A Non-Exercise Prediction of Cardiorespiratory Fitness for Patients with Cardiovascular Disease: Data from the Fitness Registry and the Importance of Exercise International Database (FRIEND)

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FRIEND Fitness Registry: Importance of Exercise National Database

ABSTRACT

INTRODUCTION: The importance of cardiorespiratory fitness (CRF) for stratifying mortality risk and guiding clinical care in patients with cardiovascular disease (CVD) is well-established. An American Heart Association Scientific Statement suggests routine clinical assessment of CRF using non-exercise prediction equations when direct assessment from a cardiopulmonary exercise test is not feasible. However, current prediction equations have been created from cohorts of apparently healthy individuals and a CVD-specific prediction equation is needed. **We hypothesized** a CVD-specific non-exercise equation would have higher accuracy for predicting CRF compared to an equation developed from a cohort without known CVD.

METHODS: Participants from the Fitness Registry and Importance of Exercise International Database (FRIEND) with a diagnosis of coronary artery bypass surgery (CABG), myocardial infarction (MI), percutaneous coronary intervention (PCI), or heart failure (HF) who performed a cardiopulmonary exercise test were studied (83% [10,417 of 12,578] male; age 62.7 ± 10.3 years). The cohort (12,578 tests; 49% [6,190] treadmill tests) was split into development (10,062) and validation (2,516) groups. The prediction equation was developed using linear regression analysis and comparisons were made with a different CRF prediction equation developed on an apparently healthy cohort using FRIEND.

RESULTS: Age, sex, height, body mass, exercise mode, and CVD diagnosis were all significant predictors of CRF. The regression equation was:

CRF (ml·kg^{-1}·min^{-1}) = 17.03 – (0.21 * age [years]) + (3.60 * sex [male = 1; female = 0]) + (0.12 * height [cm]) – (0.11 * body mass [kg]) + (3.75 * mode [treadmill = 1; cycle = 0]) – (2.40 * CABG [yes = 1, no = 0]) – (0.29 * MI [yes = 1, no = 0]) + (0.75 * PCI [yes = 1, no = 0]) – (3.90 * HF [yes = 1, no = 0])

(R = 0.65, adjusted R^2 = 0.42, SEE = 4.74 ml·kg^{-1}·min^{-1})

When compared to measured CRF in the validation group (19.6 ± 6.2 ml·kg^{-1}·min^{-1}), predicted CRF was similar for the CVD equation (19.8 ± 4.1 ml·kg^{-1}·min^{-1}[101%]) and higher for the healthy cohort equation (28.2 ± 7.0 ml·kg^{-1}·min^{-1}[144%]; *P*<0.05). Significant Pearson correlations were found when using either prediction equation although the correlation when using the CVD equation was significantly higher (r = 0.65) than that for the healthy cohort equation (r = 0.48, *P*<0.05). Differences between equations were also observed for root mean square error (4.7 and 10.9 ml·kg^{-1}·min^{-1} for the CVD and healthy cohort equations, respectively).

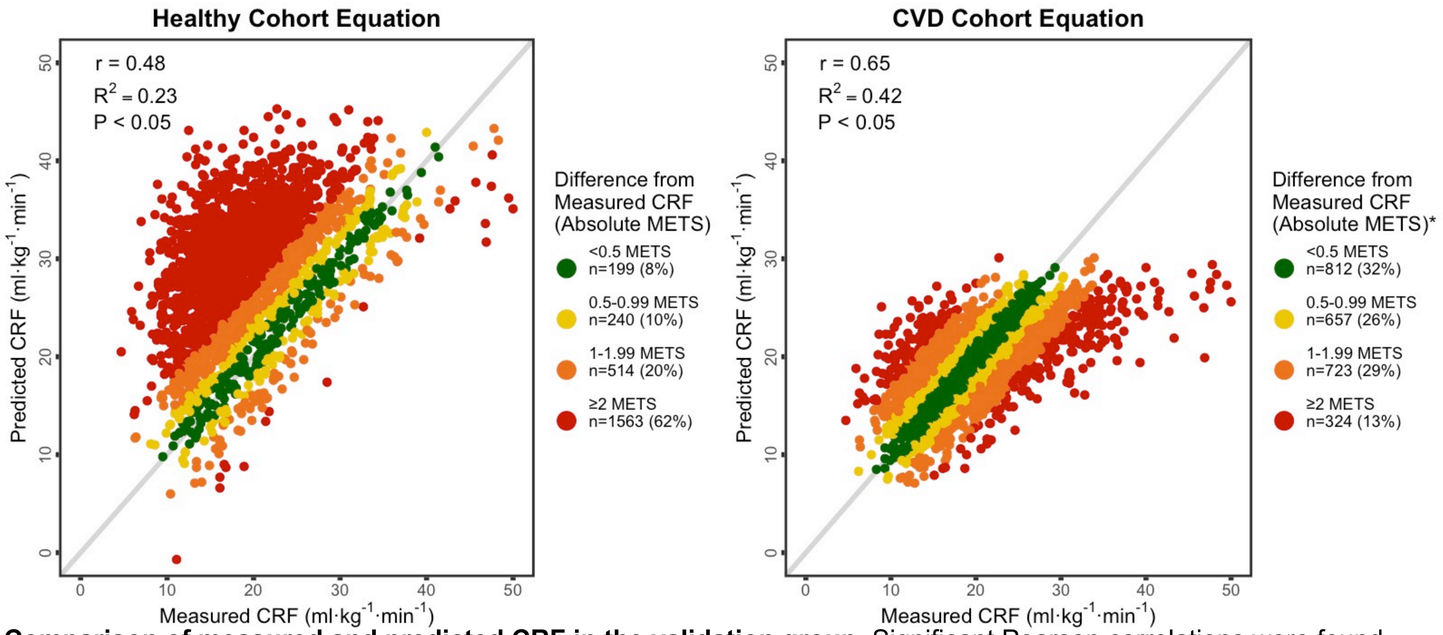
CONCLUSIONS: As hypothesized, the CVD-specific non-exercise equation was a better predictor of CRF in a cohort of individuals with CVD. The new equation for individuals with CVD provided a lower mean error between measured and predicted CRF than an equation developed from an apparently healthy cohort. Thus, population specific equations are needed for predicting CRF; however, the error associated with non-exercise prediction equations suggests CRF should be directly measured whenever feasible.

RESULTS

Measured CRF, predicted CRF, and root mean square error (RMSE) of predicted CRF in different subgroups of the validation group. Predicted CRF was significantly higher than measured CRF for each subgroup when using the healthy equation (P < 0.05). The RMSE from the healthy equation was roughly double the CVD equation in each sub-analysis.

		Healthy Equation			CVD Equation		
	Measured CRF (ml·kg^{-1}·min^{-1})	Predicted CRF (ml·kg^{-1}·min^{-1})	Mean Percent of Measured	RMSE (ml·kg^{-1}·min^{-1})	Predicted CRF (ml·kg^{-1}·min^{-1})	Mean Percent of Measured	RMSE (ml·kg^{-1}·min^{-1})
CABG (n=725)	18.0 ± 5.1	28.7 ± 6.5 *	160%	12.4	18.3 ± 3.5	102%	4.3
MI (n=897)	21.1 ± 6.4	28.9 ± 6.8 *	137%	10.3	21.3 ± 3.4	101%	5.0
PCI (n=559)	21.5 ± 6.6	27.4 ± 7.3 *	127%	8.6	21.3 ± 3.7	99%	4.9
HF (n=260)	15.4 ± 4.6	25.3 ± 7.4 *	164%	12.3	15.5 ± 4.0	101%	4.4
Any CVD (n=2,516)	19.6 ± 6.2	28.2 ± 7.0 *	144%	10.9	19.8 ± 4.1	101%	4.7
Males with CVD (n=2,107)	20.3 ± 6.2	30.0 ± 5.7 *	148%	11.6	20.5 ± 3.8	101%	4.9
Females with CVD (n=409)	15.9 ± 4.6	18.8 ± 5.2 *	118%	5.9	16.1 ± 3.6	102%	3.9

* Significantly different from measured CRF (P < 0.05)



Comparison of measured and predicted CRF in the validation group. Significant Pearson correlations were found when using either prediction equation, yet the correlation when using the CVD equation was significantly higher compared to the healthy cohort equation (P < 0.05). * The distribution of individuals grouped by degree of error from measured CRF in absolute METS was significantly different when using the CVD equation compared to the healthy equation (*P* < 0.05).