RELATIONSHIP OF EXERCISE WITH HEART RATE, EQUATION FOR CALCULATING HEART RATE ZONES FOR VARIOUS EXERCISES INTENSITIES

INTRODUCTION

The heart rate is the speed or frequency with which an event or circumstance occurs per unit time, population, or other standard of comparison. However, Heart rate, also known as pulse, is the number of times a person's heart beats per minute. A normal heart rate depends on the individual, age, body size, heart conditions, whether the person is sitting or moving, medication use and even air temperature. Even emotions can have an impact on heart rate. For example, getting excited or scared can increase the heart rate. But most importantly, getting fitter lowers the heart rate, by making heart muscles work more efficiently.

EFFECTS OF EXERCISE ON HEART

Inactivity is one of the major risk factors for heart disease. However, exercise helps improve heart health, and can even reverse some heart disease risk factors. Like all muscles, the heart becomes stronger as a result of exercise, so it can pump more blood through the body with every beat and continue working at maximum level, if needed, with less strain. The resting heart rate of those who exercise is also slower, because less effort is needed to pump blood.

A person who exercises often and vigorously has the lowest risk for heart disease, but any amount of exercise is beneficial. Studies consistently find that light-to-moderate exercise is even beneficial in people with existing heart disease. Note, however, that anyone with heart disease or cardiac risk factors should seek medical advice before beginning a workout program.

Exercise has a number of effects that benefit the heart and circulation (blood flow throughout the body). These benefits include improving cholesterol and fat levels, reducing inflammation in the arteries, helping weight loss programs, and helping to keep blood vessels flexible and open. Studies continue to show that physical activity and avoiding high-fat foods are the two most successful means of reaching and maintaining heart-healthy levels of fitness and weight. The American Heart Association recommends that individuals perform moderately-intense exercise for at least 30 minutes on most days of the week. This recommendation supports similar exercise guidelines issued by the Centers for Disease Control and Prevention, and the American College of Sports Medicine.

EXERCISE INTENSITY LEVELS

Intensity is the amount of physical power, the body uses in performing an activity. For example, it defines how hard the body has to work to walk a mile in 20 minutes.

MEASURING INTENSITY

There are several ways to measure exercise intensity. One common method measures the amount of oxygen consumed by the body as an activity is performed. This method is expressed in studies as the percentage of maximum oxygen consumption, or %-VO2 max. The oxygen consumption method is used most often in a research setting.

Another method of measurement works with the increased heart rate that occurs with exercise. The greater the intensity of the activity being performed, the higher the heart rate. This method is expressed as a percentage of maximum heart rate or %-MHR. Thus, Low, moderate and high levels of exercise intensity, as measured by heart rate, is defined as follows:

Low (or Light) is about 40-54% MHR.

Moderate is 55-69% MHR.

High (or Vigorous) is equal to or greater than 70% MHR.

An individual's maximum heart rate can be estimated by using the formula: 220 – age in years = MHR. Pulse rate can then be monitored while an exercise is being done and the % MHR calculated to assess intensity. The overall levels of intensity for a 50-year-old would be as follows:

Low Intensity: heart rate is 68-to-92 beats per minute.

Moderate Intensity: heart rate is 93-to-118 beats per minute.

High Intensity: heart rate is more than 119 beats per minute.

HEART ZONES

Heart zones, expressed as a percentage of the Max. Heart Rate, reflect exercise intensity and the result benefit. Once the Max. heart rate is established, it provides a chart to show the specific zones. There are five heart zones and they are each 10% of the Max. Heart Rate.

Percentage of the Heart Rate	Examples
50% of the Max Heart Rate =	(example 90 beats per min)
60% of the Max Heart Rate =	(example108 beats per min)
70% of the Max Heart Rate =	(example126 beats per min)
80% of the Max Heart Rate =	(example144 beats per min)
90% of the Max Heart Rate =	(example162 beats per min)
100% of the Max Heart Rate =	(example180 beats per min)

To determine the heart zone of an individual just join together the percentages and put them in the chart given below.

Zone Number	% of Heart Range	Enter the heart rate range for each range
1	50%-60% - bpm	(example 90 to 108 BPM)
2	60%-70% - bpm	

3	70%-80% - bpm	
4	80%-90% - bpm	
5	90%-100% - bpm	

EXERCISE PROGRAMMME

Here is the example of planning the exercise program by using the 5 zone system.

1 minute spent exercising in zone 1 = one exercise point
2 minutes spent exercising in zone 2 = two exercise points
3 minutes spent exercising in zone 3 = three exercise points
4 minutes spent exercising in zone 4 = four exercise points
5 minutes spent exercising in zone 5 = five exercise points

Inside each zone, there are different exercise changes which occur as the result of spending training time "in the zone". Let's go through each one briefly so that one can understand why we want to train in the different zones.

Zone 1: Healthy Heart Zone (50%- 60% of the individual max. heart rate)

This is the safest, most comfortable zone, reached by walking briskly. Here strengthen the heart and improve muscle mass while reduce body fat, cholesterol, blood pressure, and the risk for degenerative disease. A person gets healthier in this zone, but not more fit -- that is, it will not increase the endurance or strength but it will increase the health.

Zone 2: The Temperate Zone (60%- 70% of the individual max. heart rate)

It is easily reached by jogging slowly. While still a relatively low level of effort, this zone starts training the body to increase the rate of fat release from the cells to the muscles for fuel. Some people call this the "fat burning zone" because upto 85 % of the total calories burned in this zone are fat calories.

Zone 3: The Aerobic Zone (70%- 80% of the individual max. heart rate)

This zone is also easily reached by running, by improving the functional capacity. The number and size of the blood vessels actually increases; step up the lung capacity

and respiratory rate, and the heart increases in size and strength so one can exercise longer before becoming fatigued. It metabolizes fats and carbohydrates at about a 50-50 rate which means both are burning at the same ratio.

Zone 4: The Anaerobic Threshold Zone (80%- 90% of the individual max. heart rate)

This is where a person "feels the burn." A person can stay in this zone for a limited amount of time, usually not more than an hour. That is because the muscle just cannot sustain working anaerobically without fatigue. The working muscles protect themselves from overwork by not being able to maintain the intensity level.

Zone 5: The Redline Zone (90%- 100% of the individual max. heart rate)

This is the equivalent of running all out and is used mostly as an "interval" training regiment. Exertion is done only in short to intermediate length bursts. Even world-class athletes can stay in this zone for only a few minutes at a time. It is not a zone most people will select for exercise since working out here hurts and there is an increased potential for injury.

HEART RATE TRAINING

Heart rate training makes use of the fact that the demand for oxygen rises with exercise intensity. As would be expected heart rate has a close relationship to oxygen consumption, especially at exercise intensities between 50 and 90% **VO2 max**. Heart rate is easy to monitor and for the majority of athletes it offers a practical measure for assessing exercise intensity, which is why it is so popular. It's important to monitor exercise intensity for a number of reasons. Firstly, the specific physiological adaptations to training change depending on what relative work load is employed. It is fundamental that the athlete or coach understands which type of **endurance training** is best for their sport or event. Secondly, monitoring the intensity of individual sessions allows the coach or athlete to manipulate the overall program, helping to prevent over-training and to reach a physical peak for competition.

HEART RATE TRAINING ZONES

Different exercise intensities tax the body's energy systems in different ways. Exercising at 60% of maximum heart rate for example, is said to predominantly tax the aerobic system in most people. If exercise duration is long enough, the major source of fuel will be fat. This type of intensity is often favoured by people who want to lose weight and are generally de-conditioned. A heart rate training zone of 70-80% maximum will still predominantly tax the aerobic system in fitter individuals but the main source of fuel

will be carbohydrate, or more specifically, glycogen. This is the heart rate training zone that endurance athletes typically aim for.

TARGET HEART RATE (THR)

Normally during exercise, the heart rate varies depending on the intensity. These changes can easily be measured using a radio telemetry and continuous electocardiogram (ECG) recording. **The target heart rate** (**THR)** is the desired range of heart beats per minute that usually elicits the most benefit from working out. It is also known as the training heart rate. Recommendations for this range are dependent on age, gender, physical condition and one's previous training. THR, recording can be stored into the memory of a microcomputer with a transmitter and receiver, which is easily portable and can be worn on the wrist.

Why it is important to know one's target heart rate.

Target heart rate is used as a tool for exercise prescription. Results from the recordings are important in planning optimal training. This is especially important in athletes and is applicable for anyone else interested in exercise. Monitoring intensity is also done to avoid over-training and to accurately set max limits; for example, high speed cycling does not accurately indicate the intensity of exercise, hence the monitoring of THR by the prescribed methods.

Methods for measuring target heart rate

There are two methods which are normally used to calculate the Target Heart Rate. The first method shows the percentage of the maximum heart rate calculated from zero to peak. Method number two represents the heart rate at a specified percentage of maximum MET (VO2max).

KARVONEN METHOD

The Karvonen method was devised by a Scandinavian physiologist and is considered to be the "gold standard". This method uses the resting heart rate (heart rate reserve) into the equation. Calculations are then made using the difference between a subject's maximum heart rate and the resting heart rate.

Formula:

THR = ((HR max – HR rest) × % intensity) + HR rest

Where:

HR = Heart Rate
HR max = Maximum Heart Rate
HR rest = Resting Heart Rate
THR = Target Heart Rate

Example for someone with a HR max of 180 and a HR rest of 70:

50% intensity: ((180 − 70) × 0.50) + 70 = 125 bpm
85% intensity: ((180 − 70) × 0.85) + 70 = 163 bpm

where:

bpm = beats per minute

ZOLADZ METHOD

The Zoladz method determines exercise zones by subtracting values from HR max

THR = HR max – Adjuster ± 5 bpm

Zone 1: Long Slow Run .....Adjuster = 50 bpm
Zone 2: Easy Run .....Adjuster = 40 bpm
Zone 3: Tempo Run .....Adjuster = 30 bpm
Zone 4: Intervals/ Speed Work.....Adjuster = 20 bpm
Zone 5: Going All The Way.....Adjuster = 10 bpm

Example for someone with a HR max of 180:

Zone 1 (easy exercise) : 180 − 50 ± 5 → 125 – 135 bpm
Zone 4 (tough exercise): 180 − 20 ± 5 → 155 – 165 bpm

HEART RATE RESERVE

The heart rate reserve is the difference between one's HR max and the HR rest. If we take a typical example of someone who's HR max is 180, and the HR rest is 100,

then heart rate reserve is calculated as:

HR max – HR rest = HR reserve
180 – 100 = 80 bpm

Thus, the difference references the range of potential training heart rate intensities. This means if one has a large difference, then he/she has a great range of potential training heart rate intensities.

CONCLUSION

The heart rate is the speed or frequency with which an event or circumstance occurs per unit time. A person who exercises often and vigorously has the lowest risk for heart disease, but any amount of exercise is beneficial. Exercise has a number of effects that benefit the heart and circulation (blood flow throughout the body). These benefits include improving cholesterol and fat levels, reducing inflammation in the arteries, helping weight loss programs, and helping to keep blood vessels flexible and open.

On the other hand, intensity is the amount of physical power, expressed as a percentage of maximum, the body uses in performing an activity. There are several ways to measure exercise intensity. One common method measures the amount of oxygen consumed by the body as an activity is performed. And another method of measurement works with the increased heart rate that occurs with exercise.