An Investigation into Left Ventricular Twist during the recovery phase in trained and untrained males compared to the ECG

Cardiff Metropolitan University  |  Prifysgol Fetropolitan Caerdydd

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An Investigation into Left Ventricular Twist during the recovery phase in trained and untrained males compared to the ECG

Cardiff School of Sport
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Comments | Section
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Title and Abstract (5%)<br>Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.

Introduction and literature review (25%)<br>To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).

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Cardiff Metropolitan University
Prifysgol Fetropolitan Caerdydd

Cardiff School of Sport

Degree of Bachelor of Science
(Honours)

Sport and Exercise Science

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(Dissertation submitted under the discipline of Physiology)

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I would finally like to give a big thank you to my project partner Ben Foxwell for being there when I felt like giving up and picking me up when I have felt down. He has continued to help me through and I would have not got here without him.
**Abstract:** Studies have previously observed left ventricular twisting (LVT) in relation to both diastolic and systolic function. Yet these studies primarily monitor LVT during different exercise and intensities and rest and have not investigated the influence of EDV. This study aims to investigate LVT and EDV in a three minute recovery phase and a six minute recovery phase stage of recovery after sub-maximal exercise in trained and untrained populations. The results of this study show that there were no significant differences in EDV between the high aerobic fitness group and the moderate aerobic fitness group, yet within the moderate exercise group there were significant differences between exercise and the 3 minute recovery stage and the 6 minute recovery stage. The findings of this study conclude that a high aerobic fitness can lead lower LV twist and increase EDV. The findings of this study can be improved and further considerations could be noted in terms of further research in the future.
1.1 Introduction

The mechanics of the heart have become a regularly researched area of physiology as more begins to be discovered in order to improve performance, health and well-being in different populations. A large amount of this research is primarily concerned with the implications involving abnormal functioning of the cardiac system such as arrhythmia or hypertension. This study aims to move away from this and investigate the influence of left ventricular twisting (LVT) in males and the differences between trained and untrained participants during the recovery phase after sub maximal exercise. The study will aim to compare levels of End Diastolic Volume (EDV) and LVT at exercise and recovery and noting if there are significant changes at 3 minutes of recovery and 6 minutes of recovery. The study will record heart rate (HR), stroke volume (SV), cardiac output (CO), EDV and LVT.
Literature Review

Previous research has investigated LVT and EDV primarily looking at exercise differences compared to rest, however not much research has been conducted into what happens to LVT and EDV in the recovery phase after exercise. This study aims to look if there are significant differences between these two concepts during each of the phases and seeing if there are differences between trained and untrained athletes. This will involve looking at different aerobic groups, one group consisting of moderately aerobic trained individuals and another group of highly aerobic trained individuals who will be distinguished by running a fitness test.

Exercise

Exercise has been widely researched within physiology more importantly in relation to the heart. Exercise will not be the main concept of this study but it will be used to compare to recovery phase after exercise including 3 minutes after and 6 minutes after exercise. Different exercise intensities have been researched as well as different parameters in order to investigate what exercise does to these parameters and if this can have a positive or negative effect on the population being tested. One of these parameters that investigate exercise in certain populations is SV, this parameter will be measured throughout the study in order to investigate if SV is influenced with exercise. Previous SV research mainly investigates the impact of increased or decreased SV in relation to cardiac function. Rowland and Unnithan (2013) found that stroke volume remains constant during increased exercise intensity as blood return to the heart increases, a reflection of increased heart rate that matches the venous return and maintains a constant left ventricular filling volume. These results indicate SV remains constant even during increased exercise; however these results may not be replicated in this study as the participants in Rowland and Unnithan’s study were paediatrics between 0.6 years to 18 years which can vary from adolescents as children may be differ as they may be able to recovery quicker than adolescents or vice versa. This is important as it suggests that exercise can manipulate parameters such as SV, however this study will be focusing more upon the parameters of EDV and LVT. In terms of previous EDV research a previous study investigating left ventricular function in elite runners Jensen-Urstad et.al (1998) found that with increasing work load, left ventricular EDV and ejection fraction remained
fairly constant, resulting in an unchanged SV from the lowest to the highest exercise intensity. This evidence suggests that with increased levels of work load, the elite runners’ SV and left ventricular EDV remained fairly constant and unchanged even though there was an increased demand on the heart. This is important as it suggests that due to the runners being elite their hearts can adapt to the intensity of the exercise allowing them to continue to work with the same level of blood throughout. This is possible due to increased myocardial contractility paralleling the systolic shortening with increasing heart rate (Jensen-Urstad et al. 1998). As well as these findings from previous research, other studies investigating exercise and its effects on the heart have found that loading elicited increases in stroke volume index (SVI), HR, and cardiac index (CI) during moderate exercise in patients with heart failure (Lalande et al. 2012). This research is focused on patients with heart failure but suggests loading can have positive effects on the cardiac system by increasing levels of SVI, HR and CI. However this contradicts findings from Stark-Leyva et al. (2004) who found that SV was further reduced with prolonged loading with a slight HR compensation, making cardiac output (CO) constant during the expiratory loading. This study’s findings further support and highlight the importance of HR compensating SV in order to keep levels of CO constant throughout exercise even with the use of expiratory loading. However the most important aspect of the previous research is the research relating to left ventricular twist during exercise, a main area of research that is already known is LVT, in previous studies LVT has been linked to the condition of ventricular hypertrophy which can have effects on the heart’s ability to function efficiently. Hypertrophy can lead to hypertension in the heart and Karpha and Lip (2006) described hypertension as a major risk factor for cardiovascular mortality and morbidity through its effects on target organs like the brain, heart, and kidney. The concept of electromechanical delay (EMD) is also associated with LVT, this small delay effects the systolic phase with the transportation of blood from the left ventricle to the rest of the body. Although previous research within the area of EMD has mainly looked at populations with heart failure or other cardiac problems, however it is also investigated to discover differences between different populations. A study by Rodrigues- Ferriera and Vencesbrito (2012) looked at gender differences in a karate punch movement. Their study concluded that men and women had a similar electromechanical delay; however there was a significantly smaller delay in male athletes in the anterior portion of the deltoid muscle (Ferriera and Vencesbrito 2012). These findings are important to the study being conducted as this already previously conducted research can give indications as to what
conclusions may arise at the end of this research and also what is already known in relation to the LVT and EMD in the exercise phase.

Post Exercise Recovery

Post exercise recovery is the main phase being investigated in this research project and previous research in relation to cardiac parameters the most important of these LVT and EDV can give an insight into what to expect from the results of this research project. One area researched widely in terms of recovery is HR, Goulopoulou et.al (2006) found in their study that post-exercise HR variability was higher in late maturers, indicating higher cardiac parasympathetic nervous system activity immediately after exercise in this group. This research is relevant as the study investigates males around the same age as those used in this study with the ages ranging between 18-21 years of age. The findings of this study indicate that the mature males may have higher HR variability suggesting this may be the case of the males at the top age range scale involved in this study. HR continues to be the most related parameter associated with the recovery phase after exercise and as began to be linked with diastolic function, Giannak et.al (2008) found that the key finding of the their study is that an increased HR during recovery from low-intensity supine exercise was associated with an elevation in both Doppler flow and tissue Doppler velocity measures of diastolic function. As well as these findings further post exercise recovery literature has investigated that post exercise heart rate recovery can influence mortality when looking at populations with chronic heart failure Tang et.al (2009) found that Post-exercise HRR predicts mortality risk in patients with HF and provides prognostic information independent of previously described survival models. This further highlights the importance of recovery after exercise and shows that much of the previous research investigated concentrates on health especially heart related diseases. With this in mind there are many important research paper slinked with health yet not enough with performance especially in healthy individuals with different exercise status.

Importance of previous research
All the previous research mentioned is important to understand in relation to the study being conducted. The previous research can provide an insight into what the results may be discovered after this study, it can also explain why these results have been acquired and through comparing and contrasting with previous research the results can either support or contradict previous research that is similar to other studies. As well as this previous research can help identify what needs to be looked at and how initial studies can be improved upon or other aspects within previous studies can be studied. With this in mind the present study was chosen to be conducted as no previous studies have taken into consideration the effects of EDV and LVT together in comparison to highly aerobic trained individuals and moderately trained individuals.

**Gaps in the Literature**

Previous research does answer many questions for in relation to the heart during exercise and during the recovery phase. However while these findings are relevant and help us to understand more about how the heart during these phases there are still areas of research that are yet to be conducted in order to see if this can further improve the knowledge of the heart. With previous research being examined this study will aim to investigate if there are differences in both EDV and LVT between a high aerobic fitness group and a moderate aerobic fitness group after sub-maximal exercise. This type of study is yet to be conducted and therefore could explain how LVT and EDV are important within the recovery phase after a bout of sub-maximal exercise. Taking the previous research into consideration the recovery phase have been chosen at three minutes and six minutes post exercise as this allows time for recovery but not too much time for a person to recovery fully back to resting values.
Methods

Ethical Approval and Participant Recruitment

After approval from the research ethics committee at Cardiff Metropolitan University, the study was performed with 14 male participants aged 20cm ± 1 with body mass 80kg ± 7.1 and height 180cm ± 7. The participants were recruited to represent both well trained and untrained individuals to examine the effects of exercise training status on LVT and EDV in the recovery phase after sub maximal exercise. Each participant was given a participant information sheet prior to both test in order for them to understand what was required of them before, during and after both tests. All participants gave their informed consent and filled in a ACSM Pre exercise screening questionnaire (American College of Sports Medicine, 2010) prior to the experiment in order to establish any health concerns that may arise amongst the participants that may mean a certain participant cannot be involved in the research study.

Test Protocols

Participants were required to visit the lab on two separate occasions. Prior to both visits, participants were asked not to engage in any strenuous exercise 24 hours before tests were conducted in order to ensure true resting assessments. In order to establish correct peak power measurements, each participant was asked to perform a VO$_2$ max test in order acquire each participants peak power measurement which was used in the second visit to the lab. Upon arrival at the lab the participants' heights and weights were recorded before they were asked to perform the VO$_2$ max test. Breath-by-breath V’O2 was acquired throughout the test (Oxycon Pro, Jaeger at Viasys, Healthcare, Warwick, UK) this equipment was calibrated to determine VO$_2$max measurements were valid, participants used a Monark cycle ergometer (Monark 824E, Monark Exercise AB, Varberg, Sweden) with saddle height adjusted according to individual stature. All participants were fitted with a mask attached to a gas sensor and volume turbine and were fitted with a heart rate monitor (Polar Electro RS4000, Polar Electro, Kemple, Finland). The exercise protocol was chosen in accordance with previous literature using the Wasserman equation (Wasserman, Hansen, Sue, Stringer & Whipp, 1999) and was set up as a ramp test designed to increase by 25W every minute starting at 0W. Once all VO2 max tests had
been carried out by all the participants, the second test was conducted. The second visit involved the participants being shown their previous participant information sheets and questionnaires in order to establish whether anything had changed during the time between both tests. Each participant’s weight was taken prior to testing, providing nothing had changed in relation to weight or training status that could cause changes in participant’s performances; the participants were told in detail the protocols for the second test and what was expected of them. After this, the participants were asked to remove their shirts and lie on the tilt bed used for supine cycling (Lode, Angio 2003, Groningen, Netherlands). Before being tilted three electrodes were place on the participants’ chest to record a 3-lead ECG. The placement of the markers included one electrode at a halfway point between the base of the clavicle and the top of the clavicle on both sides and a final electrode at the bottom of the left rib cage. Before the electrodes were placed, the areas were wiped with an alcohol wipe in order to retrieve the best data possible. Once the electrodes were fitted, the ECG leads were attached. As well as the ECG, the participants were also fitted with beat-by-beat blood pressure equipment (Finometer Pro, Finapres Medical Systems B.V., Amsterdam, The Netherlands.) in order to collect blood pressure during the test. Before each test the beat-by-beat blood pressure equipment was calibrated and was attached to the participant’s middle finger on their right hand and this was attached for the duration of the test to provide blood pressure measurements throughout. Once the beat-by-beat blood pressure equipment was calibrated and fitted the participants were then put in the left lateral position tilted at a 45° angle and while in this position the participants remained as still as possible as ultrasound images of the heart were taken at rest by Dr. Eric Stohr using ultrasound equipment (GE Vividq, GE Healthcare, Chalfont St Giles, Bucks, UK.). Once this was completed the participants were asked to cycle at 60rpm against their peak power (acquired from their VO2 max test) for 6 minutes with participants being closely monitored throughout to ensure their safety. For each participant the distances of the cycling straps were moved in order for participants to cycle comfortably during the test, pillows were also provided at the hip and head areas to provide comfort during the test. During the test participants were also asked not to grip the bed with their right hand to ensure the correct blood pressure values were collected by the beat-by-beat blood pressure equipment. After 3 minutes of exercise the same ultrasound images that were taken at rest were taken during exercise, and the participants cycled for the full 6 minutes even if images were acquired before the end of the test. After the exercise was complete the participant’s feet were removed from the cycling straps and
they were told to remain still again while they recovered for 6 minutes. After 3 minutes of recovery the same ultrasound images were taken as before and this was repeated after 6 minutes of recovery also. Once the final ultrasound images were recorded, all equipment was safely removed from the participant and the participant was tilted back.

**Speckle tracking echocardiography**

In order to gather twist values, Frame-by-frame twist and twist velocity values were obtained by subtracting the apical rotation/rotation velocity data from the basal rotation/rotation velocity data (Notomi et al. 2005; Sengupta et al. 2006)
4.0 Results

4.1 Baseline Characteristics

The recorded baseline characteristics include basic measurements such as age, height and weight as well as cardiac measurements such as HR, CO and SV. $\dot{V}O_{2\text{max}}$ was also recorded as this measurement was important during the first pre-test and distinguished between participants being selected for the moderate aerobic fitness group or high aerobic fitness group. Within the basic measurements there were no significant differences in age, height or weight in both the moderate aerobic fitness group and the high aerobic fitness group ($P<0.05$, Table 1). Within the cardiac measurements there we no significant differences in LV volumes, LV lengths, stroke volume, cardiac output and ejection fraction in either of the groups ($P>0.05$, Table 1). Heart Rate had no significant differences in either of the groups ($P>0.05$, Table 1) however, was much lower in the high aerobic fitness groups. The $\dot{V}O_{2\text{max}}$ measurement was significantly higher in the high aerobic fitness group than in the moderate fitness group ($P<0.05$).
4.1 Left Ventricular End Diastolic Volumes

The end diastolic volumes were measured during exercise, 3 minute recovery and 6 minute recovery and table 2 shows these measurements for both groups. There was no significant difference in end diastolic volume between the exercise phase and 3 minute recovery phase in the highly aerobic fitness group, as well as no significant difference between the exercise phase and 6 minute recovery. There was also no significant difference between the 3 minute recovery phase and 6 minute recovery after exercise. In the moderately aerobic fitness group there were no significant differences between LVd/LVls: LV length at end-diastole/end-systole; LV EDV/ESV: LV end-diastolic volume/end-systolic volume; EF: ejection fraction.

phase. When comparing between the two groups there were no significant differences between the high aerobic fitness group and the moderate aerobic fitness group during exercise. Also there were no significant differences between the high aerobic fitness group
and the moderate aerobic fitness group during the 3 minute recovery phase. There were also no significant differences between the high aerobic fitness group and the moderate aerobic fitness group during the 6 minute recovery phase.

### Table 2: Exercise, 3 Minute Recovery and 6 Minute Recovery measurements in both groups showing left ventricular end-diastolic volumes

<table>
<thead>
<tr>
<th>LVEDV</th>
<th>High Aerobic Fitness</th>
<th>Moderate Aerobic Fitness</th>
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<tbody>
<tr>
<td>Exercise</td>
<td>235 ± 47.9</td>
<td>255.5 ± 69.3</td>
</tr>
<tr>
<td>3-Min Recovery</td>
<td>228.7 ± 45.1</td>
<td>230.7 ± 38.1</td>
</tr>
<tr>
<td>6-Min Recovery</td>
<td>226.6 ± 50.2</td>
<td>237 ± 30.9</td>
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#### 4.2 Left Ventricular Twist

Left ventricular twist was also recorded in the exercise phase and both recovery phases, the basal rotation and apex rotation was recorded and the apex value was taking away from the base value to give the value for twist. There was no significant difference between LVT during exercise between the high aerobic fitness group and the moderate aerobic fitness group. There was also no significant difference in LVT between the moderate group and high aerobic group during the three minute recovery phase. There was no significant difference in LVT in the 6 minute recovery phase between the moderate aerobic group and the high aerobic group. However, there was a significant difference in LVT between exercise and the 3 minute recovery phase in the moderate aerobic group. As well as this, there was a significant difference in LVT between exercise and the six minute recovery phase in the moderate aerobic fitness group (P<0.05). But, there was no significant difference between the 3 minute recovery phase and 6 minute recovery phase in the moderate group. Within the high aerobic fitness group there was no significant difference between exercise and the 3 minute recovery phase, this is also apparent between exercise and the 6 minute recovery phase. This is also the case between the 3
minute recovery phase and the 6 minute recovery phase in the high aerobic group as there was no significant difference.

Table 3: Exercise, 3 Minute Recovery and 6 Minute Recovery measurements in both groups showing significant differences in End- Diastolic Volumes

<table>
<thead>
<tr>
<th>LV Twist</th>
<th>High Aerobic Fitness</th>
<th>Moderate Aerobic Fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>21.4 ± 6.3</td>
<td>20.2 ± 2.8**</td>
</tr>
<tr>
<td>3-Min Recovery</td>
<td>16.7 ± 5.5</td>
<td>15.9 ± 5*</td>
</tr>
<tr>
<td>6-Min Recovery</td>
<td>15.2 ± 6.1</td>
<td>14.9 ± 6.1*</td>
</tr>
</tbody>
</table>

*significant difference to exercise within same fitness group (P<0.05)
**significant difference to 3 min recovery within same fitness group (P<0.05)

With these tables explaining the differences found between the two aerobic groups and looking at the different phases of exercise, figures will show the relationship between LVT and EDV in relation to the two groups.

Figure 1: Relationship between LVT and EDV during exercise in both the moderate aerobic fitness group and high aerobic fitness group.
During the exercise phase, the moderate aerobic fitness group displayed higher levels of EDV and all had similar degrees of LV twist (Figure 1), whereas the high aerobic group showed a bigger variation in results with lower levels of EDV than that of the moderate
group but a variety of different degrees of LV twist (Figure 1). This seems to change as during the 3 minute recovery phase, the moderate aerobic group show similar EDV volumes yet much more varied degrees of LV twist (Figure 2). Yet, the high aerobic fitness group begin to show large EDV volumes with a lower degree of LV twist (Figure 2). In the final 6 minute recovery phase there has not been much change in the EDV and degree of LV twist in both aerobic groups (Figure 3) other than few individuals showing a much lower EDV in the high aerobic group (Figure 3) and a few individuals showing a larger degree of LV twist in the moderate aerobic fitness group (Figure 3).
**Discussion**

*Baseline Characteristics*

Most previous research takes into consideration baseline characteristics when undertaking a study as a person’s baseline characteristics can affect results and can distinguish why a person is in a particular group within the study for example a sedentary or highly trained group. These studies can provide insights into health looking at different diseases and their effects on performance such as Ebstein anomaly affecting the tricuspid valve and development of the right ventricle (RV) but also on improving athletes performance by looking at reduced right ventricular ejection fraction in endurance athletes (Tobler et.al 2013, Ector at.al 2006). Yet, within this present study the participants were purposefully selected to show two distinct groups of highly aerobic trained individuals and moderately aerobic trained individuals. This was done to examine if there were any major differences between the groups as well as within them in different phases such as exercise and recovery, with these findings they can be linked to the importance of LVT and EDV during exercise and how the difference of recovery of these two between the two groups and if this helps to recover faster. In order to do this each phase was investigated in relation to EDV and LVT and then compared between the two aerobic groups.

*Exercise and EDV*

Within this present study it seems that EDV is much lower in the high aerobic fitness group than in the moderate aerobic fitness group. This could be due to many factors as well as aerobic fitness however; Stöhr et.al 2011 concluded that dehydration-induced reductions in SV at rest and during exercise are the result of reduced LV filling, as reflected by the decline in EDV. This supports the present study as a decline in EDV was found during exercise however it is believe in the Stöhr et.al study that this was because of dehydration-induced reductions in stroke volume. While this present study has support from previous research there are also other pieces of research that contradict the results found in this present study.

*Exercise and LVT*
As well as the relationship between exercise and EDV, LVT was also examined alongside exercise in order to establish the relationship between the two and if there were similar findings to that found with EDV and exercise. In the comparison between the highly aerobic fitness group and the moderately aerobic fitness group there was no significant difference found, yet a study by Stöhr et.al (2012) found that young males with high aerobic fitness have lower LV apical rotation at rest and during submaximal exercise that can occur without changes in gross LV structure, arterial haemodynamic or heart rate. While this could be the case this present study found no significant difference in LVT between the two aerobic groups meaning that the males aerobic fitness may not influence there LVT. However this present study could support the Stöhr et.al study as the study population in this present study all the participants were young males () meaning they all have relatively low LVT which could explain why there was no significant difference between the two aerobic groups. Yet, contradicting this study by Weiner et.al (2010) found that participation in endurance exercise training was associated with significant changes in LV twist mechanics characterized by increased apical rotation. This present study does not support these findings as the highly aerobic group in this study did not show a significant difference from the moderately aerobic group. Whilst this present study can support and challenge previous findings it is fair to conclude that within this study no significant difference could be found between the two aerobic groups meaning that LVT was unaffected by level of aerobic fitness.

Recovery and EDV

During the recovery phase of exercise the results showed larger EDV volumes for the highly aerobic fitness group, this may be the case however this is contradicted by (Rowland et.al 2011) study that suggests that among healthy adolescent females, like young males, myocardial systolic and diastolic functional capacities do not contribute to inter-individual variability in physiologic aerobic fitness. This study believes that variability in aerobic fitness does not influence the systolic and diastolic function of the left ventricle. This suggests that these results do not align and that EDV may not be due to aerobic fitness, but in this present study the higher aerobic fitness group show higher EDV volumes throughout both recovery phases and even during exercise.

Limitations and further considerations
The study was conducted to ensure that the results collected were as valid and accurate as possible; however there are limitations to this study and ways in which it can be improved if the study were to be conducted again. One limitation to the present study is the use of laboratory equipment and software, the use of software to analyse the ventricle data and the equipment to acquire it was a never been used before by the people conducting the study and the knowledge of this type of software was not fully experienced, however advice was given throughout when using this software by more experienced individuals who have used this type of software and equipment many times. As well as this all participants were asked to not engage in any strenuous exercise 24 hours prior to the testing and there is no guarantee that this guideline was followed meaning resting values may have been higher than at complete rest. In order to improve upon this study or adapt upon the findings further the study can be conducted by more experienced people in order to ensure even more accurate data, as well as this, the study could also be related to other area of cardiac mechanics in order to establish why these findings may have occurred. Another limitation to this study was the analyses of the ultrasound images as many were unclear and therefore not able to be analysed, yet enough images were successful to examine in order to get averages for different phases of exercise. With more time in the lab and further visits from participants more successful images could be acquired as well as increasing the number of participants in order to make sure that good, clear images can be used when analysing the ultrasound images. Further studies could also highlight the importance of aerobic exercise on LV mechanics and how these can be improved in relation to overall health and well-being on a larger scale with more participants and even participants who compete at an elite level for further comparisons. However, the findings from this study clearly indicates the relationship between LVT and EDV and the differences these two have highly aerobic trained individuals and moderately aerobic trained individuals.
Conclusion

Within the highly aerobic fitness group no significant difference was found between the three phases of exercise, 3 minute recovery and 6 minute recovery in relation to LVT and this was also the case in terms of EDV as no significant differences were found in any of the three phases. However in the moderately aerobic fitness group there was a significant difference in LVT between exercise and the 3 minute recovery phase as well as exercise and the 6 minute recovery phase. Yet, EDV showed no significant differences again during the three phrases of exercise, 3 minute recovery and 6 minute recovery. This suggests that the difference in aerobic fitness does not affect EDV in exercise or recovery but does have an effect on LVT in the moderate aerobic fitness group.
References


Appendices

APPENDIX B

ETHICAL CONFIRMATION STATUS

When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered. If the project requires ethics approval from an external agency such as the NHS or MoD, you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your NHS application in order that your School is aware of the project. The document Guidelines for obtaining ethics approval will help you complete this form. It is available from the Cardiff Met website. Once you have completed the form, sign the declaration and forward to your School Research Ethics Committee.

PLEASE NOTE: Participant recruitment or data collection must not commence until ethics approval has been obtained.

PART ONE

| Name of applicant(s): | Ben Foxwell (BF)  
| | Joseph Gibson (JG) |
| Supervisor (if student project): | Dr Eric Stöhr |
| School: | Cardiff School of Sport |
| Student number (if applicable): | ST20001595 (BF)  
| | ST20000831 (JG) |
| Programme enrolled on (if applicable): | Sport and Exercise Science |
| Project Title: | An Investigation Into the Relationship Between Regional Cardiac Function and the ECG |
| Expected Start Date: | 21/10/2013 |
| Approximate Duration: | Up to 6 months |
| Funding Body (if applicable): | N/A |
| Other researcher(s) working on the project: | Dr Eric Stöhr |
| Will the study involve NHS patients or staff? | No |
| Will the study involve taking samples of human origin from participants? | No |
In no more than 150 words, give a non technical summary of the project

Increasing evidence exists to suggest that cardiac strain and twist – collectively termed ‘cardiac mechanics’ – are altered as a result of continued exercise training. However the mechanisms underpinning these differences are not well-understood. One possible explanation is that the electrical sequence causing mechanical muscle contraction (‘electro-mechanical coupling’) may be responsible for the lower cardiac mechanics in trained individuals. This study aims to examine both the electrical impulses and left ventricular mechanics of the myocardium at rest and during submaximal exercise, and their short-term recovery from exercise.

Does your project fall entirely within one of the following categories:

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<th>Category</th>
<th>Answer</th>
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<tr>
<td>Paper based, involving only documents in the public domain</td>
<td>No</td>
</tr>
<tr>
<td>Laboratory based, not involving human participants or human tissue samples</td>
<td>No</td>
</tr>
<tr>
<td>Practice based not involving human participants (eg curatorial, practice audit)</td>
<td>No</td>
</tr>
<tr>
<td>Compulsory projects in professional practice (eg Initial Teacher Education)</td>
<td>No</td>
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If you have answered YES to any of these questions, no further information regarding your project is required.
If you have answered NO to all of these questions, you must complete Part 2 of this form

**DECLARATION:**
I confirm that this project conforms with the Cardiff Met Research Governance Framework

Signature of the applicant: Date:

**FOR STUDENT PROJECTS ONLY**

Name of supervisor: Date:

Signature of supervisor:

**Research Ethics Committee use only**

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<tr>
<td>Project approved in principle</td>
<td>YES</td>
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<tr>
<td>Decision deferred</td>
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<td>Project not approved</td>
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Project reference number: 13/10/07S

Name: Peter O’Donoghue Date: 16/10/13
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<th>Signature:</th>
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| Details of any conditions upon which approval is dependant: |
| Click here to enter text. |