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REPORTS OF ORIGINAL INVESTIGATIONS

Assessing the accuracy of algorithm-derived cardiorespiratory fitness in surgical patients: a prospective cohort study

Évaluation de la précision de la mesure de capacité cardiorespiratoire fondée sur un algorithme chez les patients chirurgicaux: une étude de cohorte prospective

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Abstract

Purpose *To determine if a non-exercise algorithm-derived assessment of cardiorespiratory fitness (CRF_A) accurately predicted estimated values obtained using a six-minute walk test (CRF_{6MWD}) and the Duke Activity Status Index (CRF_{DASI}).*

Methods *Following research ethics board approval, an observational cohort study was conducted in selected, consenting patients undergoing elective surgery. Participants completed questionnaires assessing their self-reported exercise capacity. Their height, weight, waist circumference, and vital signs were measured. A six-minute walk test was performed twice with a 45-min rest interval between tests. The correlation between CRF_A and both CRF_{6MWD} and CRF_{DASI} was determined.*

Results *Two hundred forty-two participants were included. Mean age was 62 (range 45-88 yr); 150 (62%) were male, 87 (36%) self-reported walking or jogging > 16 km per week, and 49 (20%) were current smokers. The CRF_A and CRF_{6MWD} were highly correlated (Pearson r = 0.878; $P < 0.001$). CRF_A and CRF_{DASI} were less strongly correlated (Pearson r = 0.252; $P < 0.001$). Among patients capable of walking > 427 m in the six-minute walk test, CRF_A, CRF_{6MWD}, and CRF_{DASI} were equivalent.*

Conclusion *A non-exercise algorithm can estimate cardiorespiratory fitness in patients presenting for elective surgery. The variables required to compute CRF_A can be obtained in a clinic setting without the need to engage in formal exercise testing. Further evaluation of CRF_A as a predictor of long-term outcome in patients is warranted.*

Résumé

Objectif *Nous avons tenté de déterminer si une évaluation de la capacité cardiorespiratoire (CRF_A) non fondée sur l'exercice mais dérivée d'un algorithme permettrait de prédire de façon précise les valeurs estimées obtenues dans le cadre d'un test de marche de six minutes (CRF_{6MM}) et du test de DASI (Duke Activity Status Index (CRF_{DASI})).*

Méthode *Après avoir obtenu le consentement du Comité d'éthique de la recherche, une étude de cohorte observationnelle a été réalisée auprès de patients préalablement choisis et ayant donné leur consentement, qui devaient subir une chirurgie non urgente. Les participants ont répondu à des questionnaires évaluant leur capacité d'effort selon leur propre appréciation; leur taille, poids, tour de taille et signes vitaux ont été mesurés. Un test de marche de six minutes a été réalisé à deux reprises, avec un intervalle de repos de 45 minutes entre les deux phases du test.*

Résultats *Deux cent quarante-deux participants ont pris part à l'étude. L'âge moyen était de 62 ans (45-88 ans); 150 (62 %) participants étaient des hommes, 87 (36 %) ont rapporté marcher ou courir > 16 km par semaine, et 49 (20 %) étaient actuellement fumeurs. La CRF_A et la CRF_{6MM}*

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étaient très corrélées (coefficient de Pearson r 0,878, P < 0,001); la CRF_A et la CRF_{DASI} étaient moins corrélées (coefficient de Pearson r 0,252, P < 0,001). Parmi les patients capables de marcher > 427 m au cours du test de marche de 6 minutes, la CRF_A, CRF_{6MM} et la CRF_{DASI} étaient équivalentes.

Conclusion *Un algorithme non fondé sur l'exercice peut estimer la capacité cardiorespiratoire des patients se présentant pour une chirurgie non urgente. Les variables nécessaires à calculer la CRF_A peuvent être obtenues dans un contexte clinique sans devoir tester l'exercice de façon formelle. Une évaluation approfondie de la CRF_A en tant que prédicteur des pronostics à long terme des patients serait nécessaire.*

In the evaluation of patients presenting for elective surgery, assessment of functional status assists in estimating perioperative risk and establishing the need for further testing before surgery.[1] Usually, functional status is determined by inquiring about the patient's capacity to perform routine activities of daily living or, more specifically, their ability to "climb a flight of stairs". The inability to perform the latter is closely correlated with an increase in perioperative complications[2] and is equated with an exercise capacity of < 4 metabolic equivalent of task (MET) - i.e., the metabolic rate while sitting quietly in a chair where 1 MET is approx. 3.5 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$.[3] The reliability of this form of assessment has recently been called into question, and emphasis is being placed on the need for more accurate estimates of exercise capacity.[4]

The gold standard for assessing cardiorespiratory fitness (CRF) is the cardiopulmonary exercise test (CPET) which assesses maximum oxygen consumption (VO_{2max}) and the anerobic threshold. Hill and Lupton[5] defined VO_{2max} as "the oxygen intake during an exercise intensity at which actual oxygen intake reaches a maximum beyond which no increase in effort can raise it." Anerobic threshold is defined as "the level of work or O_2 consumption just below that at which metabolic acidosis and the associated changes in gas exchange occur."[6] Studies have shown that the CPET accurately predicts the risk of postoperative cardiorespiratory events in surgical patients.[7,8] A systematic review concluded that VO_{2max}, as determined by a CPET, is a predictor of perioperative morbidly and mortality in a non-cardiopulmonary surgical population.[9] Unfortunately, CPET is impractical to perform in routine practice.

The six-minute walk test (6MWT) is a less resource-intensive method of estimating CRF.[10,11] It assesses the submaximum level of functional activity, is reflective of a patient's capacity to perform daily activities, has been validated in several populations, and is predictive of adverse outcomes following surgery. The 6MWT is considered a useful test in risk stratification of elective surgical patients. Distances walked > 563 m during the 6MWT indicate that a CPET is not necessary, whereas a walk distance of < 427 m indicates that a patient is at high preoperative risk and should undergo further evaluation.[12] Nevertheless, the 6MWT requires personnel to supervise and monitor the patient during the performance of the test. It takes time to perform and, consequently, is not widely used in preoperative assessment.

A non-exercise algorithm using routinely available clinical variables (height, weight, waist circumference, resting heart rate, smoking status, and self-reported fitness level) provides MET values that are closely correlated with treadmill testing data in healthy individuals.[13] We postulated that using a non-exercise algorithm to determine CRF preoperatively might prove to be a more accurate and feasible option in terms of time, resources, and patient burden.

This study used a consecutive sample of selected elective surgical patients to estimate and compare CRF obtained by means of 1) a non-exercise algorithm developed by Jackson *et al.*,[14] 2) data derived from two 6MWTs performed in accordance with the guidelines developed by the American Thoracic Society,[15] and 3) the Duke Activity Status Index (DASI).[16] We hypothesized that, in a population of patients awaiting elective non-cardiac surgery, CRF estimated using the non-exercise algorithm (CRF_A) would accurately predict CRF values objectively determined from the distance walked on the 6MWT (CRF_{6MWD}) and those self-reported using the widely known DASI (CRF_{DASI}).

Methods

Participants

The study was approved by the Ethics Review Board at the University of Alberta on 2014-12-17. Recruitment occurred from May to September 2015. Patients undergoing major elective surgery (see Table 1) were pre-screened, approached, and enrolled during their appointment at the pre-admission clinic (PAC) at the University of Alberta and the Royal Alexandra hospitals in Edmonton, AB, Canada. All patients were considered for inclusion unless they were American Society of Anesthesiologists class I or II or < 45 yr of age. This approach was taken in an attempt to include patients across a spectrum of CRF, not just healthy young individuals. Exclusion criteria were patients with uncontrolled

Table 1 Participant characteristics and measures of cardiorespiratory fitness

	Male n = 150 Mean (SD)	Female n = 92 Mean (SD)
Age (yr)	63.6 (9.4)	59.9 (9.6)
Height (cm)	174 (7)	162 (7)
Weight (kg)	90.8 (17.9)	77.4 (16.6)
BMI	30.0 (5.5)	29.6 (5.8)
WC (cm)	106.5 (14.5)	99.3 (15.0)
Resting heart rate (beats·min^{-1})	74 (14)	76 (12)
Systolic BP (mmHg)	132 (13)	130 (15)
Diastolic BP (mmHg)	83 (10)	77 (11)
Respiration Rate (breaths·min^{-1})	18 (2)	18 (2)
O_2 Saturation (%)	96 (2)	97 (2)
6MWT* (m)	539 (58)	506 (75)
DASI**	53.8 (7.6)	49.9 (9.6)
CRF_A† (MET value)	9.0 (2.2)	7.4 (1.9)
CRF_{6MWD}‡ (MET value)	8.9 (1.9)	7.9 (1.5)
CRF_{DASI}§ (MET value)	9.3 (0.9)	8.9 (1.2)
	n (%)	n (%)
Walk or jog >16 km·wk^{-1} (Yes)	59 (39.3)	28 (30.4)
Willing to be in fitness program (Yes)	124 (82.7)	79 (85.9)
Smoking status		
Never	55 (36.7)	30 (32.6)
Current	28 (18.7)	21 (22.8)
Former	67 (44.7)	41 (44.6)
Asthma (Yes)	12 (8.0)	16 (17.4)
Cancer (Yes)	86 (57.3)	43 (46.7)
Diabetes (Yes)	36 (24.0)	10 (10.9)
Hyperlipidemia	34 (22.7)	18 (19.6)
Cardiovascular Disease (CVD) (Yes)	17 (11.3)	12 (13.0)
Hypertension (Yes)	60 (40.0)	22 (23.9)
Pulmonary disease (Yes)	10 (6.7)	12 (13.0)
Renal disease (Yes)	9 (6.0)	3 (3.3)
Thyroid Disease (Yes)	12 (8.0)	17 (18.5)
Allergies (Yes)	55 (36.7)	51 (55.4)
Type of surgery		
Abdominal surgery	20 (13.3)	16 (17.4)
Head and Neck Surgery	32 (21.3)	27 (29.3)
General non-abdominal§§	81 (54.0)	39 (42.4)
Thoracic surgery	17 (11.3)	10 (10.9)

SD = standard deviation; BMI = body mass index; BP = blood pressure; MET = metabolic equivalent of task; WC = waist circumference

* 6MWT = six-minute walk test; ** DASI = Duke Activity Status Index; CRF = cardiorespiratory fitness; †CRF_A = non-exercise derived CRF; ‡CRF_{6MWD} = CRF derived from the 6MWT distance; §CRF_{DASI} = CRF derived from DASI. §§General non-abdominal surgery includes orthopedic (no limitation in lower limb function), urology, mastectomy, endoscopic, and laparoscopy surgeries

hypertension (> 180/110 mmHg), unstable angina, history of a recent heart attack in the last month, or a resting heart rate > 120 beats·min^{-1}. Patients who were taking beta-blocker medication, scheduled to be admitted to an intensive care unit postoperatively, or unable to provide written and informed consent were also excluded from the study. In addition, patients with physical limitations affecting their ability to perform the 6MWT were excluded. Patients gave their informed written consent prior to enrolment and data collection. Two trained medical students took the measurements, collected data, and monitored 6MWT performance.

Procedures

Before performing the 6MWT, participants provided data on their demographics, smoking status (smoker, non-smoker, ex-smoker), medical history, medications, and physical activity level by self-reporting their level of physical activity in the past 30 days (walked or jogged less or more than 16 $km \cdot wk^{-1}$). They also completed the DASI questionnaire.

Patients' height and weight were taken with a medical grade scale and stadiometer, and their waist circumference was measured at the midpoint between the iliac crest and the bottom of the rib cage in accordance with World Health Organization recommendations.[17] After patients rested for five minutes, their vital signs (blood pressure, heart rate, O_2 saturation) were recorded. Respiration rate was recorded over 15 sec and adjusted to the number of breaths per minute. Patients were to abstain from alcohol, caffeine, and nicotine for at least 30 min prior to measurement.[18]

The 6MWT was performed according to the American Thoracic Society guidelines.[15] The test was performed twice with at least a 45-min rest between the first and second tests. Patients were instructed to walk laps around a track to achieve the farthest distance possible within six minutes. The track consisted of two orange cones placed 30 m apart in a level hallway marked at 3-m intervals. Patients proceeded 30 m, turned 180° around a cone, and continued back to their initial position to complete 60 m per lap. Before and after the exercise, patients were asked to rate their shortness of breath and perceived exertion using the 6-20 Borg scale,[15] where 6 = no exertion at all, and 20 = maximum exertion. The distance walked in both tests was recorded to the nearest metre completed, and the test with the greatest distance was used in our analysis.

The CRF values, expressed in METS, were estimated for the non-exercise algorithm (CRF_A),[14,19] the distance on the 6MWT (CRF_{6MWD}),[20] and the DASI (CRF_{DASI})[16] using the following formulae. VO_{2max} values were converted to METS by dividing by 3.5, where appropriate:

CRF_A

Females equation:

$$= 14.7873 + (Age \cdot 0.1159) - (Age^2 \cdot 0.0017) - (BMI \cdot 0.1534) - (WC \cdot 0.0085) - (RHR \cdot 0.0364) + (PAI \cdot 0.5987) - (CS \cdot 0.2994).$$

Males equation:

$$= 21.2870 + (Age \cdot 0.1654) - (Age^2 \cdot 0.0023) - (BMI \cdot 0.2318) - (WC \cdot 0.0337) - (RHR \cdot 0.0390) + (PAI \cdot 0.6351) - (CS \cdot 0.4263).$$

$$CRF_{6MWD} = (70.161 + (0.023 \cdot 6MWD) - (0.276 \cdot weight) - (6.79 \cdot sex) - (0.193 \cdot RHR\ [beats \cdot min^{-1}]) - (0.191 \cdot age\ [yr]))/3.5.$$

$$CRF_{DASI} = ((0.43 \cdot \text{Duke Activity Status Index}) + 9.6)/3.5$$

where age = age (yr); BMI = body mass index ($kg \cdot m^{-2}$); WC = waist circumference (cm); RHR = resting heart rate ($beats \cdot min^{-1}$); PAI = physical activity index as assessed by self-reporting of walking >16 $km \cdot week^{-1}$ (0 inactive, 1 active); CS = currently smoke (0 no, 1 yes). 6MWD = six-minute walk test distance (m); sex = (male = 0, female = 1).

Statistical analysis

Our sample size was calculated to assess surgical short-term outcomes and the impact on quality of life at six months following the initial test (not reported in this manuscript). According to Burr *et al.*,[20] the mean (standard deviation [SD]) aerobic demand of the 6MWT for healthy adults is 28.7 (5.7) $mL \cdot kg^{-1} \cdot min^{-1}$ (MET value = 8.2). To test our hypothesis, the power was set at 0.80, and an alpha of $P < 0.05$ was used. A sample size of 201 patients was calculated as required for a one-sample non-inferiority test with the true mean (SD) MET value of 8.2 (1.6) and the equivalence margin of 0.3. Accounting for a 30% attrition rate at the six-month follow-up - according to a recently published study in Canadian surgical patients[21] - a sample size of 261 was determined.

Two variables had a single missing value, which were imputed using the median of all entries for the variable.

Continuous variables were reported using mean (SD) and compared using Student's *t* test and analysis of variance. Categorical variables were presented using frequency and percentages and compared using the Chi square test. Bivariate correlation analysis was performed, and linear regression analysis models were used to investigate the correlation between CRF_A, CRF_{6MWD}, and CRF_{DASI}.

Results

Six of the 266 recruited participants withdrew their consent and an additional 18 were excluded from analyses. Two patients refused to provide a waist circumference measurement; one was using a beta blocker; one had a pacemaker; nine showed physical limitations that prevented appropriate performance of the 6MWT; three did not follow the instructions when performing the 6MWT; and two were identified outliers for their high 6MWT distance (Fig. 1). Of the remaining 242 participants (mean age 62 yr, range 45-88 yr) included in the analysis, 150 (62%) were male, 87 (36%) self-reported being physically active, and 49 (20%) were current smokers. No significant difference was found between the two hospital groups. Table 1 shows the baseline characteristics and measures of cardiorespiratory fitness of our participants stratified by sex. There were no adverse events during the 6MWT. Borg scale data in both tests showed that < 5% of our participants reported somewhat severe to severe shortness of breath or fatigue post-test (Table 2). Patients who self-reported walking or jogging > 16 $km \cdot wk^{-1}$ walked farther on the 6MWT than less-active patients [540 (69) m *vs* 519 (71) m; Student's $t = 2.3$; $P = 0.03$].

The CRF_A and CRF_{6MWD} were highly correlated (Pearson r = 0.878; $P < 0.001$, Fig. 2a); CRF_A and CRF_{DASI} were less strongly correlated (Pearson r = 0.252; $P < 0.001$, Fig. 2b). These correlations remained when stratified by sex and level of physical activity. A comparison of CRF_A and the unadjusted distance walked during the 6MWT is also presented (Pearson r = 0.420; $P < 0.001$, Fig. 2C).

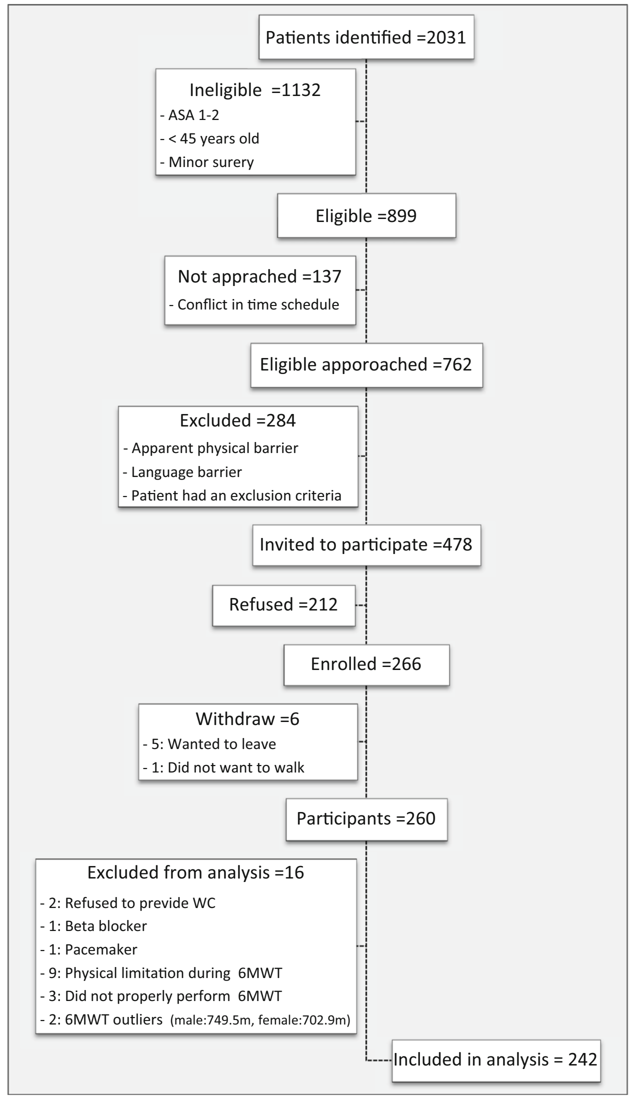

Fig. 1 Study scheme

Paired-sample Student's *t* test showed no significant difference between CRF_{6MWD} and CRF_A in patients who walked < 427 m (Student's $t = 1.61$; $P = 0.13$) or walked 427-563 m (Student's $t = 1.22$; $P = 0.23$). Nevertheless, this difference was statistically significant between CRF_{6MWD} and CRF_{DASI} for both groups (Student's $t = 4.2$; $P = 0.001$ and Student's $t = 4.8$; $P < 0.001$, respectively). For patients who walked > 563 m, no significant difference was seen for any of the estimations (Table 3). Fig. 3 graphically shows that the CRF_A is equivalent to the measured CRF_{6MWD} in patients capable of walking > 427 m.

Discussion

In this observational study involving a cohort of surgical patients, < 40% of participants self-reported being

Table 2 Borg scale for shortness of breath or fatigue pre-test and post-test

	Test 1				Test 2			
	Shortness of breath		Fatigue		Shortness of breath		Fatigue	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Nothing	163 (67.4)	40 (16.5)	150 (62.0)	81 (33.5)	157 (64.9)	39 (16.1)	150 (62.0)	74 (30.6)
Very very slight	22 (9.1)	35 (14.5)	18 (7.4)	30 (12.4)	24 (9.9)	48 (19.8)	18 (7.4)	35 (14.5)
Very slight	22 (9.1)	46 (19.0)	30 (12.4)	42 (17.4)	32 (13.2)	57 (23.6)	35 (14.5)	46 (19.0)
Slight	24 (9.9)	61 (25.2)	27 (11.2)	45 (18.6)	20 (8.3)	39 (16.1)	18 (7.4)	42 (17.4)
Moderate	9 (3.7)	49 (20.2)	13 (5.4)	36 (14.9)	7 (2.9)	43 (17.8)	18 (7.4)	35 (14.5)
Somewhat severe	1 (0.4)	9 (3.7)	3 (1.2)	6 (2.5)	1 (0.4)	12 (5.0)	2 (0.8)	7 (2.9)
Severe	1 (0.4)	2 (0.8)	1 (0.4)	2 (0.8)	-	1 (0.4)	-	2 (0.8)

Data are presented as *n* (%)

physically active. Study results showed a strong correlation between CRF_A and CRF_{6MWD} and a weak correlation with $CRF_{DASI.}$ The mean CRF_A was significantly lower for patients who walked < 563 m than those who walked > 563 m. To predict CRF in this study, we used a non-exercise algorithm developed from longitudinal rather than cross-sectional data and one that accounts for the nonlinear decline in CRF that occurs with advancing age. This algorithm has been shown to predict the future risk of non-fatal cardiovascular events and related mortality in a large cohort of more than 34,000 males and 9,000 females after adjusting for the appropriate risk factors.[19] Unlike the cohort initially used to determine the non-exercise algorithm - which was predominantly white, well-educated, and essentially healthy individuals participating in a preventive health program in Texas - our sample consisted of a wide spectrum of patients aged over 45 yr and attending preoperative assessment clinics at two tertiary care hospitals. All were covered by a provincially funded universal health care system and came from diverse social backgrounds. Our study population was older and had coexisting health issues, including cancer, diabetes, and cardiovascular disease.

We compared the estimated CRF_A using the CRF_{6MWD} derived from an analysis of the 6MWT data - obtained on two occasions 45 min apart at the time of a PAC visit. The 6MWT is considered a reasonable alternative to the CPET approach, particularly when modified by anthropometric and demographic variables.[20,22] The importance of including these variables in the estimation of CRF by the 6MWT is underscored by our finding that the distance walked according to the 6MWT or 6MWT data modified by standard constants[23,24] correlated poorly with CRF_A in our patient population. We found an excellent correlation between the estimated CRF_A and the CRF_{6MWD}, both of which adjust for anthropomorphic and demographic variables, suggesting that both equations could be used to estimate the CRF. Using the CRF_A may well obviate the need to perform a 6MWT. However, we excluded patients who were being treated with beta blocking drugs as the CRF_A includes the resting heart rate as one of the parameters of the algorithm. In consequence, only $\sim$11% of the study group had a history of heart disease. The utility of CRFA in populations with a greater prevalence of heart disease remains unknown.

In our comparison of estimated MET values using the CRF_A, CRF_{6MWD}, and CRF_{DASI}, we compared across cut points similar to those described by Sinclair *et al.*[12] These 6MWD values are of course arbitrary, but they seem reasonable for comparison purposes given the limited data on outcomes and CRF, in large part because of the practical difficulty of measuring the latter. Our data suggest that CRF_{DASI} may overestimate CRF in those who have a lower 6MWD value. Also, our observations must be treated cautiously as we had few subjects (n = 19) in the < 427 6MWD cohort, and all of the compared MET values were estimated. Others who have focused on older patients with previously diagnosed cardiac and respiratory disease have found a reasonable relation between functional tests such as the incremental shuttle walk test and the DASI.[25]

The 6MWT distance achieved by our study group was less than that recently observed in a group of healthy Canadian individuals.[24] Interestingly, positive answers to the question “In the past 30 days did you participate in some regular physical activity?” were associated with better CRF using all three measures studied (data not shown). Nevertheless, it may be valuable to include a question about participation in regular physical activity as part of routine preoperative assessment.

One study limitation was that we did not attempt to correlate the CRF - calculated by any of the three measures - with surgery outcomes, including cardiovascular outcomes. The population studied was not representative of all patients who require surgery, as the exclusion criteria

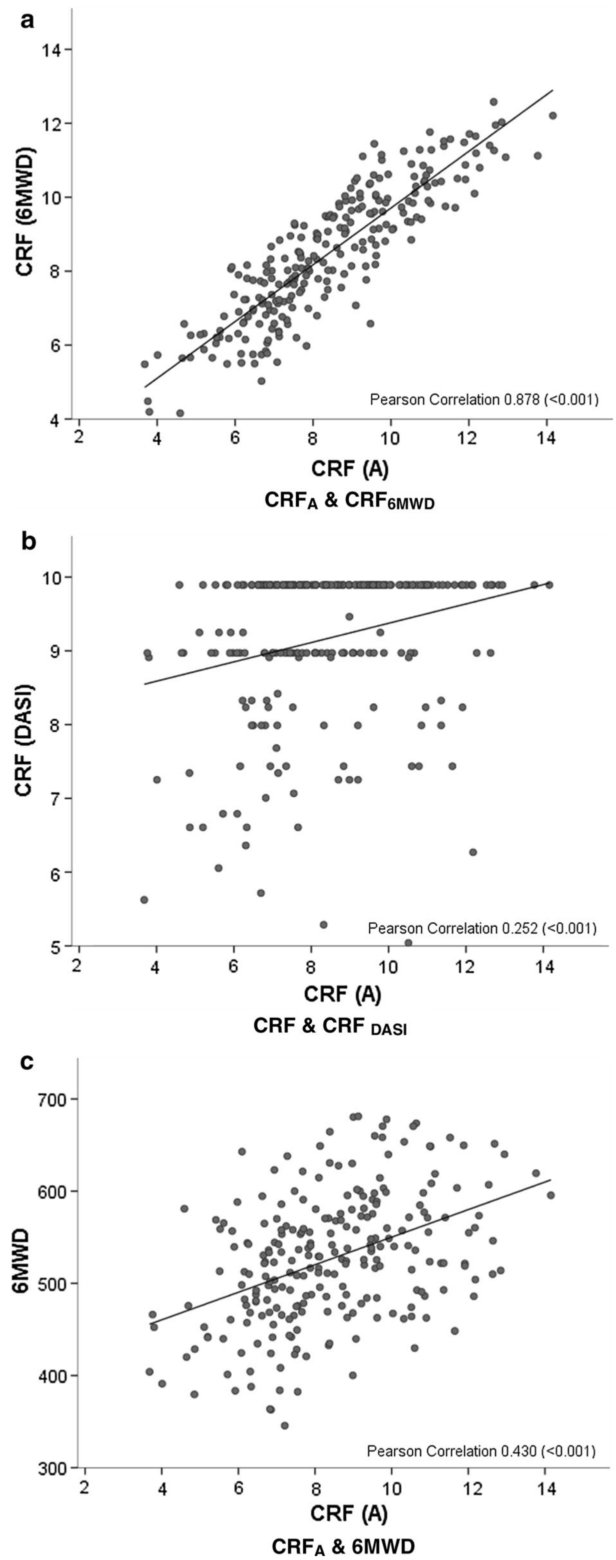

Fig. 2 Correlation of CRF_A with (a) CRF_{6MWD}, (b) CRF_{DASI}, and (c) 6MWD. CRF = cardiorespiratory fitness; CRF_A = CRF derived from the non-exercise algorithm (METS); CRF_{6MWD} = CRF derived from the distance walked on the six-minute walk test (METS); CRF_{DASI} = CRF derived from Duke Activity Status Index (METS); 6MWD = distance walked on the six-minute walk test (m)

Table 3 CRF_A, CRF_{6MWD}, and CRF_{DASI} by 6MWD cut points

6MWD*	*n*	Mean (SD) (MET value)		Difference in mean				Paired Differences			
				Mean	95% CI	*t*	*P* value (1-tailed)	Mean	95% CI	*t*	*P* value (1-tailed)
< 427 m	19	CRF_{6MWD}‡ 6.77 (0.98)	CRF_A - CRF_{6MWD}	−0.39	−1.17 to 0.39	−1.02	0.15	0.39	−0.12 to 0.89	1.61	0.06
		CRF_A† 6.38 (1.35)	CRF_{DASI} - CRF_{6MWD}	1.30	0.55 to 2.05	3.50	<0.001	1.31	0.63 to 1.98	4.07	0.005
		CRF_{DASI}§ 8.07 (1.30)	CRF_{DASI} - CRF_A	1.69	0.82 to 2.56	3.93	0.001	1.69	1.06 to 2.33	5.62	<0.001
427-563 m	152	CRF_{6MWD} 8.32 (1.68)	CRF_A - CRF_{6MWD}	−0.09	−0.50 to 0.31	0.44	0.33	0.09	−0.06 to 0.25	1.22	0.13
		CRF_A 8.23 (1.91)	CRF_{DASI} - CRF_{6MWD}	0.77	0.45 to 1.09	4.73	<0.001	0.77	0.45 to 1.10	4.83	<0.001
		CRF_{DASI} 9.09 (1.10)	CRF_{DASI} - CRF_A	0.86	0.51 to 1.21	4.81	<0.001	0.86	0.52 to 1.20	5.03	<0.001
> 563 m	71	CRF_{6MWD} 9.32 (1.73)	CRF_A - CRF_{6MWD}	0.04	−0.57 to 0.65	0.13	0.45	−0.04	−0.27 to 0.19	−0.34	0.38
		CRF_A 9.36 (1.94)	CRF_{DASI} - CRF_{6MWD}	0.31	−0.11 to 0.73	1.46	0.07	0.3	−0.11 to 0.71	1.47	0.06
		CRF_{DASI} 9.63 (0.48)	CRF_{DASI} - CRF_A	0.27	−0.20 to 0.74	1.14	0.13	0.26	−0.19 to 0.72	1.14	0.14

CI = confidence interval; CRF = cardiorespiratory fitness; MET = metabolic equivalent of task; *t* = Student's *t* test

* 6MWD = six-minute walk distance; ‡CRF_{6MWD} = CRF derived from the 6MWT distance; †CRF_A = non-exercise derived CRF; §CRF_{DASI} = CRF derived from Duke Activity Status Index

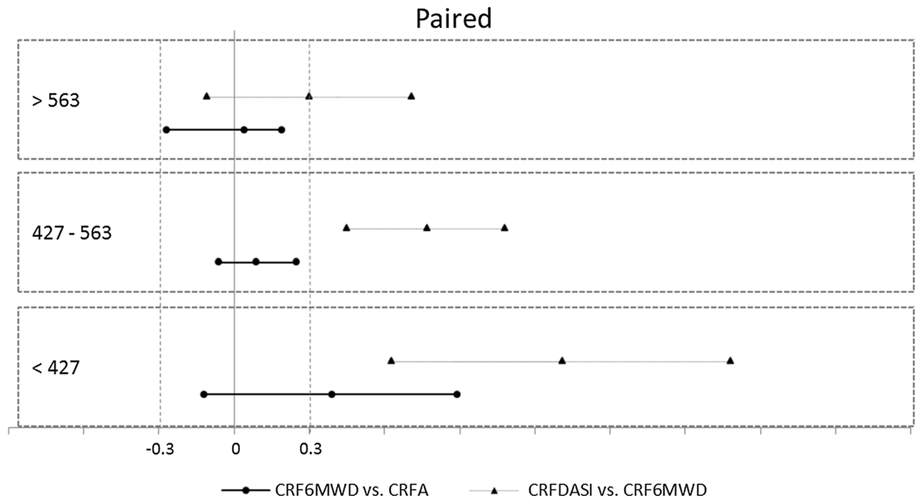

Fig. 3 Differences between CRF_A, CRF_{6MWD}, and CRF_{DASI} using 6MWD cut points. CRF_A = CRF derived from the non-exercise algorithm (METS); CRF_{6MWD} = CRF derived from the distance walked on the 6 minute walk test (METS); CRF_{DASI} = CRF derived from Duke Activity Status Index (METS); 6MWD = distance walked on the six-minute walk test (m)

eliminated the vast majority of patients with heart disease from participation. Our sample of patients who walked < 427 (19) m was relatively small, further limiting our ability to draw a firm conclusion about equivalency in this subset of patients with poor exercise capacity.

In conclusion, CRF can be relatively accurately estimated by a non-exercise algorithm in a defined subgroup of patients presenting for elective surgery. The variables required to obtain CRF in this fashion can be easily obtained in a clinical setting without the need to engage in exercise-related testing. Further evaluation of CRF_A as a predictor of long-term postoperative outcome in patients is warranted.

Conflicts of interest None declared.

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