CALCULATIONS OF DIFFERENCES IN HEART RATE FREQUENCIES BASED ON 4 EQUATIONS AS ESTIMATE STRESS OF EXERCISING AND BASE FOR DEVELOPING ENDURANCE TRAININGS PLANS

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INTRODUCTION

Exercise process is as efficient as it is accommodated to an individual – age, gender, actual fitness level, sport ambitions, selected sport activity, exercise abilities, competition preparation, connection between fitness and work activities, etc ...(Newsholme, Leech & Duesrer 1994; Noakes, 1994). Therefore is necessary to reconsider as much individual factors as we can while determining stress of exercise as base for training process planning (Karpljuk, 1999).

Max frequency of heart rate is an individual factor as it is resting frequency of heart rate or sleeping frequency of heart rate or frequency of heart rate in whatever intensity zone. In theory we could find that non-trained individuals has up to 180 beats per minute and theirs max frequency decreased while exercising (Wilmore and Costill, 1994). This is correct when intensity of exercising remains the same. When intensity of exercising increases, increases also max frequency of heart rate. When determining stress of exercise, we should reconsider several physiological and psychological factors (Ušaj, 1993; Ušaj, 1995), one of relative good indicators is certainly heart rate frequency (Karpljuk, Dolenc & Ušaj, 1995). This factor is very important on the filed when all other laboratory equipment is not available. Some authors define max frequency as 220 beats per minute minus age (Willmore and Costill, 1994). There are several major equations for max frequency of heart rate listed below(Hills, Byrne & Ramage, 1998):

Population	Equation
all	220 – age
Male	220 – age
Female	226 – age
Male athlets	205 – (0,5 * age)
Female athlets	211 – (0,5 * age)
Sedentary males	214 – (0,8 * age)
Sedentary females	209 – (0,7 * age)
Adipose	200 – (0,5 * age)

Equations listed above are results of testing very large number of people and max frequencies are average of max frequencies with standard deviation ± 10 beats per minute. So, it will cause no harm if we determine max frequency using equation 220 – age for per example. We calculate adequate percentage (60, 70, 85 per ex.) and our workout could begin. But almost everyone wishes that this calculation represents his own workout program, exercise program which serves only him and is based on his data. This is why our frequency of heart rate data - at least resting frequency data (FREST), the best are both frequencies: max frequency (FMAX) and resting frequency (FREST) data - are so important.

We can also use equations listed above with only data about resting frequency; but more accurate result could be obtained using max frequency data. For this purpose specific (lab, track) or non-specific (when an individual stress himself to topmost level while exercising a few minutes) testing should be used. We shall use Karvonen equation (Karvonen, Kentala & Mustala, 1597; Karvonen and Vourimaa, 1988; Karpljuk, 1999) described below :

Desired intensity level = % (FMAX – FREST) + (FREST)

% .... Determination of desired intensity
FMAX .... Max frequency of heart rate [beats per minute]
FREST.... Resting frequency of heart rate [beats per minute, measured in the morning]

METHODS

Data sample were 104 men – members of Slovenian Army field officers, divided into two groups by age - MEN1 (31-40 years) and MEN2(41-50 years). 3200m run test was performed. Test participants were running in groups up to 20 runners, starting run position was high. Command at the start was "Ready". Whistle sound was started the running event. Test was completed, when test participants run 3200m distance. The test assistant was measured time in seconds by stopwatch. Every passed lap he informed test participants about elapsed time and number of laps to go. Run test was performed on Athletic stadium Kodeljevo at Faculty for sport in October 1999, on Mondays and Fridays between 10 am and 14 pm. Data were analyzed by SPSS Base Series for Windows, Release 9.0. Data were analyzed in several phases: basic sample statistics were obtained first, measures of central tendency and variability were calculated, 3 equations (per Hills, Byrne and Ramage, 1998) were used for estimation of load intensity .

RESULTS

Results of group MEN1 represent big differences between calculated and measured (199 beats per minute) maximum frequencies of hart rate. Deviation was 12 –17 beats per minute. Our conclusion based on test results and size of the data sample (67 test participants) was that test participants were forced to their topmost physical and psychical abilities by the highest stress during run test performance (Table 1).
Deviation between measured max heart rate frequencies of group MEN2 (47 test participants) and calculated (4 equations) maximum hart rate frequencies were 11-19 beats per minute. (Table 2) We concluded that test participants within this group also reached their upper stress limits.
Such efforts of the individuals for achieving the best results were stimulating and positive, but also meant that individuals should be well prepared for this verification. Morphological heterogeneity of the test participants was large and we assumed a lot of motivation for achieving topmost abilities in group Men1. This group is also the largest and therefore a systematic, consistent and individually supervised workout is also needed for this group, too.
Our conclusions, based on test results of group Men2 (Table 2), were similar to conclusions for group Men1. There were 47 test participants in data sample; deviation between measured and calculated max hart rate frequencies was 11 - 19 beats per

minute. Average age difference between test participants in this data sample was 10 years.
Because we assumed that test participants in both groups reached the highest stress level while performing run test, we concluded that in general test participants were willing to activate their energetic potential to the maximum. Nevertheless that we assumed high level of motivation while performing the task (3200-m running test), we emphasized again that their workout process should be improved.

DISCUSSION

When an individual while overcoming stress reaches topmost physiological limits, activation of organic systems activate also psychological parts (narrowing or lack of rational comprehension of reality for certain time until organism recovers (few minutes)) This may have negative consequences in several cases (Karpljuk, □itko, Ro□man, Suhadolnik & Karpljuk, 2000):

- while performing pretentious task on the field (or in war), when physical activation of organism is needed and an individual has to take important decisions about military operation,
- at several days, weeks or even moths lasting activity (war conditions, stronger enemy, partisan tactic, guerrilla) , when good (topmost) physical fitness is base for progress of military operations,
- at periodical stress physical activities (every year surveys, military exercises, long lasting marches,...)

Obtained results were base for development of training programs, which execution leads an individual to better results of obligatory verification test of movable abilities and better health status (Karpljuk, □itko, Ro□man, Suhadolnik & Karpljuk, 2000). Developed training program includes three tests from movable abilities verification (sit-ups, push-ups, and 3200-m run) test and other motor abilities, which development improves physical conditioning. The training program covers 12 month period, it consists of 6 segments. An individual could take part in every segment (novice in segment 1, top fit in segment 6) according to his current fitness status. Besides this basic workout program we developed also several sets of exercises among which an individual could choose and incorporate them into his basic training program according to his current abilities, knowledge or just momentary mood.

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Table 1: Calculation of differences in heart frequency based on three equations and 3200 m run average time results of field officers of Slovenian Amy, age 31 - 40

Group	MIN	MAX	MEAN	STAN. DEV.
MEN2	118	168	143,46	7,3931
Age: 31-40	169	212	190,72	9,4497
mean = 36	152,22	198,94	178,74	8,6426

Equations	MAX	± 4 beats per min	% diff	difference beats per min	run time (mean)
220 - age	184	180-188	8,15	+15	16:48
214 - (0,8 * age)	185	181-189	7,57	+14	or
205 - (0,5 * age)	187	183-191	6,42	+12	1008
200 - (0,5 * age)	182	178-186	9,34	+17	

Table 2: Calculation of differences in heart frequency based on three equations and 3200 m run average time results of field officers of Slovenian Amy, age 41 - 50

Group	MIN	MAX	MEAN	STAN. DEV.
MEN3	122	157	142,19	7,4453
Age: 41-50	157	202	186,65	8,4261
mean = 46	144,99	193,13	175,06	9,1067

Equations	MAX	± 4 beats per min	% diff	difference beats per min	run time (mean)
220 - age	174	170-178	9,19	+19	17:24:00
214 - (0,8 * age)	177	173-181	9,04	+16	or
205 - (0,5 * age)	182	178-186	6,04	+11	1044
200 - (0,5 * age)	177	173-181	9,04	+16	

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INTRODUCTION

- individual factors for training process planning
- frequence of heart rate

Population	Equation
■ all	220 - age
■ male	220 - age
■ female	226 - age
■ male athletes	205 –(0,5 x age)
■ female athletes	211 – (0,5 x age)
■ sedentary males	214 – (0,8 x age)
■ Sedentary females	209 – (0,7 x age)
■ adipose	200 – (0,5 x age)

KARVONEN'S METHOD

DESIRED INTENSITY LEVEL =

= % (FMAX – FREST) + FREST

METHODS

- 104 men – Slowenian Army field officers
- MEN1 (31-40 y.) and MEN2 (41-50 y.)
- 3200 m RUN EVENT
- DATA ANALYZE (basic sample statistic, central tendency and variability and 3 equations (per Hills, Byrne and Ramage) for estimation of load intensity.

RESULTS

Group	min	max	mean	S.D.	
MEN1	118	168	144	7,39	
Age: 31-40	169	212	191	9,45	
Mean = 36	152	199	179	8,64	
Equations	max	+,- 4	% dif	d-bpm	run T
220-age	184	180-188	8,15	+15	16:48
214-(0,8 x age)	185	181-189	7,57	+14	
205-(0,5 x age)	187	183-191	6,42	+12	
200-(0,5 x age)	182	178-186	9,34	+17	

RESULTS

Group	min	max	mean	S.D.	
MEN2	122	157	142	7,45	
Age: 41-50	157	202	187	8,43	
Mean = 46	145	193	175	9,12	
Equations	max	+,- 4	% dif	d-bpm	run T
220-age	174	170-178	9,19	+19	17:24
214-(0,8 x age)	177	173-181	9,04	+16	
205-(0,5 x age)	182	178-186	6,04	+11	
200-(0,5 x age)	177	173-181	9,04	+16	

DISCUSSION

- Performing pretentious task on the field (or in war)
- Long lastin activity
- Stress physical activities

- The 12 month training period with 6 segments
- From novice segment –1 to top fit - 6