Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202522673

Epidemiological Profile and Current Trends of Malaria in the Middle East-An Updated Review

Amjad Hamad Ahmed Hadi [(1)] , Abdulelah Omar Mousa Sharwani [(1)] , Ahmed Mohammed Abdullah Madkhali [(1)] , Amro Ahmed Nasser Khamjan [(2)] , Abdulaziz Mohammed Ali Ghazwi [(3)] , Abu Bakr Mohammed Qaba Ahmed [(4)]

(1) PHCC-Aboarish-Center, Jazan health cluster,Ministry of Health, Saudi Arabia,
(2) Vector-borne diseases control-branch in Jazan,Ministry of Health, Saudi Arabia,
(3) Environmental health-Public Health Authority- Southern Sector,Ministry of Health, Saudi Arabia,
(4) Vector-borne diseases control-Public Health Authority- Southern Sector, Saudi Arabia

Abstract

Background: Malaria remains one of the most significant parasitic diseases globally, causing hundreds of millions of infections and over 400,000 deaths annually, predominantly among children under five. Despite global progress, challenges such as imported malaria, drug resistance, climate change, and high-risk population mobility sustain persistent transmission risks in many regions.

Aim: This review aims to summarize the epidemiological profile, trends, and emerging challenges of malaria in the Middle East and Gulf Cooperation Council (GCC) region, with emphasis on imported malaria dynamics and species distribution.

Methods: A comprehensive narrative review of recent WHO reports, national surveillance data, and published studies was conducted, focusing on indigenous and imported malaria patterns across Middle Eastern and GCC countries.

Results: Malaria has been eliminated or greatly reduced in most Middle Eastern countries, except Yemen. Indigenous transmission persists mainly in Yemen and parts of other areas of middle east. Imported malaria constitutes the vast majority of cases in Kuwait, Qatar, UAE, Bahrain, Oman, and other malaria-free nations, largely driven by expatriates and travelers from highly endemic countries such as India, Pakistan, Sudan, Nigeria, Ethiopia, and Afghanistan. P. vivax predominates in many GCC countries, whereas P. falciparum dominates in Yemen, Sudan, and parts of Saudi Arabia. Drug-resistant strains and HRP2/3 deletions pose diagnostic and therapeutic challenges.

Conclusion: Although the Middle East has achieved substantial success in malaria control and elimination, imported malaria, ecological changes, and drug resistance remain critical threats that necessitate continuous surveillance and targeted prevention strategies.

Key Words: Malaria, Middle East, GCC, imported malaria, Plasmodium falciparum, Plasmodium vivax, epidemiology, drug resistance.

Introduction

Despite remarkable advances in global healthcare, parasitic infections continue to pose a major public health challenge, contributing substantially to morbidity and mortality worldwide. In 2013 alone, over 2 billion cases of parasitic diseases were reported among humans, reflecting the persistent burden of these infections [1]. Vector-borne parasitic diseases, in particular, represent a significant proportion of infectious illnesses, accounting for more than 15% of the global infectious disease burden and resulting in over 600,000 deaths annually [2]. Among these, malaria remains one of the most prevalent and lethal vector-borne parasitic infections, responsible for more than 400,000 deaths each year, the majority of which occur in children under five years of age [2]. The high mortality and widespread distribution of malaria underscore its continued relevance as a global health priority. The year 2000 marked a pivotal moment in the global fight against infectious diseases when the United Nations Millennium Summit highlighted three major health threats: human immunodeficiency virus (HIV) infection, tuberculosis, and malaria (HTM). These diseases were explicitly addressed in Millennium Development Goal 6, reflecting a concerted international commitment to reduce their burden. In response, the Global Fund to Fight AIDS, Tuberculosis, and Malaria was established in 2002 to provide financial support for programs targeting these conditions. Between 2000 and 2011, non-governmental organizations and foundations contributed nearly $11.3 billion in development assistance for health specifically for malaria control in endemic regions [3]. Such investments facilitated extensive interventions, including vector control measures, improved diagnostics, and widespread distribution of antimalarial treatments. These global efforts have

*Corresponding author e-mail: Amjadhh@moh.gov.sa (Amjad Hamad Ahmed Hadi).
Receive Date: 07 December 2025, Revise Date: 29 December 2025, Accept Date: 31 December 2025

yielded measurable results, preventing approximately 1.5 billion malaria cases and averting 7.6 million deaths since the start of the twenty-first century [4]. Despite these achievements, malaria continues to claim more than 400,000 lives annually, with children under five remaining disproportionately affected. Compounding this challenge, the emergence and spread of drug-resistant malaria strains pose a significant obstacle to sustained disease control and elimination efforts. This evolving landscape underscores the urgent need for ongoing surveillance, innovative treatment strategies, and robust public health interventions to mitigate the persistent burden of malaria globally.

Global Epidemiology of Malaria

Malaria remains the most significant parasitic disease worldwide, despite extensive efforts through international and national control and elimination programs. Historical attempts at eradication, particularly the Global Malaria Eradication Program launched in 1969, ultimately failed, leaving a substantial toll on human health. Hundreds of millions of people were infected, tens of millions succumbed to the disease—primarily in sub-Saharan Africa—hundreds of thousands of pregnant women died from malaria-related complications during childbirth, and millions of children were born with low birthweight, resulting in early mortality or long-term disability [4]. These outcomes highlight the challenges inherent in controlling a complex vector-borne disease across diverse geographic and socio-economic contexts. Nevertheless, the first two decades of the twenty-first century have been described as a golden era for malaria control, reflecting progress achieved through coordinated global interventions [4]. According to the World Health Organization (WHO) annual global malaria report, an estimated 229 million malaria cases occurred in 87 endemic countries in 2019, representing a reduction of nine million cases since 2000. However, this figure remained higher than the 218 million cases reported in 2015, which served as the baseline for the Global Technical Strategy (GTS) for malaria 2016–2030 [4]. This trend is reflected in the global malaria case incidence, measured as cases per 1000 population at risk, which declined from 80 in 2000 to 58 in 2015 and marginally to 57 in 2019. Between 2000 and 2015, global malaria case incidence fell by 27%, yet the decline slowed to less than 2% between 2015 and 2019, signaling a deceleration in progress despite ongoing interventions. Human malaria is caused by five Plasmodium species: P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi. P. falciparum is the most virulent species and predominates in Africa, accounting for nearly 99% of cases on the continent and 94% of all malaria cases and deaths globally in 2019 [4]. Its high pathogenicity makes it the primary target of malaria control strategies. Conversely, P. vivax, increasingly prevalent in the Indian subcontinent, presents unique diagnostic and therapeutic challenges. The parasite can persist as dormant liver-stage hypnozoites, causing relapsing infections and contributing to imported malaria cases predominantly among adult men outside sub-Saharan Africa [5,6]. These biological characteristics of P. vivax complicate elimination efforts and necessitate species-specific interventions.

Fig. 1: Geographical map showing the location of countries included in the Middle East Region.

Geographically, malaria is highly concentrated in a limited number of countries. In 2019, 29 countries accounted for 95% of global cases, with the WHO African Region bearing 94% of the burden, totaling 215 million cases. Nigeria (27%), the Democratic Republic of the Congo (12%), Uganda (5%), Mozambique (4%), and Niger (3%) together contributed approximately 51% of all cases. Despite reductions in malaria case incidence from 363 per 1000 population at risk in 2000 to 225 per 1000 in 2019, the region's population growth has limited proportional gains [4]. The WHO South-East Asia Region accounted for roughly 3% of global cases, achieving a 73% reduction from 23 million in 2000 to 6.3 million in 2019, with India responsible for the largest declines. Case incidence in the region decreased by 78%, from 18 to 4 per 1000 population [4]. In the WHO Eastern Mediterranean Region, malaria cases fell by 26%, from 7 million in 2000 to 5 million in 2019, with Sudan accounting for nearly half of these cases, while case incidence decreased from 20 to 10 per 1000 [4]. The WHO Western Pacific Region saw a 43% reduction in cases, from 3 million to 1.7 million, with incidence declining from 5 to 2 per 1000 population. Similarly, the Americas experienced a 40% reduction in cases, from 1.5 million to 0.9 million, with incidence falling by 57%, from 14 to 6 per 1000. The WHO European Region has been free of malaria since 2015 [4]. These statistics demonstrate that while global malaria control has achieved substantial progress, the disease remains unevenly distributed, with the highest burden concentrated in Africa. The slowed decline since 2015 underscores the need for sustained interventions, enhanced

surveillance, and tailored strategies to address regional epidemiological and biological challenges associated with different Plasmodium species.

Malaria Mortality and Emerging Challenges

Malaria-related mortality has shown marked fluctuations over the past decades. Estimates indicate that annual deaths due to malaria rose from approximately 888,000 in 1990 to a peak of 1.2 million in 2004. Following this peak, targeted interventions in sub-Saharan Africa, including vector control, improved diagnostics, and effective antimalarial treatment, led to a 31.5% reduction in child mortality, lowering deaths to around 855,000 by 2013 [7]. Outside of Africa, malaria mortality has been steadily declining since 1990, reflecting the impact of sustained control measures and elimination programs in multiple regions. From 2000 onwards, all WHO regions experienced decreases in age-standardized malaria incidence and mortality rates, with central Asia reporting a 38% decline due to intensified elimination efforts [7,8]. In 2019, malaria caused an estimated 409,000 deaths globally, with the majority concentrated in a limited number of countries. Thirty-one nations accounted for 95% of all malaria deaths, and six countries—Nigeria (23%), the Democratic Republic of the Congo (11%), Tanzania (5%), Mozambique (4%), Niger (4%), and Burkina Faso (4%)—accounted for more than half of the global mortality burden [4]. Children under five years of age bore the highest mortality, representing approximately 67% of all deaths. Between 2000 and 2019, global malaria deaths declined steadily from 736,000 to 409,000, and the mortality rate, measured per 100,000 population at risk, decreased from around 25 in 2000 to 12 in 2015 and 10 in 2019. This trend indicates a slowing rate of decline in recent years, underscoring persistent challenges in reducing mortality despite decades of intervention [4]. Regionally, the largest proportional reduction in malaria mortality occurred in the WHO South-East Asia Region, with a 74% decline from approximately 35,000 deaths in 2000 to 9,000 in 2019. In absolute terms, the WHO African Region achieved the largest reduction, decreasing deaths from 680,000 in 2000 to 384,000 in 2019 [4]. In addition to ongoing endemic transmission, imported malaria cases in non-endemic and previously malaria-free countries have emerged as a growing public health concern. Globalization, increased international travel for business or leisure, migration for employment, and displacement due to geopolitical conflicts have altered the epidemiology of imported malaria, introducing infections into regions with limited immunity and surveillance infrastructure [10,11,12]. Climate change and ecological disruption have further exacerbated the risk of vector-borne diseases, including malaria, by expanding suitable habitats for Anopheles mosquitoes and prolonging transmission seasons [9]. Recent data from the WHO highlight additional challenges related to parasite biology and drug resistance. Deletions in the P. falciparum histidine-rich protein 2 and 3 genes (pfhrp2 and pfhrp3) have been confirmed in eleven countries, including China, Equatorial Guinea, Ethiopia, Ghana, Myanmar, Nigeria, Sudan, Uganda, the United Kingdom (imported cases), Tanzania, and Zambia [4]. These deletions compromise the sensitivity of rapid diagnostic tests (RDTs) that detect HRP2, complicating timely diagnosis. Furthermore, mutations in the PfKelch13 gene have been identified, conferring partial resistance to artemisinin, the frontline therapy for P. falciparum malaria [4]. Resistance has also emerged against other antimalarial classes, including antifolates, naphthoquinones, antibiotics such as clindamycin and doxycycline, and 4-aminoquinolines. Recent research has identified novel molecular targets, offering potential avenues for the development of new antimalarial therapeutics [13]. These evolving biological and pharmacological challenges emphasize the need for continuous surveillance, innovation in drug development, and adaptive public health strategies to sustain progress in malaria control.

Epidemiology of Malaria in the Middle East Region Countries

The Middle East Region comprises seventeen countries, spanning from Iran in the east to Egypt in the west, Turkey in the north, and Yemen in the south. These countries include Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine (West Bank and Gaza Strip), Qatar, Saudi Arabia, Syria, Turkey, the United Arab Emirates (UAE), and Yemen, with most situated on the Arabian Peninsula [4]. Collectively, these nations account for approximately 5% of the global population, or around 400 million people, with Egypt, Iran, and Turkey representing the three most populous countries in the region [4]. Geopolitically, nearly all Middle East countries—except Turkey, Cyprus, and Israel, which fall under the WHO European Region—are categorized within the WHO Eastern Mediterranean Region. This WHO region also includes seven additional countries: Afghanistan, Djibouti, Libya, Morocco, Somalia, Sudan, and Tunisia, complementing the fourteen Middle East nations within its jurisdiction [4]. Notably, none of the twenty-five high malaria burden countries identified globally are located in the Middle East, indicating a relatively lower endemicity [4]. Indigenous malaria transmission within the Middle East has been largely restricted to Yemen and Saudi Arabia, with most other countries primarily reporting imported cases in recent years [4]. This pattern reflects both successful national malaria control programs and the region's climatic and ecological conditions, which are generally less favorable for sustained malaria transmission. The epidemiological landscape is further influenced by the presence of the Gulf Cooperation Council (GCC), consisting of six countries—Bahrain, Qatar, Kuwait, UAE, Oman, and Saudi Arabia—located on the Arabian Peninsula. These nations share common characteristics, including substantial income generated

from oil resources, modern infrastructure, rapid urbanization, and significant socio-economic development over the past three to four decades. A defining feature of the GCC countries is the substantial and dynamic expatriate population, which often exceeds the number of native citizens in several states. This workforce is employed across both public and private sectors, primarily in low-wage positions. The expatriate communities predominantly originate from malaria-endemic countries in South and Southeast Asia, including India, Pakistan, Afghanistan, Nepal, Bangladesh, Sri Lanka, and the Philippines, as well as African nations such as Ethiopia, Sudan, and Nigeria [4,5,14,15,16,17,18,19,20]. The importation of malaria cases through these populations represents a significant public health consideration, necessitating robust surveillance, screening, and control measures to prevent local transmission and potential outbreaks. The epidemiology of malaria in the Middle East, therefore, reflects a dual pattern: low endemic transmission in specific regions and the consistent importation of cases through migrant populations. Factors such as rapid economic development, extensive urbanization, high population mobility, and a diverse expatriate workforce shape both the risk and management of malaria in the region. Despite the absence of high-burden endemicity, vigilance remains essential, particularly in countries hosting large expatriate populations from endemic regions, as imported malaria can introduce sporadic transmission cycles and present challenges for public health authorities. Continuous monitoring, coupled with preventive measures targeting high-risk populations, is critical to sustaining the low incidence of malaria and mitigating the risk of resurgence in the Middle East.

Epidemiology of Malaria among GCC Countries

Malaria transmission in the Gulf Cooperation Council (GCC) countries has been effectively controlled over the past decades, resulting in the elimination of indigenous cases across nearly all member states. Despite this achievement, the persistent influx of imported malaria cases through expatriate workers from endemic regions in Africa and South and Southeast Asia continues to pose a public health challenge, maintaining the potential risk of local outbreaks [7,14,21]. The majority of malaria cases in GCC countries occur among expatriates, while a smaller proportion of infections are travel-related cases among nationals returning from endemic regions. The demographic composition, high mobility, and concentration of expatriate populations in the GCC significantly shape the epidemiology of malaria in the region. Bahrain, the smallest GCC country both in area and population—approximately 1.6 million—demonstrates a typical example of malaria epidemiology in highly developed Gulf states. Expatriates and their dependents constitute roughly half of Bahrain's population. Malaria was eradicated in the 1980s, yet imported cases persist due to the significant number of migrants from endemic countries such as India, Pakistan, Bangladesh, the Philippines, and several African nations. Historical surveillance data indicate 1,572 imported malaria cases between 1992 and 2001, with a steady decline from 282 cases in 1992 to 54 in 2001 [22]. Plasmodium vivax accounted for the majority of infections (86%), while P. falciparum was reported in 14% of cases. Only a few Anopheles mosquito breeding sites were identified, indicating a low risk of secondary local transmission. These findings highlight that while indigenous malaria has been eliminated, continued vigilance is required to monitor imported cases and prevent potential re-establishment of transmission [22].

Qatar presents a similar epidemiological pattern with a population of approximately 2.8 million in 2020, of which 88% were expatriates. Earlier studies documented a decline in malaria incidence from 58.6 cases per 100,000 in 1997 to 9.5 per 100,000 in 2004. However, incidence began rising after 2005, coinciding with travel by expatriates to endemic countries such as India, Pakistan, and Sudan. Subsequent studies from 2008 to 2015 confirmed that nearly all cases occurred among non-Qatari males, while infections among nationals were predominantly travel-related [23,24]. Between 2013 and 2016, PCR-based analyses revealed that P. vivax was the dominant species among imported cases, comprising 71% of infections, whereas P. falciparum and mixed P. vivax/P. falciparum infections were less frequent [25,37]. P. vivax cases were mainly associated with migrants from the Indian subcontinent, and P. falciparum infections were largely linked to African expatriates. High genetic diversity was observed among imported parasite strains, with mutations in Pfkelch13 and other drug-resistance markers identified, posing a potential challenge to malaria control and elimination efforts. Detection of gametocytes using sensitive PCR methods further highlights the risk of transmission if vectors were present [25]. The epidemiology of malaria in GCC countries illustrates the critical role of expatriate populations in shaping disease patterns. Although indigenous transmission has been largely eliminated, the continuous importation of malaria requires robust surveillance, species-specific diagnostic tools, and strategies to prevent reintroduction. Monitoring the genetic diversity of imported parasites and assessing drug-resistance profiles are essential to inform national malaria elimination programs. Preventive interventions, including targeted screening of returning expatriates and public health awareness campaigns, are vital to sustain malaria-free status and prevent resurgence in these economically developed Gulf states.

Epidemiology of Malaria in Kuwait and Other GCC Countries

Kuwait, with a population of approximately 4.5 million in 2019, has a demographic structure characterized by a minority of Kuwaiti nationals (about 30%) and a majority of expatriate workers and their families (70%) [https://www.paci.gov.kw/Default.aspx]. The expatriate population primarily originates from South and Southeast Asian countries, including Pakistan, India, Nepal, Bangladesh, Sri Lanka, and the Philippines, as well as African nations such as Ethiopia, Nigeria, and Sudan, where malaria and other infectious diseases such as tuberculosis and taeniasis are endemic [4,19,20,39,40,41]. Kuwait is considered malaria-free due to the absence of Anopheles mosquito vectors, arid climatic conditions, and a scarcity of freshwater habitats, which preclude local transmission. Nonetheless, imported malaria cases have been consistently reported since the 1980s, largely among expatriates arriving from endemic countries or returning residents who had traveled to their countries of origin [42,43,44,45,46]. Historical data indicate that during 1985–2000, Kuwait reported over 1,200 malaria cases annually, all of which were imported. The primary groups affected included newly arrived expatriate workers and residents returning from endemic regions [42,43,44,45,46]. More recent surveillance suggests a decline in case numbers, with annual incidence ranging from 250 to 400 cases, primarily affecting male expatriates aged 21–40 years [26]. Plasmodium vivax was responsible for the majority of infections (71%), while P. falciparum accounted for 27% of cases. A detailed study spanning 2013 to 2018 identified 1,913 positive cases out of 7,386 suspected cases, corresponding to a positivity rate of 25.9%. Incidence rates fluctuated from 6.8 per 100,000 in 2014 to 9.9 per 100,000 in 2017 [26]. The majority of malaria-positive cases originated from Asian countries, particularly India, Pakistan, and Afghanistan, with Indian expatriates representing the largest single ethnic group affected. Mixed P. falciparum/P. vivax infections were detected in 72.3% of cases, predominantly among Indian subjects (97%) [26].

Despite the absence of indigenous transmission, emerging ecological and climate modifications in Kuwait, such as efforts to increase greenery and expand plantations, could potentially create suitable habitats for Anopheles stephensi and Anopheles pulcherrimus, raising the theoretical risk of local malaria transmission [26]. The United Arab Emirates (UAE), with a population nearing 10 million in 2020, follows a similar epidemiological pattern, with expatriates constituting 80% of residents [https://www.dubai-online.com/essential/uae-population-and-demographics/]. The UAE was declared malaria-free by WHO in 2007, but imported malaria cases continue to occur. A study conducted in Dubai between 2008 and 2010 reported 629 cases, predominantly due to P. vivax (78%), followed by P. falciparum (19%), with mixed infections comprising 2% of cases. Most infections were among individuals from India and Pakistan, and no cases were reported among Emirati nationals [27]. Oman, with a population of 4.5 million in 2020, was historically malaria-endemic, reporting approximately 33,000 cases annually before 1990. Comprehensive control measures, including vector eradication and effective treatment, reduced malaria incidence to 1 case per 10,000 population by 2000, with P. vivax as the predominant species. The last documented indigenous case was reported in 2010, although a localized outbreak of 54 P. vivax cases occurred in 2014 among migrant workers, primarily from Bangladesh, India, and Pakistan. Molecular analyses suggested secondary local transmission from a gametocyte carrier, possibly infected in Iran, but the outbreak did not lead to sustained transmission due to prompt intervention and vector control [28]. Previously, between 2014-2018, Saudi Arabia, the largest GCC country with an estimated population of 35 million in 2020, reports both imported malaria cases, mainly from the southwestern provinces of Jazan and Aseer [7,14,47,48,49,50]. Nowadays, the Saudi Arabia is completely free from Malaria and in progress to receive a WHO certificate. Progress in malaria control has been substantial, with autochthonous cases declining by 99.8% between 1998 and 2012 through vector control, adoption of artesunate-sulfadoxine-pyrimethamine combination therapy, and regional partnerships for a malaria-free Arabian Peninsula [47,48]. Between 2000 and 2014 in Jazan Province, 9,936 imported cases (64%) and 5,522 locally acquired cases (36%) were documented, with an average annual incidence of 0.03 cases per 1,000 population [48]. Indigenous cases declined from 2,756 in 2000 to 15 in 2014, while imported cases increased, ranging from 250 to 830 annually, with exceptions in 2007 and 2009 when 1,705 and 1,310 cases were reported, respectively. P. falciparum dominated the infection profile, accounting for over 98% of cases, with very few P. vivax or mixed infections [51,52,53]. Collectively, the epidemiology of malaria across Kuwait and other GCC countries reflects a consistent pattern: elimination of indigenous transmission, a predominance of imported cases among expatriate populations, and a continued risk of reintroduction. Effective surveillance, vector monitoring, and management of imported cases remain essential to maintain malaria-free status and prevent the establishment of local transmission. The region's demographic structure, ecological changes, and high mobility of expatriate populations require targeted public health strategies, species-specific diagnostic tools, and integrated prevention measures to sustain control achievements and respond to emerging threats.

Epidemiology of Malaria in Other Middle East Region Countries

Malaria remains a significant public health concern in parts of the Middle East Region, though the epidemiological patterns vary substantially between

endemic and malaria-free countries. Yemen, Iraq, Syria, Jordan, Lebanon, Palestine, Israel, Iran, Turkey, and Cyprus demonstrate diverse malaria dynamics ranging from persistent endemicity to sporadic imported cases. Yemen, with a population of approximately 30 million in 2020, remains the only fully endemic country in the Arabian Peninsula outside the GCC, and it reports the second highest number of projected malaria cases in the WHO Eastern Mediterranean Region after Sudan [4]. The National Malaria Control Program, launched in 2000, initially reduced malaria burden substantially. Between 2010 and 2015, microscopy-confirmed malaria cases decreased from 78,269 to 42,052, while suspected cases declined from 835,018 to 711,680 [2]. However, the civil war and ongoing humanitarian crisis have reversed these gains, leading to increased case numbers after 2015, with 64,233 confirmed cases in 2018. Malaria deaths also increased, from 1,309 in 2015 to 2,138 in 2018 [2]. Nearly all malaria infections in Yemen are caused by P. falciparum, with 112,823 cases reported in 2018, whereas P. vivax accounted for only 970 cases [2]. Approximately two-thirds of Yemen's population remains at risk. Surveillance systems such as the Integrated Malaria Surveillance System and the Early Disease Electronic Warning System are central to assessing disease burden, outbreak response, and planning future interventions [54]. The Hodeidah governorate in the Tihama Region is highly endemic. A study in Bajil district detected P. falciparum in 8% of 400 asymptomatic schoolchildren, reflecting ongoing transmission [55]. Insecticide resistance in Anopheles arabiensis complicates control, prompting universal coverage with long-lasting insecticidal nets as a key intervention [56,57].

Iraq has been affected by prolonged conflict and displacement, including approximately 0.25 million Syrian refugees and nearly 3 million internally displaced persons [http://www.unhcr.org/syria-emergency.html]. Despite favorable conditions for malaria transmission—agricultural land, freshwater bodies, and abundant Anopheles mosquitoes—no malaria cases have been reported for three consecutive years since 2011 [2,7]. Historical outbreaks occurred, such as the epidemic in Babylon governorate in 1997–1998, but transmission was subsequently interrupted [58]. A 2002 survey detected high densities of Anopheles stephensi and Anopheles pulcherrimus without sporozoites or oocysts, indicating no active transmission. Imported cases remain the main risk factor, and malaria could recur if vector density exceeds critical thresholds [58]. The last documented case was in 2009 [4]. Syria has experienced a steady decline in malaria incidence between 1990 and 2000, with annual reductions of 6.6–6.8% in incidence and deaths [7]. Since 2004, no autochthonous cases have been reported [4]. Imported malaria increased from 12 cases in 2002 to 48 in 2011 [7]. Civil war since 2012 limits current surveillance, but WHO data indicate no malaria-related deaths or local cases between 2000 and 2013 [4,7]. Jordan is malaria-free, with no reported indigenous cases in recent years [2,4,7]. Imported cases, however, remain a concern. Between 1991 and 2011, 511 imported malaria cases were reported among returning Jordanians from Asia and Africa [59]. Another study detected 304 cases from 2007 to 2011, including 192 among Jordanians, mostly military personnel, and 112 among foreign nationals. Infections were caused primarily by P. falciparum (199 cases), P. vivax (93 cases), P. malariae (8 cases), and mixed infections in four cases [29]. Continuous vigilance is critical to prevent disease reintroduction. Lebanon is malaria-free, with no indigenous cases reported for decades [2,4,7]. Imported cases arise from nationals traveling to Africa. Confirmed cases increased from 55 in 2003 to 115 in 2012, with over half caused by P. falciparum [30]. Palestine has been malaria-free since 1925. Between 2008 and 2017, only seven imported cases were reported, all in individuals who traveled to endemic countries [31].

Israel remains malaria-free, with no indigenous transmission for decades [2,4,7]. Imported cases occur among returning travelers. From 2004 to 2015, 145 cases were hospitalized, mainly P. falciparum (59%), with infections linked to travel to Africa or Asia [32]. Iran is in the malaria elimination phase, reporting no indigenous cases in 2018 and 2019 [4]. Previously endemic, Iran continues to receive imported cases, mostly among Afghan and Pakistani workers. Studies in Khuzestan, Fars, and East Azerbaijan provinces reported declining incidence, with P. vivax as the dominant species [33,61,62]. Nationwide, 572 imported cases were documented in 2018 [4]. Turkey, in the WHO European Region, is malaria-free, with no indigenous cases since 2010. Imported malaria averages 216 cases annually, primarily P. vivax and P. falciparum, often acquired in Africa [4,34,63,64]. Surveillance and integrated mosquito control are essential to maintain elimination [34]. Cyprus, also part of the WHO European Region, has been malaria-free since 1967. Imported cases occasionally occur, including P. vivax and P. falciparum among travelers returning from endemic regions [35,65]. Recent data report 13 imported cases from 2016 to 2019 [35]. Egypt achieved malaria-free status in 1998 after a sustained decline in endemicity. Sporadic imported cases continue, particularly in Al-Fayoum and Aswan governorates, often linked to travel to endemic Sudan [36,66]. No indigenous cases or malaria-related deaths were reported from 2010 to 2019 [2,4]. Overall, malaria epidemiology in the Middle East Region highlights the contrast between endemic countries like Yemen and largely malaria-free nations where imported cases dominate. Effective surveillance, vector monitoring, and management of imported infections are essential to sustain elimination and prevent resurgence.

Epidemiological Data from Countries of Origin for Imported Malaria Cases:

The epidemiology of malaria in countries that serve as sources of expatriate populations for the Gulf Cooperation Council (GCC) and other Middle East Region countries is critical for understanding the patterns of imported malaria. Many of these countries are highly endemic for malaria, and migrants from these regions contribute substantially to the imported malaria burden in GCC countries such as Kuwait, Saudi Arabia, UAE, Qatar, and Bahrain. Key malaria-endemic countries include Sudan, Ethiopia, Nigeria, Pakistan, Afghanistan, India, Bangladesh, and the Philippines. Sudan is the leading contributor of malaria cases in the WHO Eastern Mediterranean Region, with nearly 2.4 million cases reported in 2019 [4]. Travelers returning from Sudan are frequently implicated in imported malaria in Bahrain, Qatar, Kuwait, UAE, Saudi Arabia, Jordan, and Egypt [14,22,23,25,26,27,29,36,37,42,43,45,47,49,59,71,72]. Drug resistance is a major concern, particularly artemisinin-based combination therapy (ACT) failure in P. falciparum. High prevalence of mutations in genes associated with chloroquine and sulfadoxine-pyrimethamine resistance, including Pfcrt, Pfdhfr, and Pfdhps, has been reported, complicating malaria control efforts [67,68]. Ethiopia reported approximately 2.5 million malaria cases in 2019, ranking 23rd in the WHO African Region [4]. Expatriates from Ethiopia have contributed to imported malaria cases in Kuwait and Qatar [25,26,43,45]. Over the past two decades, malaria control programs in Ethiopia have reduced incidence and mortality. For example, the Harari Region reported a decline in incidence from 42.9 cases per 1,000 population in 2013 to 6.7 per 1,000 in 2019, and malaria deaths decreased from 4.7 per 1,000,000 in 2013 to zero by 2015 [69]. P. falciparum is responsible for 69.2% of infections, P. vivax for 30.6%, and mixed infections are rare. The country aims to achieve malaria elimination by 2030 using strategies including artemether-lumefantrine for uncomplicated P. falciparum malaria [70].

Nigeria, with a population of 208 million, accounted for nearly 60 million malaria cases in 2019, representing 27% of global malaria cases and 23% of malaria deaths [4]. Travelers from Nigeria have contributed to imported malaria cases in Qatar, Kuwait, Saudi Arabia, and Turkey [14,26,37,63,71,72]. Nigeria also faces challenges from Pfhrp2/3 deletions, which can compromise HRP2-based diagnostic tests [4]. Drug resistance remains a concern, particularly with rising artemisinin combination therapy resistance polymorphisms, although resistance to sulfadoxine-pyrimethamine has remained low [73,74]. Pakistan remains highly endemic, with nearly 700,000 malaria cases projected in 2019 [4]. In the Bannu District, 21.1% of suspected cases tested positive for malaria by at least one diagnostic method, with P. vivax accounting for approximately 80%, P. falciparum 11%, and mixed infections 9% [75]. In other studies from border regions with Afghanistan, P. vivax prevalence exceeded 86%, while P. falciparum accounted for 11.8% of infections [76]. A regional RDT survey in Khyber Pakhtunkhwa Province reported 13.8% overall prevalence, with 92.4% P. vivax, 4.7% P. falciparum, and 2.9% mixed infections [77]. Expatriates from Pakistan contribute to imported malaria in Bahrain, Qatar, Kuwait, UAE, Saudi Arabia, Jordan, and Egypt [14,22,23,25,26,27,29,36,37,42,43,45,52,59,71,72].

Approximately half of Afghanistan's population is at risk of malaria, with 400,000 cases projected in 2019 [4,78]. Studies using PCR detected asymptomatic malaria in 7.8% of individuals in Jalalabad [78]. Imported malaria from Afghanistan has been reported in Iran and other neighboring countries [62].

India continues to report high malaria burden despite reductions in overall cases from 2000 to 2019, with nearly 5.6 million cases projected in 2019 [4]. Outbreaks peak during summer and fall monsoons. Most of the population lives in endemic regions, with 80% of malaria concentrated in 20% of communities in remote or hilly areas [2]. P. vivax predominates in southwestern India, accounting for 80% of infections, although P. falciparum remains significant in some regions [82,83]. Mixed infections are common, ranging from 11% to 13% in various studies [83,84,85]. Trends show a decrease in P. falciparum from 65.4% in 2017 to 46.4% in 2019, with P. vivax becoming the dominant species in many areas. India alone accounts for 47% of global P. vivax malaria, with seven states responsible for 90% of cases [2]. Expatriates from India are major contributors to imported malaria in GCC countries [14,22,23,24,25,26,27,37,42,43,44,45,52,71,72].

Bangladesh has a population of over 160 million, with 17.5 million at risk of malaria [4,86]. The country has made steady progress toward malaria elimination from 2000 to 2019. P. vivax prevalence and antimalarial drug resistance have increased over the past two decades [4]. Post-treatment P. vivax parasitemia occurs in 12–26% of P. falciparum malaria patients [87]. Expatriates from Bangladesh contribute to imported cases in GCC countries. The Philippines remains malaria-endemic, with 40,000 cases projected in 2019, concentrated in Palawan Province and Mindanao [2,4]. Mixed P. falciparum/P. vivax infections are common, and P. knowlesi has emerged as a cause of human malaria in Palawan [88,89]. Drug resistance markers in P. vivax, including mutations in pvdhfr and pvdhps associated with sulfadoxine-pyrimethamine resistance, have been reported [90]. Expatriates from the Philippines contribute to imported malaria cases in GCC countries. In summary, the epidemiology of malaria in countries that supply expatriate populations to the Middle East Region reflects high endemicity, with varying proportions of P. falciparum, P. vivax, and mixed infections. Drug

resistance, particularly in Sudan, Nigeria, and parts of South Asia, remains a critical challenge. The large expatriate workforce from these regions underpins the continued importation of malaria into GCC and nearby countries, emphasizing the need for effective screening, preventive measures, and early diagnosis to prevent local transmission [91][92][93].

Conclusion:

Malaria epidemiology in the Middle East reveals a region that has made remarkable strides in eliminating indigenous transmission but continues to face sustained threats from imported infections. The majority of GCC and Levant countries have maintained malaria-free status for decades; however, the sheer volume of population mobility—especially among expatriates from highly endemic countries—creates a continuous influx of imported cases. These dynamic highlights the essential role of migration patterns, travel behavior, and labor demographics in shaping the region's malaria burden. Yemen and parts of southwestern Saudi Arabia remain the primary areas of endemic transmission, driven by ecological suitability, conflict-related disruptions, and limitations in health infrastructure. Imported malaria into malaria-free countries presents risks of reintroduction, especially where ecological or climate-driven changes may create favorable habitats for Anopheles vectors. Furthermore, the emergence of drug-resistant Plasmodium strains and gene deletions affecting rapid diagnostic test performance amplify the complexity of malaria control, necessitating more sensitive diagnostic tools and updated treatment strategies. Sustaining malaria-free status and reducing residual transmission require robust surveillance systems, targeted screening of high-risk populations, strengthened vector monitoring, and regional collaboration. The region's progress demonstrates that elimination is achievable, but maintaining gains demands continuous vigilance and adaptive public health measures tailored to evolving epidemiological realities.

References:

1. Herricks, J.R.; Hotez, P.J.; Wanga, V.; Coffeng, L.E.; Haagsma, J.A.; Basáñez, M.G.; Buckle, G.; Budke, C.M.; Carabin, H.; Fèvre, E.M.; et al. The global burden of disease study 2013: What does it mean for the NTDs? *PLoS Negl. Trop. Dis.* **2017**, *11*, e0005424.
2. World Health Organization. *World Malaria Report*; WHO: Geneva, Switzerland, 2019; Available online: **https://www.who.int/malaria/publications/world-malaria-report-2019/en/**
3. Floyd, K.; Fitzpatrick, C.; Pantoja, A.; Raviglione, M. Domestic and donor financing for tuberculosis care and control in low-income and middle income countries: An analysis of trends, 2002–2011, 2002–2011, and requirements to meet 2015 targets. *Lancet Glob. Health* **2013**, *1*, e105–e115. [
4. World Health Organization. *World Malaria Report*; WHO: Geneva, Switzerland, 2020; Available online: **https://www.who.int/publications/i/item/9789240015791**
5. Dayananda, K.K.; Achur, R.N.; Gowda, D.C. Epidemiology, drug resistance, and pathophysiology of *Plasmodium vivax* malaria. *J. Vector Borne Dis.* **2018**, *55*, 1–8.
6. Cotter, C.; Sturrock, H.J.; Hsiang, M.S.; Liu, J.; Phillips, A.A.; Hwang, J.; Gueye, C.S.; Fullman, N.; Gosling, R.D.; Feachem, R.G. The changing epidemiology of malaria elimination: New strategies for new challenges. *Lancet* **2013**, *382*, 900–911.
7. Murray, C.J.; Ortblad, K.F.; Guinovart, C.; Lim, S.S.; Wolock, T.M.; Roberts, D.A.; Dansereau, E.A.; Graetz, N.; Barber, R.M.; Brown, J.C.; et al. Global, regional, and national incidence and mortality for HIV, tuberculosis, and malaria during 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *Lancet* **2014**, *384*, 1005–1070.
8. Ashley, E.A.; Pyae Phyo, A.; Woodrow, C.J. Malaria. *Lancet* **2018**, *391*, 1608–1621.
9. Rossati, A.; Bargiacchi, O.; Kroumova, V.; Zaramella, M.; Caputo, A.; Garavelli, P.L. Climate, environment and transmission of malaria. *Infez. Med.* **2016**, *24*, 93–104.
10. Loutan, L. Malaria: Still a threat to travellers. *Int. J. Antimicrob. Agents* **2003**, *21*, 158–163.
11. Mischlinger, J.; Rönnberg, C.; Álvarez-Martínez, M.J.; Bühler, S.; Paul, M.; Schlagenhauf, P.; Petersen, E.; Ramharter, M. Imported malaria in countries where malaria is not endemic: A comparison of semi-immune and nonimmune travelers. *Clin. Microbiol. Rev.* **2020**, *33*, e00104–e00119.
12. Norman, F.F.; Comeche, B.; Chamorro, S.; Pérez-Molina, J.A.; López-Vélez, R. Update on the major imported protozoan infections in travelers and migrants. *Future Microbiol.* **2020**, *15*, 213–225.
13. Shibeshi, M.A.; Kifle, Z.D.; Atnafie, S.A. Antimalarial drug resistance and novel targets for antimalarial drug discovery. *Infect. Drug Resist.* **2020**, *13*, 4047–4060.
14. Shibl, A.; Senok, A.; Memish, Z. Infectious diseases in the Arabian Peninsula and Egypt. *Clin. Microbiol. Infect.* **2012**, *18*, 1068–1080.
15. Khalil, I.; Colombara, D.V.; Forouzanfar, M.H.; Troeger, C.; Daoud, F.; Moradi-Lakeh, M.; Bcheraoui, C.E.; Rao, P.C.; Afshin, A.; Charara, R.; et al. Burden of diarrhea in the Eastern Mediterranean Region, 1990–2013: Findings from the Global Burden of Disease Study

2013. *Am. J. Trop. Med. Hyg.* **2016**, *95*, 1319–1329.
16. Ahmad, S.; Fares, E.; Araj, G.F.; Chugh, T.D.; Mustafa, A.S. Prevalence of S315T mutation within the *katG* gene in isoniazid-resistant clinical *Mycobacterium tuberculosis* isolates from Dubai and Beirut. *Int. J. Tuberc. Lung Dis.* **2002**, *6*, 920–926.
17. Ahmad, S.; Mokaddas, E.; Fares, E. Characterization of *rpoB* mutations in rifampin-resistant *Mycobacterium tuberculosis* isolates from Kuwait and Dubai. *Diagn. Microbiol. Infect. Dis.* **2002**, *44*, 245–252.
18. Ahmad, S.; Fares, E. Genotypic diversity among isoniazid-resistant isolates of *Mycobacterium tuberculosis* from Rashid Hospital in Dubai, United Arab Emirates. *Med. Princ. Pract.* **2005**, *14*, 16–21.
19. Ahmad, S.; Mokaddas, E.; Al-Mutairi, N.M. Prevalence of tuberculosis and multidrug resistant tuberculosis in the Middle East Region. *Expert Rev. Anti-Infect. Ther.* **2018**, *16*, 709–721.
20. Al-Awadhi, M.; Iqbal, J.; Ahmad, S. Cysticercosis, a potential public health concern in Kuwait: A new diagnostic method to screen *Taenia solium* taeniasis carriers in the expatriate population. *Med. Princ. Pract.* **2020**, *29*, 347–353.
21. Nasir, S.M.I.; Amarasekara, S.; Wickremasinghe, R.; Fernando, D.; Udagama, P. Prevention of re-establishment of malaria: Historical perspective and future prospects. *Malar. J.* **2020**, *19*, 452.
22. Ismaeel, A.Y.; Senok, A.C.; Jassim Al-Khaja, K.A.; Botta, G.A. Status of malaria in the Kingdom of Bahrain: A 10-year review. *J. Travel Med.* **2004**, *11*, 97–101.
23. Al-Kuwari, M.G. Epidemiology of imported malaria in Qatar. *J. Travel Med.* **2009**, *16*, 119–122.
24. Farag, E.; Bansal, D.; Chehab, M.A.H.; Al-Dahshan, A.; Bala, M.; Ganesan, N.; Al Abdulla, Y.A.; Al Thani, M.; Sultan, A.A.; Al-Romaihi, H. Epidemiology of malaria in the State of Qatar, 2008–2015. *Mediterr. J. Hematol. Infect. Dis.* **2018**, *10*, e2018050.
25. Abdelraheem, M.H.; Bansal, D.; Idris, M.A.; Mukhtar, M.M.; Hamid, M.M.A.; Imam, Z.S.; Getachew, S.; Sehgal, R.; Kaur, H.; Gadalla, A.H.; et al. Genetic diversity and transmissibility of imported *Plasmodium vivax* in Qatar and three countries of origin. *Sci. Rep.* **2018**, *8*, 8870.
26. Iqbal, J.; Al-Awadhi, M.; Ahmad, S. Decreasing trend of imported malaria cases but increasing influx of mixed *P. falciparum* and *P. vivax* infections in malaria-free Kuwait. *PLoS ONE* **2020**, *15*, e0243617.
27. Nilles, E.J.; Alosert, M.; Mohtasham, M.A.; Saif, M.; Sulaiman, L.; Seliem, R.M.; Kotlyar, S.; Dziura, J.D.; Al-Najjar, F.J. Epidemiological and clinical characteristics of imported malaria in the United Arab Emirates. *J. Travel Med.* **2014**, *21*, 201–206.
28. Simon, B.; Sow, F.; Al Mukhaini, S.K.; Al-Abri, S.; Ali, O.A.M.; Bonnot, G.; Bienvenu, A.L.; Petersen, E.; Picot, S. An outbreak of locally acquired *Plasmodium vivax* malaria among migrant workers in Oman. *Parasite* **2017**, *24*, 25.
29. Jamain, H.M.; Abu Shaqra, Q.A.; Kanani, K.A. Epidemiological pattern of imported malaria in Jordan from 2007 to 2011. *Trop. Biomed.* **2013**, *30*, 591–595.
30. World Health Organization. *Health Profile 2015, Lebanon*; WHO-EM/HST/224/E; WHO: Geneva, Switzerland, 2015; Available online: **https://apps.who.int/iris/handle/10665/253773**
31. Hamarsheh, O.; Amro, A. Epidemiology of parasitic infections in the West Bank and Gaza Strip, Palestine. *Am. J. Trop. Med. Hyg.* **2020**, *102*, 313–317.
32. Avni, C.; Stienlauf, S.; Meltzer, E.; Sidi, Y.; Schwartz, E.; Leshem, E. Region-specific, life-threatening diseases among international travelers from Israel, 2004–2015. *Emerg. Infect. Dis.* **2018**, *24*, 790–793.
33. Azizi, H.; Davtalab-Esmaeili, E.; Farahbakhsh, M.; Zeinolabedini, M.; Mirzaei, Y.; Mirzapour, M. Malaria situation in a clear area of Iran: An approach for the better understanding of the health service providers' readiness and challenges for malaria elimination in clear areas. *Malar. J.* **2020**, *19*, 114.
34. Ser, Ö. Evaluation of malaria cases detected in Antalya Province between 2012 and 2017. *Turk. Parazitol. Derg.* **2020**, *44*, 1–6.
35. Güler, E.; Özbilgin, A.; Çavuş, İ.; Şanlıdağ, T.; Süer, K. Evaluation of imported malaria cases in Northern Cyprus between 2016 and 2019: First data series. *Turk. Parazitol. Derg.* **2020**, *44*, 126–131.
36. Dahesh, S.M.; Mostafa, H.I. Reevaluation of malaria parasites in El-Fayoum Governorate, Egypt using rapid diagnostic tests (RDTS). *J. Egypt. Soc. Parasitol.* **2015**, *45*, 617–628.
37. Al-Rumhi, A.; Al-Hashami, Z.; Al-Hamidhi, S.; Gadalla, A.; Naeem, R.; Ranford-Cartwright, L.; Pain, A.; Sultan, A.A.; Babiker, H.A. Influx of diverse, drug resistant and transmissible *Plasmodium falciparum* into a malaria-free setting in Qatar. *BMC Infect. Dis.* **2020**, *20*, 413.
38. Aabdien, M.; Selim, N.; Himatt, S.; Hmissi, S.; Merenkov, Z.; AlKubaisi, N.; Abdel-Rahman, M.E.; Abdelmola, A.; Khelfa, S.; Farag, E.; et al. Prevalence and trends of transfusion transmissible infections among blood donors in the State of Qatar, 2013–2017. *BMC Infect. Dis.* **2020**, *20*, 617.
39. Mokaddas, E.; Ahmad, S.; Samir, I. Secular trends in susceptibility patterns of *Mycobacterium*

tuberculosis isolates in Kuwait, 1996–2005. *Int. J. Tuberc. Lung Dis.* **2008**, *12*, 319–325.
40. Ahmad, S.; Al-Mutairi, N.M.; Mokaddas, E. Variations in the occurrence of specific *rpoB* mutations in rifampicin-resistant *Mycobacterium tuberculosis* strains isolated from patients of different ethnic groups in Kuwait. *Indian J. Med. Res.* **2012**, *135*, 756–762.
41. Al-Mutairi, N.M.; Ahmad, S.; Mokaddas, E. Molecular characterization of multidrug-resistant *Mycobacterium tuberculosis* (MDR-TB) isolates identifies local transmission of infection in Kuwait, a country with a low incidence of TB and MDR-TB. *Eur. J. Med. Res.* **2019**, *24*, 38.
42. Hira, P.R.; Behbehani, K.; Al-Kandari, S. Imported malaria in Kuwait. *Trans. R. Soc. Trop. Med. Hyg.* **1985**, *79*, 291–296.
43. Iqbal, J.; Hira, P. Imported malaria in Kuwait (1985–2007). *Int. J. Infect. Dis.* **2008**, *12*, e313.
44. Iqbal, J.; Sher, A.; Hira, P.R.; Al-Anezi, A.A. Risk of introduction of drug-resistant malaria in a non-endemic country, Kuwait: A real threat? *Med. Princ. Pract.* **2000**, *9*, 125–130.
45. Iqbal, J.; Hira, P.R.; Al-Ali, F.; Sher, A. Imported malaria in Kuwait (1985–2000). *J. Travel Med.* **2003**, *10*, 324–329.
46. Iqbal, J.; Siddique, A.; Jameel, M.; Hira, P.R. Persistent histidine-rich protein 2, parasite lactate dehydrogenase, and panmalarial antigen reactivity after clearance of *Plasmodium falciparum* monoinfection. *J. Clin. Microbiol.* **2004**, *42*, 4237–4241.
47. Coleman, M.; Al-Zahrani, M.H.; Coleman, M.; Hemingway, J.; Omar, A.; Stanton, M.C.; Thomsen, E.K.; Alsheikh, A.A.; Alhakeem, R.F.; McCall, P.J.; et al. A country on the verge of malaria elimination--the Kingdom of Saudi Arabia. *PLoS ONE* **2014**, *9*, e105980.
48. El Hassan, I.M.; Sahly, A.; Alzahrani, M.H.; Alhakeem, R.F.; Alhelal, M.; Alhogail, A.; Alsheikh, A.A.; Assiri, A.M.; ElGamri, T.B.; Faragalla, I.A.; et al. Progress toward malaria elimination in Jazan Province, Kingdom of Saudi Arabia: 2000–2014. *Malar. J.* **2015**, *14*, 444.
49. Alshahrani, A.M.; Abdelgader, T.M.; Saeed, I.; Al-Akhshami, A.; Al-Ghamdi, M.; Al-Zahrani, M.H.; El Hassan, I.; Kyalo, D.; Snow, R.W. The changing malaria landscape in Aseer region, Kingdom of Saudi Arabia: 2000–2015. *Malar J.* **2016**, *15*, 538.
50. Al Zahrani, M.H.; Omar, A.I.; Abdoon, A.M.O.; Ibrahim, A.A.; Alhogail, A.; Elmubarak, M.; Elamin, Y.E.; AlHelal, M.A.; Alshahrani, A.M.; Abdelgader, T.M.; et al. Cross-border movement, economic development and malaria elimination in the Kingdom of Saudi Arabia. *BMC Med.* **2018**, *16*, 98.
51. Bin Dajem, S.M. Molecular investigation of mixed malaria infections in southwest Saudi Arabia. *Saudi Med. J.* **2015**, *36*, 248–251.
52. Alshahrani, A.M.; Abdelgader, T.M.; Mohya, M.; Jubran, S.; Abdoon, A.; Daffalla, A.A.; Babiker, A.; Kyalo, D.; Noor, A.M.; Al-Zahrani, M.H.; et al. Risk associated with malaria infection in Tihama Qahtan, Aseer Region, Kingdom of Saudi Arabia: 2006–2007. *Malar. Control Elimin.* **2019**, *5*, 144.
53. Hawash, Y.; Ismail, K.; Alsharif, K.; Alsanie, W. Malaria prevalence in a low transmission area, Jazan District of southwestern Saudi Arabia. *Korean J. Parasitol.* **2019**, *57*, 233–242.
54. Anam, L.S.; Badi, M.M.; Assada, M.A.; Al Serouri, A.A. Evaluation of two malaria surveillance systems in Yemen using updated CDC guidelines: Lessons learned and future perspectives. *Inquiry* **2019**, *56*, 1–8.
55. Alwajeeh, T.S.; Abdul-Ghani, R.; Allam, A.F.; Farag, H.F.; Khalil, S.S.M.; Shehab, A.Y.; El-Sayad, M.H.; Alharbi, R.A.; Almalki, S.S.R.; Azazy, A.A. Uncomplicated falciparum malaria among schoolchildren in Bajil district of Hodeidah governorate, west of Yemen: Association with anaemia and underweight. *Malar. J.* **2020**, *19*, 358.
56. Al-Koleeby, Z.; El Aboudi, A.; Assada, M.; Al-Hadi, M.; Abdalr Ahman, M.; Awash, A.; Ahmed, A.S.; Mohamedi, H.; Al Jarbany, J.; Faraj, C. The Current Insecticide Resistance in Main Malaria Vector Anopheles arabiensis in Yemen. *J. Trop. Med.* **2020**, *2020*, 5625019.
57. Al-Eryani, S.M.A.; Mahdy, M.A.K.; Al-Mekhlafi, A.M.; Abdul-Ghani, R. Access to and use of long-lasting insecticidal nets and factors associated with non-use among communities in malaria-endemic areas of Al Hudaydah governorate in the Tihama region, west of Yemen. *Malar. J.* **2017**, *16*, 244.
58. Al-Ghoury, A.A.; El-Hashimi, W.K.; Abul-Hab, J. Epidemiology of malaria and predictions of retransmission in Babylon Governorate, Iraq. *East Mediterr. Health J.* **2006**, *12*, 270–279.
59. Kanani, K.A.; Amr, Z.S.; Alkhatib, R.; Shadfan, B.; Al-Rashadan, M.; Hani, R.B. A retrospective study on imported malaria in Jordan. 2. Malaria among non-military Jordanians. *Bull. Soc. Pathol. Exot.* **2015**, *108*, 126–129.
60. Yavne, Y.; Leshem, E.; Paran, Y.; Nadir, E.; Weinberger, M.; Stein, M.; Petersiel, N.; Yahav, D.; Grossman, T.; Schwartz, E. *Plasmodium malariae* in Israeli travelers: A nationwide study. *Clin. Infect. Dis.* **2017**, *65*, 1516–1522.
61. Salmanzadeh, S.; Foroutan-Rad, M.; Khademvatan, S.; Moogahi, S.; Bigdeli, S. Significant decline of malaria incidence in southwest of Iran (2001–2014). *J. Trop. Med.* **2015**, *2015*, 523767.

62. Delam, H.; Shokrpour, N.; Nikbakht, H.A.; Hassanipour, S.; Safari, K.; Bazrafshan, M.R. Changing patterns in epidemiology of malaria between 2006 and 2018 in the south of Fars Province, southern Iran: The fall and rise of malaria. *Ann. Glob. Health* **2020**, *86*, 80.
63. Beşli, Y.; Bengür, F.B.; Akyar, I.; Kurt, Ö. The investigation of malaria cases in a central laboratory in Istanbul region for a period of fifteen years. *Turk. Parazitol. Derg.* **2019**, *43*, 65–69.
64. Özkeklikçi, A.; Avcıoğlu, F. The epidemiology of malaria in Gaziantep between 2005 and 2015. *Turk. Parazitol. Derg.* **2019**, *43*, 102–105.
65. Emms, H.; Lee, R.; Thomas, A.; Doerholt, K.; Le Doare, K. Return of vivax malaria in Cyprus. *Arch. Dis. Child.* **2020**, *105*, 102–103.
66. Dahesh, S.M.; Bassiouny, H.K.; El-Masry, S.A. Malariometric parasitological survey in El-Fayoum governorate, Egypt. *J. Egypt. Soc. Parasitol.* **2009**, *39*, 213–225.
67. Bakhiet, A.M.A.; Abdelraheem, M.H.; Kheir, A.; Omer, S.; Gismelseed, L.; Abdel-Muhsin, A.A.; Naiem, A.; Al Hosni, A.; Al Dhuhli, A.; Al Rubkhi, M.; et al. Evolution of Plasmodium falciparum drug resistance genes following artemisinin combination therapy in Sudan. *Trans. R. Soc. Trop. Med. Hyg.* **2019**, *113*, 693–700.
68. Hussien, M.; Abdel Hamid, M.M.; Elamin, E.A.; Hassan, A.O.; Elaagip, A.H.; Salama, A.H.A.; Abdelraheem, M.H.; Mohamed, A.O. Antimalarial drug resistance molecular makers of Plasmodium falciparum isolates from Sudan during 2015–2017. *PLoS ONE* **2020**, *15*, e0235401.
69. Esayas, E.; Tufa, A.; Massebo, F.; Ahemed, A.; Ibrahim, I.; Dillu, D.; Bogale, E.A.; Yared, S.; Deribe, K. Malaria epidemiology and stratification of incidence in the malaria elimination setting in Harari Region, Eastern Ethiopia. *Infect. Dis. Poverty.* **2020**, *9*, 160.
70. Gebrekidan, M.G.; Gebremedhin, G.B.; Gebregiorgis, Y.S.; Gezehegn, A.A.; Weldearegay, K.T. Artemether-lumefantrin treatment adherence among uncomplicated *Plasmodium falciparum* malaria patients, visiting public health facilities in AsgedeTsimbla district, Tigray, Ethiopia: A cross-sectional study. *Antimicrob. Resist. Infect. Control.* **2020**, *9*, 184.
71. Memish, Z.A.; Alzahrani, M.; Alhakeem, R.F.; Bamgboye, E.A.; Smadi, H.N. Toward malaria eradication in Saudi Arabia: Evidence from 4-year surveillance in Makkah. *Ann. Saudi Med.* **2014**, *34*, 153–158.
72. Soliman, R.H.; Garcia-Aranda, P.; Elzagawy, S.M.; Hussein, B.E.; Mayah, W.W.; Martin Ramirez, A.; Ta-Tang, T.H.; Rubio, J.M. Imported and autochthonous malaria in West Saudi Arabia: Results from a reference hospital. *Malar. J.* **2018**, *17*, 286.
73. Amimo, F.; Lambert, B.; Magit, A.; Sacarlal, J.; Hashizume, M.; Shibuya, K. Plasmodium falciparum resistance to sulfadoxine-pyrimethamine in Africa: A systematic analysis of national trends. *BMJ Glob. Health* **2020**, *5*, e003217.
74. Tola, M.; Ajibola, O.; Idowu, E.T.; Omidiji, O.; Awolola, S.T.; Amambua-Ngwa, A. Molecular detection of drug resistant polymorphisms in Plasmodium falciparum isolates from Southwest, Nigeria. *BMC Res. Notes* **2020**, *13*, 497.
75. Jahan, F.; Khan, N.H.; Wahid, S.; Ullah, Z.; Kausar, A.; Ali, N. Malaria epidemiology and comparative reliability of diagnostic tools in Bannu; an endemic malaria focus in south of Khyber Pakhtunkhwa, Pakistan. *Pathog. Glob. Health* **2019**, *113*, 75–85.
76. Karim, A.M.; Hussain, I.; Malik, S.K.; Lee, J.H.; Cho, I.H.; Kim, Y.B.; Lee, S.H. Epidemiology and clinical burden of malaria in the war-torn area, Orakzai Agency in Pakistan. *PLoS Negl. Trop. Dis.* **2016**, *10*, e0004399.
77. Qureshi, H.; Khan, M.I.; Ambachew, H.; Pan, H.F.; Ye, D.Q. Baseline survey for malaria prevalence in Khyber Pakhtunkhwa Province, Pakistan. *East. Mediterr. Health J.* **2020**, *26*, 453–460.
78. Mosawi, S.H.; Dalimi, A.; Safi, N.; Ghaffarifar, F.; Sadraei, J. Evaluation of asymptomatic malaria status in eastern of Afghanistan using high resolution melting analysis. *Iran J. Parasitol.* **2020**, *15*, 177–186.
79. Singh, V.; Mishra, N.; Awasthi, G.; Dash, A.P.; Das, A. Why is it important to study malaria epidemiology in India? *Trends Parasitol.* **2009**, *25*, 452–457.
80. Baghbanzadeh, M.; Kumar, D.; Yavasoglu, S.I.; Manning, S.; Hanafi-Bojd, A.A.; Ghasemzadeh, H.; Sikder, I.; Kumar, D.; Murmu, N.; Haque, U. Malaria epidemics in India: Role of climatic condition and control measures. *Sci. Total Environ.* **2020**, *712*, 136368.
81. Haanshuus, C.G.; Chandy, S.; Manoharan, A.; Vivek, R.; Mathai, D.; Xena, D.; Singh, A.; Langeland, N.; Blomberg, B.; Vasanthan, G.; et al. A high malaria prevalence identified by PCR among patients with acute undifferentiated fever in India. *PLoS ONE* **2016**, *11*, e0158816.
82. Dayanand, K.K.; Kishore, P.; Chandrashekar, V.; Achur, R.N.; Ghosh, S.K.; Kakkilaya, S.B.; Kumari, S.N.; Tiwari, S.; Boloor, A.; Devi, R.; et al. Malaria severity in Mangaluru City in the southwestern coastal region of India. *Am. J. Trop. Med. Hyg.* **2019**, *100*, 275–279.
83. Punnath, K.; Dayanand, K.K.; Chandrashekar, V.N.; Achur, R.N.; Kakkilaya, S.B.; Ghosh, S.K.; Mukhi, B.; Midya, V.; Kumari, S.N.; Gowda, D.C. Clinical features and haematological parameters among malaria patients in Mangaluru

city area in the southwestern coastal region of India. *Parasitol. Res.* **2020**, *119*, 1043–1056.
84. Siwal, N.; Singh, U.S.; Dash, M.; Kar, S.; Rani, S.; Rawal, C.; Singh, R.; Anvikar, A.R.; Pande, V.; Das, A. Malaria diagnosis by PCR revealed differential distribution of mono and mixed species infections by *Plasmodium falciparum* and *P. vivax* in India. *PLoS ONE* **2018**, *13*, e0193046.
85. Gupta, B.; Gupta, P.; Sharma, A.; Singh, V.; Dash, A.P.; Das, A. High proportion of mixed-species *Plasmodium* infections in India revealed by PCR diagnostic assay. *Trop. Med. Int. Health* **2010**, *15*, 819–824.
86. Sarker, A.R.; Sultana, M. Cost-effective analysis of childhood malaria vaccination in endemic hotspots of Bangladesh. *PLoS ONE* **2020**, *15*, e0233902.
87. Hossain, M.S.; Commons, R.J.; Douglas, N.M.; Thriemer, K.; Alemayehu, B.H.; Amaratunga, C.; Anvikar, A.R.; Ashley, E.A.; Asih, P.B.S.; Carrara, V.I.; et al. The risk of *Plasmodium vivax* parasitaemia after *P. falciparum* malaria: An individual patient data meta-analysis from the WorldWide Antimalarial Resistance Network. *PLoS Med.* **2020**, *17*, e1003393.
88. Fornace, K.M.; Herman, L.S.; Abidin, T.R.; Chua, T.H.; Daim, S.; Lorenzo, P.J.; Grignard, L.; Nuin, N.A.; Ying, L.T.; Grigg, M.J.; et al. Exposure and infection to *Plasmodium knowlesi* in case study communities in Northern Sabah, Malaysia and Palawan, The Philippines. *PLoS Negl. Trop. Dis.* **2018**, *12*, e0006432.
89. Kotepui, M.; Kotepui, K.U.; De Jesus Milanez, G.; Masangkay, F.R. *Plasmodium* spp. mixed infection leading to severe malaria: A systematic review and meta-analysis. *Sci. Rep.* **2020**, *10*, 11068.
90. Bareng, A.P.; Espino, F.E.; Chaijaroenkul, W.; Na-Bangchang, K. Molecular monitoring of dihydrofolatereductase (dhfr) and dihydropteroatesynthetase (dhps) associated with sulfadoxine-pyrimethamine resistance in *Plasmodium vivax* isolates of Palawan, Philippines. *Acta Trop.* **2018**, *180*, 81–87.
91. Al-Awadhi, M.; Ahmad, S.; Iqbal, J. Current Status and the Epidemiology of Malaria in the Middle East Region and Beyond. *Microorganisms* **2021**, *9*, 338. https://doi.org/10.3390/microorganisms9020338
92. NATH A. Status of Malaria in the WHO Eastern Mediterranean Region. The Egyptian Journal of Community Medicine. **2023** Jul 1;41(3):202-6.
93. Patel P, Bagada A, Vadia N. Epidemiology and current trends in malaria. Rising Contagious Diseases: Basics, Management, and Treatments. **2024** Mar 11:261-82.
94. Sankineni S, Chauhan S, Shegokar R, Pathak Y. Global health and malaria: Past and present. InMalarial drug delivery systems: Advances in treatment of infectious diseases **2023** Mar 7 (pp. 1-16). Cham: Springer International Publishing.