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The effects of a graded exercise session on creatine kinase (CK) blood levels in the older adult

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"'DIE EFFECTS OF A GRADED EXERCISE SESSI<»f ⅉ '<»f ⅉ CREATINE KINASE (CK) BLOOD LEVELS IN 'DIE OLDER AWLT."

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The purpose of this project was to examine the effect of a one-time graded exercise session on creatine kinase (CK) levels in the older adult. The goal was to determine the level of exercise intensity which maximally benefits the older adult without evidence of muscle tissue damage. Eight volunteers were obtained from the DeKalb YMCA and the NIU Recreational Center's senior citizens exercise programs. Each volunteer exercised on a treadmill for a total of ten minutes, not inclusive of warm-up and of cool down periods, at a Maximal Predicted Heart Rate (MPHR) of either 50% (four volunteers) or 75% (four volunteers). Three blood samples (immediately following exercise, 24 hours following exercise, and 32 hours following exercise) were taken. The samples were analyzed for CK levels and CK-MB (form of CK) levels using the Kodak Ektachem analyzer. The results showed an increase in total CK levels in the 50% group between the second and third blood samples, and a decrease was seen in CK-MB levels in the 75% group between the second and third blood samples. It was concluded that exercise at a 50% MPHR was enough to produce skeletal muscle damage in the unconditioned older adult.

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Bad\ground:

The purpose of this project is to examine the effect of a one-time graded exercise session on CK levels in the older adult. The goal is to determine the levels of exercise intensity which maximally benefits the older adult without evidence of muscle tissue damage.

The relevance of this project can be seen when one considers the shift of the U.S. population to a more aged population. The portion of the population 65 years of age or older is growing in absolute numbers as well as in relation to other age groups. Data from the U.S. Bureau of the Census projects there will be 65.6 million Americans age 65 or older by the year 2030. Another investigator projects that the 65 years or older age group will go from about 13% of the total population in 1990 to about 22% in 2050 (Lusky, 1986). The under 25 years age group will go from 36% of the total POPulation in 1990 to about 28% by 2050. As the population ages, healthcare will become increasingly important in the maintenance of a healthy life. Therefore this project has extreme relevance for the future.

The older adult population tends to lead sedentary lifestyles. A national health survey conducted in 1985 showed that only 7.5% of the people interviewed (age 65 or older) participated in regular vigorous physical activity, and only 30% of the sedentary people had been advised by their doctor of the physical benefits of exercise (Rooney, 1993). An

increased risk of developing or exacerbating various chronic diseases, such as coronary artery disease (CAD), hypertension, and diabetes, is seen in older people with an inactive lifestyle.

A sedentary life results in a decrease in aerobic capacity. This decrease leads to physical limitations which may ultimately lead to a loss of independence for the individual. The aging process is associated with reduction in muscle mass and strength. This is the "major cause for their (elderly people) increased prevalence of disability" (Evans, 1992). Many changes previously assumed to be age-related can be shown to be related to muscle disuse. These changes in muscle tissue include "decreased insulin sensitivity, mass, strength, endurance and glycogen content" (Evans, 1992). Physical exercise can help to slow or reverse some of these changes.

The benefits of exercise for the older population have been widely studied and documented (Emery. et al. 1989; Ettinger. et al. 1989; Evans, 1992; and Rooney, 1993). These benefits include the following:

- strengthened and improved flexibility of skeletal muscle
- improved cardiovascular function including decreased risk of CAD and hypertension
- retardation of osteoporosis and increased bone density (prevention of fractures)
- aid in pain management
- improved carbohydrate metabolism by diabetics
- positive effects on mental depression, cerebral blood flow, and cognition
- improved quality of life
- maintenance of an independent lifestyle.

Although the benefits are well documented, little is known about the potential hazards of exercise in the older adult population. Muscles can be damaged during exercise and though the muscles will eventually heal, this process takes time. Therefore an ideal exercise program is one that induces maximal benefits with the least amount of muscle damage possible. Previous studies have measured V02 max, blood pressure, heartrate, perceived muscle pain, and muscle stiffness. Few studies have actually measured the extent of damage by using an objective and sensitive indicator.

Since it has been demonstrated that the older population requires a prolonged healing time for damaged muscles compared to younger populations, injury is one of the most common barriers to exercise (Matheson, 1988). Muscle damage can be detected by the release of the enzyme creatine kinase (CK) into the blood following injury. This release may correspond to muscle soreness and will usually peak 24 - 36 hours following exercise (Franklin. et al. 1992). Since CK is too large of a protein to move through the intact cell membrane, its presence in the blood indicates muscle cell rupture and therefore skeletal muscle damage (Evans, 1987). For this reason, CK is considered a good blood marker for muscle damage.

Creatine kinase is an enzyme that catalyzes the conversion of creatine phosphate and ADP to creatine and ATP.

Creatine Phosphate + ADP __CK_> Creatine + ATP

CK is found in the mitochondria and the cytoplasm of muscle cells. In the mitochondria, CK assists in the breakdown of ATP. The converse is

true of the CK present in the cytoplasm where CK assists in the production of ATP. Wu explains that the cytoplasmic CK is important in contractile tissue of muscles because it assists in the production of the ATP required for contraction (1989).

Creatine kinase exists in several different forms. These forms are called isoenzymes and are defined as "native products of different alleles and are distinguishable by differences in unique primary protein structure (the sequence of amino acids)" (Armbruster, 1991). The CK isoenzymes or isozymes are CK-BB found mainly in the brain, CK-MB found mainly in the myocardium, and CK-MM found mainly in skeletal muscle. These isozymes can be separated and quantified by electrophoresis and densitometry using agarose gel, cellulose acetate, or polyacrylamide gel electrophoresis (PAGE) techniques. The isozymes CK-MM and CK-MB can be further broken down into isoforms defined as "CK isozymes that have undergone a postsynthetic modification of their primary structure" (Armbruster, 1991). These include CK-MM1' CK-MM2' CK-MM3' CK-MB1' and CK-MB2'

The isozyme that has been the most widely studied and analyzed is CK-MB. This is due to its use in the evaluation of acute myocardial infarctions (AMI). Although CK-MB is found mainly in the myocardium, it is also present in skeletal muscle. Therefore elevated CK-MB levels may reflect conditions other than cardiac problems. A high ratio of isoforms CK-MB2/CK-MB1 is indicative of acute skeletal muscle injury.

Therefore the purpose of this project is to examine the effect of a one-time graded exercise session on CK levels in the older adult. By examining these effects, it may be possible to determine an ideal

exercise level which promotes maximal benefits with the least amount of muscle damage possible.

Methods:

Volunteers over 60 years of age were recruited from the DeKalb YMCA and the NIU Recreational Center's senior citizens exercise programs. As an incentive, potential volunteers were informed that they would be informed regarding their blood lipid profiles and fasting blood sugars, at no cost. A total of eight volunteers were obtained. The volunteers were then contacted by phone to schedule exercise and phlebotomy appointments.

Each appointment was about one hour in duration. The appointments began by taking a brief medical history from the subject (see attached form - Appendix A). The subjects' age was used with an algorithm to calculate the Maximal Predicted Heart Rate (MPHR). Each subject was then asked to read and sign an informed consent form (see Appendix B). Each subject was fitted with ten cardiac electrodes attached to a belt worn throughout the exercise such that continuous monitoring of the EKGs and heart rate could be performed. After a resting EKG was obtained, the volunteer stepped onto the treadmill. Once accustomed to the treadmill (warm-up), the speed and inClination were increased in such a way that an MPHR of either 50% (four volunteers) or 75% (four volunteers) was maintained throughout the session. The volunteer was asked to walk on the treadmill for a total of ten minutes, not inClusive of warm-up and of cool down period. After ten minutes, the inclination was lowered and the speed slowed in order to cool down the volunteer.

Finally each volunteer was asked to read and sign a phlebotomy waiver (see Appendix C) required by the University Health Service before the initial blood sample was taken. Each volunteer was then asked to return the following day 24 hours and 32 hours following exercise for two more blood collections.

Each of the three specimens for all volunteers was analyzed for CK and CK-MB. The blood lipid profiles and fasting blood sugars were also performed on the 24 hour sample (fasting sample). All laboratory analyses were performed using the Kodak Ektachem analyzer in the Clinical Laboratory Science Program laboratory (CLS laboratory). Samples were also analyzed for CK levels by St. Anthony Medical Center.

Results:

The 32 hour post exercise (32 hour) total CK levels of the group exercising at a rate of 50% MPHR (50% group) and the group exercising at a rate of 75% MPHR (75% group) taken together were significantly greater than the 24 hour post exercise (24 hour) levels. When analyzed separately, the 32 hour CK levels of the 50% group were still significantly increased over the 24 hour levels but no significant difference was obtained with the 75% group (Appendix D).

The 32 hour CK-MB levels of the 50% group and the 75% group taken together were significantly smaller than the 24 hour levels. When analyzed separately, the 32 hour CK-MB levels of the 75% group were still significantly decreased over the 24 hour levels but no significant difference was obtained with the 50% group (Appendix E).

Conc1usions:

Several possible explanations and conclusions can be drawn from the results obtained.

When the results obtained from analyses of CK performed in the CLS laboratory are compared to those obtained from St. Anthony Medical Center, it can be seen that both sets of results are similar. Although the values are not identical, similar trends are seen in both sets of results.

When the CK-MB results are examined, it can be seen that in all cases the CK-MB levels decreased following exercise. An increased level of CK-MB could be interpreted as evidence of either cardiac damage, skeletal muscle damage, or both. By demonstrating a failure of the CK-MB level to increase after exercise, it can be assumed that any increases in total CK must be due to skeletal muscle damage rather than myocardium.

When the total CK values for the separate collections are examined, it can be seen that the CK values decrease fram collection A (basal) to collection B. One possible explanation of this result may be dehydration that caused hemoconcentration. Since the subjects exercised before collection A, any perspiration could cause a slight decrease in blood volume. This decrease in volume would in turn cause the CK and other analytes to appear more concentrated. Another explanation for the decreases seen in the CK-MB levels could be muscle damage that occurred prior to the observed exercise session. This previous damage could cause the basal sample to show increased CK-MB levels above a normal basal level.

When the two groups are compared, the 50% group shows muscle damage while the 75% group shows none. This result seems unusual since it would be expected that if the 50% group showed damage then the 75% group should also show damage. One possible explanation could be the fact that the two oldest volunteers (80 and 84 years) are in the 50% group. Also the 75% groups has one individual whose MPHR was difficult to attain and then hold, possibly a result of anticonvulsant medication. Finally, it is possible that although the subjects were randomly separated into the two groups that those in the 75% group are in better physical condition.

One can suggest that for an older adult who is beginning an exercise program, a 50% MPHR is enough to produce muscle damage. Also one could suggest that an unconditioned older adult would experience fairly large muscle damage at a 75% MPHR. Further research is needed to determine if the 50% MPHR is the level of exercise producing maximal benefits with minimal muscle damage.

The final and probably the most important conclusion is the fact that a larger sample size would probably provide clearer results.

The purpose of this project is to determine the effects of a one-time graded exercise session on CK levels in the older adult. Further research is required to determine whether a 50% MPHR is the level of exercise that provides maximal benefits with minimal muscle damage for the unconditioned older adult.

APPENDIX A

"THE EFFECTS OF A GRADED EXERCISE SESSION ON CREATINE KINASE (CK) BLOOD LEVEL IN THE OLDER ADULT."

Name _____ Participant :# _____

Address _____

Phone :# _____ Age _____ Gender _____

Involved in (directed) exercise program? Yes ___ No ___

Primary Physician _____

_____

_____

Current Medications (excluding analgesics, except in large quantities)?

_____ _____

_____ _____

_____ _____

History of Chronic Disease (if so, is it being currently treated?):

_____ Diabetes _____ Arthritis _____ Renal

_____ Respiratory _____ Liver _____ Other

_____ Cancer _____ Cardiovascular

Exercise History/Habits:

Activity _____

Frequency _____

Length of Time _____

APPENDIX B

NORTHERN ILLINOIS UNIVERSITY
SCHOOL OF ALLIED HEALTH PROFESSIONS
DEKALB, IL 60115-2854

SUBJECT'S NAME _____ DATE _____

I agree to participate in the Northern Illinois University study concerning the effects of exercise on serum CK and acute phase reactants in older individuals. I understand that the purpose of this study is to identify safe and effective levels of exercise for an older population. Before giving my consent by signing this form, I have been sufficiently informed of the methods and means of doing this project, the inconveniences involved and the hazards that might occur. I have spoken directly with one of the investigators who has answered all my questions to my satisfaction. I understand that my participation is voluntary and can be ended at any time and that all information gathered during this study will be kept confidential. I have received a copy of the informed consent form.

_____ _____
SUBJECT'S SIGNATURE DATE

_____ _____
INVESTIGATOR'S SIGNATURE DATE

_____ _____
WITNESS'S SIGNATURE DATE

APPENDIX C

Research project: Effects of Moderate Exercise on CK Levels

Dianne M. Cearlock, Ph.D.
James H. Gillette, Ph.D.
School of Allied Health Professions
Northern Illinois University

Subject Information (please print)

Name_____ Birthdate_____

Address_____ Phone_____

_____

_____

Primary Physician_____

consent and Release statement

I hereby release the University Health Service and the School of Allied Health Professions at Northern Illinois University and other organizations or institutions associated with this study from any and all liability arising from or in any way connected with blood drawing for this study or from the data derived therefrom. I understand that:

a. The data derived from these tests are for research purposes only and do not constitute a diagnosis.

b. The responsibility for initiating a follow-up examination to obtain advice and treatment is mine and not that of my physician or the organizations/institutions associated with this study.

Signature_____ Date_____
(Subject)

signature_____ Date_____
(Principle Investigator)

APPENDIX D

TOTAL CK LEVELS

Results (U/L) :

	M;Bn	ffi
'Ibta1 ac		
A.	63.75	24.17
B.	61.25	24.~
C.	68.88	*Z7A9*
ac~		
A.	71.75	*19.71*
B.	69.00	24.43
C.	83.:Q	23.Il
ac 75}6		
A.	55.75	28.31
B.	53.:Q	25.05
C.	54.25	25.:Q

A = Basal
B = 24 Hours
C = 32 Hours

APPENDIX E

CK-MB LEVELS

Results (U/L):

		M:Bn	9)
'lbtal_ <J<-M3			
	A.	7.00	5.07
	B.	6.50	4.72
	C.	4.75	4.06
<J<-M3 50J6			
	A.	8.00	7.07
	B.	7.50	6.40
	C.	6.50	4.70
<J<-M3 75){,			
	A.	6.00	2.71
	B.	5.50	2.89
	C.	3.00	2.83

A = Basal
B = 24 Hours
C = 32 Hours

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HeiR **Honors Council of the illinois Region**

STUDENT PROJECT AGREEMENT

In accepting the award from the Honors Council of the Illinois Region, I agree to the following:

(1) at the end of the semester during which the project is to be completed, I agree to submit one copy of the completed project to the Executive Secretary of the HeIR; this copy will be signed by (a) me, (b) the faculty supervisor of the work, and (c) my Honors Director, and

(2) I further agree that should any publication come out of this project, I will acknowledge in it the assistance of the Honors Council of the Illinois Region in bringing the work to its completion.

Student1s name (print or type) Rebecca J. Sefton

Student1s signature Rebecca J. Sefton

Date August 25, 1994

Faculty supervisor's signature:

Honors Director1s signature:

Executive Secretary/Treasurer
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