THE INSTIGATION OF MULTIPLE, DIVERGENT METABOLIC PATHWAYS BY A SINGLE BOUT EXERCISE PROTOCOL IN ADULTS

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PURPOSE

The aim of this study was to measure the power of the application of a new model of exercise to the general population. Historically, the literature has generally established and accepted mechanical models of exercise that correlate to specific metabolic responses. The data presented here suggest strongly that those models while helpful in many cases, are unnecessarily restrictive or perhaps do not hold up in the most general case.

Using a twice per week, 15 minute protocol of specifically designed resistance training for a five week period, a group of 45 healthy adults demonstrated a statistically significantly higher response in fat loss, lean tissue increases, cardiovascular power, trunk flexibility and reduced resting blood pressure than a group of 41 healthy adults who completed an average of 3.5 hours of target zone, conventional cardiovascular exercise for the same 5 weeks. (See Table 1 in RESULTS Section).

Exercise categorization: The first general type of exercise is considered aerobic or cardiovascular. This exercise relies on a model of cardiac output levels sustained over a continuous period of time. This model holds that even in the case of interval training, the "rest" interval allows only for a diminution of heart rate to the lower limits of the "target zone" before re-engaging at a higher heart rate (or cardiac demand) level. The frequency prescription is conventionally 3 to 5 days per week.

The second general type of exercise is strength training (usually defined as anaerobic). The historically accepted model holds that designated numbers of repetitions at certain percentages of a one repetition maximum level carried on for a prescribed number of sets is required to elicit the desired response. The prescription frequency has been most popularly determined to be 3 times per week.

Lastly, no existing model of exercise indicates that both of the categories of responses (aerobic and anaerobic) can be maximally attained through a singular exercise exposure. Furthermore, it is strongly suggested in the literature that pathways instigated for cardiovascular enhancement and those stimulated for local growth or strength improvement are inhibitory or mutually exclusive of one another.

This study indicates, at a statistically significant level, that both of these models are overly and needlessly simplistic interpretations of the metabolic sequences that actually correlate to positive exercise responses. That is to say, all exercise no matter the original intent, must be translated into a set of chemical changes mediated by growth factors, chemical messengers and enzymes. Some of these molecular mediators are directly produced as a result of mechanical forces, while others are the secondary products of some integral cascade mechanism.

To suggest categorically that two distinct types of exercise are required to produce two different results is to say that their respective chemical pathways have no communication or if they do, that communication is some form of negative feedback i.e. when one operates, the other can not. While such a mechanism can easily exist in the human body with high selectivity, it has not been proven to operate for strength and cardiovascular training. In fact, we submit that the form and function of the human body make it impossible to segregate these pathways and that it would not even be desirable to do so.

All voluntary exercise is primarily dependant on muscle fiber or motor unit recruitment. The manipulation of that recruitment and the metabolic milieu that is instigated by that stimulation pattern determines the outcome(s) of the exercise intervention in reasonably healthy populations.

This new model hypothesizes that the mechanical formula of any given exercise protocol must be based on the metabolic outcome of that formulation. If one utilizes the widely accepted notion of the orderly recruitment of muscle fiber types then the following assumptions appear to be logical:

1. Muscle fiber types are stratified and characterized as having corresponding energy support pathways, mechanical tension capacities, duration limits and metabolite production responses.
2. As tension demand increases (not singularly dictated by force demand) and the metabolic status at the site of the working muscle changes, a new (higher level) stratum of muscle fibers is recruited.
3. That new level recruitment indicates that the lower level fibers are not capable of meeting the demand AND that they will continue to support the effort at their momentarily maximum capacity.
4. There is no indication in the literature of selective muscle fiber recruitment in human skeletal muscle. Therefore, it is logical to assume that when a higher stratum of muscle fiber types is being recruited ALL lower strata fibers MUST be working at their maximum available capacities.
5. Since all of these fiber types are characterized by distinctive patterns of fuel utilization and corresponding, associated metabolic responses, it is logical to assume that these patterns continue while these fibers are being recruited.
6. Therefore, the ONLY way to produce ALL of the positive effects associated with ALL types of exercise (muscle fiber recruitment) is to stimulate ALL of the muscle fiber types to a threshold level.

After completing a successful pilot study, the authors undertook this IRB reviewed clinical trial to measure body composition, cardio respiratory endurance, upper body strength, lower body strength, trunk flexibility, resting blood pressure and resting heart rate before and after 5 weeks of incorporating a proprietary protocol and comparing it to a standard cardiovascular program. The same testing (pre and post) protocol was administered to both groups.

This study proposed a model that assumes that multiple metabolic pathways may be instigated by a particularly structured exercise regimen during a single bout of the model protocol. The practical application of that assumption indicates that a full spectrum of exercise associated benefits can be attained through a significantly condensed exercise exposure. Additionally, exercise adherence to a time efficient, safe and quickly productive protocol would appear to be invaluable to both the participants and the practitioners of exercise.

Physical exercise has been thoroughly documented to be associated with a myriad of physiological benefits. Historically, a variety of protocols have been characterized as being associated with predictable outcomes. As a reflection of that historical modeling, certain external (mechanical) modes have been theoretically correlated with internal (metabolic) responses. The protocol used in this study proposed that multiple pathways heretofore considered to be exclusively stimulated or mutually inhibitory, can, in fact, be instigated simultaneously and perhaps even synergistically. In addition, a new exercise model is being proposed that questions the tenets of the traditional paradigms.

METHODS:

100 healthy adults were randomly selected and placed into two groups. Subjects age, gender and fitness levels ranged from the age of 18 to 72 within fitness levels categorized from non-conditioned to highly fit.

In the Resistance Training (RT) group, the participants all performed the same seven exercise protocol two times per week. This regimen incorporated very slow speed resistance training performed in a sequence of large to small muscle (groups) to a point of (perceived) momentary failure within time under load parameters that coincide with physiological indices and clinical observation. Each exercise follows with as little rest as required by the subject to perform the next exercise without perceived respiratory limitation. ALL subjects at all levels were readily capable of following these design parameters.

All exercises were performed on a Total Gym XL or a Total Gym 26000. All increments were recorded for each training session. All repetitions and sets were timed under load and the total workout time was recorded for each session. All exercise sessions were constantly supervised by two testers.

The second group (C) performed a minimum of 2 hours of target zone, cardiovascular exercise with sessions ranging from 20 minutes to 60 minutes at least 2 times per week. These subjects kept daily logs and reported to testers on a regular basis or whenever subjects felt that

feedback and assistance were necessary. The final mean cardiovascular exercise time was 3 hours and 15 minutes weekly for the 5 week study.

ALL participants underwent the following assessments on a pre-test and post-test basis:

BODY COMPOSITION ANALYSIS:

Using an RJL B-103 Analyzer, all subjects were pre-tested using a bio-electrical impedance method. The instrument was calibrated each day testing was recorded. All tests were performed and witnessed by two technicians.

AEROBIC POWER ASSESSMENT:

Using a Schwinn Airdyne ergometer, each subject was pre-tested using an incremental protocol of one minute intervals after a 30 second exposure at the minimum level of resistance. Each full interval was sustained for one minute and then increased for each additional minute or part thereof until the subject reported a perceived exertion of 8 to 8.5 on the Borg scale. (14)

UPPER BODY STRENGTH ASSESSMENT:

Using a MAXICAM seated bench press machine, each subject was tested for a one, full repetition maximum lift. If the subject succeeded, he or she elected to increase the load by 5 to 20 pounds until a maximum lift was attained.

LOWER BODY STRENGTH ASSESSMENT:

Using a MAXICAM leg extension machine, each subject was tested for a one, full repetition maximum lift. If the subject succeeded, he or she elected to increase the load by 5 to 20 pounds until a maximum lift was attained.

TRUNK FLEXIBILITY:

Each subject was pre-tested performing a simple sit and reach trunk extension test. The subjects were given 3 attempts and instructed not to bounce or strain.

RESTING BLOOD PRESSURE:

Each subject was seated for 5 minutes and a simple plethysmographic measurement was taken on the left arm and repeated to insure accuracy.

RESTING HEART RATE:

While seated for the blood pressure analysis, each subject was manually tested for resting heart rate using a left arm radial pulse count for 60 seconds.

The authors would like to note that NONE of the strength performance testing indices were performed during the study in order to prevent any level of skill acquisition from convoluting the data

RESULTS:

A one-way Analysis of Variance (ANOVA) was conducted to assess for differences between Cardio and Resistance Training participants on pretreatment scores. There were no significant differences between the groups on the pretreatment scores of weight, upper body strength, lower body strength, flexibility score, blood pressure-systolic, & blood pressure-diastolic. (Weight: $F = .830$, $p = .37$; Upper Body: $F = .33$, $p = .57$; Lower Body: $F = .03$, $p = .87$; Flex: $F = 1.34$, $p = .25$; BP-systolic: $F = .44$, $p = .51$; BP-diastolic: $F = .45$, $p = .50$).

A series of 9 Paired-Samples T-Tests were conducted for our examination of treatment outcome for the Cardio treatment group (see Table 1). The Cardio treatment condition was associated with significant pre-post treatment differences in METS score ($t = -2.79$, $p < .01$), upper body strength ($t = -6.13$, $p < .001$), lower body strength ($t = -7.56$, $p < .001$), Flex score ($t = -3.87$, $p < .001$) and BP diastolic ($t = -2.34$, $p < .05$). No significant pre-post treatment differences were found for weight ($t = 1.43$, $p = .161$), body fat % ($t = .73$, $p = .47$), BP systolic ($t = -.04$, $p = .97$) and heart rate ($t = .35$, $p = .73$) in the Cardio treatment condition.

A series of 9 Paired-Samples T-Tests were conducted for our examination of treatment outcome for the Resistance Training treatment group (see Table 2). The Resistance Training treatment condition was associated with significant pre-post treatment differences on all study measures: weight ($t = 4.14$, $p < .001$), body fat % ($t = 9.53$, $p < .001$), METS score ($t = -9.85$, $p < .001$), upper body strength ($t = -10.49$, $p < .001$), lower body strength ($t = -9.96$, $p < .001$), Flex score ($t = -8.99$, $p < .001$), BP systolic ($t = 5.51$, $p < .001$) BP diastolic ($t = 3.32$, $p < .01$) and heart rate ($t = 4.63$, $p < .001$).

ANCOVA revealed that the RT group significantly exceeded the C group in measurements of: Improved body composition (increased lean tissue and decreased fat content), cardio respiratory endurance, upper body and lower body strength, trunk flexibility, decreased resting blood pressure and heart rate.

Table 1

Comparison of Pre- and Post- treatment Outcome Measures for Cardio (n = 41) vs. Resistance Training (n = 45) Treatment Groups

Variable	Pre				Post				Group Status by Treatment Interaction	
	Cardio		Training		Cardio		Training			
	M	SD	M	SD	M	SD	M	SD	F	p
Weight (lbs.)	**171.30**	40.34	**164.33**	30.30	**170.40**	40.18	**162.20**	29.73	2.72	.103
Body Fat %	**25.49**	8.18	**29.01**	7.27	**25.25**	8.13	**24.51**	7.61	47.23	.000***
METS Score	**12.84**	2.67	**11.05**	2.67	**13.67**	2.97	**14.50**	2.54	20.70	.000***
Upper Body	**77.31**	39.46	**72.54**	36.94	**86.94**	42.21	**89.88**	44.11	14.63	.000***
Lower Body	**89.90**	40.57	**88.69**	28.43	**103.54**	41.35	**111.44**	36.99	9.80	.002**
Flex Score	**0.32**	4.41	**-0.79**	4.38	**1.52**	4.36	**1.94**	4.28	10.60	.002**
BP Systolic	**125.49**	8.83	**124.11**	10.28	**125.56**	11.69	**116.80**	6.84	20.12	.000***
BP Diastolic	**82.32**	5.15	**81.24**	8.94	**84.59**	6.82	**77.13**	6.47	29.50	.000***
Heart Rate	**71.12**	9.44	**76.87**	8.88	**70.59**	12.26	**70.58**	8.04	3.05	.084

CONCLUSIONS:

The benefits of both aerobic training and resistance training are widely and consistently reported and supported in the literature. An overview of that scientific data provides the consensus that aerobic activity reduces the long-term development of cardiovascular disease. Concurrently, resistance training has been more recently reported to promote musculoskeletal fitness and metabolic improvements in insulin sensitivity, glucose metabolism and a host of other health related conditions.

Perhaps the most significant hypothesis proposed by this study is the concept that multiple (beneficial) metabolic pathways can be stimulated by a singular mechanical (exercise) intervention. In addition, it is hypothesized that the exercise exposure (time) required to elicit these myriad responses can be reduced drastically from that supported in the existing literature