

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

The Effects of Different Forms of Exercise on Body Composition
and Cardiorespiratory Fitness in Previously Sedentary Females

A thesis in partial fulfilment of the requirements for the degree of

Masters of Science

in

Exercise Physiology

at Massey University, Palmerston North,

New Zealand

Amy Catherine Barr

2002

Erratum in the light of Examiners Comments

Amendments

1. Appendix B. 1., new heading 'Pre-training Mean Values and Comparisons of Age, Body Mass, Height, Blood Pressure, Pre-Exercise Heart Rate, Circumferences, Skinfold Measurements and Estimated VO_2max for Control, 'Pump It' and Walking groups, Experiment 2 (Week = 0)'.
Appendix B.2., new heading 'ANOVA Summary Tables Comparing Groups Prior to Exercise Intervention, Experiment 2 (Week = 0)'
2. Pg. 42, replace incorrectly written formula 'Work = Mass x Vertical height' with Work = Force x Distance (vertical height) and Force = Mass x Acceleration (where acceleration is that due to Gravity, $\sim 9.81 \text{ m.s}^{-2}$) as was used for the calibration and calculation of Work on the treadmill.
3. Typographical and spelling errors:
 - Abstract line 2 add 'physical' before training.
 - Pg. v 1.1.8 'F' instead of 'f' in Fitness
 - Pg. xi VO_2 – Volume of oxygen consumption (ml/kg/min),
 VO_2max – Maximal Volume of Oxygen Consumed (ml/kg/min)
 - Throughout text V should have a dot over it when it is integrated with time
 - Pg. 10 pgraph 3 spelling of cardiorespiratory
 - Pg. 14 pgraph 4 whose rather than who's
 - Pg. 36 pgraph 3 Replace currently with previously
 - Pg. 37 pgraph 2 labs should read laboratories
 - Pg. 41 pgraph 2 replace 'Q' with RER
 - Pg. 46 pgraph 4 should read 'duration *at which* the exercises'
 - Pg. 48 pgraph 3 change 'inputed' to 'entered'
 - Pg. 49 pgraph 2 delete 'also represented' replace with 'in'
 - Pg. 53 pgraph 2 remove 'for gas'
 - Pg. 54 pgraph 3 remove 'to'
 - Pg. 59 pgraph 4 between fifty five *and* sixty minutes
 - Pg. 74 pgraph 1 remove 'greater'
 - Throughout text ACSM's (not ASCM's) Resource Manual for Guidelines for Exercise Testing and Prescription, 3rd Edition (1998)
 - Throughout text the correct symbol for the statistical term alpha is α not ∞
 - Appendix D5 the workload for subject 2 should be Watts not L/min
4. Errors and omissions in the Bibliography
 - Pg. 84 Baldy et al were contributing authors. Change to ACSM
 - Throughout text journal 'Medicine and Science in Sports and Exercise' is incorrectly cited as Exercise & Science in Sports and Exercise.

Abstract

Thirty-five healthy females between the ages of 18 and 45 who had not undertaken any training for at least two months prior to the experiment were studied to determine the effects of six weeks of 'Pump It' aerobics or walking training on body composition and cardiorespiratory fitness, expressed as estimated maximal oxygen consumption ($VO_2\text{max}$). Twelve of the volunteers participated in 'Pump It' aerobics while eleven took part in walking training. The remaining twelve subjects served as controls.

Prior to the training programme, subjects were assessed for their current levels of cardiorespiratory fitness and body composition (fitness test 1). Testing was repeated at the conclusion of the training period (fitness test 2). Estimated $VO_2\text{max}$ was determined from heart rate and oxygen uptake during a submaximal treadmill-walking test. This method was validated in a preliminary experiment. Oxygen consumption during 'Pump It' was overestimated by approximately 0.38L/min using the HR/ VO_2 relationship obtained during treadmill walking. This was taken into account for the calculation of VO_2 in Experiment 2. Body composition was evaluated from the sum of five skinfolds (triceps, subscapular, suprailiac, abdomen, thigh) and the sum of six circumferences (forearm, upper arm, waist, hips, thigh and calf). Data were analysed using one factor ANOVA and regression analysis.

The training programmes consisted of three 55-60 minute sessions a week. Massey University 'Pump It' aerobics consisted of a variety of traditional weight training exercises performed using light weights and high repetitions to music. Walking training involved brisk walking as a group, in and around the Massey University, Turitea Campus.

Six weeks of 'Pump It' and Walking training failed to produce significant improvements in cardiorespiratory fitness and body composition compared

with the Control group. There were no significant changes in body mass, the sum of skinfolds or the sum of circumferences. It was concluded that the length of the fitness programmes were too short to improve cardiorespiratory fitness and the training intensity of 'Pump It' and Walking were insufficient to improve body composition.

Acknowledgements

I wish to thank my supervisors Dr Rodger Pack and Patsy Watson for their help in preparing this thesis. I would also like to thank Dr Hugh Morton for his guidance throughout the study. Thanks to Christine Scott and the staff at the Massey University Recreation Centre for their support and the use and transportation of their treadmill. Special thanks are given to Georgina Cuttance for her sense of humour during the long hours spent in the lab. Thanks to all of my 'Guinea Pigs', without your hard work this thesis could not have happened. . A very special thanks goes to Dr Heather Simpson for her time and effort in the last few days. Thanks to Dave, Sarah and Rissy for crossing my t's and dotting my i's. Finally, I would also like to thank my family and friends for the wonderful support they have given me.

Table of contents

Abstract	ii
Acknowledgements	iv
Table of contents	v
List of Tables	viii
List of Figures	ix
List of Appendices	x
List of Abbreviations	xi
CHAPTER 1. LITERATURE REVIEW	1
1.1 CARDIORESPIRATORY FITNESS	1
1.1.1 Benefits of Cardiorespiratory Fitness	1
1.1.2 Specificity of Training	1
1.1.3 Cardiorespiratory adaptations to training	2
1.1.4 Recommendations for improving Cardiorespiratory Fitness	3
1.1.5 Adherence to Training	5
1.1.6 Prescription of Exercise for Sedentary People	5
1.1.7 Effects of 'Pump It' on Cardiorespiratory Fitness	6
1.1.8 Effects of Walking on Cardiorespiratory fitness	7
1.1.9 Training Volume	9
1.2 ASSESSING CARDIORESPIRATORY FITNESS	10
1.2.1 Treadmill Protocols	11
1.2.1 HR/VO ₂ relationship	12
1.2.2.1 Prediction of Oxygen Consumption using HR/VO ₂ relationship	13
1.2.2.2 Estimation of VO ₂ max using the HR/VO ₂ relationship	14
1.2.2.3 Factors that affect the HR/VO ₂ relationship	15
1.2.2.4 Effect of mode of exercise on the HR/VO ₂ relationship	16
1.3 OBESITY AND ITS IMPLICATIONS ON HEALTH	18
1.3.1 Incidence and Causes of Obesity	19
1.4 EXERCISE AND WEIGHT LOSS	21
1.4.1 Recommendations for promoting weight loss through exercise	22
1.4.2 Effects of Resistance Training on Body Composition	23
1.4.3 Effects of Walking on Body Composition	24
1.5 BODY COMPOSITION ASSESSMENT	27
1.5.1 Hydrostatic Weighing	27
1.5.2 Skinfolds	28
1.5.2.1 Predicting Percentage Body Fat using Skinfold Measurements	30
1.5.2.2 Comparison of Skinfold Protocols	31
1.5.3 Circumferences	32
1.5.3.1 Comparison of Circumference Protocols	34
1.6 THE CURRENT STUDY	36
CHAPTER 2. PREDICTING OXYGEN CONSUMPTION USING THE HR/VO₂ RELATIONSHIP	39

2.1 INTRODUCTION	39
2.2 METHODS.....	40
2.2.1 <i>Experimental Design</i>	41
2.2.1.1 Respiratory Gas Analysis	41
2.2.1.2 Treadmill Calibration	42
2.2.2 <i>Subjects</i>	42
2.2.3 <i>Testing Procedures</i>	43
2.2.3.1 Exercise Sessions	43
2.2.3.2 Treadmill Test	44
2.2.3.3 Cycle Ergometer Test.....	45
2.2.3.4 'Pump It' exercise test.....	46
2.3 RESULTS	47
2.4 DISCUSSION	49
CHAPTER 3. THE EFFECTS OF DIFFERENT FORMS OF EXERCISE ON BODY COMPOSITION AND CARDIORESPIRATORY FITNESS IN PREVIOUSLY SEDENTARY FEMALES	51
3.1 INTRODUCTION	51
3.2 METHODS.....	55
3.2.1 <i>Experimental Overview</i>	55
3.2.2 <i>Subjects</i>	56
3.2.3 <i>Experimental Design</i>	56
3.2.3.1 Non-experimental Exercise	56
3.2.3.2 Dietary Intake.....	57
3.2.3.3 Control Group.....	57
3.2.3.4 'Pump It'	58
3.2.3.5 Walking	59
3.2.3.6 Training Intensity	60
3.2.3.7 Fitness testing	60
3.2.3.7.1 Body Composition	61
3.2.3.7.1.1 Height and Body Mass	61
3.2.3.7.1.2 Circumferences	61
3.2.3.7.1.3 Skinfolds	62
3.2.3.7.2 Cardiorespiratory Fitness	62
3.2.3.8 Statistical Analysis:	65
3.3 RESULTS	66
3.3.1 <i>Dietary Intake</i>	67
3.3.2 <i>Body Composition</i>	68
3.3.3 <i>Pre-exercise Heart Rate and Blood Pressure</i>	70
3.3.4 <i>Cardiorespiratory Fitness</i>	70
3.3.5 <i>Training Intensity</i>	71
3.4 DISCUSSION	73
3.4.1 <i>Individual Subjects</i>	73
3.4.2 <i>Cardiorespiratory Fitness</i>	74
3.4.2.1 Improvements in predicted VO ₂ max	74
3.4.2.2 Methodology	75
3.4.2.3 Initial Fitness Levels of the Subjects	76
3.4.2.4 Exercise Intervention Programmes.....	76
3.4.3 <i>Body Composition</i>	78
3.4.3.1 Methodology	78
3.4.3.2 Exercise Intervention Programmes.....	80

3.4.4 Summary.....	81
CHAPTER 4 GENERAL DISCUSSION	82
BIBLIOGRAPHY	84
APPENDICES	97

List of Tables

Table:	Page:
1. Cardiorespiratory Fitness Classification for Women based on VO_2 max	8
2. Balke Protocol	12
3. Modified Balke Protocol.....	12
4. Changes in Body Composition with Walking Training	25
5. Testing Schedule for Experiment 1	44
6. Example of a typical 'Pump It' aerobics class.....	58
7. Total Dietary Intakes for week one and six, Experiment 2.	67

List of Figures

Figure:	Page:
1. Formulae used in gas analysis calculations, Experiment 2	65
2. Body Mass of Control, 'Pump It' and Walking group before (week 0) and after the training period (week 7), Experiment 2.....	67
3. Biceps Circumference at week 0 and week 7 for the Control, 'Pump It' and Walking groups, Experiment 2.....	68
4. Abdominal Skinfold for Control, 'Pump It' and Walking groups over 6 weeks, Experiment 2.....	69
5. Pre-exercise Heart Rate at weeks 0 and 7 for the Control, 'Pump It' and Walking groups, Experiment 2.....	70
6. Estimated VO_2 max for the Control, 'Pump It' and Walking groups at weeks 0 and 7, Experiment 2.	71
7. Exercise Intensity (%HRmax) for weeks 1-6 for the Control, 'Pump It' and Walking groups, Experiment 2.....	72

List of Appendices

Appendix:

- A
1. Physical Activity Readiness Questionnaire (PAR-Q)
 2. Consent Form
 3. Information Sheet
 4. Daily Activity Diary: recommendations and recording sheet
 5. The 'Green Prescription'
 6. Dietary Intake: instructions and recording sheet
 7. Anatomical Pictures: Muscles of the Human Body
 8. Anatomical Sites of Skinfold Measurements
 9. Anatomical Sites of Circumference Measurements
- B
1. Group Comparisons of Age, Body Mass, Height, Blood Pressure, Pre-Exercise Heart Rate, Circumferences, Skinfold Measurements and Estimated VO_2 max at Week =1, Experiment 2
 2. Summary Tables for ANOVA, Fitness Test I, Experiment 2
 3. Summary tables for ANOVA, Fitness Test I & II, Experiment 2
 4. Graphs Experiment 2
 5. Summary Tables of post hoc ANOVA, Fitness Test I & II, Experiment 2
- C
- Tables of Results
1. Body Composition Characteristics, Fitness test I & II, Experiment 1
 2. Pre-exercise Blood Pressure and Heart Rate, Fitness test I & II, Experiment 1
 3. Estimated maximum Oxygen Consumption, Fitness test I & II, Experiment 2
 4. Dietary Intakes for Weeks One and Six, Experiment 2
- D
1. Multiple Regression Equation for changes in oxygen uptake with increasing workload, Experiment 1
 2. Multiple Regression Equation for changes in Heart Rate with increasing workload, Experiment 1
 3. Predicted Oxygen Consumption (VO_2 , L/min) during 'Pump It' aerobics using Derived Regression Equations, Experiment 1
 4. Summary Table for Correlations, Experiment 1
 5. Graphs Experiment 1

List of Abbreviations

ATP	adenosine triphosphate
ANOVA	analysis of variance
BF	body fat
BMI	body mass index
BP	blood pressure
bpm	heart rate in beats per minute
CHD	coronary heart disease
CWT	circuit weight training
HDL	high density lipoprotein
HR	heart rate
HR _{max}	maximum heart rate
HRR	heart rate reserve
HW	hydrostatic weighing
L/min	litres per minute
ml/kg/min	millilitres per kilogram per minute
pre-exercise HR	heart rate prior to submaximal exercise test
Repetition	a single complete action of an exercise from starting position to completion and back to the starting position
RMR	resting metabolic rate
SAID	specific adaptations to imposed demands
SC-6	sum of forearm, upper arm, waist, hip, thigh and calf circumferences
SSK-5	sum of triceps, subscapular, suprailiac, abdomen and thigh skinfolds
VO ₂	volume of oxygen consumption
VO _{2max}	maximal oxygen uptake