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THE EFFECTS OF RED MEAT CONSUMPTION AND HIGH-INTENSITY RESISTANCE TRAINING ON SKELETAL MUSCLE STRENGTH, MUSCLE MASS AND FUNCTIONAL STATUS IN HEALTHY OLDER ADULTS.

A thesis submitted in partial fulfillment of the requirements for the award of the degree

Master of Science (Research)

from

The University of Wollongong

by

Irene Fe Gutteridge, BSc (Kinesiology)
I, Irene Fe Gutteridge, declare that this thesis, submitted in partial fulfillment of the requirements for the award of Master of Science, in the School of Health Science, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Irene Fey Gutteridge

27th August 2008
THE EFFECTS OF RED MEAT CONSUMPTION AND HIGH-INTENSITY RESISTANCE TRAINING ON SKELETAL MUSCLE STRENGTH, MUSCLE MASS AND FUNCTIONAL STATUS IN HEALTHY OLDER ADULTS.

ABSTRACT
With the older adult representing an increasingly large percentage of the Western world, attempts are being sought to improve their healthy aging through various modes of prevention. The age-associated declines that occur in the physiological and functional systems along with levels of physical activity and quality of life have the potential to be attenuated and ameliorated with various forms of health-related interventions. It has been suggested that intake of dietary protein in the elderly may be too low to sustain normal muscle mass and red meat intake declines in the over 65 y age group in Australia.

The present study examined the effects of a high-intensity resistance training program and two levels of red meat intake on skeletal muscle strength, body composition and other health-related markers in healthy, community-dwelling older adults. Twenty-eight healthy male and female subjects with mean age (±SD) of 67 ±3 y and randomized to either a moderate (400g/wk) or high (800g/wk) red meat diet, completed a supervised twice weekly, twelve week high-intensity resistance training program of the lower extremities. The moderate meat diet represented the usual intake for older Australians over 65 y. Diet histories, body composition assessments, mid-thigh CT scans, grip strength, lower extremity performance, physical activity levels, one-mile walk test, fasted blood samples and morning urine samples were taken at baseline and twelve weeks. Four-repetition maximum strength testing of the lower extremity was undertaken at pre-, mid- and post-intervention.
Leg strength was greater in males than in females and this was strongly associated with their muscle mass and stature independent of gender. Age related declines in grip strength and leg muscle strength were evident at baseline. Resistance training significantly increased leg muscle strength >50% (p<0.001) irrespective of gender and age but grip strength (not targeted by the training program) remained unchanged. In subjects on the higher meat diet, mid-intervention leg press strength improvements were greater than those seen with the moderate meat diet (p<0.01), although significant differences between diets were not sustained at week twelve. The sum of seven skinfolds (mm) decreased significantly in all subjects with training (131.2±8.8 to 119.9±7.3, p<0.001) and significant improvement to the proportion of cross-sectional area of thigh muscle and thigh fat were measured in the non-dominant leg (p<0.05). Physical activity levels and lower extremity performance remained unchanged. The high red meat diet provided additional short-term benefits for building muscle strength without compromising cardiovascular disease risk factors, but in the longer term had no additional beneficial effects to strength and functional parameters.

In summary, healthy older adults exhibit an age related decline in strength, yet all have the capacity to greatly increase strength with muscle specific exercise training. Marked increases in strength can be rapidly achieved with short term high intensity resistance training. Resistance training is well tolerated and can be recommended for improving strength and enhancing other health-related parameters as part of a prevention based healthy aging strategy.
Acknowledgments

This project was an amazing experience in so many ways!

I am privileged to have witnessed such change and improvement in the lives of the study volunteers over the course of the project. Without the study volunteers, none of this would have been possible. Their enthusiasm and commitment to the study was relentless. It is without a doubt a period in my life that I will never forget and will continue to inspire me into my own “older” years. Dr. Peter McLennan was a key figure throughout this journey. He took me under his wing when I had nowhere else to go and handed me this project with great trust, encouragement and supported me right to the very end! I am forever thankful to Andrew Frith, not only did his assistance during the testing and intervention prove to be stupendous, he was dedicated to ensuring “my subjects” were taken care of and looked after. Acknowledgment must go to the Exercise Science students from the School of Health Sciences. Their punctuality and dedication were critical to the exercise intervention running smoothly. Sheena McGhee was integral in many aspects. Her skilled hands and demeanor was essential to testing procedures, as was her hospitality during the write-up stages. Dr. Alice Owen was integral with supervision, guidance and early manuscript proofing as well as key in biochemical assessments. Dr. Gregory Peoples was a great co-supervisor during the final stages of the write-up and was a breath of fresh air as our conversations often diverted to many other interesting ideas about human function and performance. I am thankful for Herb Groeller who reminded me that “less is more” in the early stages of this project. Thanks must go to Dr. Dennis Calvert and Marc Brown for their assistance with the medical screening and the ECG evaluations. The collection of dietary data was possible due to the assistance of Lynda Gillen and Anne McMahon within the Smart Foods Centre and the prompt and friendly deliveries of high quality meat from Dorahy Meats, Unanderra. The one mile walk test was made possible due to the assistance from the members of the Cardiovascular Lab from the School of Health Sciences. The use of the Wollongong City Council Gymnasium was essential to the success of the study and served as a perfect setting for the exercise intervention. A big thank-you must go to all the postgraduate students, staff and friends within the Department of Biomedical Sciences who provided many friendly smiles and open ears for someone so far from her roots and loved ones.

“Do not say at the start what the final stage will be.”
Moshe-Pinhas Feldenkrais
Dedication

This thesis is dedicated to my first teachers, my parents. Their parenting has been the best and possibly the hardest kind of teaching to do for a child. They taught me without parenting and have provided me with amazing opportunities in which to learn, grow and develop into my own being.

For this I am forever grateful!
TABLE OF CONTENTS

Abstract p.iii
Acknowledgements p.v
Dedication p.vi
TABLE OF CONTENTS p.vii
LIST OF DIAGRAMS p.x
LIST OF TABLES p.x
LIST OF FIGURES p.xi
ABBREVIATIONS p.xii
GLOSSARY OF TERMS p.xiii
SCIENTIFIC COMMUNICATIONS p.xv

CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW
1.1 INTRODUCTION p.2
   1.1.1 Age-Associated Declines p.10
   1.1.2 Muscle Strength and Functional Status p.14
   1.1.3 Physical Activity Levels and the Older Adult p.16
1.2 INTERVENTION p.18
   1.2.1 Resistance Training p.20
   1.2.2 Resistance Training and the Older Adult p.21
   1.2.3 Resistance Training Interventions and the Older Adult p.23
   1.2.4 Protein Nutrition and Resistance Training Interventions p.34
1.3 SUMMARY p.36
1.4 AIMS AND HYPOTHESIS p.37

CHAPTER TWO: METHODS
2.1 INTRODUCTION p.39
   2.1.1 Research Design p.40
2.2 SUBJECTS p.41
   2.2.1 Subjects Recruitment p.41
2.2.2 Screening
   2.2.2.1 Primary Screening
   2.2.2.2 Secondary Screening
   2.2.2.2.1 Final Subject Break-Down
   2.2.2.2.2 Dietary History Interviews

2.2.3 Subject Drop-Out

2.3 INTERVENTION
   2.3.1 Design and Randomization
   2.3.2 Dietary Intervention
      2.3.2.1 Supplying Red Meat
      2.3.2.2 Assessment of Compliance and Subject Satisfaction
   2.3.3 Exercise Training
      2.3.3.1 Resistance Training Exercises
      2.3.3.2 Familiarization Period
      2.3.3.3 Borg Ratings of Perceived Exertion (RPE)
      2.3.3.4 Exercise Execution and Technique Instruction
      2.3.3.5 Warm-up Protocol
      2.3.3.6 Cool-down Protocol
      2.3.3.7 Proper Breathing Instruction
   2.3.4 Training Protocol
      2.3.4.1 Typical Training Session
      2.3.4.2 Intervention and Testing Structure

2.4 PHYSICAL TESTING PROCEDURES AND ASSESSMENTS
   2.1.1 Exercise Test Termination Criteria
   2.4.2 Physical Testing Procedures
      2.4.2.1 Four-repetition Maximum (4RM)
      2.4.2.2 Grip Strength
      2.4.2.3 One Mile Walk Test (MWT)
   2.4.3 Physical Activity and Functional Performance Assessments
      2.4.3.1 Physical Activity Scale for the Elderly (PASE)
      2.4.3.2 Short Physical Performance Battery (SPPB)
   2.4.4 Body Composition Assessment
      2.4.4.1 Anthropometric profile
      2.4.4.2 Bioelectrical Impedance (BIA)
      2.4.4.3 Mid-Thigh Computed Tomography
2.5 STATISTICAL ANALYSES p.70

CHAPTER THREE: RESULTS
3.1 DIET HISTORY p.72
3.2 SAFETY OF RED MEAT p.73
   3.2.1 Iron Status p.73
   3.2.2 Urinary Protein p.73
   3.2.3 Markers of Oxidative Damage p.73
3.3 EXERCISE INTERVENTION AND ASSESSMENT PROCEDURES p.75
3.4 EFFECT OF INTERVENTION p.76
   3.4.1 All Subjects p.76
   3.4.2 Effect of Diet Meat Intervention p.81
   3.4.3 Gender Differences p.83
   3.4.4 Analysis of Associations Between Muscle Cross Sectional Area and Strength. p.87
   3.4.5 Association Between Age and Muscle Strength p.88

CHAPTER FOUR: DISCUSSION AND FUTURE RECOMMENDATIONS p.89
REFERENCES p.117
APPENDICES p.135
List of Diagrams

Diagram 1 Potential Contributing Factors to Sarcopenia p. 4
Diagram 2 Research Design p.40
Diagram 3 Intervention Timeline p.47

List of Tables

Table 1 Dietary macronutrient and red meat consumption at pre-and post-intervention. p.72
Table 2 The effect of diet and exercise intervention upon iron status, urinary protein and oxidative stress markers. p.74
Table 3 Primary and secondary characteristics for all subjects pre- and post-intervention. p.78
Table 4 Right thigh characteristics pre- and post-intervention for all subjects and subdivided into high and low meat groups. p.79
Table 5 Thigh muscle and fat cross-sectional area proportions pre- and post-intervention in non-dominant and dominant legs for all subjects and subdivided according to meat intake. p.81
Table 6 Gender comparison of absolute measurements for leg press and leg extension strength at pre-, mid- and post-intervention. p.84
Table 7 Mid-thigh CT scan values from a male and female subject p.85
Table 8 Female thigh muscle and fat cross-sectional area proportions pre- and post-intervention for all subjects and subdivided according to meat intake. p.86
Table 9 Male thigh muscle and fat cross-sectional area proportions pre- and post-intervention for all subjects and subdivided according to meat intake. p.86
List of Figures

Figure 1 Leg press strength (4RM absolute values) for all subjects at pre, mid-and post-intervention. p.76

Figure 2 Leg extension strength (4RM absolute values) for all subjects at pre, mid-and post-intervention. p.77

Figure 3 Relationship between CT cross-sectional area of the thigh fat and mid-thigh (of three) skinfolds, pre-intervention. p.80

Figure 4 The effect of low and high meat diet on the absolute change in leg press strength in response to resistance training between pre- to mid-intervention, mid- to post-intervention and pre- to post-intervention. p.82

Figure 5 The effect of low and high meat diet on the absolute change in leg extension strength in response to resistance training between pre- to mid-intervention, mid- to post-intervention and pre- to post-intervention. p.82

Figure 6 Effect of gender and training on leg press strength at pre-, mid- and post-intervention. p.83

Figure 7 Effect of gender and training on leg extension strength at pre-, mid- and post-intervention. p.84

Figure 8 Examples of CT scan analysis from a male and female subject. p.85

Figure 9 Baseline relationship between muscle cross-sectional area (cm²) and leg press strength pre- and post-intervention. p.87

Figure 10 Baseline relationship between muscle cross-sectional area (cm²) and leg extension strength pre- and post-intervention. p.87

Figure 11 Relationship between age and grip strength at baseline. p.88

Figure 12 Relationship between age and leg press strength at baseline. p.88
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ACSM/AHA</td>
<td>American college of sports medicine and the American heart association</td>
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<tr>
<td>ADL</td>
<td>Activities of daily living</td>
</tr>
<tr>
<td>BIA</td>
<td>Bioelectrical impedance</td>
</tr>
<tr>
<td>BMI</td>
<td>Body mass index</td>
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<tr>
<td>CT</td>
<td>Computerized tomography</td>
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<tr>
<td>CSA</td>
<td>Cross-sectional area</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>LEP</td>
<td>Lower extremity performance</td>
</tr>
<tr>
<td>MWT</td>
<td>One mile walk test</td>
</tr>
<tr>
<td>PASE</td>
<td>Physical activity scale for the elderly</td>
</tr>
<tr>
<td>RDA</td>
<td>Recommended daily allowance</td>
</tr>
<tr>
<td>RM</td>
<td>Repetition maximum</td>
</tr>
<tr>
<td>RPE</td>
<td>Ratings of perceived exertion</td>
</tr>
<tr>
<td>RT</td>
<td>Resistance Training</td>
</tr>
<tr>
<td>SPPB</td>
<td>Short physical performance battery</td>
</tr>
<tr>
<td>VO_{2max}</td>
<td>Maximal oxygen consumption</td>
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Glossary of Terms

Aerobic capacity
The maximum amount of oxygen the body can use during a specified period, such as in physical exercise. It describes the functional status of the cardiorespiratory system (the heart, lungs and blood vessels) and the ability to remove and utilize oxygen from circulating blood.

Concentric muscle contraction.
Phase of movement in which the joint angle of the joint being used is decreased as the prime muscle being used is actively shortened.

Eccentric muscle contraction
Phase of movement in which the joint angle of the joint being used is increased as the prime muscle being used is actively lengthened.

Fall
An event which results in a person coming to rest unintentionally on the ground or other lower level, not as a result of a major intrinsic event (such as a stroke or syncope) or overwhelming hazard.

Muscular hypertrophy
Muscular growth in which there are increases in the synthesis of contractile proteins (actin and myosin) within the myofibril and increases of myofibrils with a muscle fiber.

Periodization
Planned variation in an exercise regime such as resistance training with the purpose to offer greater gains in performance-related variables such as strength and endurance.

Physical activity
Any bodily movement either planned or non-planned that results in an expenditure of energy.

Physical exercise
Partaking in an activity with the intent to develop or maintain physical fitness and overall health, such as resistance or endurance training.

Progressive overload
Practice of the gradual and continual increase of stress placed on the physical body during exercise. Training variables (e.g., resistance, number of sets and repetitions, rest periods, time) are manipulated to offer a progressive overload to the body.

Repetition
One complete movement of an exercise that consist of a concentric muscle contraction and a eccentric muscle contraction
**Repetition maximum (RM)**
Maximal number of repetitions performed per set for a given resistance training exercise. A 1RM is classified as the heaviest resistance that an individual can perform once with proper lifting technique.

**Rest period**
Time that occurs between exercise sets to allow for recovery. The length of rest is highly dependent on factors such as: training goals, load lifted, experience of the person training.

**Sarcopenia**
Derived from the Greek “Sarco” denoting “flesh”, and “penia” which indicates deficiency, hence a deficiency of flesh or muscle. It refers to the involuntary and gradual loss of muscle mass and strength that occur with advancing age.

**Set**
A group of repetitions completed together without stopping.

**Specificity**
Training in a specific manner to produce specific adaptations or training outcomes.

**Successful aging**
Maintaining and even enhancing functionality and quality of life into older ages through maintenance of factors such as physical activity levels, muscular strength and muscle mass etc.

**Training frequency**
Number of training sessions in a given time period.

**Usual aging**
Occurs when factors of lifestyle or environment intensify the common age related changes such as diminished muscle strength and muscle mass, increases in body fat, lower levels of physical activity etc.
