EXCELLENCE IN EDUCATION RESEARCH PROGRAM COVER PAGE

Student Researcher: Brandon Jones Department: Health and Human Performance

NMU Student ID: 00331057 Telephone Number: 608-513-0403

Course Name and Number student plans to enroll in during one of the summer sessions:

ES-599A: Master's in Exercise Science Thesis (1)

Project Title: The Effect of Hyperthermic Whole Body Heat Stimulus (Sauna) on Heat Shock Protein 70 and Skeletal Muscle Hypertrophy in Young Males during Weight Training

Project Abstract (250 Words):

Increasing muscle mass is a common goal to maximize strength. While resistance training has been demonstrated to increase skeletal muscle mass, it has limitations due to overtraining and injury. Animal studies indicate that the application of heat may aid in the recovery of muscle following stress and that heat shock proteins (HSPs) are likely involved in this process. However there have been no comparable studies in humans. Therefore the purpose of this study is to further our understanding of the effects of hyperthermic whole body heat on HSP70 and skeletal muscle hypertrophy following resistance training in humans. If the findings of this study are similar to those observed in animal models, it could change the methods used to increase muscle mass.

The study will involve 15-20 subjects separated into three groups. The experimental group (Group I) will complete a supervised resistance training (RT) protocol + sauna exposure. The RT only group (Group II) will complete RT + mental relaxation (sauna sham). The control group (Group III) will not undergo supervised RT. The primary dependent variable will be skeletal muscle mass measured through a DEXA scan. HSP70 concentrations and maximal strength (5RM Back Squat) will be measured as secondary dependent variables. I hypothesize that RT + sauna will further increase muscle mass which will be concomitant with an increase in HSP 70.

Funds from this grant will be used to afford EISA Kits, travel/airline ticket, and presentation materials for a conference on July 12-15th 2017.

SIGNATURES:

Student Researcher — Date: 1/30/17

Faculty Advisor — Date: 1-30-2017

Department Head — Date: 1-30-17

Departmental Rating of Proposal: (Additional comments can be attached)

[ ]Excellent [ ]Very Good [ ]Good [ ]Fair

Ranking of Proposal within the Department: _____ proposals.

Table of Contents

Statement of the problem

Increasing muscle mass is a common goal to maximize strength. While resistance training has been demonstrated to increase skeletal muscle mass, it has limitations due to overtraining, catabolic accumulation, and injury. Animal studies appear to indicate that the application of heat may aid in the recovery of muscle following stress and that heat shock proteins (HSPs) are likely involved in this process. However there have been no comparable studies in humans. Therefore the purpose of this study is to further our understanding of the effects of hyperthermic whole body heat on HSP70 and skeletal muscle hypertrophy following resistance training in humans. If the findings of this study are similar to those observed in animal models, it could significantly change the methods used to increase muscle mass.

Project Rational and Lit Review

It is commonly understood that resistance training increases skeletal muscle size by creating small tears in the muscle cell, followed by the addition of muscle mass during the recovery period (17). The cellular damage caused by resistance training stimulates a stress response that assists the muscle to adapt to the stress and avoid extensive damage. Resistance training also increases satellite cell proliferation that has been linked to muscle hypertrophy (5). This signaling process to increase muscle mass is important to strength gains and lean body mass accumulation.

An important part of the stress response is an increase in the concentration of heat shock proteins (HSPs). There are many different members of the HSP family which respond to different stressors such as hyperthermia, hypoxia, ischemia, and physical activity. However the most widely studied and abundant HSP that responds to stress in the human body is heat shock protein 70 (HSP70) (9). Its exact physiological mechanism of action is unknown but it has been

suggested that HSPs act as molecular chaperones which aid in the removal of denatured proteins and refold proteins into functional muscle mass (3, 11). By isolating HSPs in a rabbit's liver researchers were able to show their involvement with the correct folding of actin within skeletal muscle leading to muscle hypertrophy. (21). Additionally, the role of HSPs in protein synthesis may play an important function in muscle hypertrophy and recovery.

HSPs increase their concentration in responses to exercise in rats as well as humans (4, 6, 12, 13). In humans, it appears that the intensity of the exercise and extent of muscular damage is an important factor in the amount of HSP stimulation (9, 10, 15). Due to this interaction between the intensity of exercise, resulting cellular damage and HSP stimulation, it has been hypothesized that HSPs may play an important role in muscular recovery and muscular hypertrophy after intense exercise. It remains unclear what stimulates the increase in HSP during exercise but it has been suggested that the heat produced by the muscle during intense exercise may be the primary stimulus. (10)

An alternative method of increasing the concentrations of HSPs is by creating a whole body hyperthermic environment. Rats exposed to intermittent hyperthermia alone responded with a dramatic increase of HSPs concentration (7, 14, 16, 18). This increase in HSPs in response to heat is important because it may suggest heat could be used in combination with cellular damaging exercise to aid muscular development. A group of rats that were exposed to heat stress demonstrated the increased HSPs strongly correlated with proliferation of satellite cells and increased protein concentrations in the cell (7). This study directly correlates hyperthermia to muscular development and possibly muscle hypertrophy, further supporting the main purpose of the current study protocol.

HSP stimulation through hyperthermia has been shown to help the recovery of rats that have undergone skeletal muscle atrophy through forced inactivity. The muscle weight of the soleus decreased significantly less when rats were exposed to hyperthermic conditions (13, 14, 16, 20). This suggests that using hyperthermic conditions and stimulating HSPs may protect the muscle against cellular damage, even when inactive. If hyperthermia can assist with the recovery from muscle atrophy, it may also protect the skeletal muscle from excessive damage during resistance training and lead to heightened muscle hypertrophy. In an in-vitro study of rat skeletal muscle, heat stress along with the mechanical stress of stretching the muscle cell lead to a larger increases in cell protein concentrations than with either method alone (1). Heat stress alone was also shown to increase protein concentrations, but not as significantly as heat stress in combination with mechanical stress, thereby demonstrating the effect of external heat application on muscle development. Currently, this is the most direct study to suggest that the combination of heat and mechanical stress (such as resistance training) compound muscle hypertrophy. Other researchers, using a rat model in-vivo, supported the prior mentioned concept by observing increased weight of the soleus muscle after seven days of heat stress (19). This suggests that heat stress could promote muscle cell generation and induce muscular hypertrophy. If mechanical stress is combined with the heat stress there is a greater possibility for HSP stimulation and therefore further muscle hypertrophy.

Previous studies on the use of the sauna in humans have typically focused on the cardiovascular aspects of hyperthermic conditions. These researchers demonstrated that the use of the sauna produced cardiovascular effects which were similar to moderate exercise (e.g., increased heart rate, chronically reduced blood pressure, improved left ventricle heart function, reduced risk for cardiovascular disease) (2, 8). To the best of my knowledge, no study in humans

has investigated the effect of sauna use in combination with resistance training and its effect on muscle hypertrophy. As suggested by this literature review, the protective function of HSPs and their stimulation during the hyperthermic conditions of a sauna may assist recovery and lead to further gains in muscle mass. Hence, the purpose of this study is to elucidate the effects of hyperthermic whole body heat stimulus (sauna) on HSPs and skeletal muscle hypertrophy following resistance training in humans. If the findings of this study are similar to those observed in animal models, it could significantly change the methods used to increase muscle mass during resistance training.

Project Plan and timetable

The study will involve ~~thirty~~ 15-20 subjects separated into three groups. The experimental group (Group I) will complete the resistance training protocol and the sauna protocol. The first control group (Group II) will be the complete control group with no sauna use or structured resistance training. The second control group (Group III) will only complete the resistance training protocol. The primary dependent variable will be skeletal muscle mass. HSP70 concentrations and maximal strength (5RM Back Squat) will be measured as secondary dependent variables. I hypothesize that when used in conjunction with resistance training, the use of sauna will further increase muscle mass which will be concomitant with an increase in HSPs.

Commented [SD1]: Change this to 15-20 subjects

Commented [SD2]: Make the other two groups reflect the changes we made yesterday: Group 2 RT only and Group 3 control (no structured RT).

Data collection began on January 17th 2017 in Marquette Michigan. Baseline testing of HSP70, lean body mass, and 5RM back squat was recorded during the first week. A 7 day nutrition log was collected at the beginning and end of the study to further understand nutritional interactions with increases in muscle mass. A Visual Analog Scale (VAS) was used every week to determine the degree of soreness, specifically Delayed Onset Muscle Soreness (DOMS) and variation between groups. After six weeks of training/sauna intervention the dependent variables

of lean body mass, HSP70 concentration, and maximal strength will be measured again. After the data is analyzed the Masters in Exercise Science thesis project will be defended on March 20th 2017.

On July 12-15th of 2017 the National Strength and Conditioning Association (NSCA) is holding a conference in Las Vegas, Nevada where the researcher intends to present the finding of this research. The funds from the Excellence in Education Grant will help cover the cost of preparation, travel to the conference, and purchase of ELISA kits for HSP70.

Other resources of funding

An application to the Graduate School at Northern Michigan will also be submitted to further cover costs. In addition the NSCA and American College of Sports Medicine (ACSM) give small grants to student researchers that will be submitted by the student researcher.

Budget Form

Excellence in Education Award
Budget Information

Name: Brandon Jones

Department: Health and Human Performance

*Please indicate how you will use the $1,500 Excellence in Education Award if you are selected to receive an award this summer.
Complete this form, save, and insert in your proposal.

Expenses:

	Item Description	Cost
Equipment/ Supplies:	1. HSP70 ELISA (ADI-EKS-715) Enzo Life Sciences [x2]	$ 1,127.00
	2. Sauna Thermo Hygrometer	$ 40.00
	3. 15mL Test Tube Cryonic Labels	$ 51.00
		$
		$
	Total Equipment/ Supplies: = $1,218.00	$ ~~0.00~~
Travel:	Round Trip from Marquette to Las Vegas, NV National Strength and Conditioning Conference	$ 535.00
		$
		$
		$
		$
	Total Travel: = $535.00	$ ~~0.00~~
Living Expenses:		$
		$
		$
		$
		$
	Total Living Expenses:	$ 0.00
Miscellaneous Expenses:		$
		$
		$
		$
		$
	Total Miscellaneous Expenses:	$ 0.00

GRAND TOTAL EXPENSES: $1,753.00 $ ~~0.00~~

COMMENTS: Grants from the NSCA and ACSM will be submitted to cover additional costs.

Brandon C. Jones

5752 Bellbrook Road
Brooklyn, WI 53521
bcjones044@gmail.com

515 White Street #1
Marquette, MI 49855
608-513-0403

Education

Masters of Science in Exercise and Sports Science, May 2017
University of Northern Michigan- Marquette, MI
Exercise Physiology Emphasis
Cumulative GPA: 3.71

Bachelors of Science in Exercise and Sports Science, May 2015
University of Wisconsin- La Crosse, La Crosse, WI
Fitness Emphasis
Cumulative GPA: 3.50, Dean's List 2012, 2013, 2014, and 2015

Certifications
NSCA Certified Strength Conditioning Specialist
Red Cross First Aid/CPR/AED Certified

Professional Experience

Graduate Assistant
August 2015 – present, University of Northern Michigan: Health and Human Performance Department

- Taught undergraduate level classes including 50 student sections of health and wellbeing, rock climbing, soccer, bowling, senior swim, and senior exercise

Personal Trainer
January 2015 – present, YMCA of Marquette County

- Completed fitness evaluations, created training programs, coached clients and groups through exercise program

Intern at the University of Wisconsin: Sports Medicine
May 2015 – August 2015, UW-Sports Medicine Research Park, Madison, WI

- Gave fitness assessments, developed training programs, ran fitness classes and helped train a clinical population

Research Assistant
December 2014 – May 2015, UW-La Crosse Biomechanics Lab, La Crosse, WI

- Conducted a study on the effects of Kinesiology Tape on delayed onset muscle soreness (DOMS) with hands on experience with a Biodex, EMG system, 3D motion capture, and VO2 system.

Other Experience

Competitive USAPL Powerlifter
Volunteer for "Room at the Inn" in 2015, Marquette, MI
Volunteer for Big Brothers & Big Sisters in 2015
Youth (U12) Soccer Coach, 2014
Active member of ACSM & NSCA

Started a Senior Exercise Class at FPC Church, Marquette
Member of La Crosse Ski Club
Landscape Committee for First Presbyterian Church of Oregon
Volunteer for Habitat for Humanity in 2011
Youth Assistant Soccer Coach in 2009 & 2010

Appendix II: Unofficial Transcript

Name : Brandon C. Jones
Birth Date: 06-OCT

Curriculum Information

Current Program

Master of Science

Program:	MS in Exercise Science
College:	Coll Health Sci/Prof Studies
Major and Department:	Exercise Science, Health & Human Performance

***Transcript type:WEB Web Transcript is NOT Official ***

DEGREES AWARDED

Sought: Master of Science **Degree Date:**

Curriculum Information

Program:	MS in Exercise Science
College:	Coll Health Sci/Prof Studies
Major:	Exercise Science

INSTITUTION CREDIT -Top-

Term: Fall 2015

College:	Coll Health Sci/Prof Studies
Major:	Exercise Science
Student Type:	New First-time Graduate
Academic Standing:	Good Standing

Subject	Course	Level	Title	Grade	Credit Hours	Quality Points	Start and End Dates	R
ES	500	GR	Introduction To Research	A	2.000	8.00		
ES	511	GR	Statistics & Measurements	B	3.000	9.00		
ES	521	GR	Adv Exercise Physiology	A	3.000	12.00		

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	8.000	8.000	8.000	8.000	29.00	3.62
Cumulative:	8.000	8.000	8.000	8.000	29.00	3.62

Unofficial Transcript

Term: Winter 2016

College: Coll Health Sci/Prof Studies
Major: Exercise Science
Student Type: Continuing
Academic Standing: Good Standing

Subject	Course	Level	Title	Grade	Credit Hours	Quality Points	Start and End Dates	R
ES	475	GR	Theory-Strength Train & Cond	A	2.000	8.00		
ES	540	GR	Adv Mech Kinesiology	B	3.000	9.00		
HN	516	GR	Sports Nutrition	A	3.000	12.00		

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	8.000	8.000	8.000	8.000	29.00	3.62
Cumulative:	16.000	16.000	16.000	16.000	58.00	3.62

Unofficial Transcript

Term: Fall 2016

College: Coll Health Sci/Prof Studies
Major: Exercise Science
Student Type: Continuing
Academic Standing: Good Standing
Last Academic Standing: Good Standing

Subject	Course	Level	Title	Grade	Credit Hours	Quality Points	Start and End Dates	R
BI	425	GR	Endocrinology	A-	3.000	11.10		
ES	422	GR	Sport Biomechanics	A	2.000	8.00		
ES	571C	GR	Lab Proc-Lactate/Vent Threshld	A	1.000	4.00		

ES	599A	GR	Thesis		A	2.000	8.00	

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Current Term:	8.000	8.000	8.000	8.000	31.10	3.88
Cumulative:	24.000	24.000	24.000	24.000	89.10	3.71

Unofficial Transcript

TRANSCRIPT TOTALS (GRADUATE) -Top-

	Attempt Hours	Passed Hours	Earned Hours	GPA Hours	Quality Points	GPA
Total Institution:	24.000	24.000	24.000	24.000	89.10	3.71
Total Transfer:	0.000	0.000	0.000	0.000	0.00	0.00
Overall:	24.000	24.000	24.000	24.000	89.10	3.71

Unofficial Transcript

COURSES IN PROGRESS -Top-

Term: Winter 2017

College: Coll Health Sci/Prof Studies
Major: Exercise Science
Student Type: Continuing

Subject	Course	Level	Title	Credit Hours	Start and End Dates
ES	421	GR	Physiology of Training - Sport	3.000	
ES	531	GR	Adv Seminar/Exer Physiology	3.000	
ES	599A	GR	Thesis	2.000	

Appendix III: Letter of Support

NORTHERN MICHIGAN UNIVERSITY
MARQUETTE, MICHIGAN

School of Health and Human Performance
1401 Presque Isle Avenue
Marquette, MI 49855-5301
906 227-2130
FAX: 906 227-2181
Web site: www. nmu.edu

January 30, 2017

Dear Excellence in Education Research Program Committee,

I am writing this letter of recommendation in strong support of Brandon Jones, a current Exercise Science Graduate Student in the School of Health and Human Performance. I have known Brandon since the fall of 2015, when he became a Master's student in our program. During my first semester with him, he demonstrated a high aptitude for research in the area of resistance training (RT) and optimal performance, emerging as a gifted student. Since then, he cultivated a deep interest in the topic of sauna use after heavy RT and the upregulation of heat shock protein (HSP) 70, a protein that augments lean mass accretion from RT, especially under the influence of heat. This topic is now part of his thesis, which I direct. Furthermore, Brandon is a highly motivated student that shows great potential within and outside the classroom when it comes to critical thinking and research. Lastly, gathering data, crunching information, and writing about a specific topic is not new to Brandon. In fact, his plans post M.S. degree are to continue his education toward a Ph.D., targeting the U. of Kansas.

Brandon and I meet on a continuous basis and have routinely discussed the topic of his research proposal intended for the Excellence in Education Research Program grant. To confirm, his topic for this proposal is part of his thesis. Therefore, he intends to examine the effects of sauna + RT on HSP 70, which is unique and innovative in the ever-evolving field of RT. He has already spent countless hours reviewing the literature, writing up his methods, and recruiting participants, partly from NMU's ROTC program. I believe he has created a well-designed study protocol and timeline to complete his research without a hitch. Overall, Brandon's study has the chance to become one of the first projects to define the nature of how HSP 70 might be augmented with RT + sauna.

Please do not hesitate to contact me with questions. Brandon will certainly use project funds wisely and complete his timeline accordingly if awarded this grant.

Sincerely,

Scott Drum, Ph.D., FACSM

Associate Professor – School of HHP

O: 906-227-2195 | C: 970-371-2620 | Email: sdrum@nmu.edu

Appendix IV: IRB Approval

-----Original Message-----
From: Taylor, Janelle N [mailto:jantaylo@nmu.edu]
Sent: Wednesday, November 23, 2016 2:35 PM
To: branjone@nmu.edu; sdrum@nmu.edu
Cc: dereande@nmu.edu; scjordan@nmu.edu
Subject: IRB Approval: HS16-816

TO: Brandon Jones
Health and Human Performance

CC: Scott Drum
Health and Human Performance

DATE: November 23, 2016

FROM: Rob Winn, Ph.D.
Interim Assistant Provost/IRB Administrator

SUBJECT: IRB Proposal HS16-816
IRB Approval Dates: 11/23/2016 - 11/23/2017
Proposed Project Dates: 1/9/2017 - 4/7/2017
"The Effect of Hyperthermic Whole Body Heat Stimulus (Sauna) on Heat Shock Protein 70 and Skeletal Muscle Hypertrophy in Young Males during weight Training."

The Institutional Review Board (IRB) has reviewed your proposal and has given it final approval. To maintain permission from the Federal government to use human subjects in research, certain reporting processes are required.

References

1. Goto K, Okuyama R, Sugiyama H, et al. Effects of heat stress and mechanical stretch on protein expression in cultured skeletal muscle cells. *Pflgers Arch Eur J Physiol* 2003;447(2):247–53.

2. Hannuksela ML, Ellahham S. Benefits and risks of sauna bathing. *Am J Med* 2001;110(2):118–26.

3. Henstridge DC, Febbraio MA, Hargreaves M. Heat shock proteins and exercise adaptations. Our knowledge thus far and the road still ahead. *J Appl Physiol* 2016;120(6):683–91.

4. Huey KA. Regulation of HSP25 expression and phosphorylation in functionally overloaded rat plantaris and soleus muscles. *J Appl Physiol* 2006;100(2):451–6.

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8. Laukkanen T, Khan H, Zaccardi F, Laukkanen JA. Association Between Sauna Bathing and Fatal Cardiovascular and All-Cause Mortality Events. *JAMA Intern Med* 2015;175(4):542.

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15. Paulsen G, Vissing K, Kalhovde JM, et al. Maximal eccentric exercise induces a rapid accumulation of small heat shock proteins on myofibrils and a delayed HSP70 response in humans. *AJP Regul Integr Comp Physiol* 2007;293(2):R844–53.

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17. Staron RS, Karapondo DL, Kraemer WJ, et al. Skeletal muscle adaptations during early phase of heavy-resistance training in men and women. *J Appl Physiol* 1994;76(3):1247–55.

18. Touchberry CD, Gupte AA, Bomhoff GL, Graham ZA, Geiger PC, Gallagher PM. Acute heat stress prior to downhill running may enhance skeletal muscle remodeling. *Cell Stress Chaperones* 2012;17(6):693–705.

19. Uehara K, Goto K, Kobayashi T, et al. Heat-Stress Enhances Proliferative Potential in Rat Soleus Muscle. *Jpn J Physiol* 2004;54(3):263–71.

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21. Ys M, Nv B, Nb G. Isolation of rabbit liver heat shock protein with molecular weight 90 kD (Hsp90) and its interaction with troponin components and calponin. *Biochem Biokhimiia* 1998;63(11):1282–9.