Influencing factors of the 6-min walk distance in adult Arab populations: a literature review.

Les facteurs influençant la distance de marche de 6 minutes des populations adultes Arabes: revue de la littérature.

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RÉSUMÉ

Introduction. Les tests de marche, en en particulier le test de marche de 6 minutes (TM6), sont couramment utilisés pour évaluer la capacité d'exercice sous-maximal. La principale donnée notée lors du TM6 est la distance de marche parcourue en 6 minutes (DM6). Plusieurs facteurs démographiques, anthropométriques et physiologiques peuvent influencer la DM6 des adultes sains.
Objectif. Le but de la présente revue de littérature est de souligner et discuter les facteurs influençant la DM6 des adultes Arabes sains.
Méthodes. Une recherche de la littérature allant de 1970 au 31 Septembre 2015 a été réalisée via PubMed, Science Direct et World Wide Web sur le moteur de recherche Google. Les articles en anglais et/ou français récupérés ont été regardés pour toutes les références supplémentaires.
Résultats. Six études, menées en Tunisie (n=2), en Arabie saoudite (n=3) et en Algérie (n=1) ont été incluses. Tous les TM6 ont été réalisés selon les directives de la société thoracique Américaine établies en 2002. En plus des données anthropométriques (sexe, âge, taille, poids, indice de masse corporelle, masse maigre), les données suivantes sont reconnues comme des facteurs influençant la DM6 des Arabes: les niveaux de scolarisation et socioéconomique, l'origine urbaine, la parité, le niveau d'activité physique, l'équivalent métabolique pour les activités modérées, les données spirométriques, la fréquence cardiaque mesurée à la fin du TM6, la pression artérielle diastolique de repos, la dyspnée et le port du niqab.
Conclusion. Les facteurs influençant la DM6 des populations adultes Arabes sont nombreux et comprennent certains facteurs prédictifs spécifiques tels que la parité, le niveau d'activité physique et le port du niqab.

Mots-clés
Arabe, Facteur influençant, Niqab, Normes, Parité, Distance de marche

SUMMARY

Background. Walk tests, especially the 6-min walk-test (6MWT), are commonly used in order to evaluate submaximal exercise capacity. The primary outcome of the 6MWT is the 6-min walk-distance (6MWD). Numerous demographic, physiological and anthropometric factors can influence the 6MWD in healthy adults.
Objective. The purpose of the present review is to highlight and discuss the 6MWD influencing factors in healthy of the healthy adult Arab populations.
Methods. It is a review including a literature search, from 1970 to September 31th 2015 using the PubMed, the Science Direct databases and the World Wide Web on Google search engine. Reference lists of retrieved English/French articles were searched for any additional references.
Results. Six studies, conducted in Tunisia (n=2), Saudi Arabia (n=3) and Algeria (n=1) were included. All studies were conducted according to the 2002-American-thoracic-society guidelines for the 6MWT. In addition to anthropometric data (sex, age, height, weight, body mass index, lean mass), the following data were recognized as 6MWD influencing factors: schooling and socioeconomic levels, urban origin, parity, physical activity score or status, metabolic equivalent task for moderate activity, spirometric data, end-walk heart-rate, resting diastolic blood pressure, dyspnoea Borg value and niqab-wearing.
Conclusion. The 6MWD influencing factors in adult Arab populations are numerous and include some specific predictors such as parity, physical activity level and niqab-wearing.

Key-words
Arab, Influencing factors, Niqab, Norms, Parity, Walk distance

Exercise tolerance is usually expressed in terms of maximal oxygen consumption measured during a cardiorespiratory test realized under optimal safety conditions and in the presence of a physician and a technician [1]. However, the cardiorespiratory test requires sophisticated equipment, and must be operated by highly qualified personnel [1]. Thus, the repeated use of such a test represents a significant financial cost and cannot be performed on a large scale [1]. These drawbacks led to resorting to more simple tests such as the 6-min walk-test (6MWT) [2-4].

The 6MWT is safer, easier to administer, better tolerated, and better reflects activities of daily living than other walk-tests [2-4]. It is also inexpensive and feasable on a large scale [2-4]. It involves measuring the distance a subject/patient can walk on a level course in 6 minutes (6MWD) [2-4]. The growing popularity of this test is due to its simplicity and to the fact that it does not require sophisticated equipment and can be easily performed by even the most severely debilitated patients [2-14]. The test has been extensively used for preoperative and postoperative assessment and for measuring the response to therapeutic interventions for respiratory and cardiac diseases [2-4]. In addition, the 6MWT can be performed by several elderly, weak, and rigorously limited patients who cannot be evaluated with standard maximal cycle ergometer or treadmill exercise tests [15]. Moreover, it independently predicts the risk of death among patients with chronic diseases [2-4, 7, 8, 12, 13, 15-17].

The interpretation of the 6MWT, which is more reflective of daily life activities than other walk-tests [2-4], relies on the comparison between measured 6MWD and the predicted value derived from norms [2, 3, 18-48]. These reference equations [2, 3, 18-48] are often based on sex and anthropometric data (eg; age, height and weight) [2-5]. The influence of race and/or ethnicity is still ambiguous [2, 30]. Numerous other physiological factors can influence the 6MWD in healthy subjects and in patients with chronic conditions, such as muscle strength, symptoms of depression, health-related quality-of-life impairment, cognitive deficit, medication use, arthritis and other musculoskeletal disorders, systemic inflammation and pulmonary function alterations [2-5]. 6MWD can also be influenced by external factors, such as the effort spent and the motivation [49]. Some other specific influencing factors were noted such as parity and socioeconomic and schooling levels (SEL, SL, respectively) [18].

While several reviews and guidelines were published concerning the 6MWT [2-5], to the best of authors' knowledge, no previous review was performed to identify the 6MWD influencing factors of Arab population. Therefore, the purpose of the present review is to highlight and discuss the 6MWD influencing factors in the Arab populations.

METHODS

The present review includes a literature search, from 1970 to September 31th 2015 using the PubMed, the Science Direct databases and the World Wide Web on Google search engine. Reference lists of retrieved English/French articles were searched for any additional references.

The included key-words were the following: "influencing factor" AND [("six minute walk distance" OR "six-minute walk distance" OR "6-minute walk distance" OR "six-min walk distance" OR "6-min walk distance" OR "six minute walking distance" OR "six-minute walking distance" OR "6MWD" OR "six-minute walk" OR "6-min walk" OR "six-min walk test" OR "six minute walk test" OR "six-minute walk test" OR "6-minute walk test" OR "6-min walk test"OR "6MWT" OR "walk test" OR "walking")] AND [("reference equation" OR "reference value" OR "standard reference")] AND (Adult) AND (Arab).

RESULTS

Six studies were included [18-23]: two of which were about Tunisian population [18, 19], three about Saudi-Arabian population [20-22] and one about Algerian population [23]. Five studies were cross-sectional [18-21, 23] and one was a case-control study [22].

Recruitment methods, samples representation and non-inclusion criteria

Table 1 displays the included six studies recruitment methods, sample representation and non-inclusion criteria.

Different recruitment methods were applied. Subjects were recruited among: visitors of hospitalized patients [19] or of university [20], hospital [18, 23] or university [20, 23] or company [20] workers and/or employees, of medical school students' parents [18, 23] and public school teachers or students [20]. El-Sobkey et al. [21, 22] have opted for a verbal request and/or an invitation from the community [21] or local campus [22]. In the Algerian study [23], subjects aged 16-18 years were Hospital and Medical School workers' offspring.

All included samples were convenience ones. In the study of Masmoudi et al. [19], 55% and 44% of included subjects were, respectively, urban and illiterate. Percentages of subjects with low physical activity score or level were 82% in Ben Saad et al. study [18], 80% in Alameri et al. study [20], 51% in El-Sobkey study [21] and 26.5% in Bourahli et al. study [23]. Twenty four percent and 64% of included subjects in the studies of Ben Saad et al. [18] and of El-Sobkey [21] have, respectively, moderate obesity and inacceptable weight. In the study of Bourahli et al. [23] only 5% and 4.5% of subjects have, respectively, moderate obesity and underweight. In

Alameri et al. study [20], a non-neglected percentage of overweight subjects were included. In one study [18], 43% and 36% of included subjects have low SL and SEL, respectively. In the case-control study of El-Sobkey et al. [22] 50% of included women were niqab-wearing. Since, the Algerian study [23] was performed in the region of Constantine (649 m above sea level) the factor of altitude should be taken into account when comparing between study data.
Several non-inclusion criteria were applied. Only three studies [18, 20, 23] have looked for the 6MWT contraindications [4] (unstable angina or myocardial infarction during the previous month; resting heart-rate (Hr) ≥ 120 bpm, resting systolic or diastolic blood pressures, respectively ≥ 180 mmHg and ≥ 100 mmHg). Other non-inclusion criteria were applied: active lifestyle [19, 22], smoking [18-20, 22, 23], chronic or acute disorders [18-21, 23], recent upper-respiratory tract infections [20], thoracic or abdominal surgery [20, 23], orthopedic disease interfering with walking [18, 20, 23], chronic medication use [18, 22, 23], body-mass-index (BMI) < 18.5 kg/m² [18, 22] or > 35 kg/m² [18, 20, 22, 23], ventilator-obstructive-defect [18, 20, 23], tendency to a restrictive-ventilatory-defect [23], previous experience of 6MWT [18, 23], inability to perform the 6MWT exactly [18, 23], resting oxy-hemoglobin saturation (oxy-sat) ≤ 92% [18, 23], end-walk dyspnoea > 5/10 (visual-analogue-scale) [18, 23] and walking induced desaturation [18, 23].

6MWT applied protocols

Table 2 displays some characteristics of the 6MWT-applied protocols in the included six studies. In the two studies carried out by El-Sobkey et al. [21, 22], no information was given about either the number of performed 6MWT or the corridor length. One study has performed only one test [20] and three studies [18, 19, 23] have performed two 6MWT with 30 [18, 19] or 20-45 [23] minutes rest between tests. The corridor length is in three studies [19, 20, 23] and in another one [18]. The six studies have applied the American-thoracic-society (ATS-2002) guidelines [4]. In the studies of El-Sobkey et al. [21, 22], no information was given about either the given encouragement or the time of test or the ambient temperature. Standared phrases of encouragement were given in two studies [19, 23], and no encouragement was given in two others [18, 20]. 6MWTs were performed in the morning in three studies [18, 20, 23] and in the afternoon in one study [19]. Ambient temperature is mentioned only in three studies [18, 20, 23].
Table 3 displays the six studies sample sizes and age and 6MWD data of the included subjects. The sample sizes varied from 40 [22] to 359 [21] subjects. Included subjects were aged from 16 [20, 23] to 85 [18] years. The 6MWD (m) varied from 410±52 [20] to 680±70 [23] for the total sample and from 371±63 [22] to 634±49 m [23] and from 430±47 [20] to 726±55 [23], respectively, for women and for men. The 6MWD divergence reflects disparities in how 6MWT protocol was conducted (corridor length, encouragement, motivation aspects', etc.), applied non-inclusion criteria, sample sizes, different characteristics of recruited subjects (Tables 1 and 2). Subjects' submaximal effort could also be considered as a possibility [23].

Influencing factors

Table 4 displays the 6MWD influencing factor of adult Arab populations. The following anthropometric influencing factor were reported in the six included studies: sex [18-21, 23], age [18-20, 23], height [19, 20, 23], weight [20], BMI [18-20, 23] and lean-mass [23]. Some other influencing factors were also noted: SL [18, 19], SEL [18], urban origin [19], parity [18], physical activity score or status [18, 21, 22], metabolic-equivalent-task (MET) moderate activity [23], some spirometric data [18, 23], end-walk Hr [20], resting diastolic-blood-pressure [23], dyspnoea Borg value [20], niqab-wearing (yes/no) and niqab wearing time [22].

DISCUSSION

The six studies included in the present review show that the 6MWD performed by adult Arab population is influenced by anthropometric data (sex, age, height, weight, BMI and lean-mass), schooling and socioeconomic levels, urban origin, parity, physical activity score or status, some spirometric data, end-walk heart-rate, resting diastolic-blood-pressure, dyspnoea Borg value and niqab-wearing.
Information about factors influencing the 6MWD in healthy subjects of a wide age range have been published [2-5, 18-48, 50]. Anthropometric data [sex, age, height, weight, BMI and lean-mass] explain from 20% to 78% of 6MWD variability.

Anthropometric data effects

Sex effect. Sex is a consistent factor that has been described in several studies [2-5]. In general, men have a higher 6MWD than women (Tables 3 and 4). One plausible explanation is that muscle mass and therefore maximum leg-muscle force is lower in women than in men [18].

Age effect. In adults, age has a significant influence on the 6MWD: the 6MWD declines with ageing (Table 4). The 6MWD decline with age could be explained by the gradual reduction of muscle mass, strength and endurance (thus, defining sarcopenia), responsible of inactivity in elderly people [51-53]. Indeed, in subjects above 40 years of age, muscle mass decreases by an average of 5% per decade [54]. Other explanation of the 6MWD decline with age could be the prevalence increase of debilitating pathologies due to ageing [40, 55, 56].

Height effect. The significant effect of height on the 6MWD was attributed to a longer stride in taller individuals

Table 1 : Recruitment methods, samples representation and non-inclusion criteria of the included six studies.

.Recruitment methods **.Samples representation**	**.Applied non-inclusion criteria**
Masmoudi et al.[19] (Yr: 2008)	
.Visitors of hospitalized patients .Subjects from all Tunisia .Urban: 55% .Illiterate: 44%	.Chronic or acute disorders .Smoking .Active lifestyle
Ben Saad et al. [18] (Yr: 2009)	
.Hospital workers .Parents of medical school students .Low physical activity score: 82% .Low schooling level: 43% .Low socioeconomic level: 36% .Moderate obesity: 24%	.Usual 6MWT contraindications [4]* .Current smoking .Symptoms of or confirmed cardiopulmonary disease: heart failure, arrhythmia, major ECG abnormalities, lower limb arteritis, dyspnoea ≥ stage 2, chronic cough, COPD, emphysema, asthma, wheezing, interstitial fibrosis, pulmonary tuberculosis, cerebrovascular accident .Diabetes .Thoracic or abdominal surgery .Orthopedic disease interfering with walking .Mental disease .BMI < 18.5 or > 35 kg/m2 .Chronic medication use (corticoids, diuretics, adrenergic beta-antagonists) .Inability to perform the 6MWT exactly .Ventilatory-obstructive-defect .Resting oxy-sat ≤ 92% .End walk dyspnoea > 5/10 .Walking induced desaturation (oxy-sat fall > 5 points) .Previous experience of 6MWT
Alameri et al. [20] (Yr: 2009)	
.Public school teachers or students .Workers and visitors of university .Employees of a company .Low physical activity score: 80% .Non neglected % of overweight	.Cardiovascular or pulmonary disease .Current or past histories of smoking .Upper respiratory tract infections/last 4 weeks .Conditions affecting walking .Resting systolic-blood-pressure > 140 mmHg .Resting diastolic-blood-pressure > 90 mmHg .Resting heart-rate > 100 bpm .BMI > 35 kg/m2 .FEV1< 80% and FEV1/FVC< 0.70
El-Sobkey [21] (Yr: 2013)	
.Verbal request/community .Acceptable weight: 36% .Low physical activity level: 51%	.Acute or diagnosed pathologies
El-Sobkey et al. [22] (Yr: 2014)	
.Verbal invitation .Bulletin board announcement/local campus .Niqab-wearing: 50%	.Smoking .Abnormal weight .Medications use affecting 6MWT data .Regular exercise programs or sport activities beyond normal daily activities .Cognitive problem affecting implementing and following the instructions for the 6MWT
Bourahli et al. [23] (Yr: 2016)	
.Hospital and medical school workers and/or students. .Adolescents aged 16-18 Yrs: offspring of hospital and medical school workers .Moderate obesity: 5% .Underweight: 4.5% .Low physical activity level: 26.5% .Moderate physical activity level: 46.5%. .High physical activity level: 27% .Constantine: 649 m above sea level	.Age < 16 or > 40 Yrs .Usual 6MWT contraindications [4]* .Current or ex-smokers .Symptoms of- or confirmed cardiopulmonary disease: heart-failure or arrhythmia, major electrocardiogram abnormalities, lower limb arteritis, dyspnoea (modified medical research council scale) > stage 2, chronic cough, COPD, emphysema, asthma, wheezing, interstitial fibrosis, pulmonary tuberculosis, cerebrovascular accident] .Diabetes .Thoracic or abdominal surgery .Orthopaedic disease interfering with walking .Mental disease .Marked and extreme obesity (BMI > 35 kg/m2) .Chronic medication use (corticoids, diuretics, adrenergic β-antagonists) .Incapability to perform exactly the 6MWT .Ventilatory-obstructive-defect .Tendency to a restrictive-ventilatory-defect .Resting oxy-sat < 92% .End walk dyspnoea >5/10 .Walking induced desaturation (oxy-sat fall > 5 points)

6MWT: 6-min walk-test. BMI: body-mass-index. COPD: chronic-obstructive-pulmonary-disease. FEV1: 1st-second-expiratory-volume. FVC: forced-vital-capacity. Oxy-sat: oxy-hemoglobin saturation. *6MWT contraindications: unstable angina or myocardial infarction during the preceding month; resting heart-rate > 120 bpm, resting systolic or diastolic blood pressures (mmHg), respectively, >180 and >100.

[40]. The stride length is one of the foremost determinants of gait velocity [57].

Obesity (weight and BMI) effect. Obesity raises the workload for a given exercise intensity, reducing the 6MWD [58]. In Ben Saad et al. [18] and Bourahli et al. [23] studies, when the BMI of included healthy subjects' increases by one unit, their 6MWD decreases, respectively, by six and 10 m.

Lean-mass effect. The Algerian study [23] reports a slight but significant contribution to the lean-mass in the total sample 6MWD variability: a one kg lean mass increase leads to a 1.6 m increase in 6MWD. This confirms that lean-mass is a predictor of exercise capacity in healthy subjects [59].
Moreover, an elevated quantity of lean-mass proved to have a foremost impact on 6MWD [25]. In the same way, a heavier subject would require supplementary energy while walking to maintain an inflated weight and thus restraining the maximal intensity of effective effort [33]. However, 6MWD was comparable in chronic-obstructive-pulmonary-disease (COPD) patients with and without lean-mass decrease, signifying that skeletal muscle has a partial impact on 6MWD [60].

Other 6MWD influencing factors

In addition to anthropometric data, other data were considered as 6MWD influential factors. Nevertheless, the relationships between 6MWD and some potential factors [physical activity levels, resting spirometric data or blood pressure, SL, SEL, niqab-wearing, urban origin, end-walk Hr, end-walk dyspnoea Borg value] are rarely evaluated [2-5, 18-48, 50]. In addition, the relationship between 6MWD and parity, a particular factor in developing nations (Europe and North America [61], North Africa [62]); was evaluated only in one study [18].

SL, SEL and urban origin effects. SL, which is defined according to education level [low (illiterate, primary education) and high (secondary and university education)] was found to slightly but significantly contribute to the 6MWD variability [18]: it justified an additional 2.2% of the 6MWD variance [18]. In Masmoudi et al. study [19], it was noted that the "higher the SL was, the longer the 6MWD". In an American study [56], high SL was a non-significant independent predictor of 6MWD. SEL, defined according to occupational status [low (eg; unskilled worker, jobless) and high (eg; skilled worker, farmer, manager) [63]], was found to slightly but significantly contribute to the 6MWD variability [18]: it explained an additional 0.2-1.5% of the 6MWD variance. In Masmoudi et al. study [19], compared to rural subjects, urban ones proved to have a significantly higher 6MWD. SL and SEL and urban origin should be taken into consideration when interpreting the 6MWD of patients/subjects suffering from a precarious situation.

Parity effect. Significant negative univariate linear correlation was found between Tunisian women 6MWDs and parity [18]. Moreover, parity appeared to be a negative independent variable included in the Tunisian forward linear stepwise multiple regression models for 6MWD. Data analysis of the two parity subgroups of women aged 45-59 years who differed only in parity found that the 6MWD was significantly lower in the high parity (> 6, n=38) vs. low parity (£ 5, n=38) groups (589±60 vs. 555±; respectively). These results may be clinically relevant when interpreting 6MWD in women with chronic diseases. As parity was not entered into their final norms [18] and as the 6MWD was lower by ~35 m in women with high parity, the authors [18] suggest solving this problem by subtracting from the lower-limit-of-normal of Tunisian women. The decline of the 6MWD with parity increase may reflect general findings about aging and parity effects on health [64-68]. Several hypotheses have been previously advanced: hormonal alterations, biochemical modifications and impaired respiratory muscle [18]. The medical literature provides very little information on the influence of parity on exercise tolerance. However, the effects of repeated gestations on 6MWD should now be taken into account. Two recent studies showed that high parity is associated with lower 6MWD in patients with type 2 diabetes-mellitus [8] or with severe obstructive-sleep-apnea-hypopnea-syndrome [17]. This may be a promising new direction towards physiological and pathophysiological research, particularly in developing countries.

Physical activity status effect. In four studies, physical activity was significantly correlated with 6MWD [18, 21-23]. In a sedentary healthy population (82% were sedentary) [18], physical activity score [69] was found to slightly but significantly contribute to the 6MWD variability: it explained an additional 1.1 to 4.4% of the 6MWD variance. In the Algerian study [23], the 6MWD value was 36 m lower in non-active adults (n=146) when compared to active ones (n=54). In addition, the MET moderate activity [70] explained an additional 0.3 to 2.6% of the 6MWD variance. In another study [21], where physical activity status was calculated using the last 7-days international physical activity questionnaire [70], in all age groups, significant increase in 6MWD from low, moderate, to high physical activity level was found. In addition, physical activity level was a predictor factor for 6MWD of Saudi healthy subjects [21]. Similar data were found by the same authors in another case-control study [22]. According to Alameri et al. [20], differences in the reported 6MWD of Saudis and other populations may stem from higher rates of physical inactivity rather than anthropometric characteristics. In fact, there is a high

Table 2 : Some characteristics of the 6MWT-applied protocols in the included six studies.

.Number of performed 6MWT .Interval between tests .Corridor length	.6MWT instructions	.Encouragement .Time of test .Temperature
Masmoudi et al. [19] (Yr: 2008)		
.2 tests .30 min .30 m	.ATS instructions [4] .Sat in a chair located near the starting position for at least 10 min before the test started .Wear comfortable shoes	.Standard phrases of encouragement .2 pm to 4 pm .NR
Ben Saad et al. [18] (Yr: 2009)		
.2 tests .30 min .40 m	.ATS instructions [4] .Avoid vigorous exercise in the 2 h prior to testing. .Wear comfortable clothes and appropriate walking shoes .Sat in a chair located near the starting position for at least 10 min before the test started	.No encouragement .8 am to 12 noon .Temperature: 16-20 °C.
Alameri et al. [20] (Yr: 2009)		
.1 test .30 m .NR	.ATS instructions [4]. .Eat a light morning meal .Wear comfortable clothes and shoes	.No encouragement .9 am to 1 pm .Temperature: 16-20 °C.
El-Sobkey [21] (Yr: 2013)		
.NR .NR .NR	.ATS instructions [4]	.NR .NR .NR
El-Sobkey et al. [22] (Yr: 2014)		
.NR .NR .NR	.ATS instructions [4]	.NR .NR .NR
Bourahli et al. [23] (Yr: 2016)		
.2 tests .20-45 min .30 m	.ATS instructions [4] .Avoid forceful exercise in the 2 h prior to testing .Wear comfortable clothes and suitable walking shoes .Sat in a chair located near the starting position for at least 10 min before the test started	.Homogeneous encouragement in the form of statements such as "you're doing well," and "do your best." .8 am to 12 noon .Temperature: 15-21 °C

ATS: American-thoracic-society. 6MWT: 6-min walk-test. NR: not-reported.

prevalence of physical inactivity among Saudis, particularly those who are middle-aged [71, 72]: up to 80% adult Saudi males are inactive, which exceeds values reported for other Westernized countries [73]. Decreased physical activity (ie; inactivity) usually leads to altered muscle metabolism, decreases in muscle mass and lower physical capacity [74]. This relation is more obvious among patients with co-morbid conditions, in which the rate of inactivity correlates significantly with 6MWD [8, 75].

Resting spirometric effect. The better the resting spirometric data were, the greater the 6MWD [18, 23, 37]. Earlier researchers used the 6MWD as a measure of the COPD severity and an outcome measure in COPD treatment [76, 77]. Camarri et al. [37] were the first to report a significant correlation between 6MWD and 1st-second-forced-expiratory-volume (FEV_1) in healthy subjects: FEV_1 was a significant independent predictor and explained an additional 4.5% of the 6MWD variance. Ben Saad et al. [18] and Bourahli et al. [23] found FEV_1 to be the first independent variable included in the 6MWD norms: alone it explains 55% and 50% of the Tunisian [18] and Algerian [23] 6MWD total samples variabilities. Significant correlations were also observed between 6MWD and FEV_1 [26, 42] or forced-vital-capacity (FVC) [26]. In community-dwelling elderly women [37], lower FEV_1 was a strong independent predictor of a lower 6MWD. In practice, spirometric data are not as easily assessed, as anthropometric ones, since spirometers are necessary to quantify pulmonary function.

End-walk dyspnoea Borg value effect. In the study of Alameri et al. [20] dyspnoea Borg value was negatively correlated with 6MWD. Dyspnoea may be an important determinant of the 6MWD in patients with chronic respiratory disease [78-81], which reflects both the physiology of exercise limitation [82, 83] and the impact of exercise limitation on daily life [84].

End-walk Hr effect. In the study of Alameri et al. [20] end-walk Hr value was negatively correlated with 6MWD. Some other studies have reported that end-walk Hr expressed as a percentage of the predicted maximum Hr

Table 3 : Sample sizes, age and 6MWD data of the subjects included in the included six studies.

.Total number .Women/Men		.Age (Yr)	.6MWD (m) .Total sample	.6MWD (m) .Women	.6MWD (m) .Men
	Masmoudi et al. [19] (Yr: 2008)				
.155 .75/80		.55±11a .40-79b	.509±83a	.498±74a	.586±82a
	Ben Saad et al. [18] (Yr: 2009)				
.229 .125/104		.40-85b	.624±111a .345-893b	.551±75a	.711±81a
	Alameri et al. [20] (Yr: 2009)				
.238 .127/111		.16-50b	.410±52a	.386±46a	.430±47a
	El-Sobkey [21] (Yr: 2013)				
.359 .253/106		.31+14a .18-71b	.481±107a	.471±103a	.503±114a
	El-Sobkey et al. [22] (Yr: 2014)				
.40 .40/0		.23±3a .20-30b	.NA	.Niqab-wearing: 510±82a .Not niqab-wearing: 371±63a	.NA
	Bourahli et al. [23] (Yr: 2016)				
.200 .100/100		.28±7a .16-40b	.680±70a .540-888b	.634±49a	.726±55a

6MWD: 6-min walk-distance. NA: not-applied. aData are mean±standard-deviation. bData are minimum-maximum.

(%Hrend) [20] or the difference between resting and end-walk Hrs (∆Hr) [25] were significantly correlated with 6MWD measured in healthy subjects. The result observed by Alameri et al. [20] was similar to other results observed in other populations [25, 42, 43], with significant correlations between the 6MWD and ∆Hr [25] or %Hrend [42, 43]. Though the interference of Hr in the 6MWD has been recommended and considered essential [20, 24, 25, 42, 43], only some studies [25, 42, 43] have considered these variables in their 6MWD reference equations. Poh et al. [43] consider the %Hrend in the equation as well as age, height, and weight and elucidated 78% of the 6MWD variability. Jenkins et al. [42] also included the %Hrend in the final equations as well as age, height and BMI and explained 0.58 and 0.61 of the Australian women and men 6MWD's variability. Britto et al. [25] considered the ∆Hr in the equation as well as age, sex and height and explained 0.62 of the Brazilian 6MWD's variability. The use of Hr data as a parameter included in the reference equation is controversial. The application of the %Hrend in the equation may be restricted when measuring the 6MWD in individuals with low fitness levels or with cardiac diseases or medications which have an impact on predicted maximum Hr or when signs such as dyspnoea or musculoskeletal pain limit test performance [42, 43]. However, according to Britto et al. [25] the ∆Hr use could in part neutralize this limitation. This may occur since these diseases and medications interfere not only in the end-walk Hr but also in the resting Hr, and thus their influence on the ∆Hr may be compensated and decreased [23, 25].

Resting diastolic-blood-pressure. In the Algerian study [23], although a resting diastolic-blood-pressure ≥ 100 mmHg was applied as a non-inclusion criteria, its values were negatively correlated with 6MWD in men and women, but not in the total sample (Table 4). The increase of the diastolic-blood-pressure by 10 mmHg decreases the 6MWD by 6.1 m and 6.2 m, respectively, in women and men [23]. To the best of authors' knowledge, among all studies aiming at establishing 6MWD norms in "healthy" adult subjects [2, 3, 18-48], the Algerian one was the first to report such findings. In patients with chronic respiratory conditions, such as obstructive-sleep-apnoea, arterial-hypertension was related to shorter 6MWD [17, 85]. Specific studies evaluating the relatioship between blood-pressures and 6MWD in patients with solely arterial-hypertenion are recommended.

Niqab-wearing effect. Only one study [22] looked for the effect of the niqab-wearing on the 6MWD. The authors investigated the effect of physical activity on a 6MWD among young adult niqab-wearing healthy Saudi women [22]. Women in the niqab-wearing group had a significantly longer 6MWD (n=20; mean±SD=510±82 m), than those in the niqab-nonwearing group (n=20; mean±SD= 371±63 m). Does this mean that submaximal exercise capacity for niqab-wearing women is better than the one of those who do not wear the niqab? Surprisingly, according to El-Sobkey et al. [22], the answer is "yes". More surprisingly, according to these authors [22], their result was rational because the niqab-wearing women were found to be physically more active than those who did not wear the niqab. The variation in the physical activity level between the two study groups was explained by the longer duration of walking practiced by the niqab-wearing group than by the niqab-nonwearing one [22]. The "positive" effect of niqab-wearing on 6MWD should be considered with a lot of doubt, since a previous study

Table 4 : 6MWD influencing factor of adults Arab populations

Sex	Age			Anthropometric data: Height			Weight			BMI			Other factors
	W	M	TS	W	M	TS	W	M	TS	W	M	TS	
Masmoudi et al. [19] (Yr: 2008)													
Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	no	Yes	.Schooling-level .Urban origin
Ben Saad et al. [18] (Yr: 2009)													
Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	Yes	.Parity .Schooling-level (W) .Socioeconomic-level (W and TS) .Physical activity score (W and TS) .FEV1 (W and TS)
Alameri et al. [20] (Yr: 2009)													
Yes	NR	NR	Yes	NR	NR	Yes	NR	NR	Yes	Yes	NR	NR	.End-walk heart-rate .End-walk dyspnoea Borg value
El-Sobkey [21] (Year: 2013)													
Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	.Physical activity
El-Sobkey et al. [22] (Yr: 2014)													
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	.Physical activity level .Niqab-wearing time (min/week) .Niqab-wearing (yes/no)
Bourahli et al. [23] (Yr: 2016)													
Yes	Yes	No	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	.FEV1 (W, M and TS) .Resting diastolic-blood-pressure (W and M) .MET moderate activity (M and TS) .Lean-mass (M and TS)

BMI: body-mass-index. FEV1: 1st-second-expiratory-volume. M: men. MET: metabolic-equivalent-task. NA: not-applied. NR: not-reported. TS: total sample. W: women. 6MWT: 6-min walk-test.

showed mean values of spirometry data including FVC, FEV1, FEV1/FVC ratio and the maximum-voluntary-ventilation for niqab-wearing women significantly lower than the values for niqab-nonwearing ones [86]. As the respiratory system has a vital role in determining a person's functional exercise capacity [87, 88] and as there is a significant reduction of ventilatory function with niqab-wearing [86], the functional exercise capacity of Saudi women wearing niqab should be altered.

Study limitation. The main limitation of the present review concerns the search for the "Arab world" in PubMed. PubMed has two challenges for those seeking literature on "Arab world" public health: as PubMed is mainly biomedical, there is no separate group for public health and there is no exact group for "Arab world" or "Arab countries". To confront the above difficulties, some authors [89] proposed a special strategy to capture literature focusing on public health in the region. The component of the search related to the 'Arab world' should include the combination of the following "Medical Subject Headings, MeSH" or "Title/Abstract, tiab" terms: «arabs» [MeSH] OR arab* [tiab] OR «middle east*»[tiab] OR «africa, northern»[MeSH] OR «north* Africa*»[tiab] OR «lebanon»[MeSH] OR leban*[tiab] OR syria*[tiab] OR iraq*[tiab] OR saud*[tiab] OR palestin*[tiab] OR gaza[tiab] OR «jordan»[MeSH] OR jordan*[tiab] OR bahrain*[tiab] OR egypt*[tiab] OR libya*[tiab] OR tunisia*/algeria*[tiab] OR yemen*/aden*[tiab] OR kuwait*[tiab] OR oman*[tiab] OR qatar*[tiab] OR «egypt»[MeSH] OR «morocco»[MeSH] OR sudan*[tiab] OR west-bank[tiab]. The use of the above-proposed terms does not modify the results of the present review.

Perspectives. Several other physiological factors can influence the 6MWD in healthy individuals and in patients with chronic conditions and thus, should be evaluated in future studies involving Arab populations. Among them some special factors should be highlighted, such as muscle strength, symptoms of depression, health-related quality-of-life impairment, cognitive deficit, medication use, arthritis and other musculoskeletal disorders, systemic inflammation and pulmonary function alterations [2-5]. Moreover, 6MWD can also be influenced by external factors, such as the effort spent and the motivation [49].

In conclusion, the 6MWD influencing factors in adult Arab populations are numerous and include some specific predictors such as parity, physical activity level and niqab-wearing.

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