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Rising Anemia Rates Amidst the COVID-19 Pandemic: Is There A Connection?

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Abstract

Rationale: This study aims to analyze data from patients who developed anemia during the COVID-19 pandemic and assess the risk of developing different types of anemia among patients diagnosed with COVID-19.

Methods: This retrospective cohort study used the National Inpatient Sample (2020–2021). We included males and females of various ethnicities (White, Black, Hispanic, Asian/Pacific Islander, Native American, and others) with ICD-10 codes D50–D64. The data was weighted with hospital strata. Data analysis was performed using IBM SPSS Statistics™ 25.0, applying inferential statistics.

Results: This study encompassed a cohort of 136,636,051 with a mean age of 49.93 years (+/- 27.26), of whom 75,904,558 (55.6%) were females. The mortality rate was 2.4% (3,316,244), with a mean length of stay of 4.77 days (± 26.322). Of all patients, 24.9% (16,382,561) had anemia, whereas 75.1% (49,306,986) did not. Compared with 2018, when 8,257,430 patients (23.2%) had anemia, the figure rose during the COVID-19 pandemic in 2021 to 8,398,512 (25.2%), a significant increase ($p<0.001$). Further analysis showed that this increase is not associated with the COVID-19 pandemic, as COVID-19 patients were 13% less likely to have anemia RR= 0.874 [95% CI 0.872-0.876]. Further analysis by subgrouping anemia types reveals that COVID-19 patients were less likely to develop most types of anemia except for other aplastic anemias and bone marrow failure syndromes RR= 1.209 [95% CI 1.201-1.217] and other anemias RR=1.095 [95% CI 1.092-1.099] which is ambiguous diagnosis.

Conclusions: While anemia rates rose during the pandemic, COVID-19 was not a major driver except for specific anemia subtypes. Further research is needed to understand these associations.

Keywords: Anemia, COVID-19, National Inpatient Sample, Temporal trends, Hospitalized patients, Hematologic abnormalities, Aplastic anemia, Bone marrow failure syndromes

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Introduction

Anemia remains one of the most common hematologic abnormalities encountered in clinical practice and continues to represent an important public health concern worldwide. It has been associated with increased morbidity, reduced functional status, longer hospital stays, and worse overall clinical outcomes, particularly among vulnerable and hospitalized patients. Because anemia may result from a broad range of nutritional, inflammatory, chronic, hereditary, and bone marrow-related conditions, changes in its prevalence may also reflect larger shifts in population health and healthcare access.

Since the emergence of coronavirus disease 2019 (COVID-19), increasing attention has been given to

its systemic manifestations beyond the respiratory tract. In addition to pulmonary and thromboinflammatory complications, COVID-19 has been associated with several hematologic abnormalities, including inflammation-related changes in iron metabolism and alterations in red blood cell homeostasis. At the same time, the pandemic significantly affected access to healthcare, hospitalization patterns, and the recognition and management of chronic diseases. These overlapping factors created uncertainty regarding whether rising anemia rates during the pandemic were directly related to COVID-19 infection or instead reflected the broader indirect effects of the pandemic on inpatient care.

Given this context, evaluating anemia trends at the population level may help clarify whether COVID-19 was associated with a greater likelihood of anemia overall or with specific anemia subtypes. In the present study, we analyzed National Inpatient Sample data to examine temporal trends in anemia prevalence and to assess the association between COVID-19 and different forms of anemia among hospitalized patients. As outlined in the abstract, the study was designed to analyze data from patients who developed anemia during the COVID-19 pandemic and to assess the risk of different anemia types among patients diagnosed with COVID-19.

Methods

We performed a retrospective cohort study using the National Inpatient Sample (NIS). To evaluate temporal trends in anemia prevalence, weighted hospitalizations from 2018 through 2021 were analyzed. To assess the association between COVID-19 and anemia, analyses were restricted to hospitalizations from 2020 through 2021, corresponding to the period included in the COVID-specific crosstabulations. National estimates were generated using the NIS discharge weight, and all analyses were performed in IBM SPSS Statistics version 25.0.

Hospitalizations with anemia were identified using ICD-10 codes D50-D64. The study included male and female hospitalizations across the racial and ethnic categories available in the database, including White, Black, Hispanic, Asian/Pacific Islander, Native American, and other groups. In addition to overall anemia, subgroup analyses evaluated iron deficiency anemia, vitamin B12 deficiency anemia, folate deficiency anemia, nutritional anemia, enzyme disorder anemia, thalassemia, sickle cell anemia, hereditary anemia, acquired anemia, erythroblastemia, bone marrow failure syndromes/other aplastic anemias, posthemorrhagic anemia, anemia of chronic disease, and other anemia. The primary objectives were to assess temporal trends in anemia prevalence and to evaluate the association between COVID-19 and both overall anemia and specific anemia subtypes.

Continuous variables were summarized as mean ± standard deviation, and categorical variables were reported as weighted frequencies and percentages. Cross-tabulation analyses were performed to compare the frequency of anemia and anemia subtypes according to COVID-19 status in the 2020–2021 cohort. Pearson chi-square testing was used for group comparisons, and risk estimates with 95% confidence intervals were calculated for each anemia subtype and for anemia overall.

Results

For the temporal trend analysis, a total of 136,636,051 weighted hospitalizations from 2018 through 2021 were included. Anemia prevalence increased progressively across the study period, from 23.2% in 2018 to 23.7% in 2019, 24.7% in 2020, and 25.2% in 2021, representing a significant upward trend over time ($p<0.001$) (**Figure 1**).

For the COVID-specific analysis, 65,689,547 weighted hospitalizations from 2020 through 2021 were evaluated. In this cohort, the mean age was 49.83 years, mean length of stay was 5.05 days, 55.1% of patients were female, in-hospital mortality was 2.9%, 6.3% had a COVID-19 diagnosis, and 24.9% had anemia (**Table 1**).

Despite the temporal increase in anemia prevalence, COVID-19 was not associated with a higher overall likelihood of anemia. Among hospitalizations with anemia, 926,409 (5.7%) had a concurrent COVID-19 diagnosis, compared with 3,188,636 (6.5%) among hospitalizations without anemia. This corresponded to a lower likelihood of anemia in patients with COVID-19 (RR 0.874, 95% CI 0.872–0.876) (**Figure 2**).

Subtype analysis showed that COVID-19 was associated with a lower likelihood of most anemia categories, including iron deficiency anemia (RR 0.836, 95% CI 0.832–0.840), vitamin B12 deficiency anemia (RR 0.784, 95% CI 0.760–0.809), folate deficiency anemia (RR 0.692, 95% CI 0.652–0.733), nutritional anemia (RR 0.809, 95% CI 0.800–0.818), thalassemia (RR 0.848, 95% CI 0.825–0.873), sickle cell anemia (RR 0.700, 95% CI 0.690–0.711), hereditary anemia (RR 0.751, 95% CI 0.716–0.786), acquired anemia (RR 0.883, 95% CI 0.854–0.913), posthemorrhagic anemia

(RR 0.511, 95% CI 0.508–0.513), and anemia of chronic disease (RR 0.976, 95% CI 0.972–0.980) (**Table 2**, **Figure 3**).

In contrast, COVID-19 was associated with a higher likelihood of bone marrow failure syndromes/other aplastic anemias (RR 1.209, 95% CI 1.201–1.217) and other anemia diagnoses (RR 1.095, 95% CI 1.092–1.099) (**Table 2**, **Figure 3**).

No significant association was identified for enzyme disorder anemia (RR 0.947, 95% CI 0.832–1.078; p=0.408) or erythroblastemia (RR 0.975, 95% CI 0.788–1.205; p=0.814) (**Table 2**, **Figure 3**).

Discussion

In this national inpatient analysis, anemia prevalence increased steadily from 2018 to 2021, rising from 23.2% to 25.2%. At the same time, COVID-19 was not associated with a higher overall likelihood of anemia among hospitalized patients during 2020-2021. Instead, COVID-19 admissions showed a lower recorded likelihood of anemia overall, as well as lower frequencies of most anemia subtypes, including iron deficiency anemia, vitamin B12 deficiency anemia, folate deficiency anemia, nutritional anemia, thalassemia, sickle cell anemia, hereditary anemia, acquired anemia, and anemia of chronic disease. The main exceptions were bone marrow failure syndromes or other aplastic anemias and the broader category of other anemia, both of which were more frequent among COVID-19 hospitalizations.

At first glance, these findings may seem inconsistent with the existing literature, since several studies have reported that anemia is common in patients with COVID-19 and is associated with greater inflammatory burden, more severe disease, and worse outcomes. (1–3) However, our results likely reflect a different level of analysis rather than a true contradiction. Most prior studies have evaluated anemia within cohorts of patients already diagnosed with COVID-19, often using laboratory-confirmed hemoglobin values and focusing on prognosis or disease severity. (1–3) By contrast, the present study examined discharge-level diagnosis patterns in a large national administrative dataset. As a result, our findings are more likely to reflect population-level hospitalization patterns, coding practices, and shifts in healthcare utilization during the pandemic than direct biological effects of SARS-CoV-2 alone.

This distinction is important for interpretation. Administrative inpatient data do not capture anemia severity, iron indices, transfusion requirements, or the temporal relationship between infection and hematologic abnormalities. Therefore, the lower coded prevalence of anemia among COVID-19 admissions should not be interpreted as evidence of a protective effect. A more plausible explanation is that pandemic-era hospitalization patterns changed substantially, with delayed care, reduced access to routine follow-up, and major fluctuations in hospital and ICU occupancy. (4,5) These system-level disruptions may have altered which patients were admitted, which chronic comorbidities were documented, and how preexisting anemia diagnoses were coded during acute hospitalizations for COVID-19.

The subtype analysis adds further nuance. The lower likelihood of nutritional, deficiency-related, hereditary, and chronic disease-associated anemias among COVID-19 admissions may reflect the fact that many of these diagnoses are chronic conditions more commonly recognized in patients with ongoing outpatient monitoring or repeated healthcare contact. During the pandemic, interruptions in access to care and changes in admission thresholds may have reduced the identification or coding of these longstanding anemia phenotypes. (4,5) In contrast, the increased association observed for bone marrow failure syndromes and aplastic anemias is notable. Although rare, aplastic anemia following SARS-CoV-2 infection or vaccination has been described in the literature, raising the possibility that immune dysregulation may contribute to marrow suppression in susceptible individuals. (6) Our study cannot establish causality, but it does suggest that marrow-failure phenotypes may behave differently from the more common nutritional or chronic inflammatory forms of anemia. The association observed in the “other anemia” category should be interpreted cautiously, since this is a heterogeneous group that likely includes nonspecific or variably coded diagnoses.

These findings add an important epidemiologic perspective to the current literature. Rather than supporting a uniform relationship between COVID-19 and anemia, our results suggest that the observed association depends heavily on the level at which it is measured. At the patient level, anemia may still function as a marker of inflammation, disease severity, and adverse prognosis in patients with COVID-19. (1–3) At the population level, however, national discharge data may instead capture the downstream effects of healthcare disruption, selective hospitalization, and documentation practices during the pandemic. (4,5) These perspectives are not mutually

exclusive. Instead, they likely describe different dimensions of the same broader clinical reality.

This study has several strengths. It uses the National Inpatient Sample, the largest publicly available all-payer inpatient database in the United States, which is designed to generate national estimates and is particularly useful for evaluating large-scale trends and relatively uncommon inpatient diagnoses. At the same time, its limitations should be acknowledged. Because the NIS is a discharge-level administrative database derived from billing data, the analysis depends on coded diagnoses rather than direct clinical or laboratory measurements. The database does not allow assessment of hemoglobin levels, anemia severity, iron studies, treatment details, or precise temporal sequencing between COVID-19 and anemia. In addition, residual confounding and coding heterogeneity are inherent to this type of study design. Accordingly, the associations identified here should be interpreted as population-level patterns rather than causal relationships.

Overall, our findings suggest that the increase in anemia observed during the pandemic years was real at the national inpatient level, but that COVID-19 itself was not the principal driver of this pattern for most anemia subtypes. Instead, the relationship appears to be more complex, shaped by the interaction between pandemic-related healthcare disruption, hospitalization dynamics, and possibly subtype-specific hematologic responses. The signal observed for bone marrow failure and aplastic anemia deserves further investigation in studies with laboratory-based data and clearer temporal resolution. More broadly, the difference between the temporal rise in anemia prevalence and the lower coded likelihood of anemia among COVID-19 admissions highlights the importance of distinguishing between biologic associations and system-level epidemiologic patterns when interpreting pandemic-era inpatient data.

Conclusion

In conclusion, anemia prevalence increased during the pandemic years; however, COVID-19 was not associated with a higher overall likelihood of anemia in hospitalized patients. Most anemia subtypes were less frequently recorded among COVID-19 admissions, while bone marrow failure syndromes or other aplastic anemias and the broader category of other anemia showed a positive association. These findings suggest that the rise in anemia observed during the pandemic was likely influenced by factors beyond COVID-19 infection alone, including changes in healthcare utilization, hospitalization patterns, and diagnostic coding. Overall, while anemia rates rose during the pandemic, COVID-19 was not a major driver except for specific anemia subtypes, and further research is needed to better understand these associations.

Table 1. 2020-2021 cohort summary

Variable	Value
Weighted hospitalizations (2020-2021)	65,689,547
Mean age, years	49.83
Mean length of stay, days	5.05
In-hospital mortality	1,919,669 (2.9%)
Female gender	36,204,235 (55.1%)
COVID-19 diagnosis	4,115,045 (6.3%)
Overall anemia	16,382,561 (24.9%)

Table 2. Exact Anemia Subtype Risk Estimates

Subtype	RR	Lower	Upper	p-value
Iron deficiency anemia	0.836	0.832	0.84	<0.001
Vitamin B12 deficiency anemia	0.784	0.76	0.809	<0.001
Folate deficiency anemia	0.692	0.652	0.733	<0.001
Nutritional anemia	0.809	0.8	0.818	<0.001
Enzyme disorder anemia	0.947	0.832	1.078	0.408
Thalassemia	0.848	0.825	0.873	<0.001
Sickle cell anemia	0.7	0.69	0.711	<0.001
Hereditary anemia	0.751	0.716	0.786	<0.001
Acquired anemia	0.883	0.854	0.913	<0.001
Erythroblastemia	0.975	0.788	1.205	0.814
Bone marrow failure / aplastic anemia	1.209	1.201	1.217	<0.001
Posthemorrhagic anemia	0.511	0.508	0.513	<0.001
Anemia of chronic disease	0.976	0.972	0.98	<0.001
Other anemia	1.095	1.092	1.099	<0.001
Overall anemia	0.874	0.872	0.876	<0.001

Figure 1. Temporal trend in anemia prevalence, 2018-2021

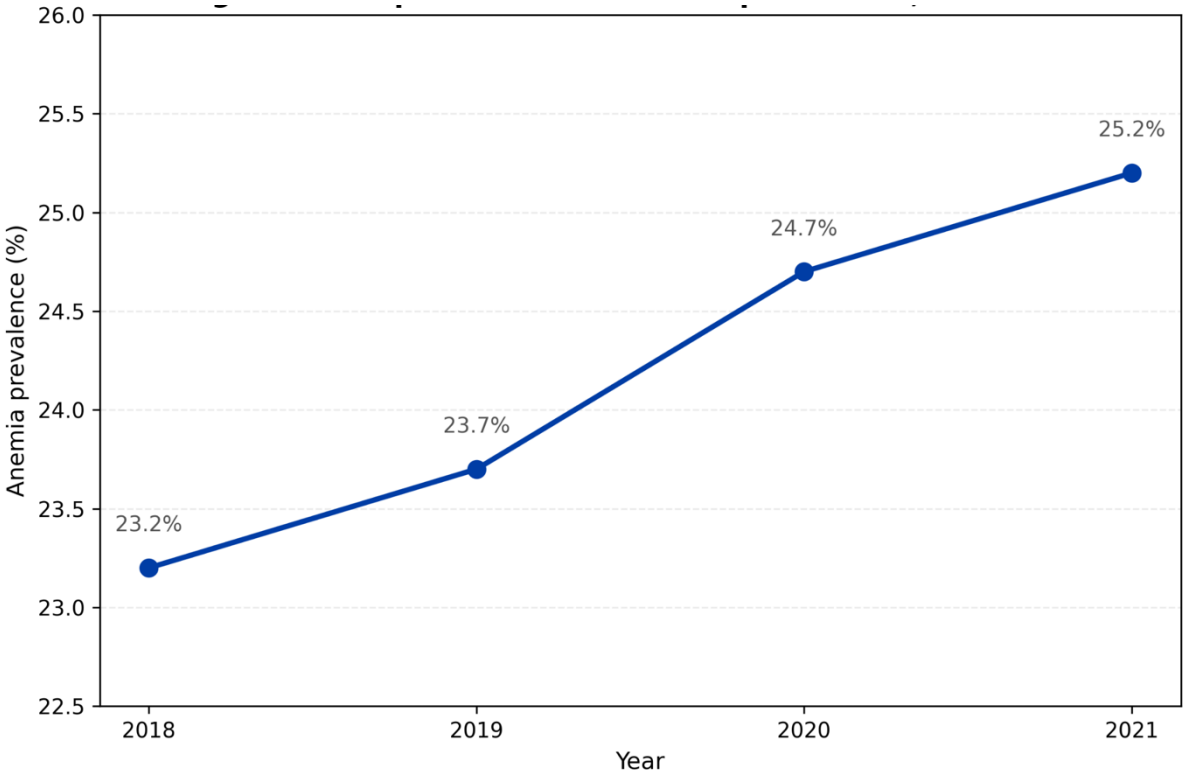


Figure 2. Overall association between COVID-19 and anemia.

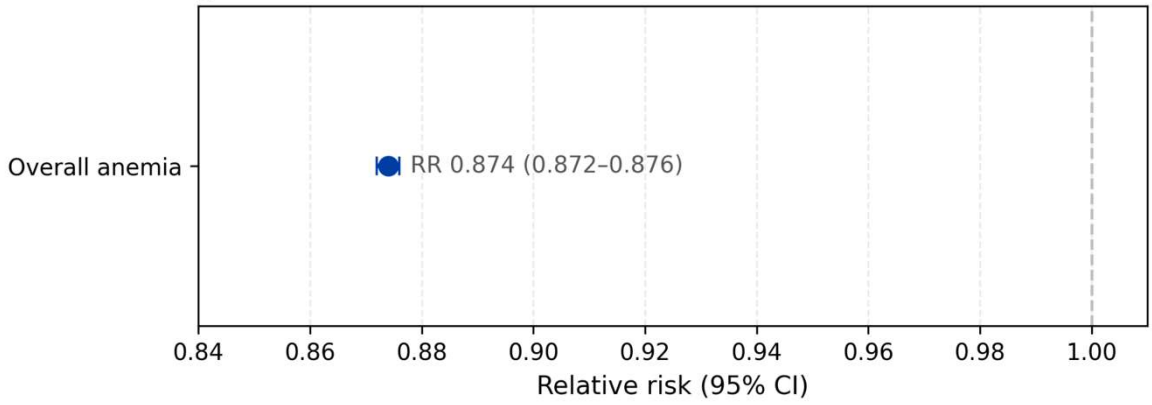
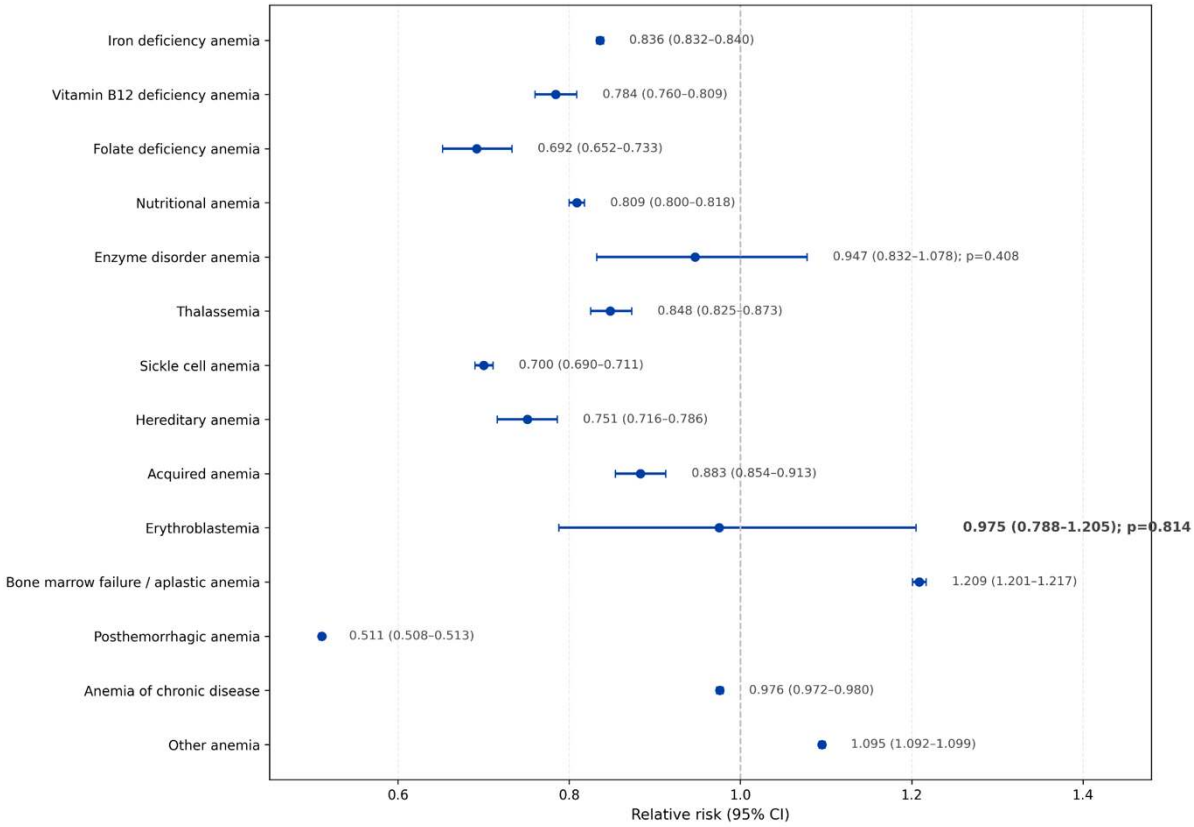


Figure 3. Relative Risk of Anemia subtypes by COVID-19 status



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