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REVIEW ARTICLE

An Overview of the Incidence, Causes, and Impact of Iron Deficiency Anemia in Saudi Arabia

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SUMMARY

Background: **Iron deficiency anemia (IDA) is the most prevalent cause of micronutrient anemia globally, accounting for 50% of all anemia cases. It poses a major health burden, reaching epidemic levels in developing countries compared to developed countries. This review aimed to provide a comprehensive overview of the incidence of IDA among young adults, particularly females, and children in Saudi Arabia, and to identify its most common causes and risk factors.**

Methods: **A systematic search was carried out in electronic databases for publications addressing IDA or iron deficiency in Saudi Arabia.**

Results: **In Saudi Arabia, the incidence of IDA is alarmingly high, reaching 67% in certain cities, predominantly affecting females, teenager, children, and infants. This high prevalence of IDA has been attributed to nutritional, socioeconomic, and genetic factors.**

Conclusions: **IDA is a major health burden in Saudi Arabia that requires urgent attention. The detrimental impact of iron deficiency on health necessitates immediate action to reduce its incidence and long-term complications on quality of life as well as mortality and morbidity related to iron deficiency within the Saudi population.**

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INTRODUCTION

Anemia is the most common medical condition worldwide, affecting approximately one-fourth of the global population [1]. The World Health Organization estimates that 1.92 billion individuals are anemic, with iron deficiency anemia (IDA) accounting for more than 50% of all anemia in the world [1]. IDA is particularly prevalent in developing countries (43%) [2], with low incidence in developed countries (3 - 9%) [2,3]. The condition predominantly affects children and females in middle- and low-income countries [4]. IDA, a micronutrient anemia primarily caused by iron deficiency (ID), can initially be asymptomatic and clinically insignificant. However, in later stages, complete iron depletion leads to symptomatic IDA [1-3]. The demand for iron increases during pregnancy and body development, plac-

ing women of childbearing age and children at heightened risk of IDA [5]. Reports indicate that 52% of pregnant women in developing countries experience IDA, a significantly lower percentage is reported in developed countries [6]. IDA is highly prevalent in Saudi Arabia, with variations across different regions [7-13]. This review aimed to provide an overview of the prevalence of IDA among young adults, particularly females, and children in Saudi Arabia, and to identify its most common causes and risk factors.

MATERIALS AND METHODS

A systematic search of the electronic databases, including Saudi Digital Library, Medline, PubMed, Web of Science, OVID, Directory of Open Access Journals (DOJA), the Cumulative Index to Nursing & Allied Health Literature (CINAHL), Scopus, and Google Scholar, was carried out. Publications addressing IDA or ID in Saudi Arabia were included in this study. Although numerous publications discuss anemia, particularly microcytic hypochromic anemia, those that did not confirm the diagnosis of IDA or ID through serum iron profiles in the study population were excluded.

Iron deficiency anemia in the developing world, Middle East, and North Africa

The incidence of anemia, including IDA is notably high in Africa, particularly in sub-Saharan Africa and South Asia [1,4]. In Africa, ID was estimated to represent 34% of cases, making it a leading cause of disability [14]. In Morocco, the incidence of IDA among women is estimated at 70%, with ID affecting 20% of all anemic women [15]. In Iran, approximately 20% of children under six years old have IDA [16]. Lebanon reports an IDA incidence of 57.5% among females and 7.6% among males in 1,784 adults aged 18 - 50 years [17]. The Gulf countries, including Saudi Arabia, Kuwait, Bahrain, the United Arab Emirates, Qatar, and Oman, have high incidences of IDA among children and females. The prevalence among children ranges from 12.6% to 67% and among pregnant women from 22.7% to 54% [18]. In Oman, a study reported a 38% incidence of ID and 26% of IDA among 350 female students aged 17 - 29 years old [19].

Iron deficiency anemia in Saudi Arabia

The incidence of anemia is notably high in Saudi Arabia, which varies by region. Unlike hemoglobinopathies, which are more prevalent in the eastern and southeastern regions, IDA is widespread across all regions, particularly among females and children, with rates ranging from 10% to 67% [7-11]. A nationwide study in 2018 that surveyed 1,638 adult females reported a 43.5% prevalence of IDA [13]. Furthermore, a recent comprehensive nationwide study involving 981 healthy college students from four main provinces, including Riyadh, Makkah, Medina, and the Eastern Province, reported a 28.6% incidence of IDA, primarily affecting females [12]. A comparison of IDA incidences among different cities in Saudi Arabia is illustrated in Table 1.

Riyadh province

The incidence of IDA in Riyadh ranges from 2.3% to 60.4%. Furthermore, a study of 1,210 girls from 25 primary schools in Riyadh, aged 7 to 14 years, revealed a 55.4% incidence of anemia, with 26.3% classified as either ID or IDA based on serum iron and ferritin levels [20]. In 2007, Al-Assaf reports indicated a high percentage of IDA in the Riyadh region. The incidence of IDA was approximately 21% among adult non-pregnant females (102 females) and 2.3% among adult males (132 males) [21]. Another study in 2007, reported 40% (n = 390) incidence of IDA among 969 non-pregnant women in Riyadh city [10]. Furthermore, this high prevalence of IDA was confirmed by Alswailem et al. in 2018 [22]. The incidence of IDA among 683 non-pregnant women aged 18 - 40 years in Riyadh was found to be 41.6% [22]. In 2021, the incidence of IDA among non-pregnant females aged 20 to 65 years was reported at 28.4% in a sample of 250 females [9]. A recent study conducted at the obesity center of King Fahad Medical Center found that 46% (128 out of 240) of participants were anemic, with 60.4% of these cases attributed to IDA [23].

Madinah province

The incidence of IDA among female students at Taibah University was reported at 64% (171 of 268 female students) [11]. However, this study relied on MCV and MCH for the diagnosis of IDA without measuring serum iron profiles for confirmation. A study of 500 infants aged 6 - 24 months reported a 49% incidence of anemia with IDA, representing 51% from the anemic infants (126 out of 246 anemic infants) [24].

Asir province

Alkhaldy et al. (2020) reported a 63% prevalence of IDA among 200 female students aged 19 to 27 years in the Asir region [25]. In addition, a recent report from 2022 indicated that 58.27% (398 out of 683) of anemic patients at the hematology unit of King Abdullah Hospital in Bish had IDA [25]. Females and children were the most affected groups, with 229 females and 138 children under 10 years old diagnosed with IDA [26].

Tabuk province

The study of 6,839 infants aged 6 – 9 months reported 4,751 anemic infants; out of the 4,751 anemic infants, 578 (12.1%) had IDA [27]. In young females aged 18 - 25 years old, the incidence of IDA among 200 young females was reported at 12.5% [28].

Jazan province

The incidence of anemia among pregnant women in Jazan region was reported at 58.7% (227 out of 389) in 2015 [29]. A recent study in 2020 among young female

Table 1. Reported iron deficiency anemia incidence among Saudi population, including infants, children, teenagers, and adults in Saudi Arabia.

Province	City	Year	Population	Age	% of ID/IDA	Ref.
Riyadh	Riyadh	1999	1,210 schoolgirls	7 - 14 years old	26.3%	[20]
		2007	102 non-pregnant females	adults	21%	[21]
		2013	969 non-pregnant women	15 - 49 years old	40%	[10]
		2018	683 non-pregnant women	18 - 40 years old	41.6%	[22]
		2024	240 males/females	> 18 years old	46%	[23]
		2021	250 non-pregnant women	20 - 65 years old	* 31.6%	[9]
Eastern Province	Dammam	2018	120 female students	18 - 25 years old	38.3%	[32]
	Dhahran	2019	201 female students	18 - 25 years old	35.3%	[33]
Madina	Madina	2025	268 female students	20 - 31 years old	64%	[11]
		2025	500 infants	6 - 24 months old	49%	[24]
Tabuk	Tabuk	1996	4,752 anemic infants	6 - 9 months old	12.1%	[27]
		2017	200 female students	18 - 25 years old	12.5%	[28]
Asir	Bisha	2020	200 female students	19 - 27 years old	63%	[25]
	Abha	2022	683 anemic patients	children (< 10) and adults (> 20)	58.27%	[26]
Jazan	Jazan	2015	389 pregnant women	18 - 49 years old	58.7%	[29]
		2020	49 female students	18 - 25 years old	67.35%	[8]
		2022	90 female students	18 - 25 years old	51.1%	[7]
		2022	130 female students	18 - 25 years old	51.6%	[31]
		2024	118 females	18 - 25 years old	52.5%	[30]
Makkah	Makkah	2022	12,020 non-pregnant women	> 15 years old	38.2%	[34]
		2023	100 female students	19 - 23 years old	13%	[35]
	Jeddah	2008	123 female children	6 - 12 years old	23%	[37]
		2011	310 female students	18 - 23 years old	49.8%	[36]
Najran	Najran	2019	240 teenagers	13 - 19 years old	22.5%	[39]

*** - Suspected cases.**

university students at Jazan University reported 67.35% (33 out of 49) of the females with IDA and ID [8]. A follow-up study from the same group indicated a higher prevalence (51.1%; 46 out of 90 females) of IDA among young female university students at Jazan University [7]. This high prevalence of IDA reported by the latter study was confirmed by a recent study among female university students at Jazan university, in which IDA was around 52.5% among 118 female university students [30]. Additionally, 51.6% of 130 female university students in Farasan Island, Jazan, were anemic [31], which was associated with nutritional anemia. However, the status of iron and ferritin was not measured, so these cases were not confirmed as IDA.

Eastern province

The incidence of IDA was reported at 38.3% (46 out of 120 females) among female university students at Imam Abdulrahman Bin Faisal University in Dammam (32). A similar percentage (35.3% of 35.3% was reported among female students aged 18 - 25 years attending Prince Sultan Military College of Health Sciences in Dhahran (33).

Makkah province

A recent study in 2022, which collected data over one month from adult non-pregnant women visiting a hospital in Makkah city, found that 4,589 out of 12,020 females were anemic, representing a 38.2% incidence [34]. This prevalence was particularly noted among females aged 18 to 49 years, attributed to IDA [34]. Among 100 female students at Umm Al-Qura University (aged 19 - 23 years), the incidence of IDA was reported at 13% [35]. In Jeddah, ID and IDA were found to be 25.9% and 23.9%, respectively, among 310 female students aged 18 to 23 years at King Abdulaziz Univer-

sity [36]. The incidence of IDA and ID among 123 female children, aged 6 - 12 years, attending elementary school was reported at 23% [37]. This study indicated that anemia incidence was higher in older children (aged 10 - 20 years) than in younger children, potentially due to the consumption of iron-rich foods by the younger age group [37]. In addition, IDA with thalassemia were highly prevalent in infants [38]. In 1989, a study on 138 infants in Western part of Saudi Arabia indicated the presence of 25% of anemia mainly due to thalassemia and IDA [38].

Najran province

The incidence of IDA among 240 teenagers aged 13 - 19 years in Najran was reported at 22.5% [39].

Symptoms and impact of iron deficiency on health

The symptoms of anemia, including IDA, range from fatigue, loss of strength, and lack of energy to shortness of breath, lethargy, and a decreased desire to perform or participate in physical activities [40]. Iron plays a crucial role in growth, including cognitive development [41]. Consequently, ID can adversely affect children's learning ability. ID has been associated with low academic performance. Cognitive disorders may manifest first in children with IDA before other symptoms appear. Furthermore, mild ID can impact movement, and speech, and linked with language disorders, and behavioral issues [42-46].

ID significantly affects women's health, extending beyond anemia to include other serious health issues, and their pregnancy [47]. IDA has a deleterious effect on maternal and infant health. ID and IDA have been linked to adverse outcomes such as psychological issues, cognitive skills, physical development challenges, reduced work capacity, and psychiatric disorders [48, 49], as well as increased maternal and fetus mortality and morbidity [42-46].

Causes of iron deficiency

Physiological factors

Increased demand for iron in children, teenage females, and females of childbearing age is driven by growth and pregnancy requirements [5]. Other causes include poor dietary intake (including malnutrition, vegan diets, and chronic diseases), malabsorption (such as celiac disease), and blood loss [41]. Several reports in Saudi Arabia have identified various risk factors associated with the development of IDA and ID [7,8]. These factors are linked to lifestyle and dietary habits, including red meat consumption, tea consumption, menorrhagia, NSAID usage, inadequate iron and vitamin C intake, socioeconomic characteristics among female students, and IDA history [7,8,10,11,22,28,32,33].

One of the primary causes identified is the tendency to skip breakfast and irregular meal patterns, which have been recognized as risk factors for developing IDA [7,9, 50-52]. Approximately 28% of primary school students and 51% of secondary school students in Saudi Arabia report skipping breakfast [53]. This behavior is not unique to Saudi Arabia; similar trends have been observed in the USA and Europe, where 10 - 30% of children and adolescents skip breakfast [54]. Those who regularly consume breakfast are less likely to develop IDA [33]. Regular meals, including breakfast, are associated with a reduced risk of developing anemia [33]. Another significant factor is the consumption of red meat, which has been identified as a risk factor for IDA among female students [7,8,26,36]. AlSheik (2018) demonstrated a negative correlation between meat consumption and socioeconomic factors concerning the risk of developing IDA [32]. Other factors in Saudi Arabia that show significant association include BMI, vitamin C intake, and education. Low serum iron levels have been negatively correlated with age and BMI in Saudi girls [55]. Obesity has also been identified as a risk factor in Saudi Arabia [23]. Additionally, vitamin C intake has been reported to be low among IDA patients in Saudi Arabia [32]. Sociodemographic characteristics have been found to correlate with the risk of developing IDA in some studies [48,54], while other studies have shown no correlation in Saudi Arabia [36]. Education levels have also been linked to IDA risk [26]. These findings suggest that IDA is a multifactorial issue within Saudi society.

Genetic factors

While nutritional and socioeconomic characteristics contribute to the risk of developing IDA, genetic polymorphisms have also been identified as the risk factors [56-59]. Genome-wide association studies have revealed genetic loci, primarily in iron-related genes, associated with the development of ID [57-59]. Several studies have identified the presence of these polymorphisms in the Saudi population, correlating them with low iron levels and the development of IDA [60-65]. However, the relationship between these genetic factors and IDA requires further elucidation.

Awareness of the impact of iron deficiency

Numerous reports have addressed knowledge, awareness, attitudes, misconceptions, and motivational factors regarding ID and IDA within Saudi society [66,67]. Despite these discussions, the high incidence of IDA and ID persists, particularly among young female students, women of childbearing age, children, and infants. Therefore, IDA should be recognized as an urgent health issue, warranting immediate action.

CONCLUSION

IDA represents a major health burden in Saudi Arabia that requires urgent attention. The high prevalence of IDA among adults, teenagers, and children necessitates further investigation to identify its underlying causes and impact on health and its complications. The high incidence reached by ID is similar to the incidence levels

observed in developing and low-income countries. Both nutritional factors and genetic polymorphisms should be explored within the Saudi population.

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Declaration of Interest:
The author declares that he has no conflicts of interest.

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