The comparison of exercise modalities (aerobically only or resistance only) effects on 24 hour blood pressure.

BSc Biomedical Sciences [health, exercise, and nutrition]

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School of Sport and Health Sciences
2018.
Declaration

Statement 1
This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Statement 2
This dissertation is the result of my own investigations, except where otherwise stated. Where corrections services have been used, the extent and nature of the correction is clearly marked in a footnote. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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Abstract

Background: Exercise is prescribed regularly by medical organisations as a lifestyle modification for the non-pharmacological treatment of hypertension. The most effective form of exercise at reducing blood pressure is yet to be determined however, studies have illustrated aerobic exercise to be an effective treatment for controlling and preventing high blood pressure. There remains limited research on the effects of resistance training, although, a number of studies have reported resistance exercise to be likewise as effective at controlling blood pressure as aerobic exercise and therefore is highly recommended to include both exercise modalities in anti-hypertensive treatment programs.

Aim: This current study aimed to investigate the effect of aerobic and resistance training on 24hr blood pressure in normotensive subjects in order to determine whether different exercise modalities have greater effects at controlling blood pressure. The secondary aim of this study was to determine the most beneficial exercise type for the treatment of hypertension as a non-pharmacological method.

Method: 24 hour blood pressure monitoring was taken on sixteen healthy, normotensive individuals using a 24 hr Mobil-o-graph device. Participants were categorised into group A (aerobically trained) and group B (resistance trained) dependant on their self-reported activity type. The study required all participants to wear the Mobil-O-graph cuff and a sensewear band for 24 hours to obtain 24hr blood pressure profile and physical activity levels of all participants.

Results: Both groups illustrated normal blood pressure values. Group A demonstrated slightly lower 24hr systolic blood pressure of 115 ± 12.42 compared to those in group B which demonstrated a 24hr SBP of 116 ± 9.3 however, no significant difference was found between the two groups (p = 0.653).

Discussion: The results from this study provide evidence that both exercise modalities have potential to be beneficial at lowering and controlling 24hr blood pressure. These results suggest that the type of exercise does not impact the effectiveness of physical activity in controlling and preventing high blood pressure, therefore, exercise type can be of personal preference.

Conclusion: This study provides evidence that both exercise modalities have potential to be beneficial at reducing 24hr blood pressure therefore, greater beneficial benefits would arise from an anti-hypertensive training programme including the combination of both
exercise modalities. Having said this, further research is recommended in order to compare the effect of various intensities of exercise on blood pressure. These results are supported by the recent recommendations of the American College of Sports Medicine that the combination of modalities of exercise are to be included in programmes to achieve the greatest benefits for reducing 24hour blood pressure.
Introduction

Hypertension is classed as the constant elevation of blood pressure above 140/90 mmHg and is becoming an increasing issue in the public health. According to the World Health Organisation Hypertension accounted for approximately 9.4million deaths worldwide in 2008 (1). JNC states that the desired range of blood pressure to be <130/80 mmHg and stated an increment of 20/10 mmHg is shown to be highly problematic to patients health and can potentially double the risk of cardiovascular disease (2). Individuals suffering from hypertension may also experience higher prevalence of many diseases such as stroke, coronary heart disease, heart failure, peripheral vascular disease, renal impairment and retinal haemorrhage (3). This increased risk to many diseases in hypertensives highlights the importance of an effective treatment and prevention intervention to lower and control high blood pressure.

Sedentary lifestyles are becoming increasingly prevalent in today’s society and is possibly the underlying cause of many diseases. Evidence from studies have proposed inactive individuals elicit a 30-50% greater risk of having high blood pressure and developing hypertension (4) (5). Physical activity of less than 1hr a week can be associated with doubling cardiovascular mortality therefore, highlighting the importance of physical activity for protection against these diseases.

Due to the evident benefits of exercise, physical activity is often prescribed by health care professionals as a lifestyle modification for the treatment and prevention of hypertension (6). The evidence from studies supports the non-pharmacological intervention and suggests that physical activity could be the most effective lifestyle modification for the prevention and progression of hypertension (7).

Therefore, the ACSM recommendations for physical activity are 30 minutes of moderate-intensity five days per week with additional strength training two days a week (8).

The relationship between physical activity and cardiovascular health has been examined in great depth over the past 4 decades with several studies suggesting both aerobic and resistance training to provide substantial benefits to the cardiovascular health of individuals (9) (10). Scientific evidence has suggested a higher prevalence of cardiovascular events and higher death rates to be seen in individuals who do minimal
amounts of physical activity (9). Due to this, aerobic exercise is often prescribed over antihypertensive drugs in stage 1 hypertension cases and is the preferred method of prevention. Findings from studies supported this by illustrating an average reduction of 3.84 mmHg for systolic BP and 2.58 mmHg for diastolic BP by increasing the patients aerobic exercise training (4). Studies have found the effect to be greater in hypertensive individuals compared to healthy normotensive individuals (11) although, the mechanism behind the hypotensive effect of aerobic exercise is still uncertain.

In addition to aerobic exercise, resistance exercise is becoming an exercise regime of interest for protection and prevention of hypertension, recent meta-analysis found resistance training to reduce systolic and diastolic blood pressure by 3.2 mmHg and 3.5 mmHg and is now often recommended alongside aerobic exercise as a non-pharmacological intervention for hypertensives (12). Although, previous studies have suggested positive benefits to BP from resistance training, recommendations by American Heart Association and the American College of Sports Medicine suggest hypertensives use resistance training as a supplement alongside their aerobic exercise training program to prevent and control high blood pressure (13). This recommendation is aimed at hypertensives therefore recommendations may be differ when considering normotensive individuals. The mechanism behind the hypotensive effect from resistance training remains unclear however, many believe resistance training to be beneficial due to factors such as increasing muscular strength, improving the haemodynamic responses and subsequently increasing VO2max (12). Alongside this proposed mechanism, it is generally accepted that the decrease in circulating catecholamine’s and a decreased heart rate is potentially the factor behind the blood pressure reduction from exercise. However the exact mechanism remains unclear and requires further research (14). The hypotensive effect of both exercise modalities can be dependent on type, duration, intensity and frequency of the exercise program, therefore, the variability in training is an important area for further research in order to achieve desired effects for the maximal reduction and maintenance of blood pressure.

This current study investigated 24 hour blood pressure monitoring in normotensive individuals. 24hr BP monitoring was the chosen method over office blood pressure monitoring due to the precise values of blood pressure obtained during 24hr monitoring.
This method has been considered highly reliable and valid when compared to office or clinical blood pressure measurements (15). The 24hr BP monitoring is important not only in the detection of hypertension but also provides easy detection of abnormal nocturnal BP, identifying whether an individual is a dipper or non-dipper (16). It is the preferred method over office BP to obtain an accurate assessment of the patients 24-h blood pressure which cannot be assessed by office or home BP measurements. Due to this, it is now widely used for hypertension diagnosis and most importantly used to detect the ‘non dippers’ which are considered at greater risk of developing cardiovascular complications (17) (15) (18).

Due to the clear evidence of the benefits from exercise, physical activity has been advocated as an effective intervention to reduce hypertension and decrease risk of cardiovascular disease however, optimal type, intensity and length of exercise program to produce the desired hypotensive effect is yet to be discovered (19). For normotensive individuals the magnitude of the post exercise hypotension is found to be less pronounced suggesting that the effect of exercise may also be dependent on individuals underlying disease state (20). Fewer studies have investigated the effect of physical activity on healthy normotensive subjects therefore, the primary aim of this study is to investigate the effect of aerobic and resistance training on 24hour blood pressure in young normotensive individuals.

From previous studies, aerobic exercise caused the most significant improvement in SBP and DBP by 9.41% and 10.06% however they also illustrated that resistance training produced a significant reduction of 3.99% for SBP and 6.81% for DBP (21). Therefore, it can be hypothesised that both exercise modalities will cause a hypotensive effect and are both effective methods for the control and regulation of blood pressure, however, aerobically trained individuals may elicit a slightly lower mean blood pressure in comparison to resistance trained individuals.
3.0 Methods

3.1. Experimental Overview
The study consisted of two visits to the laboratory in Cardiff Metropolitan University separated by 24 hours of which the participant had their 24 hour blood pressure measured.

3.2. Participants inclusion:
This study had an inclusion criteria of healthy male and females aged 18-30yrs, that regularly take part in either aerobic exercise or resistant exercise for >150 minutes a week. Exclusion for this study included individuals that exercise using a combination of both modalities and having a history of high blood pressure. Participants were categorized into two groups; group A and group B depending on their self-reported exercise type.
To qualify for either group A or group B, specific inclusion criteria were set:
(Group A) individuals that perform >30-60 min of moderate intensity aerobic exercise 5 or more days a week or 20-60min vigorous activity 3 days a week. Likewise, inclusion for Group B included individuals who train each muscle group >2-3 days each week and do no aerobic training alongside their resistant training.
Subjects used had no known diseases or injuries and did not take any antihypertensive medication.
Ethics approval was granted by the Cardiff Metropolitan University ethics committee alongside all participants completing an informative consent form.

3.3 Study design:
The study was designed to evaluate 24 hour blood pressure and physical activity levels using a 24hr ambulatory blood pressure monitor (Mobil-O-graph) and a bodymedia sensewear pro3 armband. Recruited participants were assigned to either group A or group B dependent on their self-reported activity type, group A being aerobically trained and group B being resistance trained.
3.4. Visit One:
At the beginning of visit one, participants' height and weight were measured using Seca® electronic scales and a Seca® height monitor based at the laboratory at Cardiff Metropolitan University. From these measurements, participants' BMI was calculated. Each individual had a device set with their individual information; once the individual's information was inputted, equipment was then fitted to each participant. The Mobil-O-graph is to be fitted on the upper right arm with the sensewear band placed on the upper left arm.

3.5. Visit 2:
Following the 24-hour measurement period, each participant returned for a second visit during which equipment was removed and data was uploaded. The software used to input data was the HMS client server version 4.7 and the BodyMedia SenseWear 7.0.

3.6. Equipment description:
To measure 24-hour ambulatory blood pressure in this study, a Mobil-O-graph monitor was used. The Mobil-O-graph is the most efficient piece of equipment used to obtain 24hr blood pressure profiles and is useful for use in large studies due to it allowing quick turnover for the next patient (22). Components of the Mobil-O-graph include an arm cuff which attaches to a cuff tube and links the arm cuff to the Mobil-O-Graph NG 24Hr BP Monitor (see image 1). The arm cuff is placed on the upper right arm, the cuff tube is then placed around the back of the patient and attached to the monitor to avoid any discomfort. The Mobil-o-graph blood pressure monitor displays systolic and diastolic blood pressure (mmHg) and heart rate (HR). For this study, measurements were set to be taken every half hour during the day and every hour during the night. This technique was used for this study due to previous studies suggesting that 24hr blood pressure measurements to be superior than clinic BP measurements at predicting the risk of cardiovascular disease (23).

Other equipment used included the SenseWear pro3 arm band which observed 24hr physical activity levels of participants.
All techniques used in this study were considered non-invasive, nevertheless, all participants were informed and instructed to remove any equipment immediately if it caused any pain, discomfort or irritability.

3.7. Statistical Analysis:

Data collected from the study were analysed using Minitab software version 14 and are expressed as mean ± standard deviation (SD) unless stated otherwise. Data from the two groups were compared using an independent sample T test with the significance level set at <0.05 to determine the significance. All means were considered to be significantly different when p= ≤0.05.

Image 1 – Image taken from Numed Healthcare (24)
4.0 Results

4.1. Subject demographics:

For this research study, sixteen participants (10 male and 6 females) were recruited through advertisement at Cardiff Metropolitan University and word of mouth in areas around Cardiff and Carmarthenshire. All participants demographics are displayed in table 1. Participants recruited were healthy, normotensive individuals that take part in regular aerobic or resistance exercise.

Age, body weight, height and BMI for subjects in group A were calculated as 23 ± 4.5 yrs, 65 ± 9.8 kg, 173 ± 10.8 cm and 21.7 ± 1.9, and likewise for group B were 21 ± 2 yrs, 74.1 ± 13 kg, 177 ± 10 cm and 23.3 ± 2.

Table 1 illustrates that resistance trained individuals presented higher values for weight, height and BMI than aerobically trained individuals, this may be the result of a higher muscle mass in resistance trained individuals and that the majority of participants in group B were male therefore, may affect the mean value.

Previous to the study a participant information sheet, consent form and risk assessment were completed and agreed by each participant. This study did not involve a Physical Activity Readiness Questionnaire or a health questionnaire, therefore, these factors were all self-reported by the participants.

All participants were further instructed to avoid caffeine, alcohol and exercise for the duration of the study.

Table 1: Table of participants demographics, given as a mean ± SD.

<table>
<thead>
<tr>
<th></th>
<th>Group A (n=5)</th>
<th>Group B (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>23 ± 4.53</td>
<td>21 ± 2.2</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65 ± 9.86</td>
<td>74.1 ± 13.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>173 ± 10.81</td>
<td>177 ± 10.5</td>
</tr>
<tr>
<td>BMI</td>
<td>21.7 ± 1.9</td>
<td>23.3 ± 2.6</td>
</tr>
</tbody>
</table>
4.2. Measurements:

This study examined daytime systolic (SBP) and diastolic blood pressure (DBP), night-time SBP and DBP and Mean Arterial Blood Pressure (MAP). However, the primary outcome measure were comparisons in daytime, night-time and 24 hour systolic blood pressure. Table 2 shows the BP difference between group A and B.

**Table 2: Comparison of daytime, nighttime and 24 hour blood pressure results obtained in group A and B (A= aerobic, B= resistance).**

<table>
<thead>
<tr>
<th>Blood Pressure</th>
<th>Group A</th>
<th>Group B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime SBP (mmHg)</td>
<td>118 ± 12.24</td>
<td>120 ± 9.2</td>
<td>0.673</td>
</tr>
<tr>
<td>Nighttime SBP (mmHg)</td>
<td>105 ± 11.48</td>
<td>104 ± 13.9</td>
<td>0.369</td>
</tr>
<tr>
<td>Daytime DBP (mmHg)</td>
<td>70 ± 3.10</td>
<td>67 ± 7.2</td>
<td>0.240</td>
</tr>
<tr>
<td>Nighttime DBP (mmHg)</td>
<td>59 ± 3.84</td>
<td>55 ± 6.9</td>
<td>0.141</td>
</tr>
<tr>
<td>24hr MAP (mmHg)</td>
<td>90 ± 8.14</td>
<td>88 ± 7.4</td>
<td>0.164</td>
</tr>
<tr>
<td>24hr Systolic BP (mmHg)</td>
<td>115 ± 12.42</td>
<td>116 ± 9.3</td>
<td>0.653</td>
</tr>
</tbody>
</table>

*All values presented as mean ± SD*

4.3. Differences in daytime SBP

As hypothesised, group A presented a lower mean ± SD daytime systolic blood pressure of 118±12.24 compared to group B who presented a daytime SBP of 120±9.2. However, analyses of the statistical significance found there to be a significance of 0.673 suggesting that no significance difference can be assumed between the groups(Table 1).

The different number in groups potentially causes a limitation to the results, group A had a lower participant number n=5 than group B n=11.
4.4. Differences in Night-time SBP

On the other hand, results for night-time SBP displayed a different pattern to daytime SBP. Figure 2.b reveals group A to have a higher mean ± SD night-time SBP (105 ± 11.48) when compared to the mean ± SD night-time SBP in group B (104 ± 13.9) (Table 2). The results found in this study support the findings by Nami et al, 2000 who similarly exhibited aerobic exercise to cause a reduction in blood pressure during daytime with no further effect observed on the nocturnal blood pressure of participants (18). Similarly to other studies, the results in this study illustrate that resistance trained individuals had a lower night-time blood pressure than aerobically trained individuals.

4.5. Differences in 24hr SBP

Twenty-four-hour blood pressure monitoring is a superior prognostic marker for any cardiovascular outcome with many studies suggesting emphasis to be applied to systolic blood pressure for the prevention of hypertension (25) (26). Due to these findings, 24hr systolic blood pressure was the major focus of this study. Figure 2.a reveals that aerobically trained individuals presented with lower 24 hour SBP than those in group B who predominately resistance train.

Group A had a mean ± SD of (115 ± 12.42) (table 2) compared to Group B who presented a mean ± SD of (116 ± 9.3) (table 2).

The results from this study support the findings found by multiple studies (27) (28), however, this study found there to be no statistically significant difference between individuals who do aerobic exercise or resistance exercise (p=0.653).

To clearly display the findings from this study, the comparison in results of group A and B were displayed in figure 2.
Figure 2:

**Figure 2.a** – A comparison between the effect of aerobic and resistance exercise on 24hr systolic blood pressure (mmHg). (Confidence level of 95% and significant at p = 0.653)

**Figure 2.b** – A comparison between the effect of aerobic and resistance exercise on daytime systolic blood pressure (mmHg). (Confidence level of 95% and significant at p = 0.673)
Figure 2.c – A comparison between the effect of aerobic and resistance exercise on Night-time systolic blood pressure (mmHg). (Confidence level of 95% and significant at p = 0.369)
5.0. Discussion

The aim of this current study was to investigate the effects of aerobic and resistant exercise on 24-hour systolic and diastolic blood pressure in normotensive subjects. The results obtained from this study support the literature that suggests both modalities of exercise are effective at maintaining healthy blood pressure. However, due to conflicting research no hypothesis was made on which exercise type had greater effects, results from this study show no significant difference in systolic and diastolic blood pressure between aerobic and resistance trained individuals.

Recent recommendation by the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure states that any individual with a blood pressure above 140/90 mmHg should be treated for hypertension (2). Medication is not the only way to treat hypertension, lifestyle modifications such as increasing physical activity are often used as a substitute or to accompany the antihypertensive medication for the control and prevention of high blood pressure. However, individual variation and dosing between patients should be considered when referring patients to an exercise program (29).

Aerobic exercise is predominately used as a lifestyle modification for the treatment and prevention of hypertension however, further studies have suggested resistance exercise to also be significantly beneficial for prevention of cardiovascular diseases due to the clear improvements to individuals muscular strength and muscular endurance from resistance training (30). Supporting this idea further was Ozaki et al, 2013 who reported significant improvements in VO2 max from resistance training, and further suggested the mechanism for improving VO2max to be an increased cardiac output and a-vo2 diff, alongside increased muscle mass contributing to the improvements of VO2max (31). However, due to the many factors involved in the hypotensive effect of resistance training, the exact mechanism is yet to be totally understood and requires further research.

The major findings from this study were that there was no statistically significant differences between 24 hr systolic blood pressure in individuals that only take part in aerobic exercise compared to those that only resistance train. The results from this current study support the findings found in a study by Lima et al, 2017 which reported combined
exercise, aerobic exercise and resistance training were all equally as effective at reducing blood pressure (32). The results obtained from this study for 24hr systolic blood pressure reported there to be a small difference of 3.6 mmHg between aerobic and resistance trained individuals. However, the difference had a significance level of $p = 0.653$, suggesting that there was no true difference in blood pressure between the two exercise groups.

This studied findings demonstrate that the hypotensive effect of exercise is potentially present from undergoing both aerobic and resistance training. The 3.6 mmHg difference in 24 hour SBP between the aerobic group and the resistance group may be due to the different numbers in group A and B and would require a larger sample size to prove its significance. Although, a large study in 2017 supported the results from this current study. The meta-analysis observed no greater decrease in BP after a combined exercise programme and an aerobic only exercise program suggesting there to be no optimal choice of exercise (32). On the other hand, contradicting these findings was a study that observed greater significant changes to blood pressure in an aerobic training program. The study concluded aerobic training to show greater beneficial effects than resistance training on reducing risk of cardiovascular diseases (33).

Aerobic exercise is observed to exert an anti-inflammatory action on the sympathetic nervous system and hypothalamic-pituitary-adrenal, which further directly reduces blood pressure unlike many medications prescribed for hypertension. Ghadieh et al, 2015 observed physical activity to cause an anti-hypertensive effect, which was due to many factors such as enhancing baroreceptor sensitivity, decreasing norepinephrine levels, reducing peripheral vascular resistance, improving insulin sensitivity and the alteration of the vasodilator and vasoconstriction factors (34). That specific study stated that the chronic adaptations to physical activity included inducing changes to neuroendocrine, immune and the vascular systems (34). From previous research, it is clear that there are many factors involved in the hypotensive effect of exercise, this explains why the exact mechanism is yet to be fully understood. Nevertheless, studies have concluded that aerobic training has the ability to reduce blood pressure in hypertensives and normotensives although it remains unclear as to the intensity of exercise required to obtain the beneficial effect due to the response variability between individuals (20).
For many years resistance exercise had been believed to increase blood pressure and has not always been considered as an appropriate intervention for the reduction and prevention of cardiovascular disease (20) however, recent studies have observed that resistance exercise plays an important role in the treatment and prevention of cardiovascular diseases. Many studies including this study, have observed resistance exercise to be beneficial in improving cardiovascular risk factors such as high blood pressure and thus preventing potential hypertension cases (35).

Results from the current study found individuals that resistance train to have a similar 24hr blood pressure profile when compared to individuals who aerobically train, illustrating that there is no greater type of exercise for the reduction and control of blood pressure. Similar results were found in a meta-analysis by Cornelissen and Smart in 2011, which concluded that dynamic endurance training, dynamic resistance training and combined training all exhibit a reduction in SBP and DBP at similar magnitudes (36). Supporting these results further, de Sousa et al, 2017 investigated the effect of resistance training alone on blood pressure and concluded resistance training to reduce both systolic and diastolic blood pressure in pre hypertensive and hypertensive individuals, and further recommended the use of resistance training as a tool for the management and prevention of hypertension (37).

It was further believed by a study that a combination of both modalities may elicit the greatest reduction in blood pressure (27). Had this current study had a larger sample size in both groups, it is possible that a larger difference in blood pressure reduction could be seen to support the findings from previous studies.

This study was conducted on healthy normotensive individuals, therefore, to begin with all individuals had blood pressure values in the normal blood pressure range. All participants were did regular physical activity suggesting that exercise has an important role at maintaining healthy blood pressure in normotensive individuals and should be encouraged to the public in order to reduce future hypertension cases. One study has shown there to be no difference observed in the magnitude of BP reduction between normotensives and hypertensives from exercise however more recent studies contradict this theory and suggest chronic exercise can reduce blood pressure at various magnitudes and is dependent on many factors including disease state, type, duration and intensity of exercise (38) (20). Due to this it is recommended that such factors are considered in future
studies. This current study compared the 24 hr blood pressure in normotensive individuals that are aerobic exercisers or resistance exercisers, therefore, the results in this study are only relatable to normotensive individuals.

There remains few studies examining effects of exercise on normotensive subjects therefore this current study highlights the area needed for further research.

5.1. Strengths and Limitations

Results from this study support the growing research on the benefits of exercise to prevent and control high blood pressure.

A major strength of this current study was the use of 24hr blood pressure measurements in place of the more often used office BP. 24hr BP measurements provide blood pressure values for daytime and night-time, the 24hr BP values serve an importance due to evidence showing an abnormal nocturnal blood pressure to be a high predictor of cardiovascular risk (23). Evidence has further suggested 24hr Ambulatory Blood Pressure to be superior to clinic measurements for the prediction of CVD mortality (23).

Another strength of this study was that the study received no participant drop outs during the study. The technique used was considered as non-invasive therefore was not a burden on participants, therefore all participants were able to complete the study with no complications. Consequently all data was able to be used to make a final conclusion. Thirdly, data was analysed by Minitab software which allowed easy and quick analyses of results and avoids the possibility of human error.

However, there are a few limitations present in this current study. Participants were instructed to avoid caffeine and alcohol during the 24 hours that blood pressure was being measured, however, this cannot be totally controlled and may have affected the mean BP value.

The study had a small sample size of sixteen participants therefore, the results cannot be considered definitive, although the findings from this study agree and support the findings found in studies with larger sample sizes and combined can be used to aid future research (39).
It should also be considered that there was no physical activity questionnaire set for the purpose of participant inclusion, instead the study used participants self-reported physical activity type and level for recruitment therefore, this cannot be totally assertive.

To increase the level of accuracy, previous to the study an International Physical Activity Questionnaire (IPAQ) could be completed by all participants so that correct recruitment and grouping can be executed.

The results observed in this study were from 24hr in young normotensive individuals and therefore are only transferable for young normotensive individuals. Therefore, the results obtained in this study are not relatable when considering hypertensive individuals.

This current study took no consideration into account for gender and ethnicity factors, such factors could affect the mean blood pressure readings significantly. Previous studies have reported Afro-Caribbean populations and Asians to have a higher risk of Hypertension (40), the results were seen to vary as the response to exercise differed by ethnicity and gender (7). Moreover contradicting this was a study which examined both male and female and found no significant difference between the genders (41). Taking this into account, greater research is required which consider factors such as gender and ethnicity.

5.2. Conclusion and future study

The current study highlighted that aerobic exercise and resistance exercise are both effective at maintaining normal blood pressure therefore further confirming the importance of engaging in regular exercise throughout your life to ensure blood pressure is controlled and maintained. These results, suggest that the effect of exercise is potentially influenced by the intensity and duration of exercise rather than the type of exercise therefore when prescribing regular exercise as an intervention to treat and control blood pressure, guidelines should follow the FITT recommendations (Frequency, Intensity, Time and Type) for hypertensive patients (13). However for normotensive individuals, regular physical activity of either aerobic and/or resistance training will provide no difference in benefits such as the control of healthy blood pressure.

The findings from this study encourage future research to determine the greater exercise modality for the reduction of blood pressure. The results also direct future research to
compare the exact intensity and duration of resistance and aerobic exercise and whether combined exercise elicits the greatest effect on BP. A previous study have suggested the importance of type, intensity, duration and frequency of exercise on the magnitude of hypotension response, therefore, further research in this area would be recommended (13). There is limited research on the effect of exercise on normotensive individuals, this current study directs further research to investigate the effects of aerobic and resistance training on normotensive individuals, specifically in comparison to hypertensives.
6.0. References


40) Lane D. Ethnic differences in hypertension and blood pressure control in the UK. QJM. 2001;94(7):391-396.

7.0. Appendix

7.1. Ethical Approval

Jones, Isabelle
BSc: Biomedical Sciences [Health, Exercise & Nutrition]
Cardiff School of Health Sciences

Dear Applicant

Re: Application for Ethical Approval: Understand if exercise modality (aerobically trained or resistance only trained individuals) affects 24 hour (ambulatory) blood pressure, aortic stiffness

Project Reference Number : 9562

Your ethics application, as shown above, was considered by the Biomedical Sciences Ethics Panel on 01-11-17.

I am pleased to inform you that your application for ethical approval was APPROVED.

Minor issues may still need addressing before you commence any work – if so these will be listed below.

1. Indicate "no" to human samples
2. Answer questions in Part 1
3. In B2, embellish on previous experience
4. Poster, consent form and PIL need ethics reference number

Where changes to the information sheet, consent form and/or procedures are deemed necessary you must submit revised versions to the relevant ethics inbox. If you are a student – your supervisor must do this on your behalf.

Note: Failure to comply with any issues listed above will nullify this approval.

Standard Conditions of Approval

1. Your Ethics Application has been given a Project Reference number as above. This MUST be quoted on all documentation relating to the project [e.g. consent forms, information sheets], together with the full project title.
2. All documents must also have the approved University Logo and the Version number in addition to the reference and project title as above.
3. A full Risk Assessment must be undertaken for this proposal, as appropriate, and be made available to the Committee if requested.
4. Any changes in connection to the proposal as approved, must be referred to the Panel/Committee for consideration without delay quoting your Project Reference Number. Changes to the proposed project may have ethical implications so must be approved.
5. Any untoward incident which occurs in connection with this proposal must be reported back to the Panel without delay.
6. If your project involves the use of human samples, your approval is given on the condition that you or your supervisor notify the HTA Designated Individual of your intention to work with such material by completing the form entitled “Notification of Intention to Work with Human Samples”. The form must be submitted to the PD (Sean Duggan), BEFORE any activity on this project is undertaken.

This approval expires on 01-11-18. It is your responsibility to reapply/request extension if necessary.

Yours sincerely

[Signature]

Dr Rachel Adams
Chair of BMS Ethics Panel
Cardiff School of Health Sciences

Tel: 029 20416855
E-mail: radams@cardiff.ac.uk
Cc:

PLEASE RETAIN THIS LETTER FOR REFERENCE