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Applicability of globally used spirometric reference equations in Arabic world: a systematic review

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ABSTRACT

Background: Spirometric reference equations are essential for accurate interpretation of lung function tests. However, most globally used equations are derived from Western populations and may not reflect the physiological norms of Arab populations. *Aim*: To systematically evaluate the applicability of internationally adopted spirometric reference equations within Arab populations and to assess the availability of population-specific equations in the Arab world. *Methodology*: A systematic review was conducted using PubMed, Scopus, Google Scholar, and CORE databases for studies published up to July 2023. Studies were included if they developed, validated, or assessed spirometric reference equations in Arab populations. Out of 57 initially identified studies, 14 met the inclusion criteria. *Results*: Based on the 14 studies conducted, the majority of studies reported that predicted values for forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) in Arab populations were significantly lower than those predicted by equations derived from Western populations. This discrepancy suggests potential misclassification of respiratory diseases when non-local reference values are applied. *Conclusion*: The routine application of spirometric reference equations developed in Western populations may lead to inaccurate interpretation of lung function in Arab individuals. There is a clear need for developing standardized, population-specific reference equations that account for the ethnic and anthropometric characteristics of Arab populations to enhance diagnostic accuracy and clinical decision-making.

KEYWORDS

respiratory diseases, Arabic world, COPD, spirometry, spirometric equation

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1. INTRODUCTION

Lung diseases such as chronic obstructive pulmonary disease (COPD) and asthma are among the most prevalent and burdensome chronic conditions globally [1]. Asthma affects more than 300 million individuals worldwide, contributing to significant limitations in daily activities, reduced quality of life, and increased healthcare utilization. On the other hand, COPD is responsible for over 3 million deaths annually, ranking as the third leading cause of death globally, particularly in low and middle income countries where diagnostic resources may be limited [2,3]. Spirometry is a cornerstone of respiratory medicine, playing a vital role in the diag-

nosis, assessment, and monitoring of lung diseases such as asthma and chronic obstructive pulmonary disease (COPD) [4]. It is a simple, non-invasive test that measures the volume and flow of air that can be inhaled and exhaled. Key spirometric parameters include the forced vital capacity (FVC), the forced expiratory volume in the first second (FEV_1), and the ratio of FEV_1 to FVC (FEV_1/FVC) [5]. These values are interpreted by comparing the patient's results to population-based predicted reference values derived from large-scale epidemiological data [6]. To interpret spirometry results accurately, it is essential to use spirometric reference equations that estimate predicted normal values based on variables such as age, sex, height, and ethnicity [7]. These equations are crucial because they serve as the benchmark for determining whether lung function is within normal limits or indicative of pathology. When inappropriate reference values are used, there is a significant risk of misclassification [7]. For instance, using equations derived from a different ethnic group or population may lead to overestimation or underestimation of lung function, potentially resulting in misdiagnosis, over-treatment, or under-treatment of respiratory conditions [8]. Historically, many of the most widely used spirometric reference equations, such as those from the National Health and Nutrition Examination Survey (NHANES) III, were developed in Western populations, primarily in North America and Europe. These equations often categorize individuals by broad racial or ethnic labels, such as "Caucasian," "African American," and "Mexican American," but do not include data from populations in the Arab world [9]. The same limitation applies to the Global Lung Function Initiative (GLI) 2012 equations, which have become the international standard due to their large, multi-ethnic dataset of over 73,000 healthy, lifelong non-smoking individuals from 33 countries [10]. The GLI provides separate reference equations for Caucasians, African Americans, Southeast Asians, and Northeast Asians, but crucially, data from Arab populations were not included in the development of these equations. The lack of representation of Arab populations in these globally accepted reference equations raises concerns about their applicability in clinical and research settings across Arab countries. Several factors may explain ethnic differences in lung function observed. Genetic determinants influence lung growth, airway diameter, and chest wall compliance, all of which affect baseline pulmonary function [11]. In addition, anthropometric differences such as height, sitting height ratio, and chest circumference vary between populations and significantly affect spirometric parameters such as FEV_1 and FVC. Other exposures to the environment, including the levels of air pollutants, work-related hazards, early-life recurrent lower respiratory infection, and nutrient intake, affect lung development and function [12]. These, and also inequalities in socioeconomic status and access to health care, may be implicated in the differences in smaller calculated spirometric values achieved on Arab compared to Western-based equations [13]. Findings of such population-specific variations are essential for the correct diagnosis and disease classification, emphasizing the requirement for regionally relevant reference standards [8,12,14,15]. Therefore, applying equations derived from non-Arab populations to Arab individuals may not accurately reflect their normal pulmonary function, leading to diagnostic and management errors. For example, it has been observed in several regional studies that predicted values for FEV_1 and FVC in Arab populations are generally lower than those observed in Western populations [16,17]. As a result, using Western-based equations could falsely categorize healthy Arab individuals as having abnormally low lung function or, conversely, fail to detect genuine cases of impairment. These issues have prompted researchers in several Arab countries to develop local or population specific spirometric reference equations. However, these efforts have largely been limited to individual countries and are not yet harmonized across the region. Furthermore, it remains unclear whether the GLI or other international reference equations can be applied with appropriate accuracy in Arab populations or whether the differences are significant enough to warrant the creation of new, unified regional equations. The absence of a clear, evidence-based consensus on which reference equations should be used in Arab populations creates variability in clinical practice and undermines the standardization of care. A systematic evaluation of the existing literature is essential to determine the current state of knowledge, identify gaps, and inform the development or validation of appropriate spirometric reference standards for use in the Arab world.

This systematic review aims to evaluate the applicability of globally used spirometric reference equations in Arab populations and to determine whether there is a need for population-specific reference equations to improve diagnostic accuracy and clinical outcomes.

2. METHODOLOGY

2.1. Study design

This study is a systematic review that evaluates

the applicability of globally used spirometric reference equations in the Arabic population. The study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological transparency and reproducibility. A comprehensive literature search was conducted across multiple electronic databases to identify relevant studies assessing the performance of internationally recognized spirometric reference equations in Arabic populations. Studies were screened, assessed for eligibility, and selected based on inclusion and exclusion criteria. To provide a structured overview of the study selection process, a PRISMA flowchart (Figure 1) is included, detailing the number of studies identified, screened, included, and excluded at various stages.

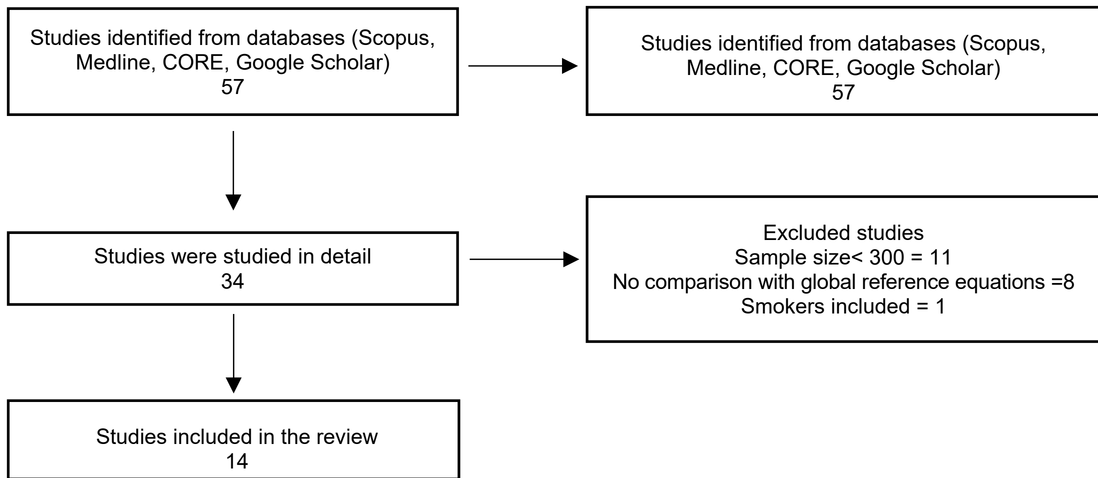

Figure 1: PRISMA Flowchart of study selection process.

2.2. Search strategy

A comprehensive literature search was conducted across four electronic databases: PubMed, Scopus, Google Scholar, and CORE. The goal was to identify studies that developed, validated, or evaluated spirometric reference equations within Arab countries or among Arab populations.

The search strategy included a combination of keywords and phrases such as: “spirometry,” “spirometric reference equations,” “forced vital capacity (FVC), expiratory volume (FEV_1),”, “lung function.” and “spirometry in Arab countries.” In addition, the names of individual Arab countries (e.g., Egypt, Saudi Arabia, Jordan, Algeria, etc.) were included to maximize retrieval of region-specific studies.

No publication date restrictions were applied. All types of studies were considered for inclusion, although emphasis was placed on cross-sectional studies, as they are the primary study design for establishing reference equations. The final search was completed in June 2023.

2.3. Inclusion criteria

All studies conducted in the Arab world that measure-FEV_1, FVC and FEV_1\FVC were eligible for inclusion if they involved healthy, non-smoking people. In addition, the studies had to include at least 300 participants [18], including a minimum of 150 women, according to the European Respiratory Society and the American Thoracic Society [19]. Selected scientific sites were searched for studies conducted in the Arab countries that examining lung function, using spirometry. Spirometric data related to FEV_1 and FVC were collected, along with information on participant numbers and ages, medical history, health status, smoking status, the spirometer used, study location, study date, and comparative equations applied.

Studies with fewer than 300 participants, or fewer than 150 participants of either sex, as well as those not following the European Respiratory Society or American Thoracic Society guidelines, were excluded from this review.

On the other hand, studies conducted outside the Arab world or that included data from outside the region were excluded. Studies with fewer than 300 participants, or fewer than 150 participants of either sex, as well as those not following the European Respiratory Society or American Thoracic Society guidelines, were excluded from this review. In addition, studies that included non-healthy people or smokers were not included.

2.4. Exclusion criteria

Studies conducted outside the Arab world or that included data from outside the region were excluded. Studies with less than 300 participants, or with fewer than 150 participants of either sex, as well as studies that did not follow the European Respiratory Society, or the American Thoracic Society were also excluded from this review. In addition, studies that included non-healthy people or smokers were excluded.

2.5. Data extraction

Data extraction was performed manually by the primary author (A.H. Alsajri) and verified by a second reviewer (W. Al-Qerem) using a structured Excel form developed specifically for this review. Any discrepancies between the two reviewers were resolved through discussion and consensus. This approach ensured the reliability and consistency of the extracted data. Extracted data included country, sample size, age range, sex distribution, spirometry parameters (e.g., FEV_1, FVC), and the reference equations evaluated (e.g., GLI-2012, ECSC, NHANES III, ATS, Caucasian, Japanese, African). When available, mean values and standard deviations for FEV_1 and FVC were recorded for each group (e.g., by sex or age). Studies reporting comparisons between local Arab population values and global reference equations were prioritized. Extracted information was later used to create comparative summary, which highlight differences in predicted values across populations and evaluate the applicability of global reference equations in different Arab countries.

3. RESULTS

3.1. Applicability of spirometric reference equation in Saudi

Several studies have been conducted in Saudi Arabia to establish a reference spirometric equation for the Saudi population and to evaluate the suitability of the equation used in Saudi Arabia for the Saudi population. One of these studies [20] was carried out at the University of Tabuk on 300 participants, half of whom were female. All participants were non-smokers and healthy, with no history of respiratory or other chronic diseases. Individuals with chronic diseases or those who had recently undergone surgeries that would preclude spirometric testing were excluded. Spirolab II was used to obtain the results of spirometry. The study followed the Guidelines of the American Thoracic Society ATS for data collection and participant examination. The findings indicated that the predicted values for most of the parameters tested were lower in adult Saudis compared to Caucasian, Japanese and African populations as shown in Table 1.

These findings clearly indicate that applying Western or international reference equations significantly overestimates expected spirometry values in the Saudi population. This suggests that international spirometric equations may not be suitable for use in Saudi population, and that is better to utilize reference equations based specifically on Saudi data. One limitation of this study is that it was conducted at a single location, Tabuk University, and focus on a small age group, university students, which may reduce its representation of the broader Saudi society. Another study conducted in Saudi Arabia [21] included more than 600 healthy and non-smokers individuals found that the measured spirometric parameters were significantly lower for Saudis compared to the predicted values obtaining when applying the American spirometric equation [22].

3.2. Applicability of spirometric reference equation in Oman

A study was conducted to establish the spirometric equation for measuring lung function parameters in Oman, one on adults and the other on adolescents and children. The first study [23] included more than 400 participants, including 163 women, all healthy, non-smokers, over 18 years old. Data for this study were collected using a portable spirometer (Compaq, Buckingham, UK) at Sultan Qaboos University Hospital. Data was collected by following the American Thoracic Society guideline ATS. This study found that most of the spirometric parameters were less than the expected values when applying the equations that are used in western countries compared to the equation derived from the same study [22,24]. In Omani males (n = 256), the observed mean FEV_1 was 3.32 L, which was 0.42 L lower than the ECSC-predicted value (3.74 L) and 0.56 L lower than the NHANES III prediction (3.88 L). Similarly, for females (n = 163), the observed FEV_1 was 2.49 L, 0.22 L lower than ECSC and 0.36 L lower than NHANES III predictions. These findings demonstrate a consistent underestimation of lung function when global reference equations are applied to the Omani population (Table 2). Another study conducted in Oman included more than 800 healthy, non-smoking students, between the ages of six to nineteen years. The data were collected by spirometry in the village of Al-Khad in the north of the Sultanate of Oman. This study found

that the predicted normal values of spirometric parameters were lower for Omani children and adolescents than their counterparts in Western society [25].

Table 1. Comparison between Saudi and global spirometry equations in Saudi population.

Sex	Age	Spirometry parameters							
		Saudi		Caucasian		Japanese		African	
		FEV_1	FVC	FEV_1	FVC	FEV_1	FVC	FEV_1	FVC
Male N=150	20.7±1.3	3.43	3.94	4.10	4.8	3.65	4.27	3.57	4.18
Female N=150	20.5±1.3	2.32	2.69	2.89	3.32	2.57	2.95	2.51	2.89

N: number of participants, Fev1: forced expiratory volume in first second, FVC: forced vital capacity

Table 2. Comparison between Omani and global spirometry equations in Oman population.

Sex	age	Spirometry parameters					
		Omani		ECSC		NHANES III	
		FEV_1	FVC	FEV_1	FVC	FEV_1	FVC
Male N=256	32.6±10.5	3.32±0.47	3.96±0.57	3.74±0.42	4.46±0.47	3.88±0.04	4.74±0.36
Female N=163	33.0±12.3	2.49±0.44	2.90±0.50	2.71±0.40	3.13±0.43	2.85±0.33	3.36±0.33

ECSC: European Coal and Steel Community, NHANES III: The Third National Health and Nutrition Examination Survey

3.3. Applicability of GLI-2012 equations in Iraq

One study was conducted in Iraq in order to find out whether the equations of the Global Lung Function Initiative (GLI-2012) are applicable and reliable for monitoring lung functions in the Iraqi community. Approximately 738 healthy, non-smoking Iraqis who did not suffer from chronic diseases participated in the study, about 46.7% of whom were female. The study found that none of the equations matched the collected data and that they are not suitable for application to the Iraqi population. Therefore, it is necessary to develop spirometric equations derived from the Iraqi society itself [26].

3.4. Applicability of different global and regional spirometric reference equations in Jordan

In Jordan, many studies have been conducted to assess the suitability of global spirometric equations for Jordanian society across all age groups. One of these studies [27] was conducted on adult Jordanians, where a spirometric examination was conducted on more than 1,800 Jordanian adults in various regions of Jordan. All participants were healthy, did not suffer from chronic diseases, and were non-smokers. A spirometric examination was performed using a MIR spirometer, following the guideline of the European Respiratory society [19].

A study conducted in 2019 [28] aimed to determine whether the spirometry reference equations that were established by the Global Lung Function Initiative (GLI) in 2012 are applicable to Jordanian adolescents between the ages of 14 and 17. Pulmonary function tests were performed on more than a thousand people, more than half of them were healthy and non-smoker males. The results of this study found that the Lung function initiative equations 2012 were not applicable to young Jordanians. It is remarkable that two additional studies were conducted on children aged three to five and from six to thirteen years, with 582 and 765 participants, respectively. The results found that it is possible to use the GLI 2012 to assess and monitor lung function in Jordanian children under the age of 13 [29,30].

3.5. Spirometric reference equation in Egypt

Many studies have been conducted in Egypt in order to establish a reference equation for examining lung function and to compare the results of the study with the Global equations used in Egypt. [31] About 600 people (49%) female, from different regions of Egypt were examined at Imbaba Chest Hospital in 2020. All participants in the study were healthy, non-smokers and did not suffer from chronic diseases. The study showed that the expected lung function values in the Egyptian community are slightly higher than normal when applying the global spirometric equations used. In Egyptian males (n = 308, mean

age 32.1 ± 8.9 years), the observed mean FEV_1 was (4.10 L), which was (0.22 L) higher than the US-predicted value (3.88 L). The observed FVC was (4.74 L), closely matching the predicted value of 4.74 L. In Egyptian females (n = 302, mean age 33.3 ± 0.49 years), the observed FEV_1 was (2.87 L), which was (0.29) L higher than the US-predicted value (2.58 L). The observed FVC was (3.51 L), which was 0.15 L higher than the predicted value (3.36 L) as shown in Table 4. The study found that the predicted lung function values in the Egyptian community are slightly higher than normal when applying the global spirometric equations used as shown in Table 4. These differences were also found in a previous study conducted in Assiut Governorate in Egypt [32]. This study emphasized the importance of establishing and adopting reference spirometric equations originating from the Egyptian community.

Table 3. comparison between Jordanian and global spirometry equations in Jordon population.

Sex	Age	Spirometry parameters					
		Jordanian		GLI Caucasian		GLI Other	
		FEV_1	FVC	FEV_1	FVC	FEV_1	FVC
Male N=846	38.5 ± 14.4	3.7±0.8	4.3±0.9	4.0±0.59	4.9±0.65	3.73±0.55	4.51±0.60
Female N=1029	37.8 ± 13.4	2.6±0.5	3.0±0.6	2.8±0.41	3.43±0.43	2.67±0.38	3.15±0.38

GLI: global lung function initiative

Table 4. comparison between Egyptian and global spirometry equations in Egypt population.

Sex	Age	Spirometry parameters			
		Cairo		US population	
		FEV_1	FVC	FEV_1	FVC
Male N=308	32.12±8.9	4.1±0.50	4.74±0.31	3.88±0.04	4.74±0.36
Female N=302	33.31±0.49	2.87±0.17	3.51±0.16	2.58±0.33	3.36±0.33

3.6. Applicability of GLI-2012 and other regional spirometric equations in Tunisia

In a study that included 489 healthy, non-smoking Tunisians adults, researchers aimed to determine whether the equations of the Global Lung Function Initiative (GLI) 2012 are applicable to lung function parameters in the Tunisian population, and whether these equations can be reliably used. A uni-directional digital volume transducer (Micro Medical Limited. PO Box 6, Rochester. Kent ME1 2AZ England) was used in the study. Data were collected in the Occupational Medicine Group in Sousse. that the equations for calculating European lung function values (GLI 2012) do not apply to the Tunisian society [33]. What supports the results of this study is a second study conducted in Tunisia, which included more than 1,000 Tunisians, whose ages ranged from 18 to 60 years. This study also concluded that the use of outdated European equations increases the probability of error during the examination and diagnosis of patients with respiratory diseases, emphasizing the need for a local spirometric equation for lung function assessments [34]. Another study conducted in 2002 in Tunisia [35] targeted children and adolescents of school age (from six to sixteen years). Approximately 1,100 participants participated in the study, half of whom were girls. This study demonstrated the possibility of relying on the equations used in America [22] and Europe [36] to measure lung function in children and adolescents.

3.7. Applicability of GLI-2012 and other regional spirometric equations in Algeria

In Algeria, studies were also conducted to find out the appropriateness of the equations of the Global Lung Function Initiative 2012. Two studies were discussed in this review. The first study included 481 healthy, non-smoking Algerian participants, whose ages ranged from 18 to 80 years, 49.5% of whom were males. The study concluded that it is possible to apply and use the equations of the Global Lung function Initiative on Algerian adults, and there is no need to create an equation for the Algerian society [37]. The second study that was discussed in this review included 300 Algerians whose lung function parameters were calculated according to the Guidelines of the American Thoracic Society. The results of the study supported the possibility of using the Global

Lung Function Initiative equations in the examination and follow-up of lung function in Algeria [38]. Table 5 summarizes the characteristics of the studies included in this review.

Table 5. Applicability of global spirometric reference equations across Arab countries: summary of systematic review findings.

Country	Sample size	Age range	Equation evaluated	Applicability	Notes
Saudi	300–600	18–30	Global/ATS	Not applicable	Lower values vs. Caucasian norms
Oman	400+ adults, 800+ children	6–19 (children), 18+(adults)	Western	Not applicable	Lower predicted values in both age groups
Iraq	738	Mixed	GLI-2012	Not applicable	No tested equations matched Iraqi population
Jordan	>3,000	3–80	GLI-2012	Partially (age dependent)	Not suitable for adults; usable in children <13
Egypt	~600	18–65	GLI-2012 Western	Slight mismatch	Slightly higher than predicted
Tunisia	489–1100+	6–60	GLI-2012 European	Partially (age dependent)	Not suitable for adults; may apply to children
Algeria	481–781	18–80	GLI-2012	**Applicable**	No need for separate equations

4. DISCUSSION

This systematic review highlights a critical and under-addressed gap in pulmonary diagnostics: the limited applicability of globally used spirometric reference equations to Arab populations. Of the 57 studies initially screened, only 14 met the inclusion criteria, indicating that research in this area remains sparse and unevenly distributed across the Arab region. Most included studies emphasized that spirometric indices such as forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) are significantly lower in Arab individuals compared to values predicted by reference equations derived from Western populations, such as the Global Lung Function Initiative (GLI) 2012 equations. This finding is consistent with similar studies conducted in non-Western populations across Asia, sub-Saharan Africa, and Latin America, where the use of Western-based equations has been shown to overestimate lung function and result in underdiagnosis of respiratory impairment. For instance, research from sub-Saharan Africa has shown that GLI equations significantly overpredict FEV_1 and FVC in African populations, a problem also observed in studies from South and Southeast Asia. The emerging consensus across these regions is that anthropometric, genetic, and environmental differences necessitate population-specific reference values.

Although studies in most countries showed that Western equations could not be applied, studies conducted in Algeria and studies conducted in Tunisia on children under 16 years old, and studies conducted in Jordan on children under 13 years showed the possibility of using these equations to diagnose pulmonary diseases and Follow-up of lung function in this age group. The results of these studies were similar to most of the studies conducted in Asia and Africa, which showed the inability to use Western equations in the examination and diagnosis of pulmonary diseases [39–41]. This difference may be due to genetic and environmental factors, as well as different eating habits between Arab and Western countries [42]. Lung function varies between ethnic groups due to the effects of genetics on airway structure, chest volume, and lung volume. Consistently, studies have established an Arab population with decreased lung function values compared to their same-height, same-age, and same-sex European counterparts, and FEV_1 and FVC were significantly lower in Arabs [43]. This is due to differences in thoracic dimensions, where Western populations tend to have longer torso lengths in relation to their height, resulting in increased lung capacity [44].

On the other hand, Middle Eastern Arabs and other populations may have various ribcage architecture and thoracic cavity dimensions, which would influence lung volume and respiratory mechanics. Certain populations, like Arabs, have been observed to have smaller airway diameters, which may lead to differences in airflow dynamics [45]. In addition, lung compliance and alveolar surface area can be influenced by genetic factors, which further complicate the relationship between height and lung capacity [46]. Although height is the primary determinant of lung volume, the proportions of the body also play a large role and vary between ethnic groups [47]. Arabs tend to have a more compact trunk-to-limb ratio compared to Europeans, which alters the height-lung volume relationship and can explain differences when Western spirometric reference equations are applied in Arabs [48]. In addition to these anatomical factors, environmental exposures in Arab countries may affect lung development. The hot, dry climate typical of many Arab countries results in increased exposure to airborne dust and pollutants. In urban areas, high levels of vehicular emissions and industrial pollution contribute to further respiratory burdens. Chronic exposure to these pollutants can impair alveolar development and lung elasticity, particularly if exposure begins during childhood [49]. Socioeconomic disparities also influence lung health. Malnutrition in early childhood, which persists in pockets of the Arab region, is associated with impaired somatic and pulmonary development [15]. Moreover, access to quality healthcare, nutritional support, and early intervention for respiratory illness varies widely between and within Arab countries. These disparities are further complicated by cultural practices such as consanguineous marriages, which may increase the prevalence of certain hereditary conditions affecting lung growth and function [50]. From a clinical perspective, continued reliance on non-local reference equations may have profound consequences. Misclassification of healthy individuals as having impaired lung function or the failure to diagnose genuine abnormalities can lead to inappropriate treatment, psychological distress, and misallocation of healthcare resources. For example, underestimating airflow limitation in a patient with early-stage chronic obstructive pulmonary disease (COPD) may delay essential intervention. Conversely, overestimating impairment could lead to unnecessary pharmacological treatment and monitoring [7,51–53]. However, the review is not without limitations. There was heterogeneity in study design, age groups, sample sizes, and statistical methods used to generate reference equations. Many excluded studies failed to meet the minimum recommended sample size of 300 healthy individuals for equation development, as recommended by international guidelines such as ATS/ERS (American Thoracic Society/European Respiratory Society). Additionally, methodological inconsistencies, including variations in equipment, technician training, and adherence to quality control protocols, limit the comparability of findings across studies. To address the limitations identified in this review and improve the accuracy of pulmonary diagnostics in Arab populations, several key recommendations are proposed. First, future studies should aim to conduct large, multi-center research across diverse Arab countries, ensuring representation of various age groups, ethnic backgrounds, and geographic regions. These studies should follow harmonized protocols aligned with international spirometry standards (e.g. ATS/ERS guidelines) to ensure methodological consistency and data comparability. Second, there is an urgent need to develop region-specific spirometric reference equations based on robust datasets from healthy Arab populations, using appropriate statistical modeling techniques such as GAMLSS. Third, Arab populations should be actively included in global initiatives such as future updates of the Global Lung Function Initiative (GLI), to enhance the inclusivity and applicability of global reference standards. Finally, future research should investigate the influence of genetic, anthropometric, and environmental variables on lung function within Arab populations to improve understanding of the underlying determinants of pulmonary differences and support the creation of more precise predictive models.

5. CONCLUSION

This systematic review demonstrates that spirometric reference equations derived from Western populations, including the widely used GLI 2012 equations, may not accurately reflect normal lung function in Arab populations. The evidence shows consistent underestimation of FEV_1 and FVC when applying these equations in most Arab countries, which may lead to misclassification and misdiagnosis of respiratory conditions. There is a clear and pressing need to establish population-specific spirometric reference equations tailored to the anthropometric and genetic characteristics of Arab populations. Future research should aim to develop unified, large-scale, multicenter studies across the Arab region to generate reliable and ethnically appropriate reference values, ensuring more accurate and equitable respiratory healthcare.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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