THE RELATIONSHIP BETWEEN METHOD USED AND FITNESS CATEGORY IN DETERMINING TARGET HEART RATE

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The need to effectively overcome the sedentary habits and improve the cardiorespiratory fitness of our adult population has been known for years. Physical inactivity has been associated with obesity, premature cardiovascular disease, unnecessary orthopedic problems, anxiety, and emotional tension. Shephard (1982) defined cardiorespiratory fitness as the "ability of a man to maintain the various processes involved in metabolic exchange as close to the resting state as is mutually possible during the performance of a strenuous and fully learnt task for moderate time (1 -60 minutes), with a capacity to reach a higher steady state of working than the <u>unfit</u>, and to restore promptly after exercise all equilibria which are disturbed."

It is generally accepted by exercise physiologists that the ability to perform hard physical work is related to the capacity of the cardiorespiratory system to take up, transport, and give off oxygen to active tissues. Maximum oxygen uptake (VO2 MAX) or functional capacity is the accepted measure of cardiorespiratory fitness (ACSM, 1986, 1991; Faria, 1970; Mitchell, Sproule & Chapman, 1958; Shephard, 1982). Although all the fitness components (mode, intensity, duration, & frequency) are important in developing and maintaining VO2 MAX, it is generally agreed that intensity is the key factor (Faria, 1970; Karvonen, Kentala, & Mustala, 1967; Sharkey & Holleman, 1967; Shephard, 1968). Fox et al. (1973) conducted a study relating intensity to distance and found a significant relationship between training intensity and the change in VO2 MAX, indicating that intensity rather than distance is the more important factor in improving VO2 MAX. The ACSM (1986) recommends physical activity intensity for healthy adults corresponding to 65-90% of maximal heart rate (MHR) or 50-85% of VO2 MAX.

The simplest and most efficient way to prescribe and monitor intensity is through a predetermined target heart rate (THR). There are three generally accepted methods for calculating the THR:

(1) Percentage of Maximal Heart Rate (% MHR)

(2) Karvonen

(3) Percentage of functional capacity (%fc) or METS

Justification

Although all three methods for calculating THR are used extensively in exercise prescription, the comparisons and relationships between them are scarce in literature. The ACSM (1986) stated that the three methods are comparable as long as an additional 15% is added to the % MHR method. Pollock and Schmidt (1986) and Pollock, Wilmore, and Fox (1984) said the % MHR method could be brought more in line with the other two methods by adding ten percent. Davis and Convertino (1975) hailed the Karvonen method as superior to the % MHR because the % MHR procedure yielded consistent underpredictions of exercise intensity (e.g. 63.8% VO2 = 79.9% MHR). This shows the inherent difference between the % MHR and the other two methods, which can be corrected with the addition of approximately 15% to the % MHR method.

Shephard (1979) expressed the prime determinant of the response to training to be the intensity of effort relative to the individuals initial fitness. Because intensity is dependent upon which method is used in calculating THR, an investigation into the relationship between the three THR methods and fitness classification is warranted.

Statement of the Problem

The intent of this study was to determine if a subject's THR value was influenced by the method used for calculation or fitness category of the subject, as well as the interaction of these two factors.

Hypothesis

The following hypothesis will be tested at the .05 level of significance:

1. There will be no significant differences in the THR among target heart rate calculation methods.
2. There will be no significant differences in the THR among fitness level classifications.

3. There will be no significant differences in THR as a result of interaction between method and fitness level classification.

Delimitations

1. The subject selection was delimited to Oklahoma residents who participated in the Oklahoma State University Wellness Center Mobile Lab Study.
2. The study was delimited to the Balke Treadmill Protocol with a speed of 3.4 mph.
3. The subjects were delimited to apparently healthy individuals.

Limitations

The limitations of this study were:

1. The THR determined using the METS method was estimated using interpolation techniques and might not be as accurate as they would have been had they been calculated using regression equations.
2. The study was limited to male subjects.

Assumptions

This study was based on the following assumptions:

1. All subjects came from an apparently healthy population.
2. All subjects achieved VO2 MAX during the treadmill test.
3. Testing conditions were similar for all subjects.

Definition of Terms

Maximum oxygen uptake (VO2 MAX) or functional capacity - The highest rate at which oxygen can be used during exercise. Usually expressed in milliliters of oxygen consumed per kilogram of body weight per minute (ml O2 kg-1•min-1)

Target Heart Rate (THR) - The heart rate associated with a given percentage of functional capacity. Varies depending on the subjects fitness level or disease state or what the subject wants to accomplish from exercise.

Anaerobic Threshold - The level of work or oxygen uptake just below that at which metabolic acidosis and associated changes in ventilation and gas exchanges occur (Palka & Rogozinski, 1986).

CHAPTER II

LITERATURE REVIEW

Introduction

The purpose of this chapter is to offer a review of the literature which appears relevant to the present study. The review will cover the following subjects: (1) Exercise prescription as it relates to intensity and fitness level and (2) Target heart rate calculation methods - % MHR, Karvonen, and % fc.

Exercise Prescription

The American College of Sports Medicine (ACSM, 1991) defines exercise prescription as, "The process whereby a person's recommended regimen of physical activity is designed in a systematic and individualized manner" (p. 93). Any exercise prescription should consist of the following components: (1) mode, (2) intensity, (3) duration, (4) frequency, and (5) progression of physical activity. ACSM has made recommendations for the quantity and quality of exercise for developing and maintaining cardiorespiratory fitness and body composition based on the five aforementioned fitness components (Appendix A). These principles apply regardless of age, functional capacity or presence or absence of disease states.

<u>Intensity</u>

The most important and difficult issue in exercise prescription is assigning the appropriate exercise intensity (ACSM, 1986; Pollock, Foster, Rod, & Wible, 1982; Fox, Naughton & Haskell, 1971; Wilmore, 1974; Wilmore & Haskell, 1971). An activity performed above certain intensities could have serious medical consequences. Intensity has also been shown to be the most important variable in eliciting an adequate training effect (Davies & Knibbs, 1971; Faria, 1970; Fox et al., 1973; Karvonen, 1967; Sharkey & Holleman, 1967; Shephard, 1968).

The literature is equivocal regarding what the minimum threshold for improving VO2 MAX is. Karvonen et al. (1957) in a classical study found that the minimum threshold for VO2 improvement is 60% HRR (Heart Rate Reserve [MHR -RHR]). Faria (1970) and Sharkey and Holleman (1967) also found 60% HRR to be the minimum threshold. Davies and Knibbs (1971) found no improvement at or below 50% VO2 MAX, which is approximately equal to 50% HRR. Shephard (1968) found VO2 MAX improvements of 5-10% for an exercise intensity of 39% fc.

Much of the recent research focuses on using anaerobic (lactate) threshold as a criterion variable for intensity prescription (Katch, Weltman, Sady, & Freedson, 1978;

Wasserman, Whipp, Koyal, & Beaver, 1973; Weltman, Snead, Seip Schurrer, Levine, Rutt, Reilly, Weltman, & Rogol, 1987). Holloszy (1973) suggested that the effects of physical training are probably more evident in subtle internal cellular adaptations which may or may not be manifested in gross changes in VO2 MAX. Henritze, Weltman, Schurrer, and Barlow (1985) stated that an increase in the Lactate Threshold (LT), regardless of whether VO2 MAX increases, may be important for improving endurance. Rising levels of blood lactate may interfere with free fatty acid utilization and thus progressively reduce the capacity of the body to utilize fat as an energy substrate. An increase in the LT should delay this inhibitory effect and result in a glycogen sparing effect, thus, increasing endurance. This is to say that a trained person can exercise at a higher percentage of his/her VO2 MAX without experiencing the discomfort of lactate accumulation. This training effect, however, has nothing to do with an increase in VO2 MAX. According to Holloszy (1973) training at an intensity below or above the anaerobic threshold (AT) should result in different physiological changes. If an individual trains at intensities below the AT more fat will be burned for fuel, and there would be greater changes in body composition than if one were to train above the AT. Conversely, training at intensity levels above the AT should result in greater changes in cardiorespiratory fitness parameters than when training below the AT.

When using anaerobic threshold as the criteria for assigning intensity, the literature concurs with the findings of Karvonen et al. (1957) and others; that is, the minimum threshold for prescribing intensity should be approximately 60% of functional capacity or HRR, or 75% of MHR (Francis, McClatchey, Sumsion, & Hansen, 1989; Katch et al., 1978; Palka & Rogozinski, 1986; Weltman, Weltman, Rutt, Seip, Levine, Snead, Kaiser, and Rogol, 1989).

Fitness Level

Shephard (1968) stated that the response to a training regime is determined largely by the intensity of effort and the initial fitness of the subjects. Gledhill and Eynon (1972) substantiated Shephard's findings in concluding that lower fit subjects have a lower threshold of intensity for training improvements than do the higher fit subjects.

When using anaerobic threshold as the critical variable in assigning intensity, the results are the same. The more fit the individual is, the higher his/her intensity threshold for gaining training effects. Weltman et al. (1989) tested 33 sedentary females and found the minimum intensity for the majority to be at or above the AT was 75% MHR or approximately 60% VO2 MAX. Dwyer and Bybee (1983) tested 20 normal, healthy females who were not highly trained but all engaged in regular recreational activities and found their AT to be at 70.1% VO2 MAX or 86.3% MHR. This AT was approximately 10% higher than that of the sedentary females of the Weltman et al. (1989) study. Weltman et al. (1990)

treadmill tested 31 male runners. The subjects were recreational runners with a history of training more than 40 km/week for at least the previous six months. The majority of these subjects were not above AT until an intensity of 90% MHR was attained. These three studies clearly indicate an intensity threshold related to fitness level.

Target Heart Rate Calculation Methods

As stated earlier, the most efficient way of prescribing intensity is via the Target heart rate (THR). The THR is a specified percentage of maximum limit recommended for training (Pollock & Wilmore, 1984). There are three primary methods for calculating THR - % MHR, Karvonen, and % fc or METS (Davis & Convertino, 1975; Karvonen & Vuorimaa, 1988; Pollock & Wilmore, 1984).

Percentage Maximal Heart Rate

This is the simplest method for calculating THR as it only requires the measurement of maximal HR. Regression analysis has shown this method to underestimate the other two methods by as much as 17% (@ ± 48% VO2 MAX) and as little as 6% (@ ± 89% VO2 MAX) (Hellerstein, 1973; Londeree & Ames, 1976). In other words, the more fit the individual, the less the underestimation. Pollock (1984) said that this method could be brought in line with the other two with an addition of approximately 10% to the calculated value. ACSM (1986) recommends 15%, and that is the correction value used in this study.

Karvonen

Karvonen et al. devised this method in 1957 during landmark research where they studied the effects of exercise on the heart rate. This method makes use of the subjects potential heart rate increase (Heart rate reserve [HRR]) and assumes that resting and maximum HR's represent zero and maximal exercise intensity, respectively. Pollock et al. (1982) and Davis and Convertino (1975) found this method inherently superior to the % MHR method, because the latter method was thought to be too conservative. As stated earlier, however, this problem can be eliminated with the addition of a 10-15% correction factor.

Percentage Functional Capacity (fc) or METS

The final method represents the heart rate at a specified percent of maximum METS (VO2 MAX). Even though this is probably the most definitive method of establishing the THR, it requires a maximal exercise test with the measurement of steady-state HR and VO2 at various submaximal exercise intensities. For a very accurate estimation of THR, a regression equation relating HR and VO2 would have to be calculated. This method is time consuming and requires elaborate laboratory equipment.

Summary

Even though intensity is the most important component in prescribing exercise, there have been very few studies comparing the three accepted ways of assigning intensity by THR.

In reviewing the literature on intensity and fitness level as they relate to exercise prescription, it has been established that the more fit the person is, the higher his/her threshold for training improvements. A logical way to examine the efficacy of the THR methods would be to examine their interaction with fitness level classification.

CHAPTER III

METHOD

Subjects

The 269 male subjects chosen for this study were a portion of approximately 800 subjects stress tested by the Oklahoma State University (OSU) Wellness Center Mobile Lab across the state of Oklahoma between 1979 and 1985. The subjects were assumed to come from an apparently healthy population and were chosen based on the following criteria: (1) Supine resting heart rate (RHR) less than 90 beats per minute (BPM) (2) Maximal HR achieved within 10 BPM of predicted maximal HR (220 BPM - age) (3) Resting blood pressure (RPB) less than 145/95 (4) Maximal blood pressure (MBP) less than 220/100 (5) Functional capacity greater than five METS (6) Reason for test termination was general fatigue, and (7) Data obtained from treadmill stress test must have been complete.

Subject characteristics were: (1) Mean age = 40.2 ± 9.62 years (2) mean weight = 70.2 ± 2.66 kilograms (3) mean height = 181.4 ± 25.35 centimeters. Figure 1 represents the age distribution of the participants.

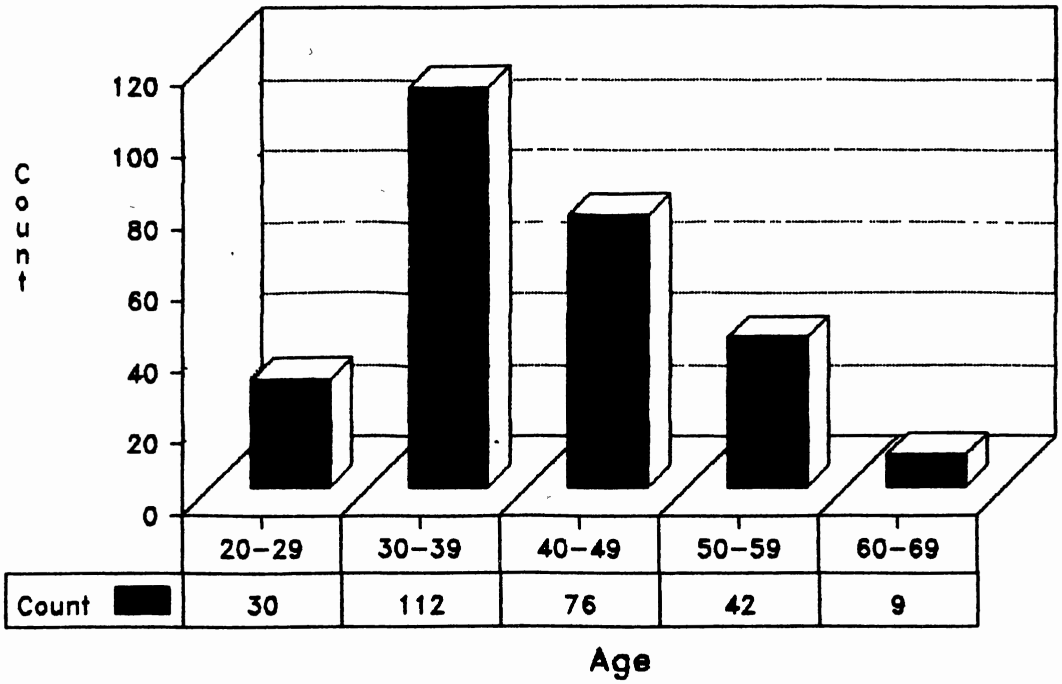

Figure 1. Age Distribution Adult Males

Apparatus

The exercise stress tests were conducted to maximum using the Balke protocol (Appendix B). Only those tests with treadmill speeds of 3.4 MPH were included in the study. The subjects RBP and supine RHR were taken before the test. Heart rate and blood pressure were monitored throughout the test to completion.

Procedure

The 269 subjects were randomly (using a table of random digits) divided into three groups representing the three standard methods for calculating target heart rate (THR) (Method 1, N = 90; Method 2, N = 90; Method 3, N = 89). Method 1 target heart rate was calculated using % MHR. Method 2 target heart rate was calculated using Karvonen, and Method 3 target heart rate was calculated using %fc or METS. Formulae for these calculations are shown in Figure 2. In calculating the intensity for all three methods, the decimal equivalent of the highest METS level achieved was added to the established base level of 60% or .60. This sliding scale accounts for the known effect of functional capacity in the relative exercise intensity that can be tolerated (ACSM, 1986). (Example: if the highest METS level achieved was 12 METS, then .12 would be added to .60 for an intensity of .12 + .60 = .72 or 72%). This allowed for the prescribing of higher exercise intensities to the higher fit subjects and lower intensities to the lower fit subjects.

Karvonen	Percent MHR	METS
THR = MHR - RHR ----------- HR reserve X (.60 + y) + RHR -----------	THR = MHR X (.60 + y) X 1.15 ------------	THR = Max MET X (.60 + y) ------------ * Target METS level * This value is extrapolated into THR by referring to treadmill sheets.

where y = decimal equivalent of highest METS level achieved.

Figure 2. Target Heart Rate Calculation Methods

Each method group was then divided into fitness categories using Cooper's Fitness Classification (Appendix C). To increase the subject numbers in the method X fitness category interaction groups and thus allow a credible statistical analysis, Cooper's six classifications were reduced to four by combining categories I and II and categories V and VI (Table I).

TABLE I

COOPER'S "REVISED" FITNESS CLASSIFICATION
FOR MEN (ml O2 kg-1·min-1)

Category	13-19	29-29	AGE 30-39	40-49	50-59	60+
1. Poor	<38.3	<36.4	<31.5	<30.2	<26.1	<20.5
2. Fair	38.4 - 45.1	36.5 - 42.4	35.5 - 40.9	33.6 - 38.9	31.0 - 35.7	26.1 - 32.2
3. Good	45.2 - 50.9	42.5 - 46.4	41.0 - 44.9	39.0 - 43.7	35.8 - 40.9	32.3 - 36.4
4. Excel	>50.9	>46.4	>44.9	>43.7	>40.9	>36.4

Statistical Treatment of Data

Means and standard deviations were computed for each THR method group and each fitness category. An overall mean and standard deviation was also calculated in addition to means and standard deviations for each method by fitness category interaction group. A 2-way ANOVA was performed to see if the method used or fitness category, as well as the interaction of these two factors influenced subject THR values. The Neuman-Keuls Multiple Range Test was then performed to locate the significant differences.

CHAPTER IV

RESULTS AND DISCUSSION

Results

Table II shows the means and standard deviations for each method, fitness category, and interaction group as well as the overall mean and standard deviation. A 2-way ANOVA was used to determine if significant differences existed in target heart rate values among the three calculation methods as well as the four fitness categories, and if the target heart rate values were affected by the interaction of method by fitness category.

There was no significant effect on target heart rate due to method as demonstrated in Table III, F (2,257) = 1.051, p > .05. The means for the % MHR, Karvonen, and METS methods were 152.71 BPM, 149.92 BPM, and 149.09 BPM respectively. There was, however, a main effect on THR due to fitness category, F (3,257) = 5.738, p < .01. As shown in Table II, the lower fitness category had the lower average THR and the higher fitness category had the higher average THR. The Neuman-Keuls Multiple Range Test showed the significant (p < .05) differences among fitness classifications to be located between categories 1 & 4, 2 & 4, and 3 & 4. There was also a significant interaction between method and fitness category affecting THR as shown in Table III, F (6,257) = 2.472, $p < .05$. Inspection of Figure 3 shows that the greatest differences in THR among the four fitness categories are within the % MHR method. Fitcat 1 had the lowest THR (143.76 BPM) and fitcat 4 the highest THR (160.96 BPM), a difference of more than 17 BPM. Post hoc analysis showed no significant ($p > .05$) interaction among the lower three fitness categories, but that all three of these categories differed significantly ($p < .05$) from fitcat 4. There was also some variation in THR within the METS method, with the difference between fitcat 1 THR and fitcat 4 THR being more than 8 BPM. Post hoc analysis however, showed these differences not to be significant ($p > .05$).

In contrast to the previous mentioned methods, the Karvonen method showed almost no difference in target heart rate among fitness categories, with the difference between fitcat 1 and fitcat 4 being less than 1 BPM. The post hoc analysis showed this difference not to be significant ($p > .05$).

TABLE II

TARGET HEART RATE ($\bar{X}$, s,)
(Method by Fitness Category)

	METHOD %MHR(1)	KAR(2)	METS(3)	Marginal
Fitcat 1	143.76 10.85 n = 11	148.10 8.86 n = 19	149.2 12.70 n = 20	147.58 10.95 n = 50
Fitcat 2	149.83 8.84 n = 33	149.88 9.01 n = 29	146.19 11.05 n = 32	148.61 9.75 n = 94
Fitcat 3	152.12 9.39 n = 21	150.17 8.15 n = 24	149.96 15.06 n = 26	150.67 11.35 n = 71
Fitcat 4	160.96 9.47 n = 25	149.08 7.80 n = 18	155.28 13.22 n = 11	155.84 11.00 n = 54
Marginal	152.71 10.84 n = 90	149.42 8.41 n = 90	149.09 13.05 n = 89	150.41 11.00 n = 269

TABLE III

TWO-WAY ANALYSIS OF VARIANCE FOR THR
(Method by Fitness Category)

Source of Variance	SS	df	MS	F-Ratio
Method	230.000	2	115.000	1.051
Fitcat	1882.586	3	627.529	5.738**
Method x Fitcat	1622.163	6	270.361	2.472*
Error	28,108.400	257	109.371	

* P < .05 ** P < .01

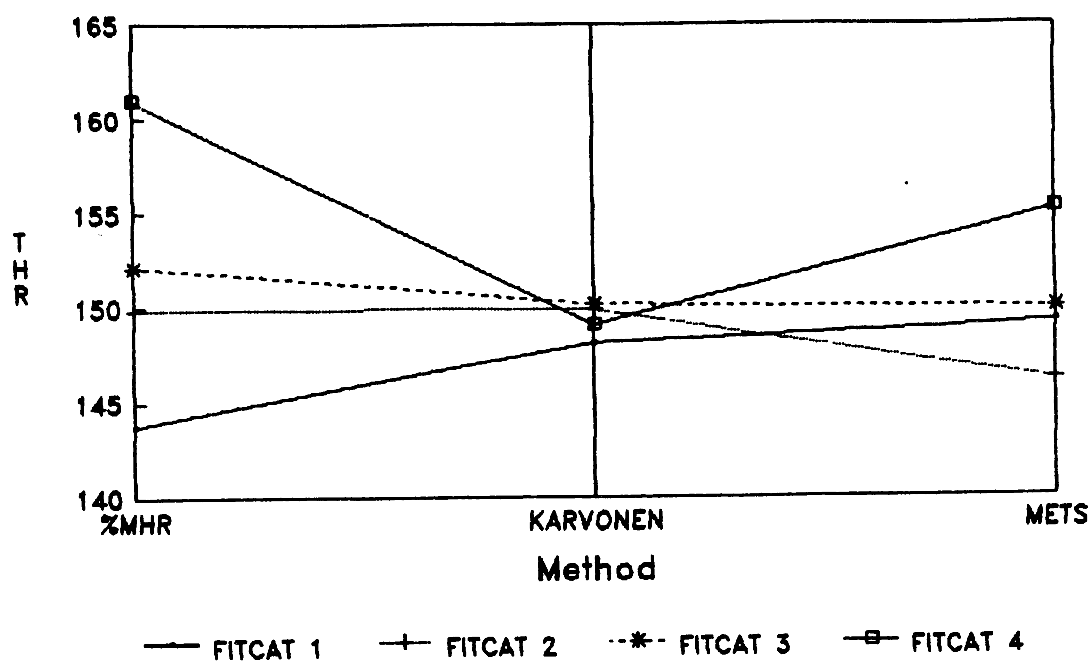

Figure 3. Method X Fitcat Interaction

Discussion

There was no significant difference found in THR among the three methods of calculating THR. These findings agree with the ACSM (1986) which found the three methods to be comparable. There was a significant difference within method due to fitness category with the higher fit people having a higher THR and the lower fit people having a lower THR. These results are not surprising in that the intensities assigned to the subjects were increased by the decimal equivalent of the maximal MET level achieved to account for the lower threshold of exercise required for training results in the lower fit individuals and the higher threshold of exercise required for training results in the higher fit individuals (Sharkey, 1970; Shephard, 1967, 1968; Gledhill & Eynon, 1972).

The interaction between method and fitness level also proved significant. The % MHR method boasted the largest difference in THR between the lowest and highest fitness levels (17 BPM). Although there were no significant differences among the lower three fitness levels, fitness level 4 differed significantly from the three lower levels. This method of calculating THR seems to discriminate somewhat among fitness categories. A possible reason for the lack of significance among the lower three fitness categories might have been the high variability of the target heart rates caused by the variability in the ages of the subjects. This problem could be remedied by restricting the subjects to one age category. The % fc method demonstrated over an 8 BPM difference between fitcat 1 and fitcat 4 with none of the differences being significant. It should be noted that in the METS method, the fitcat 1 THR was actually higher than the fitcat 2 THR. This and the fact that there were no significant differences might have been due to the interpolation error inherent in this method of calculation if regression is not used.

The most interesting phenomenon in the study occurred within the Karvonen method. The difference between the highest and lowest fitness categories was less than 1 BPM and none of the differences within this method were significant. This indicates that the Karvonen method has no regard for level of fitness, and prescribes the same THR intensity independent of functional capacity. This would lead to over prescribing exercise to unfit people and under prescribing exercise to more fit people. In other words, the unfit person would be training at an unnecessarily high THR, when training at a lower THR would be beneficial and safer. The more fit person, on the other hand, would not be training at an intensity sufficient for training results. Because this method is dependent on resting heart rate (THR = RHR + [MHR - RHR] X Intensity), the variance in RHR could be an explanation for the closeness of the target heart rate values among fitness levels. The lower fit person would have a higher resting heart rate, the higher fit person a lower resting heart rate.

The combination of these two factors would tend to bring the THR values closer together when calculating THR using the Karvonen method.

In summary, the three THR calculation techniques, on average, figure similar THR values. These results might be misleading, however, when one views the relationship between method and fitness category. This relationship shows the % MHR method to at least attempt to discriminate among fitness categories whereas the Karvonen method has nearly the same target heart rate for all four fitness categories. This would seem to indicate that the % MHR method would be more accurate in prescribing exercise intensity than the Karvonen method. This finding is contrary to findings of previous studies (Pollock, Foster, Rod, & Wible, 1982; Davis & Convertino, 1975) which recommend the Karvonen method over the % MHR method.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains a summary of the study, the findings derived from the analysis of the data, conclusions, and recommendations for further study.

Summary

The purpose of this study was to determine if a subject's THR value was influenced by the method used for calculation or fitness classification of the subject, as well as the interaction of these two factors.

A total of 269 apparently healthy male subjects stress tested by the OSU Wellness Center Mobile Lab were chosen for this study. They were randomly divided into three groups representing the three standard methods for calculating THR (% MHR, Karvonen, % fc [METS]), and then divided into fitness categories using Cooper's Fitness Classification. A 2-way ANOVA (Method x Fitness Category) was then performed followed by a Neuman-Keuls Multiple Range Test.

Findings

The data in this study were analyzed and yielded the following findings:

1. Ho: There will be no significant differences in the THR among target heart rate calculation methods. Hypothesis 1 was accepted as there were no significant differences in the THR due to calculation method.
2. Ho: There will be no significant differences in the THR among fitness level classifications. Hypothesis 2 was rejected as there were significant differences in the THR due to fitness level classification.
3. Ho: There will be no significant difference in THR as a result of interaction between method and fitness level classification. Hypothesis 3 was rejected as there was a significant difference in THR as a result of interaction between method and fitness level classification.

Conclusions

The differences within the methods due to fitness level classification suggest that the Karvonen method may have some serious drawbacks when used to prescribe exercise. Because some type of exercise test is needed for the calculation of THR using the % fc (METS) method, it seems the % MHR method should be used instead of the Karvonen method for the "Quick" calculation of THR.

Recommendations

In reviewing the methods, procedures, and results of this study, the author believes the following recommendations to be in order:

1. The study should be replicated using female subjects.
2. A more accurate method should be used (i.e. regression) when generating THR values using the % fc (METS) method.
3. The addition of the 15% correction factor used in the % MHR method should be adjusted to reflect fitness level. Research has found that lower fit people should probably have a larger factor (± 18%), and higher fit people a smaller factor (± 8%) (Hellerstein, 1973; Londeree and Ames, 1976).
4. The sample group should be expanded to include females a well as males. This would allow for a comparison of THR between females and males.
5. The study should be replicated using men in a similiar age grouping to reduce variability.

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APPENDIXES

APPENDIX A

ACSM POSITION STAND ON THE RECOMMENDED QUANTITY AND QUALITY OF EXERCISE FOR DEVELOPING AND MAINTAINING CARDIORESPIRATORY AND MUSCULAR FITNESS IN HEALTHY ADULTS

The American College of Sports Medicine (ACSM) makes the following recommendations for the quantity and quality of training for developing and maintaining cardiorespiratory fitness, body composition, and muscular strength and endurance in the healthy adult:

1. Frequency of training: 3 - 5 days/week.

2. Intensity of training: 60-90% of maximum heart rate (HRmax), or 50-85% of maximum oxygen uptake (VO2max) or HRmax reserve.

3. Duration of training: 20-60 min of continuous aerobic activity. Duration is dependent on the intensity of the activity; thus, lower intensity activity should be conducted over a longer period of time. Because of the importance of "total fitness" and the fact that it is more readily attained in longer duration programs, and because of the potential hazards and compliance problems associated with high intensity activity, lower to moderate intensity activity of longer duration is recommended for the nonathletic adult.

4. Mode of activity: any activity that uses large muscle groups, can be maintained continuously, and is rhythmical and aerobic in nature, e.g. walking-hiking, running-jogging, cycling-bicyling, cross-country skiing, dancing, rope skipping, rowing, stair climbing, swimming, skating, and various endurance game activities.

5. Resistance training: Strength training of a moderate intensity, sufficient to develop and maintain fat-free weight (FFW), should be an integral part of an adult

fitness program. One set of 8-12 repetitions of eight to ten exercises that condition the major muscle groups at least 2 days/week is the recommended minimum.

APPENDIX B

BALKE TREADMILL PROTOCOL

Treadmill Results

Name:________________ SS#:__________ Age:_____ Sex:_____ Date:______

Allergies:________________ Medications:________________

		HR	B/P	
Resting:	Supine	_______	_____/_____	Category:__________
	Standing	_______	_____/_____	MPHR:__________
				85% MPHR:__________

3.4 mph

Grade	METS / O2		Heart Rate	BP	EKG Comments
0	3.4	11.2			
2	4.2	14.5			
3	4.7	16.5			
4	5.1	18.0			
5	5.7	20.0			
6	6.1	21.5			
7	6.6	23.0			
8	7.1	24.5			
9	7.5	26.5			
10	8.0	28.0			
11	8.5	29.5			
12	9.0	31.5			
13	9.4	33.9			
14	9.9	34.5			
15	10.3	36.0			
16	10.8	37.5			
17	11.2	39.0			
18	11.7	41.0			
19	12.2	43.0			
20	12.7	44.5			
21	13.2	46.0			
22	13.6	47.0			
23	14.0	49.0			
24	14.9	51.9			
25	15.3	53.6			
26	15.8	55.7			
27	16.3	56.9			
28	16.7	58.5			
29	17.2	60.2			
30	17.7	61.8			
31	18.13	63.5			
32	18.6	65.1			

APPENDIX C

COOPER'S FITNESS CLASSIFICATION

Cooper's Fitness Classification: Men

Category	Measure O^2 ml/kg/min	Age 13-19	20-29	30-39	40-49	50-59	60+
I. Very Poor		< 35.0	< 33.0	< 31.5	< 30.2	< 26.1	< 20.5
II. Poor		35.0-38.3	33.0-36.4	31.5-35.4	30.2-33.5	26.1-30.9	20.5-26.0
III. Fair		38.4-45.1	36.5-42.4	35.5-40.9	33.6-38.9	31.0-35.7	26.1-32.2
IV. Good		45.2-50.9	42.5-46.4	41.0-44.9	39.0-43.7	35.8-40.9	32.3-36.4
V. Excellent		51.0-55.9	46.5-52.4	45.0-49.4	43.8-48.0	41.0-45.3	36.5-44.2
VI. Superior		> 56.0	> 52.5	> 49.5	> 48.1	> 45.4	> 44.3

VITA

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