Normes pour la distance de marche de 6 minutes des populations adultes arabes: revue de la littérature.

6-min walk-distance norms in adults Arab populations: a literature review

Monia Daami [1], Imed Latiri [2], Sonia Rouatbi [2], Raoudha Sfaxi[3], Helmi Ben Saad [4]

1-Hopital ksar hellal / faculté de médecine de sousse
2-Laboratoire de Physiologie / Faculté de Médecine de Sousse
3-Groupement de Santé de Base / Faculté de Médecine de Sousse
4-Research Laboratory N° LR14ES05: interactions of the cardiopulmonary system. / Faculté de Médecine de Sousse

RÉSUMÉ

Introduction : La principale variable déterminée lors du test de marche de 6-min est la distance parcourue pendant 6 minutes (DM6). Sa base d'interprétation repose sur la comparaison de la distance mesurée avec celle prédite à partir des normes publiées.

Objectif. Le but de la présente revue de la littérature est de rapporter les normes de la DM6 disponibles pour les populations Arabes comportant des adultes sains.

Méthodes. Une recherche de la littérature allant de 1970 au 5 Janvier 2017 a été réalisée via PubMed. Les articles en anglais et/ou français récupérés ont été regardés pour toutes les références supplémentaires. La recherche a comporté la combinaison des termes suivants: «marche» ET «valeurs de référence» ET «Arabe».

Résultats. Cinq études, menées en Arabie saoudite (n=2), en Tunisie (n=2) et en Algérie (n=1) ont été incluses. Les variables dépendantes suivantes ont été introduites dans les normes: âge (ans), taille (cm), poids (kg), indice de masse corporelle (IMC, kg/m2), sexe (0:femme; 1:homme) et le niveau d'activité physique. Cinq équations de référence ont été proposées pour les Tunisiens âgés de 40 à 79 ans [DM6 (m) = 299,8 – 4,34xAge + 3,43xTaille – 1,46xPoids + 62,5xSexe] ou âgés de 40 à 85 ans [DM6 (m) = 720,50 + 160,27xSexe – 5,14xAge – 2,23xPoids + 2,72xTaille], pour les Saoudiens âgés de 16 à 50 ans [DM6 (m) = - 28,5 + 2,81xTaille + 0.79xAge] ou âgés de 18 à 71 ans [DM6 (m) = 342,650 + 74,31xNiveau d'activité physique + 33,88xSexe – 4,25xAge] et pour les Algériens âgés de 16 à 40 ans [DM6 (m) = 800,05 + 64,71xSexe – 10,23xIMC – 1,63xAge + 2,05xPoids]. Ces normes expliquent entre 25% et 77% de la variabilité de la DM6.

Conclusion. Peu de normes de la DM6 existent pour les populations Arabes comportant des adultes sains. D'autres normes sont souhaitables.

Mots-clés
Distance de marche; Arabe ; Normes; Equation de référence, Interprétation

SUMMARY

Introduction. The primary outcome of the 6-min walk-test is the 6-min walk-distance (6MWD). Its interpretation relies upon the comparison of the measured 6MWD with the predicted one from published norms.

Objective. The aim of the present review is to report the 6MWD norms published for healthy adults Arab populations.

Methods. The review includes a literature search, from 1970 to January 5th 2017 using the PubMed search engine. Reference equations lists of retrieved English/French articles were searched for any supplementary references. The research includes the combination of the following (or their synonyms) "Medical Subject Headings" or "Title/Abstract" terms: «walking» AND «reference values» AND «Arabs».

Results. Five studies, conducted in Saudi-Arabia (n=2), Tunisia (n=2) and Algeria (n=1) were included. Norms comprised the following factors: age (Yrs), height (cm), weight (kg), body mass index (BMI, kg/m2), sex (0:women; 1:men) and physical activity level. Five norms were proposed for Tunisian aged 40-79 years [6MWD (m) = 299.8 - 4.34xAge + 3.43xHeight - 1.46xWeight + 62.5xSex] or aged 40-85 years [6MWD (m) = 720.50 + 160.27xSex - 5.14xAge - 2.23xWeight + 2.72xHeight], for Saudi-Arabian aged 16-50 years [6MWD (m) = - 28.5 + 2.81xHeight + 0.79xAge] or aged 18-71 years [6MWD (m) = 342.650 + 74.31xPhysical activity level + 33.88xSex - 4.25xAge] and for Algerian aged 16-40 years [6MWD (m) = 800.05 + 64.71xSex - 10.23xBMI - 1.63xAge + 2.05xWeight]. These norms explained 25% to 77% of the 6MWD variability.

Conclusion. Fewer 6MWD norms exist for adults' Arab population. Other norms are welcome.

Key-words
6-min walk distance; Arab; Norms; Reference equation; Reference values; Interpretation

The 6-min walk-test (6MWT) has been extensively used to assess functional exercise performance across various adults' subject populations [1-50]. It involves measuring the distance a subject can walk on a level course in 6 minutes (6MWD) [1-4].

The interpretation of the 6MWT relies on the comparison between measured 6MWD and the predicted value derived from norms [51-91]. Since, norms are essential to guide the diagnostic and prognostic use of the 6MWT and because the success in medical decision-making depends as much on selecting and properly using norms and their limits, international scholarly societies [especially the American thoracic and/or the European respiratory societies (ATS/ERS) [1-3]] encourage investigators to publish 6MWD norms for healthy persons using the 6MWT guidelines. In fact, 6MWD norms generated and verified in a local population should be applied where possible [1-4].

While several papers (original research, reviews and guidelines) were published concerning the 6MWT procedures [1-4] and norms [49-91], to the best of the authors' knowledge, only one recent narrative review [92] has highlighted and discussed the 6MWD influencing factors of the healthy adult Arab populations and no previous review was performed to report their 6MWD norms. The incorrect selection of a 6MWD norm can result in potential errors associated to the interpretation of the level of physical fitness and the progress of the 6MWD following interventions in subjects with chronic conditions [49]. Consequently, the deeper awareness of the circumstances under which norms were obtained is essential. Therefore, the objective of this narrative literature review was to report the studies that have created reference equations to predict the 6MWD in healthy adults Arab populations.

METHODS

A part of the methods applied in the present review was previously published in a previous narrative review aiming to establish the 6MWD influencing factor for the adults' Arab population [92].

In brief, the present review includes a literature search, from 1970 to January 5th 2017 using the PubMed search engine. The research includes the mixture of the "Medical Subject Headings, MeSH" or "Title/Abstract, tiab" terms [92] exposed in Box 1.

Reference lists of retrieved English/French articles were searched for any supplementary references.

RESULTS

Eight studies [51-58] were found. However, three were excluded [56-58]. Two studies were perfomed on Arab children populations [56, 57] and another study did not report 6MWD norms [58]. The retained five studies, concerning Tunisian [52, 55], Saudi-Arabian [51, 54] and Algerian [53] populations, were cross-sectional.

Samples representation

Table 1 displays the samples characteristics of the retained studies. All samples were convenience ones.

Weight status was not reported in two studies [51, 55]. Almost, 28%, 36% and 56% of participants, respectively in the studies of El-Sobkey [54], Bourahli et al. [53] and Ben Saad et al. [52], have overweight. Nearly, 5%, 24% and 24% of participants, respectively in the studies of Bourahli et al. [53], El-Sobkey [54] and Ben Saad et al. [52], were obese.

Physical activity level was lacking in one study [55]. Almost 26.5%, 51%, 80% and 82% of participants, respectively, in the studies of Bourahli et al. [53], El-Sobkey [54], Alameri et al. [51] and Ben Saad et al. [52] have a low physical activity level.

Socioeconomic-level was reported in one study [52].

Schooling-level, reported in two studies [52, 55], was low in 43% and 75% of participants of Ben Saad et al. [52] and Masmoudi et al. [55] studies. In the study of Masmoudi et al. [55], 55% of participants have an urban origin. The Algerian study [53] was carried out in the area of Constantine, which is 649 m exceeding sea level.

Box 1. "Medical Subject Headings MeSH" or "Title/Abstract, tiab" terms applied in the present research.

Synonyms of "walking" AND	Synonyms of "reference value" AND	Synonyms of "Arabs" [92]
"walking"[MeSH] OR "six minute walk distance"[tiab] OR "six-minute walk distance"[tiab] OR "6-minute walk distance"[tiab] OR "six-min walk distance"[tiab] OR "6-min walk distance"[tiab] OR "six minute walking distance"[tiab] OR "six-minute walking distance"[tiab] OR "6MWD"[tiab] OR "six-minute walk"[tiab] OR "6-min walk"[tiab] OR "six-min walk test"[tiab] OR "six minute walk test"[tiab] OR "six-minute walk test"[tiab] OR "6-minute walk test"[tiab] OR "6-min walk test"[tiab] OR"6MWT"[tiab] OR "walk test"[tiab]	"reference value"[MeSH] OR "reference equation"[tiab] OR "reference standards"[MeSH] OR "norms"[tiab]	"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]

Table 1. Samples characteristics of the included five studies

	Masmoudi [55]	**Ben Saad [52]**	**Alameri [51]**	**El-Sobkey [54]**	**Bourahli [53]**
Weight status	.NR	.Normal: 20% .Overweight: 56%a .Moderate obesity: 24%a	.NR	.Underweight: 11%a .Normal: 36%a .Overweight: 28.4%a .Obesity: 24%a	.Underweight: 4.5%a .Normal: 54%a .Overweight: 36.5%a .Moderate obesity: 5%a
Physical activity level	.NR	.Low : 82%a .Moderate:14%a .High: 4%a	.Low: 80%[a]	.Low: 51%a .Moderate: 18% .High: 31%a	.Low: 26.5% .Moderate: 46.5%a .High: 27.0%a
Socioeconomic level	.NR	.Low : 36%	.NR	.NR	.NR
Schooling level	.Low: 75%a	.Low: 43%a	.NR	.NR	.NR

NR: not-reported. aData are percentage of subjects.

Non-inclusion criteria

Several non-inclusion criteria, previously described [92], were applied.

The following specific non-inclusion criteria were applied in three studies [51-53]: 6MWT contraindications [3], moderate obesity (body mass index (BMI) > 35 kg/m^2) and abnormal lung function data.

Some abnormal 6MWT results were applied as non-inclusion criteria in two studies [52, 53] such as a resting oxy-hemoglobin saturation (oxy-sat) ≤ 92%, an end-walk dyspnoea > 5/10 (visual analogue scale) and a walking induced desaturation.

6MWT protocols

All the retained studies [51-55] have applied the ATS-2002 guidelines [3].

The number of 6MWTs varied from one [51] to two [52, 53, 55] with 30 [52, 55] or 20-45 [53] minutes rest between tests.

6MWTs were performed in one site in three studies [52, 53, 55] and five different sites in one study [51].

The corridor length varied from 30 [51, 53, 55] to 40 [52] m. In all studies [51-55], only one investigator was implicated in the 6MWT practice.

Homogeneous expressions of encouragement were given in two studies [53, 55], and no encouragement was given in two others [51, 52]. 6MWTs were completed in the afternoon in one study [55] and in the morning in three others [51-53]. Ambient temperature was stated only in three studies [51-53].

Samples sizes and participants characteristics

Table 2 displays the samples sizes, anthropometric and spirometric data of the participants divided by sex: 1181 participants (56% were women) were included.

Samples sizes, calculated in one study [53], varied from

Box 2. Retained 6MWD norms and interpretation methods

Masmoudi et al. [55]: Tunisian aged 40-79 Yrs
6MWD = 299.8 - 4.34 x Age + 3.43 x Height - 1.46 x Weight + 62.5 x Sex. LLN= 124.5 m

Ben Saad et al. [52]: North-African aged 40-85 Yrs
6MWD = 720.50 + 160.27 x Sex - 5.14 x Age - 2.23 x Weight + 2.72 x Height. LLN= 89 m

Alameri et al. [51]: Saudi-Arabian aged 16-50 Yrs
6MWD = - 28.5 + 2.81 x Height + 0.79 x Age. LLN= NR

El-Sobkey [54]: Saudi-Arabian aged 18-71 Yrs
6MWD = 342.65 + 74.31 x Physical activity level + 33.88 x Sex - 4.25 x Age. LLN= NR

Bourahli et al. [53]: North-African aged 16-40 Yrs
6MWD = 800.05 + 64.71 x Sex - 10.23 x BMI- 1.63 x Age + 2.05 x Weight. LLN= 74.31 m
Notes:
6MWD in m, age in Yrs, height in cm, weight in kg, BMI (body mass index) in kg/m2, sex (0:women; 1:men).
LLN: lower limit of normal. NR: not-reported.

Table 2. Samples sizes, anthropometric and spirometric data.

Table 2. Samples sizes, anthropometric and spirom

		Masmoudi [55]	Ben Saad [52]	Alam [51]
Sample size (M/W)		155 (80/75)	229 (104/125)	238 (127/
Age (Yr)	TS	55 ± 11^{a} 40-79[b]	56 ± 10^{a} 40-85[b]	29 ± 8^{a} 16-50
	M	57 ± 11^{a} 40-79[b]	58 ± 11^{a}	28 ± 8^{a}
	W	$53\pm10^{a*}$ 40-75[b]	$55\pm10^{a*}$	30 ± 8^{a}
Height (cm)	TS	163 ± 9^{a} 145-189[b]	162 ± 10^{a}	NR
	M	169 ± 6^{a} 155-189[b]	170 ± 7^{a}	170±5
	W	$156\pm6^{a*}$ 145-175[b]	$156\pm6^{a*}$	157±6
Weight (kg)	TS	74 ± 12^{a} 46-109[b]	73 ± 12^{a}	NR
	M	76 ± 12^{a} 46-100[b]	79 ± 10^{a}	76±1
	W	$72\pm12^{a*}$ 48-109[b]	$68\pm11^{a*}$	64±1
BMI (kg/m^2)	TS	28 ± 4^{a} 18-38[b]	28 ± 3^{a}	NR
	M	26 ± 4^{a} 17-35[b]	27 ± 3^{a}	26 ± 4^{a}
	W	$29\pm5^{a*}$ 20-38[b]	28 ± 3^{a}	26 ± 5^{a}
Lean-mass (kg)	TS	NR	NR	NR

155 [55] to 359 [54] subjects.Percentages of women were 47%, 48%, 50%, 55% and 70%, respectively, in the studies of Alameri et al. [51], Masmoudi et al. [55], Bourahli et al. [53], Ben Saad et al. [52] and El-Sobkey [54]. Subjects were aged from 16 [51, 53] to 85 [52] years. The age means of the total samples varied from 28 [53] to 56 [52] years. In Bourahli et al. [53] study, 14 adolescents aged 16 to 18 years were included. The means of height, weight and BMI of the total samples varied, respectively, from 162 [52, 54] to 169 [53] cm, from 67 [54] to 74 [55] kg and from 24 [53] to 28 [52, 55]. Lean and fat-free masses were reported in one study [53].

Some spirometric data were reported in three studies [51-53]: 1[st] s forced expiratory volume (FEV_1) [51-53], forced

Table 3. . 6MWD and resting 6MWT data

Table 3. 6MWD and resting 6MWT data

		Masmoudi [55]	Ben Saad [52]	Alameri [
6MWD (m)	TS	509±83[a]	624±111[a] 345-893[b]	410±52[a]
	M	586±82[a]	711±81[a]	430±47[a]
	W	498±74[a]	551±75[a]	386±46[a*]
SBP (mmHg)	TS	NR	130 (115-140)[c]	NR
	M	NR	135 (120-150)[c]	NR
	W	NR	120 (110-135)[c*]	NR
DBP (mmHg)	TS	NR	80 (60-85)[c]	NR
	M	NR	80 (70-90)[c]	NR
	W	NR	80 (60-80)[c*]	NR
HR	TS	78±9[a]	79±10[a]	NR

vital capacity (FVC) [51-53], FEV_1/FVC [51-53], maximal mid expiratory flow [52, 53] and peak expiratory flow [52]. No study has reported lung volumes data.

6MWD and resting 6MWT data

Table 3 displays the resting 6MWT data and measured 6MWD of the included subjects.

In all studies [51-55], 6MWTs were well tolerated and no 6MWT was interrupted before the 6-min mark.

The lowest and highest measured 6MWD were noted in Saudi-Arabian and Algeria populations [51, 53]. The 6MWD means were 410±52 m, 386±46 m and 430±47 m, respectively, for the total sample, women and men subgroups of the Saudi-Arabian population [51]; and 680±70 m, 634±49 m and 726±55 m, respectively, for the total sample, women and men subgroups of the Algerian population [53].

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured in three studies [52-54]. The total sample SBP and DBP medians or means varied, respectively, from 116 [53] to 130 [52] mmHg and from 70 [53] to 80 [52] mmHg.

Heart-rate (HR), expressed in bpm and as percentage of maximal predicted HR, varied, respectively, from 78±9 [55] to 81±12 [54] and from 42±5% [53] to 47±6% [52].

Oxy-sat data, reported in three studies [52-54], was almost 98%.

The mean±SD (min-max) of the respiratory-rate, noted in one study [54], was 18±3 (12-30) cpm.

The mean±SD of dyspnoea, reported in one study [51], was 0±0.

6MWD influencing factors

The following anthropometric data were reported as 6MWD influencing factors [92]: sex [52-55], age [51-55], height [51, 53, 55], weight [51, 55], BMI [52, 53, 55] and lean-mass [53]. Among all spirometric data, only FEV_1 apperared to be an influencing factor in two studies [52, 53]. Physical activity levels/scores were retained as influening factors in three studies [52-54]. Additional influencing factors were: schooling level [52, 55], socioeconomic level [52], urban origin [55], parity [52], end-walk HR or dyspnoea Borg value [51] and resting DBP [53].

6MWD norms

Table 4 displays the 6MWD norms in healthy adults Arab populations. Two studies [52, 53] have reported three norms for the total sample, women and men subgroups. The remaining three studies [51, 54, 55] have reported norms only for the total sample. Moreover, Masmoudi et al. [55] have proposed two norms models for their total sample.

All recommended norms, presented in Box 2, were those proposed for the total samples.

All authors have opted for 6MWD regression linear models explaining 25% [51] to 77% [52] of the 6MWD variability.

All included data were anthropometric ones, except in the study by El-Sobkey [54], where "physical activity level" (evaluated by the international physical activity questionnaire, IPAQ [93]) was introduced.

The following five anthropometric data were included in the retained 6MWD norms (Box 2): sex [52, 53, 55], age [51-55], height [51, 52, 55], weight [52, 53, 55] and BMI [53].

6MWD interpretation method

Three studies [52, 53, 55] have proposed a clear method to interpret the 6MWD (Box 2). After the predicted 6MWD value from the norm is computed for an individual subject, the lower limit of normal (LLN) for that subject may be obtained by subtracting "X" m ("X" = 124.5 [55] or 89 [52] or 74.31 [53] m).

Validation of the 6MWD norms

Three studies [51-53] have validated their 6MWD norms (Table 5). The validation groups samples varied from 30 [52] to 58 [51] healthy participants who met the study inclusion-criteria in two studies [52, 53]. Adequate agreements between the measured and predicted 6MWD were found with non-significant differences between the measured and the predicted 6MWDs. In the Algerian study [53], no participant have a 6MWD <81% or <LLN

DISCUSSION

Five studies have published 6MWD norms for adults Arab populations. They were proposed for Tunisian population aged 40-79 years or aged 40-85 years, for Saudi-Arabian population aged 16-50 years or aged 18-71 years and for Algerian population aged 16-40 years. These norms explained 25% to 77% of the 6MWD variability.

Table 4. . 6MWD norms

Table 4. 6MWD norms

	Masmoudi [55]	Ben Saad [52]	Alameri [51]	E
Total sample	Model 1 = 299.8 - 4.34 x A + 3.43 x H - 1.46 x W + 62.5 x S *r^2=0.60* *LLN=124.5 m* Model 2 = 852.7 - 4.55 x A - 3.8 x BMI + 90.8 x S r^2=0.58 LLN=120.4 m	= 720.50 + 160.27 x S - 5.14 x A - 2.23 x W + 2.72 x H *r^2=0.77* *LLN=89 m*	= - 28.5 + 2.81 x H + 0.79 x A *r^2=0.25* *LLN=NR*	= P 3: r L
Men	NR	= 905.45 - 5.40 x A - 2.22 x W + 1.72 x H r^2=0.53	NR	N

Table 5. Validation of the published 6MWD norms.

Table 3. 6MWD and resting 6MWT data

		Masmoudi [55]	Ben Saad [52]	Ala
6MWD (m)	TS	509±83[a]	624±111[a] 345-893[b]	41(
	M	586±82[a]	711±81[a]	43(
	W	498±74[a]	551±75[a]	38(

Rational of the review

In the last decade, the 6MWT has been increasingly used to assess functional exercise performance across various adults' subject populations [1-3, 5-50]: pulmonary [5-22], cardiac [23-28] and neuromuscular [29-32] diseases, scleroderma [33], chronic renal failure [34], colon resection surgery [35], infection with human immunodeficient virus [36], obesity [37], diabetes-mellitus [41], and ageing [38]. At least, it has been shown that the 6MWT independently predict the risk of death among subjects with chronic diseases [1-3, 12, 39, 40, 42].

6MWD interpretation

Once the 6MWD for a given subject was determined, how the results of a single 6MWD made to determine functional status should be interpreted? Two steps are needed. The first step is to express the 6MWD as a percentage of the predicted value derived from published norms [1-3, 49] performed in a sample of healthy people of the same population [50-55, 59-91]. Despite the popularity of the 6MWT, there is limited data relating 6MWD norms in healthy adults' overall the world [50-55, 59-91], and especially among Arab population [51-55]. In fact, to date, only five studies have determined norms to predict 6MWD in healthy adults Arab populations [51-55]. In many Arab populations, no local 6MWD norms exist, and interpretation of 6MWD data is thus based on foreigner published norms [50-55, 59-91]. This is a questionable practice, since their reliability hasn't been verified in these populations. Moreover, there is some evidence of differences in 6MWD among different ethnic samples [65, 84]. The second step consists to interpret the measured 6MWD and therefore to choose what limit of the reference range to apply. In literature, several methods were proposed: use of the LLN range [52, 64, 74, 84], use of a fixed percentage of predicted value (81% [71] or 82% [80]) below which the 6MWD is considered as abnormal and use of reference centile tables by age-decade [72].

Because of the differences in the population characteristics, in the 6MWT protocols and data, in the norms and in the interpretation methods, the universal application of the published norms [50-55, 59-91] is limited and may provide misleading information concerning therapeutic or prognostic determinants. The following two examples illustrate the possible clinical misinterpretation of 6MWD results among Arab participants, even if Arab norms are applied. When expressed as a percent of predicted values, a 450-m measured 6MWD for a man [40 Yr, 70 kg; 160 cm; physical activity level=7] will vary by 46% [53%, 57%, 62%, 71% and 99%, respectively, according to the reference equations of Bourahli et al. [53], Ben Saad et al. [52], El-Sobkey [54], Masmoudi et al. [55] and Alameri et al. [51]]. When expressed as a percent of predicted values, a 450-m measured 6MWD of a woman [40 Yr, 70 kg; 160 cm; physical activity level=7] will vary by 42% [57%, 65%, 71%, 79% and 99%, respectively, according to the reference equations of Bourahli et al. [53], El-Sobkey [54], Ben Saad et al. [52], Masmoudi et al. [55] and Alameri et al. [51]]. In the one hand, this argues for the use of specific norms and supports the ATS recommendation to continue establishing regional norms [3]. In the other hand, the implications of this for subjects with chronic diseases may be considerable and include potential errors regarding the level of subject disability and unrealistic expectations of interventions or therapeutic designed to improve 6MWD.

Origins of 6MWD norms differences

The application of 6MWD norms may be fraught with difficulties if: *i)* Norm derived from cross-sectional data is applied to longitudinal studies; *ii)* Characteristics of the reference equation population differ from those of the sample being studied with respect to age, body size, sex or ethnic origin; *iii)* Methods and techniques used in a study differ from those applied when establishing the norms; or *iv)* Criteria for identifying the «normal range» have not been established. Tables 1-5 show that there are several differences between the 6MWD published norms for Arab adults' population. These differences interested at least ten points detailed in the following paragraphs.

Studies design. The five published studies were cross-sectional [51-55]. Some authors [80] warranted some caution when interpreting the results of such cross-sectional studies in volunteers, which may overestimate 6MWD in the oldest subjects because of a possible selection bias [94]. Change in 6MWD within an individual in time can be related to coefficients in regression equations. The latter are almost invariably obtained in cross-sectional studies; there, the results may be biased by selection effects (persons with the greatest decline in 6MWD being least likely to survive to old age), and by cohort effects, so that the age or height coefficients are not representative of age-related changes within an individual [94]. Thus, longitudinal studies analysed by appropriate statistical models are necessary to correctly describe the functional changes associated with ageing [95].

Recruitment methods. The five studies recruitment methods', previously detailed [92], were different. The recruited healthy volunteers could be not representative of subjects recruited from the community. To avoid such limitation, Alameri et al. [51] and Bourahli et al. [53] randomized, respectively, 80% and 84% of their samples individuals to formulate their 6MWD norms. The remaining 16% and 20% were enrolled in the cross-validation studies of the developed equations (Table 5). In future, standardisation method recruitment is needed. Although the sampling technique developed by Alameri et al. [51] and Bourahli et al. [53] are able of diminishing the biases that are inherent to convenience sampling; these studies cannot be classified as randomized ones. In future, and as done in some related studies [61, 74], randomized samples are necessary.

Samples sizes. Only four studies [51-54] included a large number of adults (*ie*; ≥ 200 [95]). Although there is evidence for the accuracy of their published norms, Masmoudi et al. [55] study population (n=155) was not large enough to determine 6MWD norms. In practice, and as for spirometry, a relatively large number of subjects (i.e, >100 [95] or > 150 [96] for each sex) is necessary to ensure no significant difference between the published norms and the values from the local community [95, 96]. Moreover, the sample size was calculated [97] in only one study [53]. The calculation of the sample size is a statistically central point since determining its finest size for a study guarantees enough power to distinguish statistical significance and is a serious step in the design of a planned research procedure [97]. In the future and accordingly, similar studies should comprise a suitable calculated sample size [97] and included at least 100 or 150 subjects for each sex.

Non-inclusion criteria. Norms should be obtained from studies of ''normal'' subjects with the same anthropometric and, where applicable, ethnic characteristics of the subject being evaluated [95]. Criteria to define subjects as ''normal'' have been discussed in earlier statements [98, 99]: a healthy person is defined as one in whom there is: *i)* No presence of acute and no past chronic disease of the respiratory system; *ii)* No major respiratory disease, such as congenital anomalies, destructive type of pneumonia or thoracic surgery in past medical history; *iii)* No systemic disease which may directly or indirectly influence the respiratory system and general state of health (*e.g*. cardiovascular, neuromuscular, skeletal or renal disease); *iv)* No history of upper respiratory tract infection during three weeks prior to investigation; *v)* Normal body composition (weight within 5 and 95 percentile for height, taking into account ethnic group) and vi) Lifelong non-smokers or no more than incidental smoking experience. As previously highlighted [92], some of the above criteria were not applied in the retained studies [51-55]. In future studies, standardization of the non-inclusion criteria is needed. One interesting method, defining a "healthy group", was applied in two related studies [74, 84]: subjects with disease-related factors that were significantly negatively associated with 6MWD were excluded. When the factor was a continuous variable, participants who fell beyond the 95th percentile toward abnormality were excluded from the "healthy group". As no 6MWT was terminated prematurely and as no subject required a rest during any test [100], stopping during the 6MWT should be considered as exercise intolerance sign [7, 21, 22, 41, 44, 47].

Samples representation. Convenience samples have been included in the five retained studies [51-55]. This could be considered as a major limitation. Ideally, norms are designed from measurements observed in a representative sample of healthy subjects in a general population [95]. Norms can also be derived from large groups of volunteers provided proper distribution of anthropometric characteristics is satisfied [95]. The principal points, which can introduce bias, are noted in Table 1. In summary, they were around percentages of subjects undertaking sufficient physical activity or having low socioeconomic- or schooling- levels and with abnormal weight status. Obesity influence gait and increases the workload for a given amount of exercise, resulting in the shorter 6MWD by subjects with a higher body weight or BMI [1, 2, 61, 65, 74, 83, 92]. Alameri et al. [51] have recognized that their sample may not be representative of the entire Saudi-Arabian population. However, in view that Riyadh is the largest city and a major commercial center of Saudi-Arabia that attracts workers, students and visitors from different parts of the country; according to these authors [51], the sample and therefore the study results can reasonably be extrapolated to the rest of the Saudi-Arabian population.

Age ranges. Different age ranges were studied (Table 2). However, only one study covered a large age range from 18 to 71 years [54]. Although 6MWT performance has been assessed in subjects at relatively young age [6, 14, 37], only two studies [51, 53] have included participants aged less than 40 years.

6MWT guidelines. As previously described [92], there are many differences according the 6MWT applied-protocols. In spite of that intraday variability can be a source of bias [1-3], only four studies [51-53, 55] mentioned the day-time (often in the morning [51-53]) of the 6MWTs. Precision about ambient temperature was noted in three studies [51-53]. This information is very important since exercise capacity is impaired in hot, compared to temperate conditions [101]. Different pre-test instructions, that can modify the 6MWT data, were recommended in four studies [51-53, 55]. Encouragement, noted in two studies [53, 55], might have influenced the 6MWT results, since it can significantly increases the 6MWD [102, 103]. According to the ATS guidelines [3], a practice test is not needed in most clinical settings but should be considered in research protocols. Two 6MWTs were performed in three studies [52, 53, 55]. Norms derived from studies with more than one practice test [52, 53, 55] should prove useful for interpreting multiple repetition 6MWD performance in subject's particularly in settings such as pulmonary rehabilitation where test familiarization is often included in entry and exit 6MWT methodology [3]. A single test was performed in one study [51]. Performing a single 6MWT underestimate 6MWD, as repeated testing is required to account for the effect of familiarization on the 6MWD walked by healthy subjects [52, 61, 63-65, 72, 78, 80]. Alameri et al. [51] theorized that the single test method was more appropriate for clinical settings, where the test will typically be performed once. Nevertheless, these authors [51] recognized that the ''learning effect'' phenomena in 6MWT, wherein repeating the test more than once significantly increases 6MWD. If a practice 6MWT is done, and in order to reach similar resting HR, the 2002-ATS guidelines [3] recommend waiting for at least 60 minutes before the second 6MWT. Nevertheless, in the published norms, interval between repeated intraday tests varied largely between 20 minutes and 45 minutes [52, 53, 55]. The ATS [3] recommends performing the 6MWT indoors, but if the weather is comfortable, the test may be performed outdoors. In two studies [52, 53] 6MWTs were done outdoors. However, comparison between indoor and outdoor courses reported little difference in 6MWD (mean difference 4 m) [104]. Performance on the 6MWT can be influenced by the course layout and track length [1-3]. The published studies corridor length varied between 30 m and 40 m. According the ATS [3], the walking course must be in length and no differences in average outcome were found between tracks of 15-50 m [105]. In the retained studies [51-55] only one evaluator has conducted the 6MWT in healthy subjects. In subjects with chronic obstructive pulmonary disease (COPD), it was recently shown that the 6MWT can be compared when conducted by two different investigators [106].

6MWD influencing factors. The adults Arab population 6MWD influencing factors were recently discussed [92]. However, some other potential factors described in literature [exhaled carbon-monoxide (CO) values, leg length, quadriceps or grip strengths, ankle-arm-index (AAI)] [50-55, 59-88] should be evaluated in future studies. The presence of carboxyhaemoglobin from passive smoke and/or exposure to non-tobacco sources of CO, is a factor that can influence the 6MWT results [107]. It has been known that exposure to low-level environmental CO impairs exercise performance in normal persons as well as those with underlying coronary artery disease [108-110]. The measurement of CO in future study subjects may contribute to the understanding of the sources of variation and reproducibility of the 6MWD in cross-sectional and longitudinal studies of normal subjects [107]. The hypothesis that mean leg length may be a better predictor of 6MWD than height as it is a primary determinant of stride length [74] was tested in some studies [61, 76, 78]. While this hypothesis wasn't supported by some authors [61, 76], Singaporean [78] data showed significant direct relationships between 6MWD and leg length. A significant correlation between 6MWD and quadriceps strength (r=0.62) was found [80]. However, after correcting for anthropometric data, peripheral muscle strength played no independent role [80]. This contrasts with the previously reported relationship of peripheral muscle strength to the 6MWD in subjects with moderate to severe COPD [111]. Grip strength is a direct measure of skeletal muscle strength of the hands, but it is also an index of overall muscle strength, endurance, and disability [112]. It remained a strong, independent predictor of 6MWD in healthy subjects [84]: for a 10-kg increment in grip strength, men and women walked an average of farther. The subclinical peripheral vascular disease was bivariately associated with substantially shorter 6MWD [84]: a nonlinear association of AAI with 6MWD with a breakpoint at an AAI of women and men was found and this AAI effects remained as strong predictors of 6MWD. At least, since the Algerian study [53] was achieved at an altitude of 649 m, the height above sea level should be considered when comparing between studies data.

Statistical methods for 6MWD norms. As recommended [3], in studies performing two 6MWTs [52, 53, 55], the greatest 6MWD covered by each healthy subject was used as the primary outcome variable in the analysis. In the retained studies [51-55], a linear regression model was used to evaluate the independent variables explaining the variance in 6MWD. For practical and routine daily interpretation of 6MWT, the scientific societies recommend that norms be derived by convincing and biologically significant statistical models, taking into account the reliance of the parameter studied with anthropometric data [95]. For that reason, four [51-53, 55] out of the five retained 6MWD norms were established using only anthropometric data as predictors of 6MWD (Box 2). Although the inclusion of physical activity level increased the amount of variance explained in 6MWD Saudi-Arabian norms [54] (Box 2), this finding has limited practical application. In three studies [52, 53, 55] (Box 2), and in order to determine the LLN, the 95% confidence interval was calculated (95% CI = 1.64 x residual standard deviation [100]). Two other methods were proposed in literature: *i)* use of a fixed percentage of predicted value (*ie*; 81% [71] or 82% [80]) below which the 6MWD is considered as abnormal and *ii)* use of reference centile tables by age-decade [72]. The published 6MWD norms for adults Arab populations explained between 25% and 77% of the 6MWD variance. This is in line with results reported in literature where 6MWD norms explained between 20% [84] and 78% [78] of the 6MWD variance using variables such as anthropometric data and/or FEV_1 and/or end-walk %HR [50-55, 59-88].

Reliability of the 6MWD norms. Some authors [51-53] recognized that verification of the 6MWDs achieved by subjects in their study should be undertaken in a prospective cohort of healthy subjects recruited using identical inclusion criteria (Table 5). The reliability of the 6MWD norms was satisfactory and the authors recommended their use in similar populations. In future, verification of the 6MWD norms reliability is essential.

To conclude, the present review underlines the paucity of 6MWD norms from Adults Arab population-based healthy subjects. The present review can help researcher to avoid some limitations when preparing their study design. Additional studies with considerably larger sample sizes and using a randomized sampling method are required, so that the 6MWD norms can be even more representative.

References

1. Singh SJ, Puhan MA, Andrianopoulos V, et al. An official systematic review of the European Respiratory Society/American Thoracic Society: measurement properties of field walking tests in chronic respiratory disease. Eur Respir J 2014;44(6):1447-1478.2. Holland AE, Spruit MA, Troosters T, et al. An official European Respiratory Society/American Thoracic Society technical standard: field walking tests in chronic respiratory disease. Eur Respir J 2014;44(6):1428-1446.
3. American Thoracic Society. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med 2002;166(1):111-117.
4. Enright PL. The six-minute walk test. Respir Care 2003;48(8):783-785.
5. Carter R, Holiday DB, Nwasuruba C, Stocks J, Grothues C, Tiep B. 6-minute walk work for assessment of functional capacity in patients with COPD. Chest. 2003;123(5):1408-1415.
6. Chetta A, Aiello M, Foresi A, et al. Relationship between outcome measures of six-minute walk test and baseline lung function in patients with interstitial lung disease. Sarcoidosis Vasc Diffuse Lung Dis2001;18(2):170-175.
7. Ben Moussa S, Rouatbi S, Ben Saad H. Incapacity, Handicap, and Oxidative Stress Markers of Male Smokers With and Without COPD. Respir Care 2016;61(5):668-679.
8. Poulain M, Durand F, Palomba B, et al. 6-minute walk testing is more sensitive than maximal incremental cycle testing for detecting oxygen desaturation in patients with COPD. Chest 2003;123(5):1401-1407.
9. Chatterjee AB, Rissmiller RW, Meade K, et al. Reproducibility of the 6-minute walk test for ambulatory oxygen prescription. Respiration 2010;79(2):121-127.
10. Callens E, Graba S, Gillet-Juvin K, et al. Measurement of dynamic hyperinflation after a 6-minute walk test in patients with COPD. Chest 2009;136(6):1466-1472.
11. Kasymjanova G, Correa JA, Kreisman H, et al. Prognostic value of the six-minute walk in advanced non-small cell lung cancer. J Thorac Oncol 2009;4(5):602-607.
12. Miyamoto S, Nagaya N, Satoh T, et al. Clinical correlates and prognostic significance of six-minute walk test in patients with primary pulmonary hypertension. Comparison with cardiopulmonary exercise testing. Am J Respir Crit Care Med 2000;161(2 Pt 1):487-492.
13. Lee AL, Button BM, Ellis S, et al. Clinical determinants of the 6-Minute Walk Test in bronchiectasis. Respir Med 2009;103(5):780-785.
14. Chetta A, Pisi G, Zanini A, et al. Six-minute walking test in cystic fibrosis adults with mild to moderate lung disease: comparison to healthy subjects. Respir Med 2001;95(12):986-991.
15. Holden DA, Rice TW, Stelmach K, Meeker DP. Exercise testing, 6-min walk, and stair climb in the evaluation of patients at high risk for pulmonary resection. Chest 1992;102(6):1774-1779.
16. Cahalin L, Pappagianopoulos P, Prevost S, Wain J, Ginns L. The relationship of the 6-min walk test to maximal oxygen consumption in transplant candidates with end-stage lung disease. Chest 1995;108(2):452-459.
17. Pepin V, Brodeur J, Lacasse Y, et al. Six-minute walking versus shuttle walking: responsiveness to bronchodilation in chronic obstructive pulmonary disease. Thorax 2007;62(4):291-298.
18. Rejbi IB, Trabelsi Y, Chouchene A, et al. Changes in six-minute walking

distance during pulmonary rehabilitation in patients with COPD and in healthy subjects. Int J Chron Obstruct Pulmon Dis 2010;5:209-215.
19. Izumizaki M, Satake M, Takahashi H, Sugawara K, Shioya T, Homma I. Effects of inspiratory muscle thixotropy on the 6-min walk distance in COPD. Respir Med 2008;102(7):970-977.
20. Swigris JJ, Wamboldt FS, Behr J, et al. The 6 minute walk in idiopathic pulmonary fibrosis: longitudinal changes and minimum important difference. Thorax 2010;65(2):173-177.
21. Ben Saad H, Ben Hassen I, Ghannouchi I, et al. 6-Min walk-test data in severe obstructive-sleep-apnea-hypopnea-syndrome (OSAHS) under continuous-positive-airway-pressure (CPAP) treatment. Respir Med 2015;109(5):642-655.
22. Ben Saad H, Babba M, Boukamcha R, et al. Investigation of exclusive narghile smokers: deficiency and incapacity measured by spirometry and 6-minute walk test. Respir Care 2014;59(11):1696-1709.
23. Shah MR, Hasselblad V, Gheorghiade M, et al. Prognostic usefulness of the six-minute walk in patients with advanced congestive heart failure secondary to ischemic or nonischemic cardiomyopathy. Am J Cardiol 2001;88(9):987-993.
24. Kervio G, Ville NS, Leclercq C, Daubert JC, Carre F. Intensity and daily reliability of the six-minute walk test in moderate chronic heart failure patients. Arch Phys Med Rehabil 2004;85(9):1513-1518.
25. Verrill DE, Barton C, Beasley W, Lippard M, King CN. Six-minute walk performance and quality of life comparisons in North Carolina cardiac rehabilitation programs. Heart Lung 2003;32(1):41-51.
26. Pereira de Sousa LA, Britto RR, Ribeiro AL, et al. Six-minute walk test in patients with permanent cardiac pacemakers. J Cardiopulm Rehabil Prev 2008;28(4):253-257.
27. Cipriano G, Jr., Yuri D, Bernardelli GF, Mair V, Buffolo E, Branco JN. Analysis of 6-minute walk test safety in pre-heart transplantation patients. Arq Bras Cardiol 2009;92(4):312-319.
28. de Arenaza DP, Pepper J, Lees B, et al. Preoperative 6-minute walk test adds prognostic information to Euroscore in patients undergoing aortic valve replacement. Heart 2010;96(2):113-117.
29. Takeuchi Y, Katsuno M, Banno H, et al. Walking capacity evaluated by the 6-minute walk test in spinal and bulbar muscular atrophy. Muscle Nerve2008;38(2):964-971.
30. Falvo MJ, Earhart GM. Six-minute walk distance in persons with Parkinson disease: a hierarchical regression model. Arch Phys Med Rehabil 2009;90(6):1004-1008.
31. King S, Wessel J, Bhambhani Y, Maikala R, Sholter D, Maksymowych W. Validity and reliability of the 6 minute walk in persons with fibromyalgia. J Rheumatol 1999;26(10):2233-2237.
32. Maanum G, Jahnsen R, Froslie KF, Larsen KL, Keller A. Walking ability and predictors of performance on the 6-minute walk test in adults with spastic cerebral palsy. Dev Med Child Neurol 2010;52(6):e126-132.
33. Villalba WO, Sampaio-Barros PD, Pereira MC, et al. Six-minute walk test for the evaluation of pulmonary disease severity in scleroderma patients. Chest 2007;131(1):217-222.
34. Fitts SS, Guthrie MR. Six-minute walk by people with chronic renal failure. Assessment of effort by perceived exertion. Am J Phys Med Rehabil 1995;74(1):54-58.
35. Moriello C, Mayo NE, Feldman L, Carli F. Validating the six-minute walk test as a measure of recovery after elective colon resection surgery. Arch Phys Med Rehabil 2008;89(6):1083-1089.
36. Oursler KK, Katzel LI, Smith BA, Scott WB, Russ DW, Sorkin JD. Prediction of cardiorespiratory fitness in older men infected with the human immunodeficiency virus: clinical factors and value of the six-minute walk distance. J Am Geriatr Soc 2009;57(11):2055-2061.
37. Hulens M, Vansant G, Claessens AL, Lysens R, Muls E. Predictors of 6-minute walk test results in lean, obese and morbidly obese women. Scand J Med Sci Sports. 2003;13(2):98-105.
38. Hovington CL, Nadeau S, Leroux A. Comparison of walking parameters and cardiorespiratory changes during the 6-minute walk test in healthy sexagenarians and septuagenarians. Gerontology 2009;55(6):694-701.
39. Celli BR, Cote CG, Marin JM, et al. The body-mass index, airflow obstruction, dyspnea, and exercise capacity index in chronic obstructive pulmonary disease. N Engl J Med. 2004;350(10):1005-1012.
40. Lederer DJ, Arcasoy SM, Wilt JS, D'Ovidio F, Sonett JR, Kawut SM. Six-minute-walk distance predicts waiting list survival in idiopathic pulmonary fibrosis. Am J Respir Crit Care Med 2006;174(6):659-664.
41. Latiri I, Elbey R, Hcini K, et al. Six-minute walk test in non-insulin-dependent diabetes mellitus patients living in Northwest Africa. Diabetes Metab Syndr Obes 2012;5:227-245.
42. Criner GJ, Cordova FC, Furukawa S, et al. Prospective randomized trial comparing bilateral lung volume reduction surgery to pulmonary rehabilitation in severe chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1999;160(6):2018-2027.
43. Rouatbi S, B.Saad H, Abdelghani A. The Six Minute-Walk Test is it the Most Effective Way to Follow an Overlap Syndrome? J Sleep Disord Treat Care 2013;02(01):1-4.
44. Ben Saad H, Babba M, Boukamcha R, et al. Submaximal exercise capacity and quality of life in exclusive water-pipe smokers. Rev Mal Respir 2010;27(5):489-495.
45. Ben Saad H, Hamadou R, Ben Cheikh I, et al. Réadaptation respiratoire des malades atteints d’une bronchopneumopathie chronique obstructive: données préliminaires de l’expérience tunisienne. Journal de Réadaptation Médicale 2008;28(4):138-147.
46. Miadi-Messaoud H, Chouchane A, Ben Saad H, Debbabi H, Ben-Jebria A, Tabka Z. Six-minute walk test improved forearm skin blood flow in Tunisian obese women. Obesity 2012;20(9):1773-1779.
47. Abdelghani A, Ben Saad H, Ben Hassen I, et al. Evaluation of the deficiency and the submaximal exercise capacity in obstructive sleep apnoea patients. Rev Mal Respir 2010;27(3):266-274.
48. Lataoui S, Belghali S, Zeglaoui H, Bouajina E, Ben Saad H. Sub-maximal aerobic capacity and quality of life of patients with rheumatoid arthritis. Rev Mal Respir 2017;34(1):74-85.
49. Dourado VZ. Reference Equations for the 6-Minute Walk Test in Healthy Individuals. Arq Bras Cardiol 2011;96(6):e128-e138.
50. Dourado VZ, Vidotto MC, Guerra RL. Reference equations for the performance of healthy adults on field walking tests. J Bras Pneumol 2011;37(5):607-614.
51. Alameri H, Al-Majed S, Al-Howaikan A. Six-min walk test in a healthy adult Arab population. Respir Med 2009;103(7):1041-1046.
52. Ben Saad H, Prefaut C, Tabka Z, et al. 6-minute walk distance in healthy North Africans older than 40 years: influence of parity. Respir Med 2009;103(1):74-84.
53. Bourahli M-K, Bougrida M, Martani M, Mehdioui H, Ben Saad H. 6-Min walk-test data in healthy North-African subjects aged 16–40 years. Egypt J Chest Dis Tuberc 2016;65(1):349-360.
54. El-Sobkey S. Influence of physical activity level on Saudi reference values of 6-minute walk test. Middle-East J Sci Res 2013;16(2):164-171.
55. Masmoudi K, Aouicha MS, Fki H, Dammak J, Zouari N. The six minute walk test: which predictive values to apply for Tunisian subjects aged between 40 and 80 years? Tunis Med 2008;86(1):20-26.
56. Abdel Rahman S, Alnegimshi A. Normative values of six-minute walk distance for healthy Saudi girls. World Appl Sci J 2014;32(8):1721-1730.
57. Ben Saad H, Prefaut C, Missaoui R, Mohamed IH, Tabka Z, Hayot M. Reference equation for 6-min walk distance in healthy North African children 6-16 years old. Pediatr Pulmonol 2009;44(4):316-324.
58. El-Sobkey SB, Aly FA, Alghadir AH. The effect of physical activity on 6-minute walked distance among niqab wearing healthy Saudi women. Asian Biomed 2014;8(3):381-386.
59. Ajiboye OA, Anigbogu CN, Ajuluchukwu JN, Jaja SI. Prediction equations for 6-minute walk distance in apparently healthy Nigerians. HKPJ 2014;32(2):65-72.
60. Britto RR, Probst VS, de Andrade AF, et al. Reference equations for the six-minute walk distance based on a Brazilian multicenter study. Braz J

Phys Ther 2013;17(6):556-563.
61. Camarri B, Eastwood PR, Cecins NM, Thompson PJ, Jenkins S. Six minute walk distance in healthy subjects aged 55-75 years. Respir Med 2006;100(4):658-665.
62. Casanova C, Celli BR, Barria P, et al. The 6-min walk distance in healthy subjects: reference standards from seven countries. Eur Respir J 2011;37(1):150-156.
63. Chetta A, Zanini A, Pisi G, et al. Reference values for the 6-min walk test in healthy subjects 20-50 years old. Respir Med 2006;100(9):1573-1578.
64. Iwama AM, Andrade GN, Shima P, Tanni SE, Godoy I, Dourado VZ. The six-minute walk test and body weight-walk distance product in healthy Brazilian subjects. Braz J Med Biol Res 2009;42(11):1080-1085.
65. Gibbons WJ, Fruchter N, Sloan S, Levy RD. Reference values for a multiple repetition 6-minute walk test in healthy adults older than 20 years. J Cardiopulm Rehabil 2001;21(2):87-93.
66. Kim AL, Kwon JC, Park I, et al. Reference equations for the six-minute walk distance in healthy korean adults, aged 22-59 years. Tuberc Respir Dis (Seoul) 2014;76(6):269-275.
67. Nusdwinuringtyas N, Widjajalaksmi, Yunus F, Alwi I. Reference equation for prediction of a total distance during six-minute walk test using Indonesian anthropometrics. Acta Med Indones 2014;46(2):90-96.
68. Osses AR, Yanez VJ, Barria PP, et al. Reference values for the 6-minutes walking test in healthy subjects 20-80 years old. Rev Med Chil 2010;138(9):1124-1130.
69. Palaniappan Ramanathan R, Chandrasekaran B. Reference equations for 6-min walk test in healthy Indian subjects (25-80 years). Lung India 2014;31(1):35-38.
70. Rao NA, Irfan M, Haque AS, Sarwar Zubairi AB, Awan S. Six-minute walk test performance in healthy adult Pakistani volunteers. J Coll Physicians Surg Pak 2013;23(10):720-725.
71. Soaresa MR, Pereira CA. Six-minute walk test: reference values for healthy adults in Brazil. J Bras Pneumol 2011;37(5):576-583.
72. Tsang RCC. Reference Values for 6-Minute Walk Test and Hand-Grip Strength in Healthy Hong Kong Chinese Adults. HKPJ 2005;23(1):6-12.
73. Tveter AT, Dagfinrud H, Moseng T, Holm I. Health-related physical fitness measures: reference values and reference equations for use in clinical practice. Arch Phys Med Rehabil 2014;95(7):1366-1373.
74. Enright PL, Sherrill DL. Reference equations for the six-minute walk in healthy adults. Am J Respir Crit Care Med 1998;158(5 Pt 1):1384-1387.
75. Hill K, Wickerson LM, Woon LJ, et al. The 6-min walk test: responses in healthy Canadians aged 45 to 85 years. Appl Physiol Nutr Metab 2011;36(5):643-649.
76. Jenkins S, Cecins N, Camarri B, Williams C, Thompson P, Eastwood P. Regression equations to predict 6-minute walk distance in middle-aged and elderly adults. Physiother Theory Pract 2009;25(7):516-522.
77. Ngai SPC, Jones AYM, Jenkins SC. Regression equations to predict 6-minute walk distance in Chinese adults aged 55–85 years. HKPJ 2014;32(2):58-64.
78. Poh H, Eastwood PR, Cecins NM, Ho KT, Jenkins SC. Six-minute walk distance in healthy Singaporean adults cannot be predicted using reference equations derived from Caucasian populations. Respirology 2006;11(2):211-216.
79. Suwanachaiya S, Kulaputanaa O, Chaiwanichsirib D. Walk performance in Thai men and women: physical activity dependence. Asian Biomed 2010;4:87-93.
80. Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. Eur Respir J 1999;14(2):270-274.
81. Vaish H, Ahmed F, Singla R, Shukla DK. Reference equation for the 6-minute walk test in healthy North Indian adult males. Int J Tuberc Lung Dis 2013;17(5):698-703.
82. Beekman E, Mesters I, Gosselink R, et al. The first reference equations for the 6-minute walk distance over a 10 m course. Thorax 2014;69(9):867-868.
83. Capodaglio P, De Souza SA, Parisio C, Precilios H, Vismara L, Cimolin V, et al. Reference values for the 6-Min Walking Test in obese subjects. Disabil Rehabil 2013;35(14):1199-1203.
84. Enright PL, McBurnie MA, Bittner V, et al. The 6-min walk test: a quick measure of functional status in elderly adults. Chest 2003;123(2):387-398.
85. Mbada C, Jaiyeola O, Johnson O, et al. Reference Values for Six Minute Walk Distance in Apparently Healthy Young Nigerian Adults (Age 18-35 Years). International Journal of Sports Science 2015;5(1):19-26.
86. Mosharraf-Hossain AKM, Chakrabortty R. Reference values of 6 minutes walk test (6 MWT) in Bangladeshi healthy subjects aged 25-55 years. Bangladesh Med Res Counc Bull 2014;40(2):70-73.
87. Shrestha S, Shristava B. Six Minute Walk Distance and Reference Equations in Normal Healthy Subjects of Nepal. Kathmandu Univ Med J 2015;50(2):97-101.
88. Steffen TM, Hacker TA, Mollinger L. Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. Phys Ther 2002;82(2):128-137.
89. Jay SJ. Reference equations for the six-minute walk in healthy adults. Am J Respir Crit Care Med 2000;161(4 Pt 1):1396.
90. Teramoto S, Ohga E, Ishii T, Yamaguchi Y, Yamamoto H, Mastsuse T. Reference value of six-minute walking distance in healthy middle-aged and older subjects. Eur Respir J 2000;15(6):1132-1133.
91. Teramoto S, Kume H, Ishii T, et al. Reference values for 6-min walk distance in Asian adults may not be different from that of Caucasian adults. Respirology 2006;11(5):669-670.
92. Joobeur S, Rouatbi S, Latiri I, Sfaxi R, Ben Saad H. Influencing factors of the 6-min walk distance in adult Arab populations: a literature review. Tunis Med 2016;94(5):339-348.
93. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35(8):1381-1395.
94. Ganguli M, Lytle ME, Reynolds MD, Dodge HH. Random versus volunteer selection for a community-based study. J Gerontol A Biol Sci Med Sci 1998;53(1):M39-46.
95. Pellegrino R, Viegi G, Brusasco V, et al. Interpretative strategies for lung function tests. Eur Respir J 2005;26(5):948-968.
96. Quanjer PH, Stocks J, Cole TJ, Hall GL, Stanojevic S, Global Lungs I. Influence of secular trends and sample size on reference equations for lung function tests. Eur Respir J 2011;37(3):658-664.
97. Kang M, Ragan BG, Park JH. Issues in outcomes research: an overview of randomization techniques for clinical trials. J Athl Train 2008;43(2):215-221.
98. Lung function testing: selection of reference values and interpretative strategies. American Thoracic Society. Am Rev Respir Dis 1991;144(5):1202-1218.
99. Quanjer PH, Tammeling GJ, Cotes JE, Pedersen OF, Peslin R, Yernault JC. Lung volumes and forced ventilatory flows. Report Working Party Standardization of Lung Function Tests, European Community for Steel and Coal. Official Statement of the European Respiratory Society. Eur Respir J Suppl 1993;16:5-40.
100. Jenicek M, Cleroux R. Clinical epidemiology: its evolution and role in clinical practice and research. Union Med Can 1985;114(8):625-632, 651.
101. Tyler CJ, Reeve T, Hodges GJ, Cheung SS. The Effects of Heat Adaptation on Physiology, Perception and Exercise Performance in the Heat: A Meta-Analysis. Sports Med 2016;46(11):1699-1724.
102. Guyatt GH, Pugsley SO, Sullivan MJ, et al. Effect of encouragement on walking test performance. Thorax 1984;39(11):818-822.
103. Vanjare NV, Kodgule RR, Brashier BB. 6-minute walk distance: effect of instructions. Chest 2014;145(6):1439-1440.
104. Brooks D, Solway S, Weinacht K, Wang D, Thomas S. Comparison between an indoor and an outdoor 6-minute walk test

among individuals with chronic obstructive pulmonary disease. Arch Phys Med Rehabil 2003;84(6):873-876.
105. Sciurba F, Criner GJ, Lee SM, et al. Six-minute walk distance in chronic obstructive pulmonary disease: reproducibility and effect of walking course layout and length. Am J Respir Crit Care Med 2003;167(11):1522-1527.
106. Labadessa IG, Arcuri JF, Sentanin AC, da Costa JN, Pessoa BV, Di Lorenzo VA. Should the 6-Minute Walk Test Be Compared When Conducted by 2 Different Assessors in Subjects With COPD? Respir Care 2016;61(10):1323-1330.
107. Jay SJ. Passive smoking and the 6-minute walk test in heart failure. Chest 1997;112(1):289-290.
108. Glantz SA, Parmley WW. Passive smoking and heart disease. Mechanisms and risk. JAMA 1995;273(13):1047-1053.
109. Chevalier RB, Krumholz RA, Ross JC. Reaction of nonsmokers to carbon monoxide inhalation. Cardiopulmonary responses at rest and during exercise. JAMA 1966;198(10):1061-1064.
110. Sheps DS, Herbst MC, Hinderliter AL, et al. Production of arrhythmias by elevated carboxyhemoglobin in patients with coronary artery disease. Ann Intern Med 1990;113(5):343-351.
111. Gosselink R, Troosters T, Decramer M. Peripheral muscle weakness contributes to exercise limitation in COPD. Am J Respir Crit Care Med 1996;153(3):976-980.
112. Rantanen T, Guralnik JM, Sakari-Rantala R, et al. Disability, physical activity, and muscle strength in older women: the Women's Health and Aging Study. Arch Phys Med Rehabil 1999;80(2):130-135.