**Comparing the responses to the 60 second sit to stand test a the six minute walk tests in heart failure**

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# Background

Exercise training is strongly recommended for people with stable heart failure (HF) as it has been shown to improve exercise capacity, quality of life (QoL) and to reduce hospital readmissions[1]. In recent years, poor uptake and attendance at centre-based programmes has led to support for flexible models of care such as home-based exercise training [2-5]. Home-based exercise training has been shown to improve exercise adherence and to be equally effective compared to traditional centre-based programmes, for improving exercise capacity and QOL [6-8].

Prior to commencing an exercise programme, people with HF complete a thorough assessment in order to i) identify safety concerns, ii) collect physiological measures to assist accurate exercise prescription and iii) provide baseline information to enable evaluation of progress. A fundamental component of this assessment is a measure of exercise capacity, which in clinical practice is most commonly the six minute walk test (6MWT). This submaximal exercise test requires individuals to walk up and down a 30-metre track whilst oxygen and heart rate are recorded. The space required for this test therefore necessitates that it is most commonly conducted at a health facility.

The recent COVID-19 pandemic led to a change in practice which rapidly reduced face-to-face appointments at health facilities. This period highlighted an urgent need for accurate and reliable assessments which are able to be conducted in the home environment, either in person or remotely, whilst not compromising on quality of information and thus safety.

The sit-to-stand test (STST) is a short-duration test, frequently used in rehabilitation settings as a measure of balance and mobility.  It is often used to evaluate lower limb muscle power, frailty and balance and to differentiate between fallers and non fallers [9-12]. Being a functional activity and easy to administer in any setting, the STST has been proposed as a viable option for assessment of exercise capacity in people with HF. Whilst several versions of the test exist, all require individuals to repetitively move from sitting to standing for different durations. The 60 second sit to stand test (STST-60) for example, records the number of stands completed during a 60 second period.

In non HF populations, the STST-60 has been shown to have a strong correlation with 6MWT distance[12] and in people with COPD, has also been shown to elicit similar levels of dyspnoea to the 6MWT [13]. There has been very little published on the STST in people with HF, however anecdotal reports suggest that it may impose a similar physiological demand to the 6MWT in this population. Understanding this in more detail will enable us to determine whether this test is appropriate for i) evaluating exercise performance and ii) prescribing an exercise program, for people with stable HF. This observational study will therefore be undertaken to compare physiological and non-invasive haemodynamic responses elicited during 6MWT and STST-60 in people with HF enrolled in an exercise training programme.

# Aims of the project

The primary aim of this study is to compare the physiological and non-invasive haemodynamic responses to the STST-60 and the 6MWT in people with stable heart failure

# Methods

**Study Design**

This study will be undertaken at Griffith University in GO2\_2.44 (Integrative Physiology Research Laboratory) with participants recruited through the Heart Failure Service at Gold Coast University Hospital, Robina Health Precinct. Participants will be required to attend two appointments, one week apart. All measures will be undertaken by investigators Morris (NM), Louis (ML) Chen (DC), Roberts (LR) and Aitken (CA). NM and ML are experienced Physiotherapists very familiar with these test procedures. DC is a Physiotherapy student at Griffith University, who will be undertaking this study as part of her Physiotherapy Honours studies. LR is an experienced exercise physiologist and accredited to undertake body composition testing using the dual xray. Craig Aitken is a doctoral candidate and experienced in undertaking metabolic and non-invasive haemodynamic measurement.

## Participants

Participants will be eligible for the study if they have HF of any cause confirmed by echocardiography in preceding 12 months, and are enrolled in a HF exercise training programme at Robina Health Precinct. As all people referred for HF rehabilitation undergo stringent safety review prior to being accepted into the programme and will have undertaken both a six minute walk test and a sit to stand test as part of their rehabilitation program, no further safety criteria will be required. We aim to recruit 25 participants for this study.

*Exclusion criteria*

* Participants deemed unsafe to exercise on the day of assessment according to American College of Sports Medicine (ACSM) and Australian guidelines[14, 15].
* Symptomatic postural hypotension, defined by dizziness in the presence of a reduction in systolic BP by 20mmHg or more upon standing from a seated position
* Orthopaedic or neurological conditions which preclude performance of any of the proposed exercise tests
* Significant lower limb musculoskeletal pain that may preclude performance of the STST-60
* Severe cognitive, language and psychological condition that precludes participation in the exercise tests

## Recruitment

Eligible participants will be identified by the Physiotherapist (ML) associated with the HF exercise programme at the Robina Health Precinct. This Physiotherapist will provide eligible participants with written and verbal information about the study. Those who consent to the study will then attend two appointments in Building G02, Room 2.44 at Griffith University, approximately one week apart.

Eligible participants who choose not to participate in the study will attend the exercise training programme and all assessments as per usual practice.

## Protocol

Participants who consent to the study will be scheduled to attend two visits. Participants will be randomised to perform either the STST or 6MWT during visit 1 and 2.

Visit 1

During the initial appointment, the consent process will be completed and participants’ medical history and current symptoms will be reviewed to ensure safety on the day of testing. Participants will then be asked to complete two 6MWTs, which will be supervised by investigators NM, ML and DC. Participants will rest between tests to allow full recovery of heart rate, blood pressure, oxygen saturation and rating of perceived exertion prior to commencement of 6MWT 2. Physiological measures will be measured throughout one of the two 6MWTs. Following completion of both tests, participants will then be asked to complete a quality of life measure. The final assessments for this appointment will be two measures of lower limb strength. Also, the DEXA scan will be conducted to assess lower extremity muscle mass and the quadriceps muscle group cross sectional area. It is anticipated that time required for the first visit will be around 90 minutes.

Following this first appointment, investigator DC will contact participants 24 hours later to complete a questionnaire via the phone. This questionnaire will ask participants to quantify and describe presence of leg pain, specifically delayed onset muscle soreness (DOMS) of the quadriceps.

Visit 2

Approximately one week following the initial appointment, participants will be scheduled to return to the same room at Griffith University for completion of the remaining outcome measures. The study team will again ask screening questions to ensure stability of symptoms and thus safety of participation. Participants who are determined to have a deterioration of symptoms since the preceding week will be advised to contact their GP and the assessment will be rescheduled for another time. The Heart Failure Service at Robina Health Precinct will also be advised of this occurrence. Participants who are appropriate for testing, will complete their assessment by performing the STST-60. The test will then be repeated after a sufficient rest period to allow blood pressure, heart rate, oxygen saturation and rating of perceived exertion return to baseline. It is anticipated that visit 2 will take approximately 30-45 minutes to complete. Physiological measures will be measured continuously throughout one of the two STST-60s.

As per the first assessment day, investigator DC will contact participants 24 hours later to quantify and describe the presence of DOMS, using a validated questionnaire.

## Outcome measures

*Six minute walk test (6MWT):*

The 6MWT is a measure of submaximal exercise capacity. The test will be performed according to recommended procedure on a 30-metre track with standard encouragement provided every minute. Participants will be instructed to walk at their own pace whilst attempting to cover the greatest distance possible during the six minutes. To account for a learning effect, the test will be performed twice, with sufficient time between tests to allow full recovery.

Pulmonary gas exchange exchange (Metamax, Cortex BXB, Lepzig, Germany) and cardiac output (PhysioFlow, Manatec Biomedical, Paris, France) will be measured throughout the 6MWT. All data will be collected continuously and reported as 15 s averages. The following data will be collected: oxygen consumptions (V̇O2); carbon dioxide production (V̇O2), ventilation (V̇E), cardiac output (Q̇), heart rate (HR), oxygen saturation (SpO2). Dyspnoea, (modified 0-10 Borg Scale) and forehead oxygen tissue saturation (RAD-5v Masimo Corp, Irvine, CA, USA) will also be recorded throughout the test.

*60 second Sit to Stand Test (STST-60)and 30 second Sit to Stand Test (STST-30):*

Participants will be randomised to perform either the STST-30 or STST-60.The STST-60 and STST-30 will be conducted using a standard height chair (seat height of 43cm), placed against a wall for support. Participants will commence the test sitting in the middle of the chair with feet shoulder width apart and flat on the floor. With arms crossed in front of their chest, participants will be asked to stand to a full standing position prior to fully sitting again, whilst the assessor counts out loud the number of complete stands during this time. If participants are unable to stand without support of their arms, this will be recorded as “unable” and no further testing will take place.

Physiological data collected during the test will be the same as that for the 6MWT. Pulmonary gas exchange will be measured using a portable metabolic system and cardiac output using the Physioflow system. The same data as collected during the six minute walk test will be continuously monitored. In addition mean arterial blood pressure (MAP) and stroke volume (SV; Modelflow method) will be measured beat by beat using photoplethysmography on the phalanx of the middle finger (Finometer; Finapres Medical Systems, Arnhem, The Netherlands) on the right hand positioned at heart level.

The test will be undertaken twice with the repeat test only completed once the participant has fully recovered from the first. Blood pressure will be measured manually immediately prior to commencement of the test and immediately following completion of the STST.

*Muscle strength*:

Isometric quadriceps muscle strength*:* will be assessed using hand-held dynamometer. It has been shown to be a reliable and valid measure of isometric muscle strength in a healthy population and sensitive to detect changes in muscle strength for groups of people with COPD.

Peak knee extensor isometric and isokinetic torque:will be assessed using a Biodex dynamometer as per previous protocols [16]. This method is the gold standard for measuring muscle function in clinical practice and research settings.

*Body composition*

Dual energy x-ray absorptiometry (DXA) scan: will be used to measure lean muscle mass in the lower extremities. This is a non-invasive method for assessing body composition and involves only a minimal exposure to ionising radiation.  For this measurement, the participant will be asked to lie supine on the scanning bed for approximately 10 minutes, wearing comfortable clothing without any zips or metal buttons.

*Quality of life*

Quality of life will be measured using the Kansas City Cardiomyopathy Questionnaire (KCCQ-12). This 12 question instrument has been shown to be valid, reproducible and responsive for assessing disease specific quality of life in people with HF[17]. Specific domains include physical limitation, symptom frequency, quality of life and social limitation.

*Fatigue*

Leg fatigue, and in particular, delayed onset muscle soreness will be measured using a 7-point Likert scale of muscle soreness[18]. To complete this questionnaire, investigator DC will contact participants by phone, one day following each assessment. Each question will be read to participants with the hard copy questionnaire completed by the assessor.

Participant characteristics such as age, gender, left ventricular ejection fraction, HF phenotype, NYHA functional classification, co-morbidities (including musculoskeletal conditions which may impact on the ability to perform the tests), presence of musculoskeletal pain and medications will also be collected.

# Data analysis

Participant characteristics will be summarised using descriptive statistics. Differences in end exercise physiological/haemodynamic responses will be compared using a paired t-test. For data which is not normally distributed, differences will be compared using the Mann Whitney U test.

**Risk reduction**

The STST-60 is a simple, short duration test validated in non-HF populations. They are currently used by some HF clinicians to evaluate exercise capacity and functional performance, and it is common practice for clinicians to prescribe this activity (repeated sitting to standing) to appropriate individuals attending HF exercise training programmes. Despite its frequent use, the project team acknowledges that there are specific considerations relevant to this study. In particular, people with HF are frequently frail and commonly experience shortness of breath and fatigue. Those with co-existing ischaemic heart disease (IHD) may experience exertional angina. Dizziness is also common, especially in people undergoing medication up-titration. It is possible that repeated sit to stand movements may predispose to or worsen symptoms in some participants. For these reasons, measures routinely used in clinical practice to mitigate risk will be employed in this study.

These include:

* All participants deemed eligible for the study will be screened for safety on the day of testing by the study team to ensure no change in circumstances or symptoms since initial recruitment.
* Participants will be supervised by the clinicians throughout the assessment, with testing ceased immediately if any concerns arise (E.g. onset of chest pain, pallor, symptomatic dizziness). Clinicians will have a low threshold for ceasing the STST.
* Participants will be required to sit between each test until fully recovered, prior to commencing the following test. The 6MWT and STST-60 will be completed one week apart to minimise fatigue.
* All participants with a history of IHD will be asked to carry their glyceryl trinitrate (GTN) medication on their person during testing.
* ML and NM are experienced Physiotherapists who regularly supervise exercise testing and prescribe exercise programmes for people with HF. As such, investigators are highly trained to identify and to manage risk in these individuals.

# Data Management

The project team will follow the research guidelines and policies for data storage, access and privacy. All data pertaining to the study will stored electronically in an excel spreadsheet with password access only available to the study team. All hard copies of data with be stored in a locked cabinet located within the School of Physiotherapy at Griffith University. The data will be de-identified at source and only de-identified data will be loaded into the online data management system. In accordance with NHMRC data management guidelines, data will be stored for a minimum of 15 years following completion of the project. Beyond this time period, electronic data will be permanently deleted, while hard copy data will be professionally shredded.

# Dissemination of results

Results of this study will be presented locally at Griffith University and to staff at the Robina Health Precinct. Additionally, results will be presented at state-wide and national conferences such as the State-wide HF Forum, Queensland Cardiorespiratory network conference and Australian Physiotherapy Association national conference. It is anticipated that this study will also be published in a peer review journal.

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