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ORIGINAL ARTICLE

Interpreting Meaningful Change in the Distance Walked in the 10-Metre ISWT in Cardiac Rehabilitation

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Background The interpretability of change in exercise test scores is an important measurement property. This study aimed to provide a framework for the interpretation of individual change scores of the 10 metre incremental shuttle walk test (ISWT) in cardiac rehabilitation.

Methods In a quantitative pre-post design study, 52 patients who were referred to a hospital outpatient department for cardiac rehabilitation participated in this study. Participants completed two ISWTs prior to cardiac rehabilitation. Post cardiac rehabilitation, participants completed a global rating of change score and two ISWTs. Change scores were analysed for smallest detectable change (SDC) and minimum important change (MIC).

Results The SDC for an individual was 47 metres. The predicted MIC for participants to report an improvement ranged from 70 to 92 metres. The predicted MIC for participants who did not report a deterioration in the global rating of change (i.e., those who reported unchanged or improved) ranged from 16 to 42 metres.

Conclusions The MIC for patients who report any improvement in physical fitness and functional capacity is 70 metres. These results suggest that over an 8-week program, patients would need to improve by at least seven shuttles to perceive an improvement in their physical fitness and functional capacity. Patients with small increases in the 10-metre ISWT distance may still report deterioration in their physical fitness and functional capacity.

Keywords Cardiac rehabilitation • Incremental shuttle walk test • Minimal clinically important difference • Patient outcome assessment

Introduction

Exercise training to improve physical fitness and functional capacity is an important intervention in cardiac rehabilitation [1–4]. Changes in physical fitness and functional capacity can be measured in the laboratory or the field [5–8]. The 10-metre incremental shuttle walk test (ISWT) is a commonly used externally paced and incremental field exercise test in cardiac rehabilitation [9]. Previous research has supported both the retest reliability of this test when either one or two tests were performed on admission to cardiac rehabilitation [10–15] and criterion validity when either one or two tests were performed [10,11,14–17].

An important aspect of measurement properties is the interpretability of the change scores. Meaningful change has been defined by the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) group as the degree to which qualitative meaning can be

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applied to test scores [18,19] and can be expressed as the smallest detectable change (SDC) and minimal important change (MIC).

The reported SDC for the ISWT distance walked in cardiac rehabilitation has ranged from 53 to 203 metres [10,12,20,21]. A single study reported the MIC in ISWT walk distance following a 6-week outpatient cardiac rehabilitation [22]. The MIC ranged from 37 metres with a small effect size when a distribution-based method was used to 70 metres when an anchor-based method was used [22]. These values fall within the reported SDC range. When the SDC is larger than the MIC the level of important change is less than the smallest unit of real change that can be detected and it is difficult to detect meaningful change over and above measurement error.

The aim of this study was to contribute to the limited research on the interpretability of change scores for the ISWT in a cardiac rehabilitation population. Specifically, this research aimed to determine the SDC and the MIC using a variety of methods in a prospective cohort of patients referred to a mixed outpatient cardiac rehabilitation program.

Methods

Design

A consecutive series of patients referred to cardiac rehabilitation who met the eligibility criteria of the study were invited to participate by the cardiac rehabilitation nurse coordinator. All participants volunteered to participate in the study and provided written informed consent. No patient who met the inclusion criteria refused to participate in the study. University and Hospital Human Ethics Committees approved this research.

Prior to cardiac rehabilitation, all participants completed two ISWTs in a single session (ISWT-1 and ISWT-2). At completion of cardiac rehabilitation, all participants recorded a global rating of change and completed two ISWTs in a single session (ISWT-3 and ISWT-4). All testing took place in the physiotherapy department of the participating hospital. All tests took place under the same conditions by the same investigator.

Participants

All adults (>18 years) with stable and treated coronary heart disease, irrespective of severity or duration of the condition, who were referred to cardiac rehabilitation were eligible to participate in this study. Participants were excluded if they had any condition where exercise would be contraindicated or if they were unable to walk for any neurological or musculoskeletal reason. Participants were also excluded if they had previously completed an ISWT, were diagnosed with cardiovascular risk factors in the absence of diagnosed cardiovascular disease, with congenital heart disease or were children or were pregnant.

Outcome Measures

The ISWT protocol was administered according to the description of Singh et al. [9]. The ISWTs were completed on an indoor, flat, 10-metre track. A shuttle referred to one 10-metre lap. A recording of standardised instructions for the ISWT was played immediately prior to beginning the walk test. Signal beeps played at regular intervals to indicate when the participant should turn around the cone to commence the next shuttle. The test commenced with a walking speed of 0.5 m/sec, with speed increments of 0.17 m/sec each minute for a maximum of 12 minutes. The primary outcome measure was distance walked, calculated from the number of completed shuttles.

Participants were allowed a 20-minute rest prior to commencing the first ISWT and were given a 30-minute rest before starting the second ISWT [23]. Prior to commencing the test, baseline heart rate, blood pressure, respiratory rate, oxygen saturation and rate of perceived exertion using the rate of perceived exertion (RPE) Borg 6-20 scale were recorded. Participants were not able to commence the ISWT if resting systolic blood pressure was greater than or equal to 200 mmHg or resting diastolic blood pressure was greater than or equal to 110 mmHg [24,25]. Heart rate and oxygen saturation were monitored throughout each test, using a portable pulse oximeter, without interruption to the test. Monitoring of heart rate, blood pressure, oxygen saturation, respiratory rate and RPE continued after completion of the test until all values returned to within 20% of baseline.

During the post-program assessment, before the completion of the ISWTs, participants were asked to score their global rating of change on a 5-point Likert scale [26]. Participants were asked: *Do you believe your physical fitness has improved significantly, improved a little, is about the same, is slightly worse or significantly worse?* Results were recorded using the five-point scale and then recoded into a three-point scale, improved, same or worse. Improved significantly and improved a little were recoded to improved, and slightly worse or significantly worse were recoded to deteriorated.

Interventions

Participants completed an 8-week cardiac rehabilitation program that included a 60-minute exercise program and a 60-minute group education and discussion forum. The exercise program consisted of a 10-minute warm-up activity that included balance exercises, followed by 20 minutes of individualised circuit training using mostly resistance exercises, 10 to 20 minutes of continuous aerobic activity such as walking, and a 10-minute cool-down activity. An experienced physiotherapist and cardiac rehabilitation nurse coordinator supervised the exercise class. Participants were encouraged to exercise between scores 11 and 13 on the Borg rate of perceived exertion 6–20 scale [27] without exceeding 13, that is perceived exertion should fall between light and somewhat hard, and not exceed hard.

Data Analysis

Data were analysed using the statistical package for the social sciences (IBM Corp. SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA). In the case of missing values, data were not imputed. Participant characteristics were recorded to allow description of the study sample according to the global rating of change, including the percentage of respondents with the lowest and highest possible scores [26].

The SDC was calculated using the 95% confidence intervals or limits of agreement for both the group, as well as the individuals [26]. The SDC was interpreted as the change that falls outside of these confidence intervals. Confidence intervals for the group mean and individual scores were calculated according to previous descriptions based on the mean difference of retest minus test scores and the standard deviation of difference scores [12,28].

The MIC for improvement and deterioration perceived by the participant was determined three ways: first, using 95% limit cut-off points ($MIC_{95\%Cutoff}$) [29]; second, using receiver operating curve (ROC) analysis (MIC_{ROC}) [26.29]; and third, using predictive modelling (MIC_{pred}) [30]. The MIC values were calculated for the change scores between the first pre- and post- walks and the second pre- and post- walks.

The ROC curve analysis (MIC_{ROC}) method used the global rating of change scale, an external criterion, as an anchor to determine the optimal ROC curve cut-off points for discriminating between patients who had improved or deteriorated, and those patients who were unchanged [29]. Equal weighting was placed on minimising the false positives and false negatives, so the ROC curve cut-off was the value that corresponded with the least misclassification, determined by the sum of percentages of false positive and false negative classification [29].

Predictive modelling (MIC_{pred}) with 95% confidence intervals for improvement and deterioration were calculated using logistic regression analysis according to the method described by Terluin et al. [30]. Using this method, Terluin et al. [30] defined the MIC_{pred} as the score that corresponded to a likelihood ratio (*LR*) of 1, meaning that the probability of belonging to the improved (or deteriorated) group was equal to the probability of being improved (or deteriorated). In addition, the likelihood ratio and post-test probability with 95% confidence intervals for improvement and deterioration were calculated to develop a predictive framework for interpreting the change scores in a cardiac rehabilitation population.

Results

Fifty-two (52) patients participated in the study, completing two ISWTs prior to, and two ISWTs after, an outpatient cardiac rehabilitation program (Table 1). The mean age of participants was 68 years (*SD* 10). All participants were able to mobilise independently, one participant required the use of a single point stick to complete the ISWTs. The pre-program assessment was completed a mean of 29 days (*SD* 19) following the most recent cardiac intervention. Forty-one (41) (79%) participants had a general diagnosis of coronary artery disease, which included 14 (27% of the sample) who experienced angina and eight (15% of the sample) who had a myocardial infarction. Three (3) (6%) participants were diagnosed with arrhythmias and seven (14%) with chronic heart failure and one (2%) with valve disease. Thirty-one (31) (68%) participants underwent a revascularisation procedure, which included a percutaneous intervention ($n = 26$, 50%) and coronary artery bypass surgery ($n = 6$, 12%). Fourteen (14) (27%) participants underwent conservative medical management, including pharmacological therapy. Two (2) (4%) participants required valve surgery, with one undergoing both coronary artery bypass surgery and aortic valve replacement. Four (4) (8%) participants required a device such as a permanent pacemaker or implantable cardioverter defibrillator. The mean time that elapsed between the pre-program assessment and the post-program assessment was 9 weeks and ranged from 7 to 11 weeks. One (1) participant finished the program early for reasons unrelated to the study.

Of the participants, 32 (62%) reported an improvement in their global rating of change, 10 (19%) reported their global rating of change was unchanged and 10 (19%) reported deterioration in their global rating of change. Table 1 shows the distance walked in the ISWTs according to global rating of change. There were no statistically significant differences in walk distances at pre-program assessment according to the global rating of change groups. There were statistically significant differences in the post-program ISWT distance walked according to the global rating of change, specifically between the improved group and the other two groups. The difference between the distance walked for the deteriorated and unchanged groups were not statistically significant. This pattern was similar for the change scores when both the results of the first test (i.e., ISWT-1 to 3) and the second test (i.e., ISWT-2 to 4) were used. *Post hoc* analysis showed a statistically significant difference in the change scores of the improved group compared with both the unchanged group and the deteriorated group. There were no statistically significant changes between the unchanged group and the deteriorated group.

For all groups, the mean change in ISWT distance increased over an 8-week cardiac rehabilitation program. There was a significant change in ISWT distances for the improved group and unchanged group when the results of the first pre-program and post-program test and the second pre-program and post-program tests were used ($p < 0.001$). For the deteriorated group, there were no significant changes between pre-program and post-program distances ($p = 0.209$, and $p = 0.483$ respectively).

Smallest Detectable Change

Using the results from the two ISWTs that occurred at the pre-program assessment, the SDC for the group was 22

Table 1 Characteristics of the Sample According to Global Rating of Change.

	Global Rating of Change score			
	Deteriorated *n* = 10	Unchanged *n* = 10	Improved *n* = 32	
Gender (M:F) (*n*)	8:2	7:3	25:7	χ^2 (2, n = 52) = 0.35, p = 0.840
Age years (*SD*)	72 (13)	73 (10)	65 (9)	F(2,49) = 3.20, p = 0.049
Height cm (*SD*)	173 (7)	166 (9)	173 (6)	F(2,49) = 4.05, p = 0.024
Weight kg (*SD*)	84 (11)	76 (11)	87 (11)	F(2,49) = 2.46, p = 0.096
BMI kg m^{-2} (*SD*)	28 (3)	28 (5)	29 (5)	F(2,49) = 0.37, p = 0.694
ISWT-1 m (*SD*)	305 (131)	331 (142)	416 (172)	F(2,49) = 2.39, p = 0.103
ISWT-2 m (*SD*)	318 (130)	348 (139)	435 (172)	F(2,49) = 2.63, p = 0.083
ISWT-3 m (*SD*)	322 (130)	388 (145)	560 (205)	F(2,49) = 8.06, p = 0.001
ISWT-4 m (*SD*)	326 (128)	397 (151)	581 (205)	F(2,49) = 9.14, p = < 0.001
ΔISWT-1-3 m (*SD*)	17 (40)	57 (21)	143 (52)	F(2,49) = 30.318, p = < 0.001
ΔISWT-2-4 m (*SD*)	8 (35)	49 (20)	146 (57)	F(2,49) = 38.212, p = < 0.001

Abbreviations: M, male; F, female; BMI, body mass index; ISWT, incremental shuttle walk test; ΔISWT, incremental shuttle walk test change score.

metres and for the individual was 47 metres (Table 2). The results using the two ISWTs that occurred at the post-program assessment were similar, the SDC for the group was 22 metres and for the individual was 58 metres.

Minimal Important Change

The MIC was calculated for improvement and deterioration over an 8-week cardiac rehabilitation program. The predicted MIC for participants to report an improvement ranged from 70 to 92 metres. The predicted MIC for patients to not report a deterioration (i.e., to be unchanged or improved) ranged from 16 to 42 metres (Table 3).

The MIC_{ROC} for improvement sensitivity was 91% and specificity was 100%. That is, assuming a MIC_{ROC} of 85 m represents meaningful improvement: 9% of the patients who rated themselves as improved were misclassified as unchanged. All participants who rated themselves as unchanged were correctly classified.

The results of the logistic regression are presented in Table 4. The predictive framework showing meaning to the change scores is shown in Tables 5 and 6. For example, a patient with a change score of 100 metres, based on the results of a single test in each session (i.e., ISWT-1 and ISWT-3), has a likelihood ratio of 8, 95% CI [2, 40] and a probability of being improved of 89%, 95% CI [62, 98].

Table 2 The 95% Confidence Intervals for the Group and Individual (Limits of Agreement) for the Change in ISWT Distance When Repeated in a Single Session.

Tests	M_{diff} (m) (SD_{change})	Group 95% *CI*	Individual 95% *CI*
ΔISWT-1 and 2	17 (14)	13 - 21	−12 - 46
ΔISWT-3 and 4	16 (21)	10 to 21	−26 - 57

Abbreviations: CI, confidence interval; ISWT, incremental shuttle walk test.

Discussion

This study presents thresholds for the MIC of the ISWT distance perceived by a patient over a cardiac rehabilitation program. The MIC for patients to perceive any improvement in physical fitness and functional capacity ranged from 70 to 92 metres depending on the method of calculation. The MIC for patients who reported any deterioration in physical fitness and functional capacity ranged from 16 to 42 metres. Variation in the MIC thresholds was due to the statistical method used and whether one or two tests were performed in each session.

To the best of our knowledge, this is the first study to use predictive modelling to report the MIC with 95% confidence intervals for the ISWT distance over the duration of an 8-week cardiac rehabilitation program. When binary logistic regression was used, the MIC for improvement in physical fitness and functional capacity was 71 metres, 95% CI [45, 89] when one test was performed, and 70 metres, 95% CI [43, 86] when a second test was performed in a single session. In other words, when one test is performed in each session, a change score of 71 metres means the likelihood of being improved exceeds the average probability of being unchanged [30]. These findings are consistent with the previously published MIC of 70 metres for patients to rate their performance as slightly better, and 85 metres for patients to rate their performance as better over a 6-week cardiac rehabilitation program [22].

The MIC obtained from binary logistic regression was similar when one test or two tests were performed, thereby providing further support that a practice walk test is not required. However, the $MIC_{95\%cutoff}$ ranged from 92 metres

Table 3 The Minimal Important Change in ISWT Walk Over an 8-Week Comprehensive Cardiac Rehabilitation Program.

Tests	Improvement			Deterioration		
	$MIC_{95\%cutoff}$ (m)	MIC_{ROC} (m)	MIC_{Pred} (m) (95% CI)	$MIC_{95\%cutoff}$ (m)	MIC_{ROC} (m)	MIC_{Pred} (m) (95% CI)
ΔISWT-1 to 3	92	85	71 (45 to 89)	22	Unable to determine	42 (−793 to 90)
ΔISWT-2 to 4	82	85	70 (43 to 86)	16	25	32 (−19 - 71)

Note. $MIC_{95\%cutoff}$ = minimum important change calculated using 95% limit cut-off points; MIC_{ROC} = minimum important change calculated using ROC analysis; MIC_{Pred} = minimum important change calculated using predictive modelling.
Abbreviations: CI, confidence interval; ISWT, incremental shuttle walk test.

when one walk test was performed to 85 metres when a second walk test was performed. The $MIC_{95\%cutoff}$ is a distribution-based method for calculation of the MIC, and is based on the variability of the sample who rated their physical fitness and functional capacity as unchanged. The variation may have been a result of the small sample size for the unchanged group ($n = 10$) and would need further investigation.

The threshold for the MIC for improvement in physical fitness and functional capacity over an outpatient cardiac rehabilitation was higher than the SDC. For the individual, the 95% confidence intervals calculated between the first and second walk, completed before cardiac rehabilitation, were −12 to 46 metres. A change score within this range on the ISWT could not be detected as true change and may indicate measurement error. The current study showed the SDC to be 47 metres, which approximates the lower 95% confidence limits of the MIC_{pred} of 45 and 43 metres and provides further support for the clinical relevance and interpretability of the ISWT in this population [31].

An unexpected finding was that cardiac rehabilitation participants did not perceive small improvements in the ISWT distance as meaningful improvements in their physical fitness and functional capacity. Small improvements may even be associated with a self-rated deterioration in physical fitness and functional capacity. The MIC for patients to detect a deterioration in physical fitness and functional capacity was different to that for improvement. The MIC_{pred} for deterioration and using binary logistic regression was 42 metres, 95% CI [–793, 90] when one test was performed, and 32 metres, 95% CI [–19, 71] when a second test was performed. This is an important consideration in clinical practice as an increased distance of 30 or 40 metres may not reflect a meaningful improvement and patients may still rate their physical fitness and functional capacity as not being improved. This may be a result of the recovery expectations of patients attending cardiac rehabilitation.

Overall, the interpretation of the MIC for a patient to rate themselves as unchanged and deteriorated, in terms of physical fitness and functional capacity, is less clear. The threshold MIC_{pred} for a patient to report a deterioration in physical fitness and functional capacity or being unchanged, was 42 metres when one test was performed and 32 metres when two tests were performed in a single session. The wide confidence intervals reflect the large variability in the small sample size of the group and makes it difficult to interpret, especially when only one test in each session was performed. Further investigation, with a larger sample size is required to determine the MIC for those patients who reported deterioration or unchanged on the global rating of change.

Table 4 Logistic Regression results for the Groups.

Global rating of change	Test	Intercept (C)	se (C)	Regression coefficient (*B*)	se (*B*)	*r*(C-B)
Improved-Unchanged	ΔISWT-1-3	−5.119	1.985	0.072	0.025	−0.959
	ΔISWT-2-4	−8.509	3.816	0.122	0.052	−0.983
Unchanged-Deteriorated	ΔISWT-1-3	2.553	1.506	-0.061	0.031	−0.929
	ΔISWT-2-4	2.542	1.386	-0.079	0.038	−0.903

Note. Intercept (C) = constant of the regression equation; se (C) = standard error of the intercept (C); se (B) = standard error of the regression coefficient; *r*(C-B) = correlation coefficient between the intercept (C) and the regression coefficient (B).

Table 5 Likelihood Ratios of Patients Improved and Unchanged Related to Pre-Program to Post-Program Change in ISWT Distance.

Change Score (m)	ISWT-1-3		ISWT-2-4	
	Likelihood Ratio (95% *CI*)	Post-test Probability (95% *CI*)	Likelihood Ratio (95% *CI*)	Post-test Probability (95% *CI*)
0	0.006 (0–0.29)	0.006 (0–0.23)	0 (0–0.36)	0 (0–0.26)
20	0.025 (0.001–0.49)	0.025 (0.001–0.33)	0.002 (0–0.56)	0.002 (0–0.36)
40	0.11 (0.013–0.86)	0.10 (0.013–0.46)	0.027 (0.001–0.93)	0.026 (0.001–0.48)
60	0.45 (0.12–1.75)	0.31 (0.10–0.64)	0.31 (0.048–1.93)	0.23 (0.046–0.66)
80	1.90 (0.62–5.81)	0.66 (0.38–0.85)	3.49 (0.712–12.13)	0.78 (0.42–0.95)
100	8 (1.61–39.96)	0.89 (0.62–0.98)	40.1 (1.7–935.5)	0.98 (0.63–0.999)
120	33.82 (3.02–378.53)	0.97 (0.75–1.0)	459.9 (2.9–73,042.4)	0.998 (0.74–1)
140	142.74 (5.17–3,938.32)	0.99 (0.84–1)	5,276 (4.6–6,092,672)	1 (0.82–1)
160	602.45 (8.56–42,416.22)	0.998 (0.90–1)	60,536 (7–520,693,273)	1 (0.88–1)
180	2542.7 (13.93–464,165.94	1 (0.93–1)	694,537 (11–44,995,476,743)	1 (0.92–1)
200	10,732.16 (22.5–5,123,073.5)	1 (0.96–1)	7,968,446 (16–3,911,507,709,395)	1 (0.94–1)

Abbreviation: *CI*, confidence interval.

The current study presents a framework for interpreting individual change scores using probabilities, odd ratios and likelihood ratios of the ISWT in cardiac rehabilitation. This information provides another tool for the clinician when interpreting change scores after cardiac rehabilitation. When one ISWT is performed, a patient with a positive change score of 40 metres has a likelihood ratio of 1.12 for deterioration and a probability of self-reporting a deterioration in physical fitness and functional capacity of 53%, 95% CI [26,78] and a likelihood ratio of improvement of 0.11 and a probability of reporting an improvement in physical fitness and functional capacity of 10%, 95% CI [1, 40]. In comparison, with a positive change of 80 metres, the patient has a likelihood ratio of 0.1 and probability of being deteriorated of 9%, 95% CI [0.1, 51]; and for improvement a likelihood ratio of 1.9, 95% CI [38, 85] and a probability of being improved of 89%, 95% CI [62, 98].

Future research could focus on the effect of the severity of cardiac disease on the MIC as well as the effect of the initial performance on the ISWT. Using predictive modelling it is possible to investigate the effect of severity of disease or different diseases on the MIC with larger sample sizes. In previous studies and different populations, MIC values have varied using alternative anchors. Future research that uses multiple anchors will be important.

Study Limitations

The relatively wide individual confidence limits may be a result of the small sample size particularly in the unchanged and deteriorated groups. An increase in the number of participants should provide a narrowing of the confidence intervals [32]. This research used a heterogeneous sample of cardiac rehabilitation patients and did not investigate the effect of severity of cardiac disease on the MIC as well as the effect of the initial performance on the ISWT. This is an important direction for future research. Using predictive modelling, it is possible to investigate the effect of severity of disease or different diseases on the MIC with larger sample sizes.

Finally, this study used the global reporting of change as the anchor. Retrospective self-rating of change as an anchor is a commonly used method for determining the MIC. However, retrospective ratings, particularly over an extended period, are susceptible to recall bias. In this case, the reliability and validity of the global rating of change question was unknown. In previous studies and different populations,

Table 6 Likelihood Ratios of Patients Deteriorated and Unchanged Related to Pre-Program to Post-Program Change in ISWT Distance.

Change Score (m)	ISWT-1-3		ISWT-2-4	
	Likelihood Ratio (95% *CI*)	Post-test Probability (95% *CI*)	Likelihood Ratio. (95% *CI*)	Post-test Probability (95% *CI*)
−60	499 (0.77–325,630)	1 (0.434–1)	1,454 (1.30–162,588)	1 (0.57–1)
−40	147 (0.75–29,134)	0.99 (0.43–1)	299 (1.16–77,515)	1 (0.54–1)
−20	43.5 (0.72–2,639)	0.98 (0.42–1)	61.7 (1.01–3,766)	0.98 (0.50–1)
0	12.8 (0.67–246)	0.93 (0.40–1)	12.7 (0.84–192)	0.93 (0.46–1)
20	3.73 (0.58–24.8)	0.79 (0.37–0.96)	2.62 (0.58–11.9)	0.72 0(.37–0.92)
40	1.12 (0.36–3.49)	0.53 (0.26–0.78)	0.54 (0.15–1.94)	0.35 (0.130–0.66)
60	0.33 (0.08–1.36)	0.25 (0.074–0.58)	0.11 (0.011–1.14)	0.10 (0.011–0.533)
80	0.098 (0.009–1.06)	0.089 (0.009–0.51)	0.023 (0.001–0.92)	0.022 (0.001–0.48)
100	0.029 (0.001–0.962)	0.028 (0.001–0.49)	0.005 (0.00003–0.78)	0.005 (0.00003–0.44)

Abbreviations: CI, confidence interval; ISWT, incremental shuttle walk test.

MIC values have varied with alternative anchors. Future research that uses multiple anchors will be important.

Conclusions

The study supports the interpretability of the change scores of the ISWT in cardiac rehabilitation. The MIC for patients who attend cardiac rehabilitation who report any improvement in physical fitness and functional capacity is 70 metres. The MIC is greater than the SDC for an individual, which in this study was 47 metres. Patients with small increases in the ISWT distance may still report deterioration in their physical fitness and functional capacity. This study provides further support for the use of a single ISWT in cardiac rehabilitation, with little benefit gained from repeating the test in a single session.

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Conflicts of Interest

Nil.

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