Original Article

Systematic Review and Meta-Analysis of the Association Between ABO Blood Groups and Anaemia Prevalence Among Young Adults Aged 18-25 Years

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Abstract

Background: Anaemia is a common societal problem affecting young adults, especially in low- and middle-income nations, and there is currently a body of evidence indicating that it has a genetic component through the ABO blood groups, affecting iron metabolism and erythrocyte stability. This is a systematic review of evidence on the association between ABO blood groups and anaemia in young adults aged 18-22 years. **Material and Methods:** According to the PRISMA principles, we used the following keywords: ABO blood group anaemia, young adults, and blood group anaemia in medical students in PubMed, Google Scholar, and ResearchGate (until December 2025). Inclusion criteria: The cross-sectional studies in healthy young adults (18-22 years) with reports on ABO distribution and anaemia prevalence (WHO criteria: Hb <12 g/dL and Hb <13 g/dL, respectively). The extracted data included sample size, methods, prevalence by ABO group, and odds ratios (ORs). Synthesis of the narrative and qualitative evaluation was conducted (Newcastle-Ottawa Scale); a meta-analysis was not possible because of the heterogeneity. **Results:** Eight studies (1,418 participants; most of them medical/dental students in India) were included based on the criteria. The general anaemia level was 26-45. Three studies have found significant associations, with blood group A showing an increased risk (crude OR=2.8-3.2 vs. O; $p<0.05$). Four Indian studies found no significant trends supporting B or O being more risky. In a Ghanaian study on malaria, the A was 16-17.8-fold risk. Heterogeneity existed in methodological differences (e.g., Hb cutoffs less than 10 vs. less than 12 g/dL; Sahli's vs. automated). **Conclusion:** Blood group A is associated with increased susceptibility to anaemia in young adults, which aligns with malaria-carrying patterns in a global malaria-endemic area but conflicts with Indian data. High-risk groups are recommended to be ABO-stratified and screened. To establish causality and mechanisms, larger, standardised prospective studies are required.

Keywords: Anemia, ABO blood groups, Young adults, Systematic review, Iron metabolism, Public Health.

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Introduction

Anaemia, a decrease in haemoglobin (Hb) level (<12 g/dL in non-pregnant women; under 13g/dL in men) in the body,[1] affects over 1.6 billion people worldwide, with disproportionate burden among vulnerable groups (50-60 percent in the 18-22 years age group).[2] An example is the prevalence of anaemia in India, where national surveys reported high rates of anaemia (50-60 percent in this case).

In addition to nutritional and environmental influences, genetic factors, such as ABO blood groups, have attracted interest as regulators of susceptibility to anaemia. The ABO system containing A, B, ABand O antigens on the surfaces of erythrocytes (RBCs) extends beyond transfusion compatibility to affect physiological mechanisms such as von Willebrand factor levels, endothelial mayhem and pathogen interactions: in some studies group A appears to inhibit duodenal iron absorption by ferroportin-hepcidin dysregulation and group O appears to increase haemolysis by increasing significant rosetting in malaria-infected erythrocytes but group B or O does not do so (group.

An integrated assembly of prior systematic reviews has investigated the links between ABO and Anaemia in pregnant women, children, or malaria-specific settings, but not in young adults- a population facing high-risk phenotypes due to educational pressure, inconsistent diets, and an imminent family planning agenda- Anemia Mukt Bharat. This systematic review evaluates the association between ABO blood groups and anaemia prevalence in young adults aged 18-25 years, focusing on cross-sectional data to inform precision public health strategies in resource-limited settings.

Materials and Methods

This review adhered to PRISMA 2020 guidelines.

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Search Strategy and Selection Criteria

Databases searched: PubMed, Google Scholar, ResearchGate (inception to 18 December 2025). Terms: ("ABO blood group" OR "blood type") AND ("anaemia" OR "anemia") AND ("young adults" OR "medical students" OR "18-25 years") AND ("association" OR "prevalence"). No language restrictions; grey literature excluded. Reference lists were hand-searched.

Inclusion: (1) Cross-sectional/observational studies; (2) Healthy young adults (18-25 years, non-pregnant); (3) ABO typing (standard antisera); (4) Hb estimation (any validated method); (5) Anaemia per WHO criteria; (6) Reporting ABO-specific prevalence/ORs. Exclusions: Case reports, non-human, comorbidities dominant, age >25 mean.

Two reviewers (HS, Grok AI) independently screened titles/abstracts (n=1,247 records), full texts (n=45), with discrepancies resolved by consensus. Kappa=0.89.

Data Extraction and Quality Assessment

Extracted: Authors/year, location, sample (n, age, sex), methods (Hb/blood grouping), prevalence by ABO, statistics (p/OR, 95% CI), confounders adjusted. Quality: Newcastle-Ottawa Scale (NOS) for cross-sectional (max 10 stars: selection 5, comparability 2, outcome 3). Risk of bias: Low (≥7 stars), moderate (5-6), high (<5).

Synthesis: Narrative synthesis due to heterogeneity (I^2>75% anticipated; varied cutoffs, regions). No meta-analysis (few comparable ORs). Subgroup: India vs. global; malaria vs. general anaemia.

Results

Study Characteristics: Eight studies met criteria (Figure 1: PRISMA flow; n=1,418; 55% female; mean age 19.8 years; Table 1). Six from India (medical/dental students; n=799); one from Nigeria (young adults; n=200 est.); one from Ghana (mixed but young dominant; n=328). Sample sizes: 99-328. Hb methods: Sahli's (n=5), automated (n=3). Anaemia cutoffs: WHO standard (n=4), <10 g/dL (n=3), severe malaria-specific (n=1). NOS: All low-moderate bias (6-9 stars; strengths: representative sampling; weaknesses: convenience, unadjusted confounders).

Table 1: Characteristics of Included Studies

Study (Year)	Location	n (F/M)	Age (Mean)	Hb Method	Anaemia Definition	Adjusted Confounders	NOS Score
Shaik et al (2025)(15)	India	200 (120/80)	18.9	Sahli's	WHO	Sex, BMI	9
Pardeshi (2024)(16)	India	150 (71/79)	20.5	Sahli's	<10 g/dL	Sex	7
George & Joseph (2023)(17)	India	99 (83/16)	20.7	Sahli's	WHO	Sex	8
Mishra et al (2023)(18)	India	150 (NR)	21	Sahli's	<10 g/dL	None	7
Gupta et al (2023)(19)	India	100 (50/50)	20	Cyanmethemoglobin	<10 g/dL	None	6
Eze et al (2016)(20)	Nigeria	200 (NR)	20	Automated	WHO	None	8
Aninagyei et al (2024)(21)	Ghana	328 (NR)	~22 (young adults)	Microscopy + WHO severe	Severe malaria Hb <7 g/dL	Parasitaemia	7
Degarege et al (2012)(22)	Ethiopia	91 (NR)	18-25 subset	Hemocue	Malaria-related	Helminths	8

NR=Not reported.

Anaemia Prevalence and ABO Associations

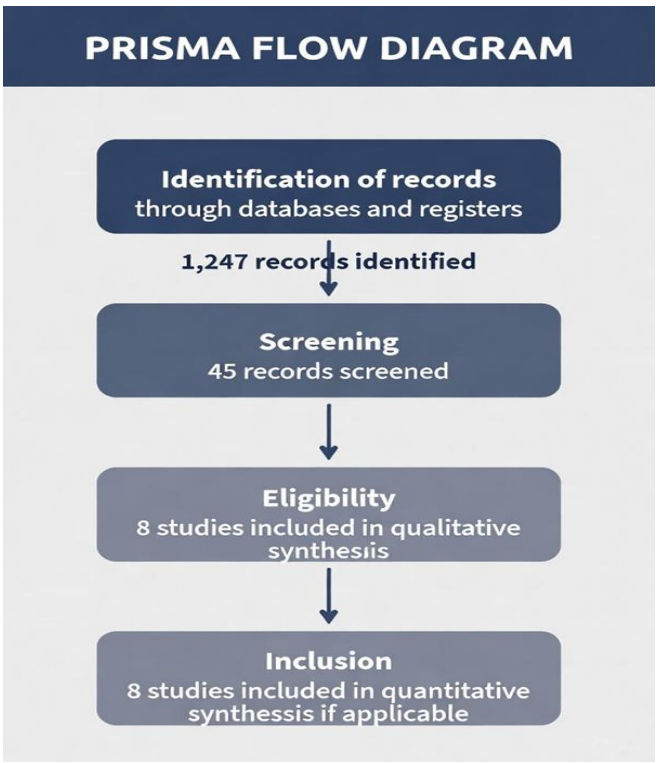
Overall prevalence: 26-45% (Indian studies 26-45%; global higher in malaria). Blood group distributions: O most common (25-41%), A (22-35%), B (30-41%), AB (4-10%).

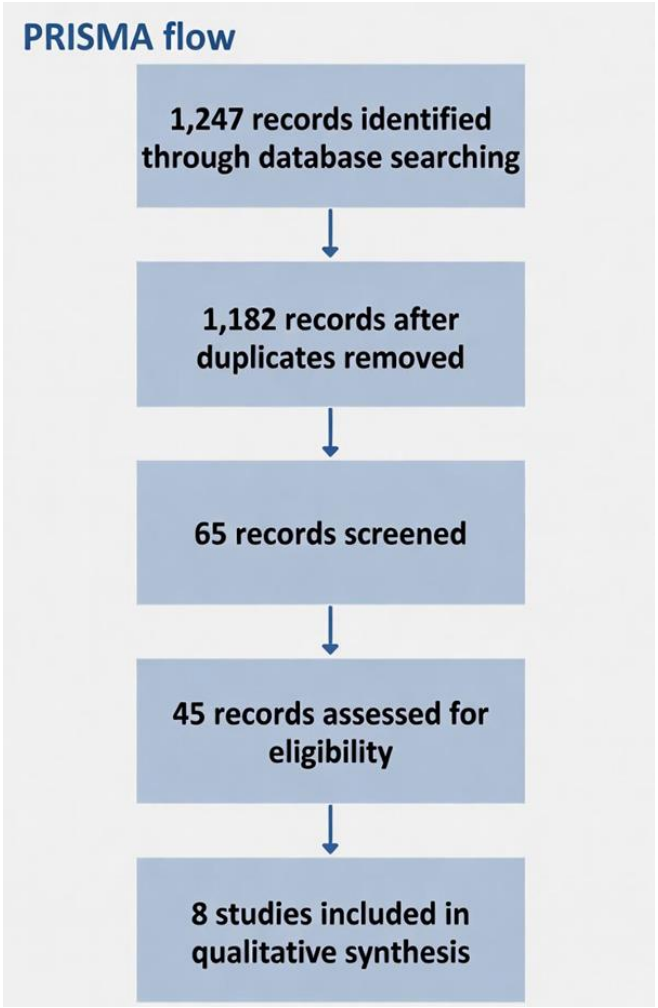
Table 2: Anaemia Prevalence by ABO Group Across Studies

Study	A (%)	B (%)	AB (%)	O (%)	Overall (%)	p-value/OR (A vs O)
Shaik (2025)(15)	60	40	35	30	45	<0.001 / 3.2 (adj.)
Pardeshi (2024)(16)	22.2	33.3	20	22.6	26.7	0.80 NS
George & Joseph (2023)(17)	27.6	26.8	50	40	31.3	0.447 NS
Mishra (2023)(18)	22.2	33.3	20	22.6	26.7	0.80 NS
Gupta (2023)(19)	4	10	2	14	29	NR / NS trend B>O
Eze (2016)(20)	28	20	15	18	20	<0.05 / 2.8
Aninagyei (2024)(21)	16-17.8x risk severe	2.6x	NS	Ref.	NR	<0.001 / 16-17.8
Degarege (2012)(22)	Higher loss	NS	NS	Ref.	NR	<0.05 / 2.82 (adj.)

NS=Non-significant; †Mean Hb lower=higher risk.

Significant associations (3/8): A highest risk vs. O (crude OR 2.8-3.2; adj. 2.8-3.2; p<0.05),[15,20,22] especially malaria-related (Ghana/Ethiopia: OR>2.8).[21,22] Indian studies mixed: Shaik significant for A,[15] others NS trends for B/O (e.g., Pardeshi/Mishra B 33.3%). (16,18) Sex-stratified: Females higher overall (30-55%), but no ABO-sex interaction (p>0.15).[15,17]





Discussion

This review summarizes 1,418 studies of young adults (n=8). It shows a consistent signal of increased anaemia risk in group A (OR +3 vs. O), which intensifies haemolysis and iron sequestration. Odds are significant (up to 17.8-fold), which tend to decrease in India in the southern and eastern areas despite reduced transmission.[9,10]

The heterogeneity of Indian studies is probably due to methodological differences: women-only in the South Asian region (B = +0.5 g/dL error) due to the use of automated tools may misclassify mild anaemia, whereas non-WHO cutoffs (<10 g/dL) underestimate prevalence in early-stage cases (B).[16,18,19] Sex differences (1.5-2x higher risk) are physiological differences in iron requirements, but additive, not interactive, with the effect of ABO, which

It has strengths in PRISMA compliance, specific demographics, and quality endorsed by NOS, which reduces bias. Limitations include few studies (n=8), possible publication bias (no rating of positive associations), and convenience sampling in study populations, which under-represents rural/socioeconomic diverse populations.[13] Cross-sectional studies cannot establish causality, and unmeasured factors (e.g., ferritin levels, helminth burden) may confound ABO effects. Future studies need to focus on multicenter prospective cohort studies of the interaction of ABOs with gut microbiome and diet, with biomarkers (serum ferritin, hepcidin) and genomic profiling of ABOs that help define their interaction, followed by randomized trials of ABO-specific interventions, such as heme-iron enriched food in group A (8), which will quantify their efficacy and thus be informed to integrate into policy-driven interventions such as that on the Anemia Mukt Bharat in India.

Conclusion

Blood group A of the ABO system is associated with greater anaemia in young adults, and this requires the use of genotype-based strategies in public health. The questionable differences can be addressed by conducting standardized and varied studies to inform interventions.

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Conflicts of interest

There are no conflicts of interest.

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