Journal of Health, Population and Nutrition

REVIEW

Open Access

Uncovering the hidden health burden: a systematic review and meta-analysis of iron deficiency anemia among adolescents, and pregnant women in Pakistan

Benazir Mahar[1*], Tazeen Shah[2], Khalida shaikh[2], Saima Naz shaikh[2], Arsalan Ahmed Uqaili[2], Khalida Naz Memon[3], Jamshed Warsi[4], Rozina Mangi[5], Sani Aliyu[6], Qamar Abbas[7] and Farheen Shaikh[8]

Abstract

Introduction Iron deficiency anemia (IDA) is the most prevalent diet-related disorder and mainly affects women and children. To determine the trend of anemia incidence in Pakistan, a current review was carried out. This review aimed to estimate the prevalence of anemia among pregnant women and adult/adolescent nonpregnant women in Pakistan and to provide a 15-year trend analysis.

Materials and methods Studies were identified by searching PubMed, Google Scholar, Scopus, and Science Direct, complementing this digital exploration, and a manual review of reference lists from previously published prevalence studies was performed to enhance the scope of relevant articles. A total of twenty-seven population-based anemia studies on adolescent/adult females and pregnant women published in Pakistan from January 1st-2007 until December 2021 were included. Systematic data extraction was facilitated through the implementation of a standardized and rigorously pretested data extraction checklist. For the subsequent analysis, the sophisticated capabilities of R statistical software were harnessed. The I^2 test was used to assess heterogeneity among studies, and the pooled prevalence of anemia was calculated.

Results The final analysis included 27 research articles as well as two extensive National Nutrition survey reports, NNS 2011 and NNS 2018. The forest plot of sixteen studies on pregnant women revealed that the overall pooled prevalence of anemia among pregnant females in Pakistan was 70.4% (95% CI: 0.619, 0.789), and the forest plot of eleven studies on non-pregnant adolescent and adult females reported the pooled prevalence was 54.6% (95% CI: 0.422, 0.669). Subgroup analysis among pregnant women based on region, trimester and socioeconomic status revealed that the highest anemia incidence was observed in Punjab (77.4%). Similarly, females in the second trimester reported a higher prevalence of anemia 78% (95% CI, 0.556 1.015), and the status-wise group with a mixed background reported a higher prevalence 72.8% (95% CI, 0.620 0.835). According to the subgroup analysis, eleven

*Correspondence:
Benazir Mahar
beenafs@hotmail.com

Full list of author information is available at the end of the article

studies of adult nonpregnant groups of mixed socioeconomic status reported a higher prevalence of 56.9% (95% CI, 0.292 0.845).

Conclusion In Pakistan, anemia, is widespread among pregnant women and nonpregnant adolescent/adult females. A deeper understanding of anemia in Pakistani women is necessary for targeted interventions and policy decisions to predict demographic shifts.

Keywords Iron deficiency, Pregnancy, Adolescent females, Anemia, Pakistan

Background

Anemia is a condition in which the amount of hemoglobin in the blood decreases along with a decrease in the red blood cell mass [1]. There are several forms of anemia; however, iron deficiency anemia frequently occurs. Iron deficiency may result from a single or a combination of several major factors: (I) insufficient dietary iron consumption and/or decreased dietary bioavailability [2]. (ii) A surge in iron requirements by the body, e.g., during pregnancy and periods of rapid growth in young children and adolescents; [3], (iii) chronic iron loss, e.g., during menstruation in women of reproductive age or due to ulceration and parasitic infestation; and [4, 5], (iv) impaired iron utilization after ingestion, as occurs with chronic and recurrent infections. Other causes of nutritional anemia in addition to iron deficiency include folic acid, vitamin C, copper, and vitamin B2 and B12 deficiencies [6, 7].

Iron deficiency anemia (IDA) is characterized by hemoglobin levels below a specific threshold. The WHO recommends a hemoglobin level of 120 gm/L for nonpregnant women (aged 15 years and older), 110 gm/L for pregnant women, and 130 gm/L for males (aged 15 years and older) [1]. Additionally, there are three types of iron deficiency: mild, moderate, and severe. Mild deficiency is defined as having reduced deposits with an average production of hemoglobin and iron-dependent protein. The cutoff values for nonpregnant women are 11–11.9, and for pregnant women 10–10.9, marginal deficiency is characterized by average Hb concentrations, reduced iron reserves, and impaired synthesis of iron-dependent proteins [2]. When iron stores are further depleted and Hb levels decline, anemia progresses to a moderate state, if it remains untreated, subsequently leading to severe forms, the cutoff values in pregnant women are 7–9.9, moderate and severe < 7; however, in nonpregnant women, the values are 8–10.9 for moderate anemia and < 8 for severe anemia [3].

One-third of the world's population is anemic and iron deficiency accounts for half of the cases [4]. It is a critical problem for global public health that affects physical health, referral to medical specialists, and maternal and infant mortality. The vulnerable population included pregnant females, young females of childbearing age, and children [5]. Iron deficiency anemia is frequently linked to several chronic conditions, including cancer, inflammatory bowel disease (IBD), kidney disorders, and chronic heart failure [6, 7]. Anemia is related to unfortunate immediate and long-term health consequences [16].

Despite current community, financial, and health-related developments, anemia remains a widespread international health problem that affects people at every stage of life and has serious implications for health and life [17]. Although women and young children are the populations most affected by anemia, they do not have enough access to interventions and supplementation in underdeveloped countries or in certain developing countries. According to a World Bank analysis, the prevalence of anemia in women increases almost everywhere in the world as income declines. In several countries, the prevalence is twice as high among poor people as among those from good socioeconomic backgrounds. [18, 19].

The incidence of anemia is an important indicator for both advanced and underdeveloped countries [8], with a prevalence of 9% in developed countries and 43% in underdeveloped countries [20]. The global prevalence in women is approximately 15–18% [21], 78.5–78.8% in adolescent girls, and 33% in women of childbearing age 15 to 49 years worldwide [22], increasingly posing a threat to population health [23]. Anemia in developing countries has a variety of causes and effects described in the literature, although they are not all summarized in one place [24].

Therefore, the objective of this systematic review was to review and synthesize the literature on the incidence of IDA in Pakistan over the last 15 years.

Research methodology

A systematic review and meta-analysis of eligible published studies was conducted to determine the pooled prevalence of anemia among females in Pakistan.

Identifying the research question

The present study investigated the prevalence of IDA among pregnant females and nonpregnant adult/adolescent females in Pakistan.

Search strategy and guidelines

A review procedure, including a strategy for search and data-gathering methods, was created. The Population,

Intervention, Comparison, Outcomes, and Study Design (PICOS) section was established based on review questions to identify search keywords.

The search also included a gray literature search, and references were searched manually for selected articles. A search was conducted from January 2022 to May 2022. The PubMed, Scopus, ScienceDirect, and Google Scholar databases were searched using the PICOS identifiers for the research questions and associated terms. ((Prevalence, OR "Frequency*" OR "Incidence") AND ("Iron deficiency anemia OR anemia OR IDA)) AND ("Adolescent girls" OR nonpregnant females") AND ("pregnant*") AND ("Pakistan")).

Inclusion criteria

Studies that included descriptive and cross-sectional designs were included. Only papers published between 2007 and 2021 were considered because our focus was on the most recent developments and previous publications were difficult to find. We also searched ScienceDirect for more articles because the number of publications was low. The reference lists of the publications that were included, as well as editorials found through the searches, were scanned. We also looked for reports of large-scale health surveys on relevant websites and in the Google search engine however, studies with secondary data and unpublished studies were not included.

This review reviewed community-based studies from everywhere in Pakistan as well as national health surveys. Language was not a criterion for excluding studies. Retrospective studies including hospital/clinic attending populations, specifically pregnant women who visited hospitals/clinics for antenatal follow-up, were also included.

All published studies that documented the incidence of iron deficiency anemia were included in the analysis. The titles and abstracts of all search results were reviewed to establish study eligibility. At this stage, all studies that had been included were thoroughly evaluated. The corresponding authors of interest were contacted with a request for the entire paper for papers whose full text was not openly available. Studies with small sample sizes were also included because we had very limited available data in our area of interest.

Exclusion criteria

Studies focusing on any type other than iron deficiency anemia (e.g., sickle cell anemia), research on patients receiving hemodialysis patients with thalassemia or cancer, or selective subpopulations were not considered.

Outcome of interest

The primary outcome of interest was iron deficiency among nonpregnant adolescent/adult females and the prevalence of anemia in pregnant females, hemoglobin concentration less than 12 mg/dl is the cutoff for pregnant/adolescent females, and a hemoglobin concentration of 11 mg/dl is the cutoff for pregnant females.

Screening of articles

Three reviewers, BM, and TS FS were independently involved in the screening of the articles included in this study by using Rayyan software, and their blinding was maintained during the screening process. By adhering to PRISMA guidelines, the identification procedure and selection criteria for the publications are summarized in Fig. 1.

Risk of bias

The quality of the included studies was evaluated by an independent reviewer, conflicts on study selection were resolved through discussion, studies with mutual consensus were included, and two independent reviewers conducted critical assessments and cross-checked the results with a third reviewer by using the Newcastle Ottawa (NCOS) tool. The characteristics of the studies were evaluated using the following indicators. The evaluation findings were calculated using the average scores of the two authors.

Heterogeneity assessment

I^2 test statistics were used to evaluate the heterogeneity of the studies. 25%, 50%, and 75% I^2 test statistics were regarded as indicating low, moderate, and significant heterogeneity, respectively. To analyze the test findings that showed heterogeneity, the random effect model was applied.

Data extraction

To extract the quality-related data and the fundamental study data, two distinct proformas were used in Microsoft Excel: clear objectives; proper methodology, including design, sampling methodologies, and data collection; appropriate analysis; method of hb estimation; risk of bias in selection; and constraints, which were all covered on the checklist. Prevalence data as percentages of anemia were collected individually for adolescent girls and pregnant women. A study was removed when there was a significant reason to doubt its validity, and tables were created to summarize the information.

Results

Results synthesis

The authors first extracted the relevant data from the selected studies, entered the data into Microsoft Excel 2016, and used R statistical software to assess the outcomes. A table and a forest plot were used to represent and report the results. By applying the binomial

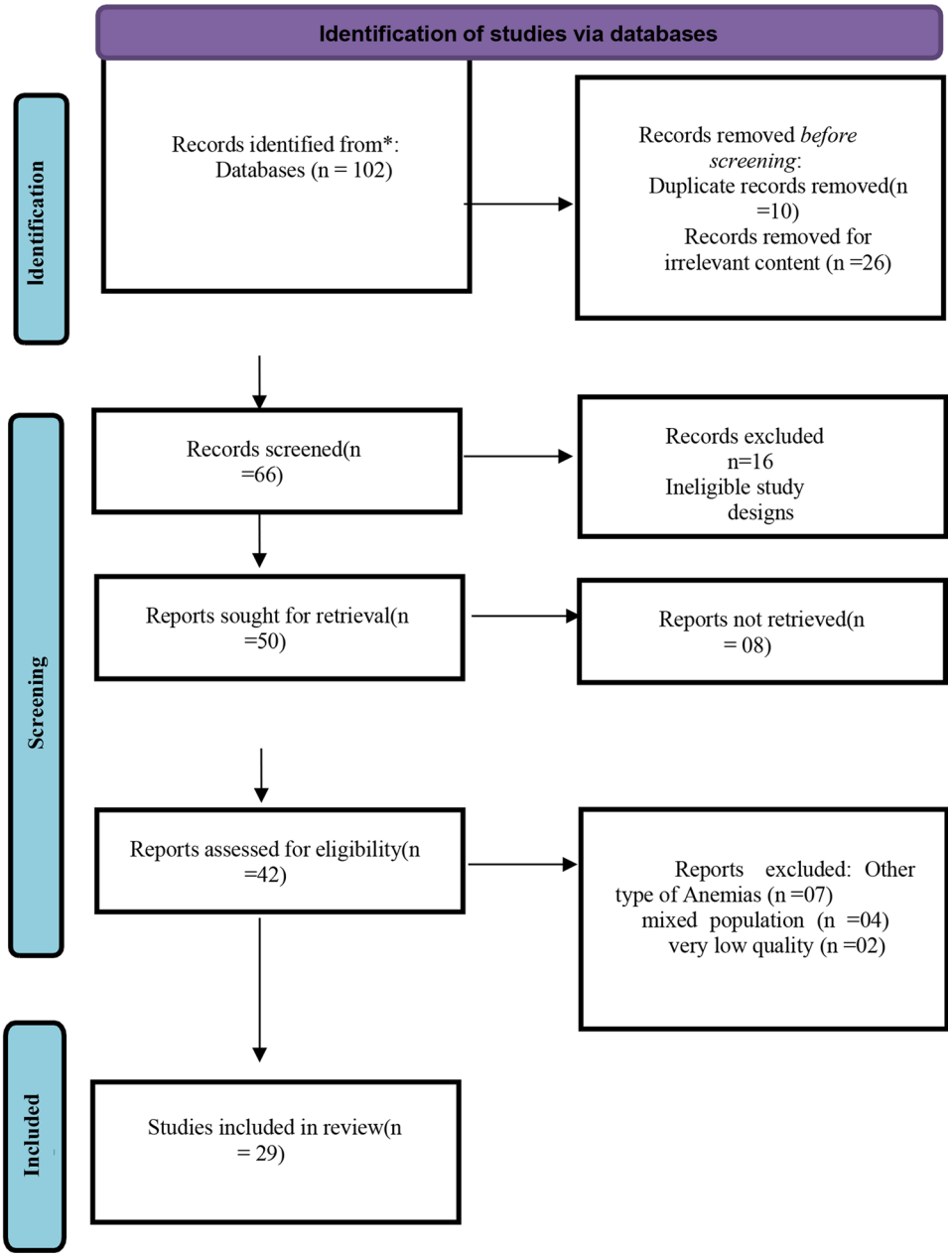

Fig. 1 Flowchart describing the details of the papers included in the review

Table 1 PICOS identifiers with keywords and additional terms used to generate data from databases

Variable	Population(*P*)	Intervention (I)	Comparison (C)	Outcome (O)		Study design(S)
Key words	Pregnant women and adolescent girls in Pakistan	NA	NA	Frequency, Prevalence	Iron deficiency Anemia	Cross sectional
Additional terms searched	Sindh, Punjab*, Baluchistan, AJK**, Gilgit Baltistan	NA	NA	Rates, proportion magnitude.	Anemia, Hemoglobin, Iron deficiency	Observational

* KPK: Khyber Pakhtunkhwa **AJK: for Azad Jammu and Kashmir

Table 2 Prevalence of anemia in Pakistan according to the National Nutrition Survey (NNS)

Variable	Population	Total	Rural	Urban	Sindh	Punjab	BN	KPK	GB	AJK
NNS 2011 [10]	**Pregnant women**	51%	50.5%	50.3%	59.7%	30.2%	49.7%	30.2%	33.6%	43%
	Non-pregnant women	50.4%	50.9%	49.3%	62.0%	48.6%	48.9%	35.6%	23.3%	(41.0%)
NNS 2018 [11]	**Pregnant women**	35.2%	38.2%	30%	38.2%	36.1%	53.9%	14.3%	29.6%	34.8%
	Non-pregnant women	43%	44.6%	40.6%	45.7%	41.3%	61.8%	34%	36.1%	56.4%

BN = Baluchistan, KPK = Khyber Pakhtunkhwa, GB = Gilgit Baltistan, AJK = Azad Jammu Kashmir, NNS = National Nutrition Survey

Table 3 Studies on the prevalence of anemia among adolescent girls/nonpregnant women in Pakistan with demographic details

Study area	Year	Authors	Population	Age	Total events	SES	NCOS	Method of Hb estimation	Prevalence
Karachi	2009	Tahir Ansari et al. [12]	Adult Females	15–45	200	poor	07	--	44.5%
Peshawar	2010	K.Muhammad Tahir et al [13]	Adults	22	259	good	05	Hem analyzer, France	23.9%
Lahore	2017	Fatima Hassan et al [14]	Adolescent Girls	13–19	112	poor	04	--	68.8%
Karachi	2017	F.AZIZ et al. [15]	Adults	18–24	160	good	04	Cyanmethemoglobin method	63.12%
Lahore	2017	Saadia Shahzad et al [16]	Adolescent Girls	----	150	Mixed	05	Sahli's	84%
Peshawar	2018	Riaz gul et al [17]	Adolescent Girls	13–19	400	mixed	09	Sahli's	61%
Mardan	2018	Sahib gul et al [18]	Adult females	19–25	50	Mixed	07	Hematology analyzer	10%
RWP	2018	Rabia Mehmood et al [19]	Adolescent Girls	11–19	104	mixed	07	Hemocue, portable HB analyzer	71.2%
Nawab Shah	2019	Niaz Hussain et al. [20]	Adolescent Girls	10–15	150	poor	05	Hemo Cue HB 201 + analyzer	67.3%
AJK	2020	Nazneen Habib [21]	Adolescent Girls	10–19	626	-	07	HemoCue Hb 301 analyzer (Sweden).	47.9%
Lahore	2021	Zafar et al [22]	Adults	18–24	83	good	05	Sahli's	57.8%

NCOS- Newcastle–Ottawa Scale score

AJK = Azad Jammu Kashmir

SES: Socioeconomic status

distribution formula, the standard error of the incidence of anemia for each original study was calculated. Using the I^2 test, any potential heterogeneity was investigated in the stated prevalence of the studies. A random effects model was employed to estimate the Der Simonian and Laird's pooled effect.

Study selection

A literature search revealed a total of 102 studies on various kinds of anemia risk factor prevention, etc. Due to duplication, 10 of them were eliminated. Another 26 studies were eliminated after the titles and abstracts were screened because the content was irrelevant to the goal of our review, as we were bound to include studies on IDA prevalence in females. We eliminated 37 of the 66 preselected papers because they did not match the selection criteria.

Study characteristics

Two National Health Surveys were considered: NNS 2011 and NNS 2018. Eleven studies on nonpregnant women/adolescent girls with 2,294 participants were included, and sixteen studies on IDA incidence among pregnant women with 9,263 participants were included in this systematic review. The data were obtained from seven studies conducted in Sindh, ten studies from Punjab, five studies from KPK, two studies from Baluchistan, two studies from AJK, and two national nutritional health surveys that show prevalence throughout the whole country. According to the WHO criteria, 12 mg/dl is the cutoff for pregnant/adolescent females, and 11 mg/dl is the cutoff for pregnant females [9].

Quality assessment of studies

The studies included in the current review were cross-sectional. The New Castle Ottawa tool was used to assess overall quality. Among the group of adolescent girls, 11 studies were included. Of these 11 studies, five were

identified as high-quality, with scores of 09 and 07, four studies were classified as moderate with a score of 5, and two studies were classified as low-quality, with scores of 04. Among the second group of pregnant females, 16 studies were included, among which six studies had high-quality scores of 7 and 8, seven had moderate quality scores of 05 and 06, and three had low-quality scores of 04 and less than 04.

Figure 1 shows the selection process for the studies involved. The following databases were used for the search: Google Scholar, PubMed, Scopus, and ScienceDirect.

Data were extracted from studies conducted in different geographical regions of Pakistan by using various key terms from the PICOS. The frequency, rates, prevalence, proportion, and magnitude of iron deficiency in young females are shown in Table 1.

Table 2 shows the results of two national nutrition surveys, which depict anemia incidence from various geographical locations in Pakistan. In both surveys, the population residing in rural settings had a greater prevalence than the females residing in urban areas, and a similar pattern was observed in pregnant and nonpregnant individuals in both groups. A survey in the 2011 Sindh Province revealed a greater prevalence of anemia in both groups, with 59.7% in pregnant females and 62.0% in the adolescent/WRA group; however, in the survey in the 2018 Baluchistan Province, the highest prevalence was 53.9% and 61.8%, respectively.

Table 3 presents the characteristics of a total of 11 studies on adolescents/nonpregnant individuals, with 2,294 sample size studies representing mostly large cities and their peripheries; no single study from Gilgit Baltistan has been conducted on IDA prevalence to date to provide figures.

In the northern areas of Pakistan, a study conducted in Peshawar had a sample size of 259 reported 23.9% and the study conducted in Mardan had a sample size of 50 reported 10% showing less prevalence; however, studies performed in Lahore and Rawalpindi have shown a higher prevalence of anemia in the non-pregnant/adolescent group (84% and 71.2%, respectively).

Meta-analysis

To provide a visual summary of the data, a forest plot (Fig. 2) was generated to evaluate the pooled effect size of each study with their respective confidence intervals (CIs). The forest plot of the 11 studies included in this analysis revealed that the pooled prevalence of anemia among nonpregnant adult/adolescent females was 54.6% (95% CI: 0.422, 0.669). We detected significant heterogeneity among the included studies, as indicated by the I^2 statistic (I^2=97.8%, p value<0.001). Because the DerSimonian and Laird random effects model provides more conservative effect sizes, we used it to estimate the total pooled prevalence of anemia among nonpregnant adult/adolescent females.

Subgroup analysis

The pooled prevalence of anemia across studies with various sample sizes was revealed by subgroup analysis by sample size (Table 4). With a broad confidence interval indicating considerable uncertainty, the estimated pooled prevalence for studies with sample sizes under 200 was greater at 60.5%. The pooled prevalence is also lower—44.4%—for studies with sample sizes over 200—again, with a confidence interval that considers this heterogeneity.

Significant variability among studies within each category is indicated by the subgroups' notably high I^2 values

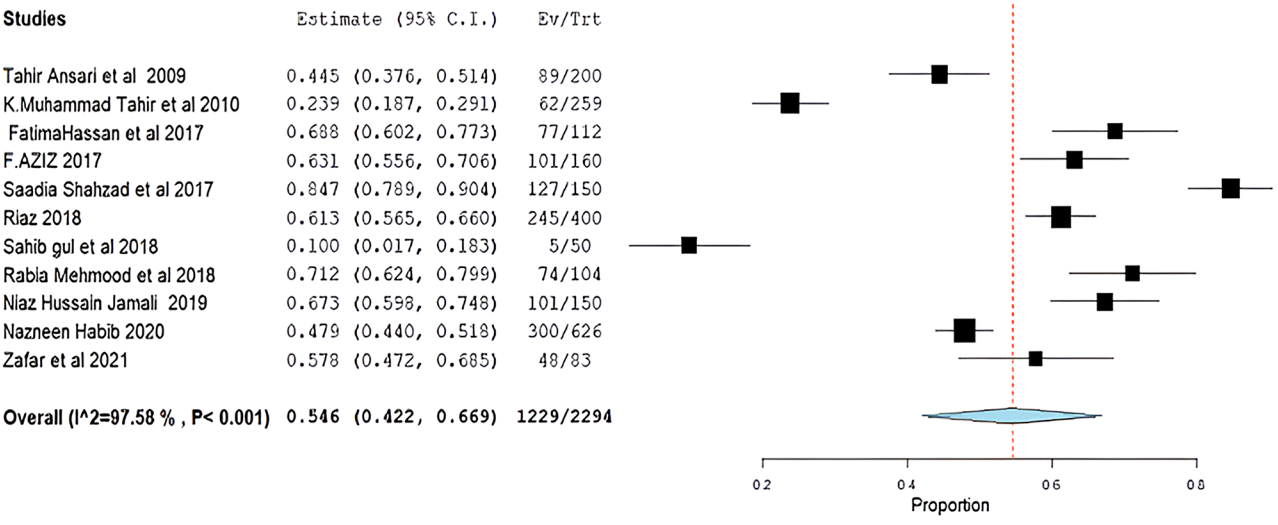

Fig. 2 Forest plot showing the pooled prevalence among nonpregnant females

Table 4 Subgroup analysis of a group of adult/adolescent nonpregnant females

Variables	Characteristics	No studies	Prevalence with 95%	I^2	*p*-value
By sample size	< 200	07	60.5 (0.426 0.784)	97.23%	< 0.001
	> 200	04	44.4 (0.293 0.596)	97.26%	< 0.001
By socioeconomic status	Lower	03	41.3 (0.653 0.061)	90.85%	< 0.001
	middle	03	48 (0.201 0.761)	97.62%	< 0.001
	Mixed	04	56.9 (0.292 0.845)	98.59%	< 0.001

Table 5 Characteristics of the study participants (pregnant women

Region	Authors	Year	Age	Total events	Trimester	SES	NCOs	Hb Estimation method	Prevalence
Rawalpindi	B Umber Jalil [23]	2007	24–27	860	3rd	Middle	06		46.70%
Karachi	R Jaleel et al [24]	2008	20–40	159	3rd	Middle	05		69.90%
Hyderabad	Naila Baig et al [25]	2008	26–28	1369	2nd	poor	08		90.50%
Mirpur Khas	Rizwan et al [26]	2010	-------	500	3rd	Middle	06		75%
AJK	Mohammad Saeed et al [27]	2014	23–36	1000	All	mixed	05		91%
Swat	Atta Ullah et al [28]	2017	16–45	250	All	mixed	04	Mindray hem analyzer	59.20%
Mardan	Suleiman Shams et al [29]	2017	18–40	300	All	mixed	03	BC 3000 Plus Auto analyzer.	76.6
Lahore	Azmat Ullah et al [30]	2019	-------	390	2nd	mixed	07	colorimetric method	57.70%
Bolan	Fouzia et al [31]	2019	31–40	1250	All	mixed	05		56%
Quetta	Akhtar Bibi et al [32]	2019	17–44	625	All	mixed	05	Sales	56%
Rural Punjab	Mohammad Saqib [33]	2019	23–25	600	All	mixed	05		89%
Sargodha	Sumbul Qamar et al [34]	2019	20–46	50	2nd	mixed	08	SYSMAX hem analyzer	88%
Sargodha	Naveed Munir et al (35)	2020	-----	150	All	Mixed	03		89%
ISB	Hina Zulfiqar et al [36]	2021	-----	500	3rd	Poor	08		63%
Karachi	Erum Jahan et al [5]	2021	-----	450	All	Mixed	08		64.66%
Karachi	Huma [37]	2013	20–40	810	All	poor	08		54.30%

NCOS- Newcastle–Ottawa Scale score

AJK = Azad Jammu Kashmir

SES: Socioeconomic status

(97.23% and 97.26%) and extremely low p-values (0.001). The socioeconomic status subgroup analysis sheds light on how anemia prevalence changes between various socioeconomic categories. In this analysis, studies with participants from mixed backgrounds showed a higher prevalence. There was considerable heterogeneity among the studies within each of the three categories, as indicated by the large I^2 values and extremely low p-values (0.001) for all three subgroups.

Table 5 represents a total of sixteen studies with 9,263 participants on the incidence of anemia in pregnant females in Pakistan by year, population, SES, and technique used for Hb estimation. The same pattern is observed here; almost all studies represent large cities or their peripheries. Most of these studies do not use Hb estimation techniques. A study from Rawalpindi showed the lowest prevalence rate of anemia which was 46.7%, with a sample size of 860, and the highest prevalence was reported by a study conducted in AJK, which was 91% in pregnant females with a sample size of 1000. The prevalence of anemia by city of residence showed significant differences when compared with studies conducted in comparatively small cities, as studies conducted in Karachi, Lahore, Islamabad, and Quetta showed a lower frequency when compared with small cities and peripheries.

Meta-analysis of studies on pregnant women

To offer a visual summary of the data in this meta-analysis, a forest plot (Fig. 3) was generated to evaluate the pooled effect size of each study with their respective confidence intervals (CIs). The pooled prevalence of anemia among pregnant women by using the Der Simonian and Laird random-effects model, was 70.4% (95% CI: 0.619, 0.789) as shown by the forest plot of the 39 studies included in this analysis. We discovered significant heterogeneity among the included studies, (I^2 = 99.0, p-value = 0.001).

Subgroup analysis

The subgroup analysis by region reported in Table 6 highlights the prevalence of anemia differs across the different regions. The pooled prevalence estimate, confidence interval, and measures of heterogeneity differ for each region. A higher prevalence was reported in Punjab Province, among other regions77.4 (0.630,0.918). Strong I^2 values and extremely low p-values (0.001) illustrate the significant heterogeneity among the studies within each region. The Baluchistan region is the exception: no observed heterogeneity exists (I^2 = 0.00%). Trimester-wise subgroup analysis of the second trimester reported a greater pooled prevalence.

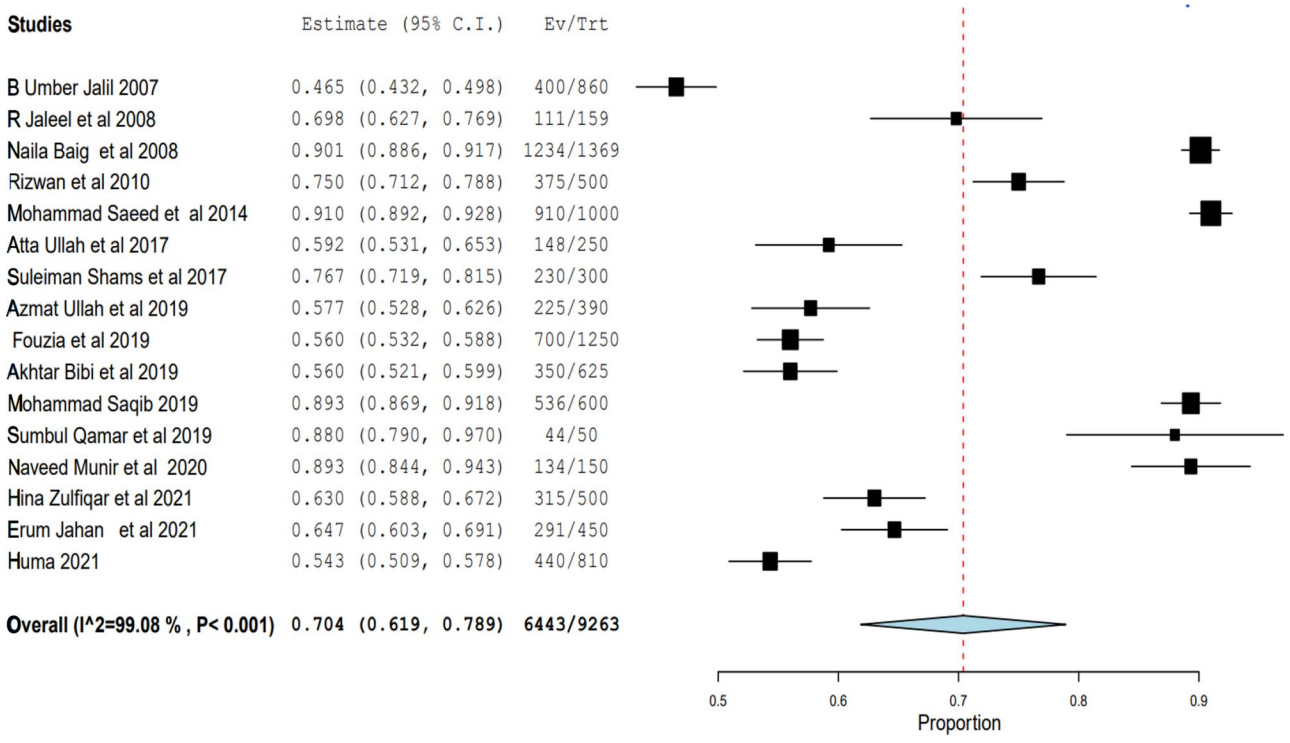

Fig. 3 Forest plot showing the pooled prevalence among pregnant females

Table 6 Subgroup analysis of pregnant females

Variables	Characteristics	No studies	Prevalence with 95%	I^2	*P*-value
By region	Punjab	06	77.4 (0.630,0.918)	98.12%	< 0.001
	Sindh	05	70(0.550, 0.867)	99.0%	< 0.001
	Baluchistan	02	56(0.538 0.582)	0.00	< 0.001
	KPK	03	75 (0.578 0.938)	98.2%	< 0.001
By Socioeconomic status	Lower	03	69.2 (0.440 0.944)	99.53%	< 0.001
	Middle	03	63(0.433, 0.841)	98.46	< 0.001
	Mixed	10	72.8 (0.620 0.835)	98.9	< 0.001
By trimester	second	03	78(0.556 1.015)	98.68	< 0.001
	Third	04	63(0.493 0.777)	97.71	< 0.001
	All	09	70(0.590 0.825)	99.13	< 0.001

Discussion

The pathological condition of anemia is characterized by abnormalities in the concentration of red blood cells per unit volume, hemoglobin, hematocrit, and erythrocytes compared with reference values [6, 44]. These values may vary due to certain factors, such as sex, hormonal stimulation, age, developmental stage, and life stage.

According to recent study results, the mean prevalence of anemia in adolescents is 54.6%. The minimum and maximum prevalence in the adolescent/nonpregnant group were 10% and 84%, respectively. The maximum and minimum prevalence of anemia reported during pregnancy were 91% and 46.7%, respectively. However, in a subgroup analysis of pregnant women in Punjab Province, a higher prevalence was found, which may be due to changes in diet and lifestyle, as most of the studies from Punjab measured prevalence in metropolitan areas. When socioeconomic status was compared, pregnant women from lower classes were found to be more prevalent than middle-class women, which could be due to the use of nutritional supplements or proper antenatal care that helps women become aware of their iron status. In pregnant women, the etiology of iron insufficiency is constant over time [38]. The high prevalence of IDA was caused by multiparity, close birth intervals, low socioeconomic status, and lack of education. In addition, most pregnant women visited the clinic in the later trimesters. Therefore, they were deficient in iron at the time of conception. Iron supplement noncompliance was also found to be a significant contributing factor. Although almost all South Asian nations, including Pakistan, have national anemia control programs, this issue still exists.

Among the adolescent/adult nonpregnant group, a severe prevalence was observed in the age group between 11 and 15 years in various studies, possibly due to menarche. Most of the research on adolescent age groups showed that the mean hemoglobin levels for those age groups, or those 13 to 14 years of age [39, 40], were the lowest [41]. This may have been related to the start of menstruation after reaching menarche age. Overall, IDA-positive women showed a similar pattern, with the highest prevalence observed in our study.

Although there is no discernible difference between the nutritional status and consumption of boys and girls, difficulties do occur for females in adolescence and adulthood, according to the National Nutritional Survey Pakistan (NNS) in 2011 [10]. Moderate to severe anemia can result from inadequate nutritional consumption. Adolescent girls and women of childbearing age are more at risk for iron deficiency due to the fetal requirement of iron and blood loss during menstruation, pregnancy, and childbirth [42]. According to NNSs in Pakistan, more than half (56.6%) of adolescent females have anemia yet only 0.9% of them have severe anemia. Similarly, young women in rural areas are more likely than their peers (58.1%) to be anemic compared to urban areas (54.2%).

Although we cannot rule out the possibility that some of the observed anemia is caused by other factors, anemia is characterized by a poor synthesis of hemoglobin in an advanced stage of iron deficiency [43]. Iron deficiency can also be caused by certain hemoglobinopathies, and anemia has been linked to other nutritional deficits. Furthermore, iron is sequestered, and its mobilization for erythropoiesis is reduced because of vitamin A insufficiency, which is thought to be the second most common cause of moderate anemia [44]. Additionally, studies have shown that riboflavin, folate, and vitamin B12 deficiency might result in anemia [45].

All studies have demonstrated a substantial proportion of anemia cases even though anemia estimates vary significantly due to different methodologies and measurement procedures. Therefore, immediate action to address this issue is needed. When the prevalence of anemia is greater than 40%, the WHO and UNICEF strongly recommend that universal supplementation be implemented.

Conclusion

The current study illustrates the significant burden of anemia on public health in Pakistan, especially for adolescent females/women of reproductive age and pregnant mothers. However, this study cannot conclusively determine the precise etiology of individual studies, but it offers comprehensive details on the frequency and possible causes, such as dietary patterns, age-associated vulnerabilities, and disparities in socioeconomic status. These data provide a strong foundation for planning comprehensive strategies that help to address the challenge of combating IDA in Pakistan.

A multifaceted strategy is needed for effective treatments. It is critical to address the underlying social, economic, and educational issues affecting women and girls. This includes measures to increase the availability of iron-rich nutrition, and iron supplementation, strengthen the healthcare system, and encourage public awareness of the value of prenatal care and healthy eating habits. The government must act decisively to improve educational standards, the socioeconomic status of women, the availability of health professionals, and the intensity of public education. Changes in health behaviors are needed, as is compliance with government-recommended programs. Furthermore, additional research is required to determine the precise impact that hemoglobinopathies and vitamin deficiencies have on regional variations in the prevalence of anemia. By implementing these combined initiatives, the disease burden can be significantly reduced, and the health and well-being of the Pakistani population can be improved.

Limitations

Certain limitations should also be discussed. Numerous studies on females in the reproductive age range that included both pregnant and nonpregnant women were omitted due to the mixed population. Furthermore, several relevant articles that were listed on search engines were not accessible; if they could be accessible, a clearer picture would be possible. Although we have found most of the data through our methodical methodology, there may still be numerous results regarding the prevalence of anemia that have not been published or made available online. Substantial heterogeneity was found while performing metanalysis and the use of various sample procedures for hemoglobin measurement may be one of several factors contributing to the observed variation within the examined research. Because different approaches, tools, and protocols are used in different studies, the procedure for measuring hemoglobin levels can change greatly between these methods. The different methods used to assess hemoglobin may cause variations in the prevalence of anemia that are reported. Additionally, the sampling strategy itself may be a factor in causing variance; however, the employed studies were cross-sectional but used different sampling techniques. The subjective evaluation of quality assessment limited the review as well. Even though the data were unsuitable for meta-analysis, the systematic approach is a valuable and understandable way to summarize the data and clearly show where gaps exist. Creating the best mitigation methods for this issue requires precise estimations of the present anemia prevalence. It would be helpful to use perspective and

standardized data gathering, preferably from samples of the total population, to better understand the prevalence of anemia in Pakistan.

Abbreviations

IDA	Iron deficiency anemia
WHO	World Health Organization
RBC	Red blood cells
IBD	Inflammatory bowel disease
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
NNS	National Nutritional Health Surveys
PICOS	Population, intervention, comparison, outcomes, and settings
KPK	Khyber Pakhtun Kha
AJK	Azad Jammu Kashmir
UNICEF	United Nations International Children's Emergency Funds
SES	Socioeconomic status
BN	Baluchistan
GB	Gilgit Baltistan

Acknowledgements
NA.

Author contributions
Study conception: BM, TS, QA, JW. Literature Search: BM, FS, TS. Data extraction: BM, KS, KNM, RM, and SNS. Writeup: BM, AAU, SA

Funding
The current study received no external/internal funding from any foreign or local agency/body.

Data availability
All data generated during the current study are included in this article [and its supplementary information files].

Declarations

Ethics approval
NA.

Informed consent to participate
NA.

Consent for publication
NA.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Community Health, University Putra Malaysia, Serdang, Selangor, Malaysia
[2]Department of Physiology, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Sindh, Pakistan
[3]Department of Community Medicine, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Sindh, Pakistan
[4]Department of Physiology, University of Sindh, Jamshoro, Pakistan
[5]Department of Physiology, Bilawal Medical College, Jamshoro, Sindh, Pakistan
[6]Department of Microbiology, Faculty of Natural and Applied Science, Umaru Musa Yar'adua University, Katsina, Nigeria
[7]Department of Biology, College of Science University of Bahrain, Manama, Bahrain
[8]Department of Biochemistry, Peoples University of Medical and Health Sciences for Women Nawab Shah-Shaheed Benazir Abad, Nawabshah, Sindh, Pakistan

Received: 1 September 2023 / Accepted: 10 September 2024
Published online: 17 September 2024

References

1. Milman N. Anemia—still a major health problem in many parts of the world! Annals of hematology. 2011;90:369 – 77.
2. Coad J, Conlon C. Iron deficiency in women: assessment, causes and consequences. Current Opinion in Clinical Nutrition & Metabolic Care. 2011;14(6):625 – 34.
3. Tandon R, Jain A, Malhotra P. Management of iron deficiency anemia in pregnancy in India. Indian Journal of Hematology and Blood Transfusion. 2018;34:204 – 15.
4. Abd Rahman R, Idris IB, Isa ZM, Rahman RA, Mahdy ZA. The prevalence and risk factors of iron deficiency anemia among pregnant women in Malaysia: a systematic review. Frontiers in nutrition. 2022;9.
5. JAHAN E, JABEEN A, IMTIAZ R, KHALID S, JAVAID S, KHAN M. Prevalence of Anemia in Pregnant Women Visiting Abbasi Shaheed Hospital: a cross Sectional Study. 2021.
6. Shah T, Warsi J, Laghari Z. Effect of Maternal Anemia on the Anthropometric Indices of Newborn. Journal of Liaquat University of Medical & Health Sciences. 2020;19(03):191-4.
7. Lopez A, Cacoub P, Macdougall IC, Peyrin-Biroulet L. Iron deficiency anaemia. The Lancet. 2016;387(10021):907 – 16.
8. Faheem B, Warsi J, Shah T. Prevalence of anemia and its association with anthropometric indices in affluent male University students. Rawal Medical Journal. 2019;44(2):233.
9. Murphy J. Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. Vitamin and Mineral Nutrition Information System. Geneva: World Health Organization; 2011. 2002.
10. Bhutta ZA, Soofi SB, Zaidi SSH, Habib A, Hussain I. Pakistan national nutrition survey, 2011. 2011.
11. UNICEF. Pakistan National Nutrition Survey 2018: Key Findings Report. Pakistan: UNICEF: Islamabad, Pakistan; 2018.
12. Ansari T, Ali L, Aziz T, Ara J, Liaquat N, Tahir H. Nutritional iron deficiency in women of child bearing age—what to do? Journal of Ayub Medical College Abbottabad. 2009;21(3):17–20.
13. Khan MT, Akhtar T, Niazi M. Prevalence of anemia among university of Peshawar students. Journal of Postgraduate Medical Institute. 2010;24(4).
14. Hassan F, Salim S, Humayun A. Prevalence and determinants of iron deficiency Anemia in adolescents girls of low income communities in Lahore. Annals of King Edward Medical University. 2017;23(2).
15. Aziz F, Siddiqui B, Jabeen F. Prevalence of Nutritional Anemia's associated with Body Mass Index and Hemoglobin Concentration among Young University Females, Karachi, Pakistan. Sindh University Research Journal-SURJ (Science Series). 2017;49(4):779 – 84.
16. Shahzad S, Islam K, Azhar S, Fiza S, Ahmed W, Murtaza Z. Impact of knowledge, attitude and practice on iron deficiency anaemia status among females of reproductive age group (20-21-year-old) studying in Government Home Economics College Lahore, Pakistan. International Archives of BioMedical and Clinical Research. 2017;3(4):31 – 6.
17. Gul R, Shehzad S, Gul H, Fakhar S. Prevalence of iron deficiency anemia (ida) in adolescence girls of peshawar. KJMS. 2018;11(1):36.
18. Begum R, Gul H, Afridi S, Shams S, Shah M. Cross sectional analysis of iron deficiency anemia among female students of abdul wali khan university mardan. 2018.
19. Khan R, Saleem S. Association of anaemia with dietary practices in adolescent girls. Pakistan Journal of Physiology. 2018;14(3):41 – 5.
20. Jamali NH, Jamali AA, Ahmer A, Jamali AA, Shah K, Shaikh SU, Kazi HA. Iron deficiency anemia among the female students of Dolatpur town Sindh, Pakistan. Isra Med J. 2019;11(4):242-6.
21. Habib N, Abbasi S-U-RS, Aziz W. An analysis of societal determinant of anemia among adolescent girls in Azad Jammu and Kashmir, Pakistan. Anemia. 2020;2020.
22. Zaffar S, Khan QU, Tanveer H, Chattha IR, Rashid N, Kamran R, Masood A. Prevalence of Anemia and Use of Iron Supplements in MBBS Students of CMH Lahore Medical College. Pakistan Journal of Medical and Health Sciences. 2021;15(6):1185-7.
23. Bakhtiar UJ, Khan Y, Nasar R. Relationship between maternal hemoglobin and perinatal outcome. Age. 2007;25:24.
24. Jaleel R, Khan A. Severe anaemia and adverse pregnancy outcome. Journal of Surgery Pakistan (International). 2008;13(4):147.
25. Baig-Ansari N, Badruddin SH, Karmaliani R, Harris H, Jehan I, Pasha O, et al. Anemia prevalence and risk factors in pregnant women in an urban area of Pakistan. Food and nutrition bulletin. 2008;29(2):132-9.

26. Rizwan F, Memon A. Prevalence of anemia in pregnant women and its effects on maternal and fetal morbidity and mortality. Pakistan journal of medical sciences. 2010;26(1).
27. Haq HS, Asif M. Prevalance of Anemia in Pregnant Women in Muzaffarabad Division of Azad Jammu and Kashmir. Ann Pak Inst Med Sci. 2014;10(1):39–42.
28. Ullah A, Yousafzai AM, Khan GN, Iqbal N, Ahmad B. Iron Deficiency Anemia (IDA) in Pregnant Women of Different Ages in Swat District, Khyber Pakhtunkhwa Pakistan. 2017.
29. Shams S, Ahmad Z, Wadood A. Prevalence of iron deficiency anemia in pregnant women of district Mardan. Pakistan J Preg Child Health. 2017;4(6):1–4.
30. Ullah A, Sohaib M, Saeed F, Iqbal S. Prevalence of anemia and associated risk factors among pregnant women in Lahore, Pakistan. Women & health. 2019;59(6):660 – 71.
31. Baksh FM. Anemia in Pregnant Women. Journal of Surgery Pakistan. 2019;24(3):144-7.
32. Bibi A, Kakar A, Shahwani F, Iqbal F. 5. Frequency of anemia in pregnant women of different age groups at Quetta: A hospital-based cross sectional study. Pure and Applied Biology (PAB). 2019;8(2):1043-50.
33. Saqib M, Manzoor F, Shahid R, Naz S, Sharif S. Incidence of anemia among pregnant females of rural areas of punjab. S Asian J Life Sci. 2019;7:25 – 8.
34. Qamar S, Azhar S, Mazhar S, Bakht K, Murtaza G. Iron deficiency anemia and associated factors among pregnant women in a tertiary care hospital, in Sargodha District, Pakistan. Tropical Journal of Pharmaceutical Research. 2019;18(10):2183-7.
35. Munir N, Zahoor T, Mahmood Z, Tahir IM, Akram M, Jahangir M, Shah SMA. Pregnancy associated iron deficiency anemia from selected rural areas of Sargodha-Punjab, Pakistan. 2020.
36. Zulfiqar H, Shah IU, Sheas MN, Ahmed Z, Ejaz U, Ullah I, et al. Dietary association of iron deficiency anemia and related pregnancy outcomes. Food Science & Nutrition. 2021;9(8):4127-33.
37. Naz H, Begum B. Prevalence and associated risk factors of anaemia in pregnant women in a teaching hospital, Korangi Industrial Area. Pak J Surg. 2013;29(2):131-3.
38. Garzon S, Cacciato PM, Certelli C, Salvaggio C, Magliarditi M, Rizzo G. Iron deficiency anemia in pregnancy: Novel approaches for an old problem. Oman Medical Journal. 2020;35(5):e166.
39. Chandrakumari AS, Sinha P, Singaravelu S, Jaikumar S. Prevalence of anemia among adolescent girls in a rural area of Tamil Nadu, India. Journal of family medicine and primary care. 2019;8(4):1414.
40. Derso T, Abera Z, Tariku A. Magnitude and associated factors of anemia among pregnant women in Dera District: a cross-sectional study in northwest Ethiopia. BMC research notes. 2017;10:1–8.
41. Habtegiorgis SD, Petrucka P, Telayneh AT, Getahun DS, Getacher L, Alemu S, Birhanu MY. Prevalence and associated factors of anemia among adolescent girls in Ethiopia: A systematic review and meta-analysis. Plos One. 2022;17(3):e0264063.
42. Stoltzfus RJ. Iron interventions for women and children in low-income countries. The Journal of nutrition. 2011;141(4):756S-62S.
43. Tussing-Humphreys L, Pustacioglu C, Nemeth E, Braunschweig C. Rethinking iron regulation and assessment in iron deficiency, anemia of chronic disease, and obesity: introducing hepcidin. Journal of the Academy of Nutrition and Dietetics. 2012;112(3):391–400.
44. Saraiva BC, Soares MC, Santos LCd, Pereira SC, Horta PM. Iron deficiency and anemia are associated with low retinol levels in children aged 1 to 5 years. Jornal de pediatria. 2014;90:593-9.
45. McNulty H. The Role of B-Vitamins in Nutritional Anemia. Nutritional Anemia: Springer; 2022. p. 173 – 85.

Publisher's note