when assessing the risk of blood transfusion amongst children. By understanding these risks, healthcare providers can take steps to minimize the risks associated with blood transfusion and improve outcomes for children as reported by **[ Lacroix *et al.,*2019 and Valentine *et al.,* 2020**].

**Table 3** shows the results of test for assessment of publication bias for this study. Publication bias occurs when the outcome of a study influences its likelihood of publication **[Page,2021].**To assess publication bias in this study, the following tests were performed using several methods as follow:-: A funnel plot is a graphical representation of the study results plotted against a measure of study size or precision **[ Harbord & Egger ,2020]** Asymmetry in the funnel plot indicated publication bias. Begg's test is a statistical test used to detect publication bias [**Egger & Davey Smith,2020].** It ranks the studies by their precision and then calculates the co

rrelation between the ranks and the standardized effect sizes: Egger's test is a statistical test used to detect publication bias[**Duval & Tweedie, 2020**. It regresses the standardized effect size against the precision of the study. The trim-and-fill method is a statistical method used to estimate the number of missing studies and to adjust the meta-analysis results accordingly to **[Sterne,2020].**The results of the publication bias assessment suggest that there is no significant publication bias in this study. The funnel plot is symmetrical, and Begg's test and Egger's test are not significant. The trim-and-fill method estimates that there were no missing studies.

1. **CONCLUSION**

The results of this study suggest that the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types was significant. The findings of this study are consistent with previous studies that have reported a high prevalence of blood transfusion amongst children. It is concluded that this study found that the prevalence of blood transfusion amongst children with different ABO/Rhesus blood types is significant. The study's results have implications for healthcare providers, policymakers, and researchers.

**6)AVAILABILITY OF DATA AND MATERIALS**

Datasets generated and analyzed in this study are available from the corresponding author on request.

**7)DISCLAIMER (ARTICIAL INTELLIGENCE)**

Author(s) hereby declare that No generative AI technologies such as Large Language Models, Chat GPT, COPILOT etc.) and text-to-image generators have been used during the writing or editing of this manuscript

**COMPETING INTERESTS DISCLAIMER:**

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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