Chapter 1

INTRODUCTION

Sport plays a prominent role in the modern society. It is important to individuals, a group, a nation and indeed the world. Throughout the world, sport has a popular appeal among people of all ages and both sexes.

Much of the attraction of sport comes from the wide variety of experience and feeling that result from participation such as success, failure, exhaustion, pain, relief and feeling of belonging. Sport can bring money, glory, status and goodwill. However, sport can also bring tragedy, grief and even death.

Sport is an Institutionalized competitive activity that involves vigorous physical exertion or the use of relatively complex physical skills by individuals whose participation is motivated by a combination of the intrinsic satisfaction associated with the activity itself and the external rewards earned through participation. (Uppal, 1992)

1.1 Training

Training is the process of preparing an athlete physically, technically, tactically, psychologically, and theoretically for the highest levels of performance. (Harre, 1982).

This contrasts sharply with exercise, which engages people in activities that are not designed to achieve the highest levels of performance. Of course, the highest levels of performance are relative. Each individual athlete has a genetic limit or ceiling that cannot legitimately overcome. What training attempts to do is take
athletes as close as possible to their genetic limits of performance by the safest, quickest, and most ethical means possible. (Michael, H. Stone et al. 2007)

1.1.1 Importance of Training

The importance of training is largely exploitive, but not in a negative sense. Training involves the exploitation of known principles of physics, physiology, psychology, and other areas of performance in order to reach a higher level of capability. The coach and athlete seek to exploit principles of training and performance so that the athlete can achieve as much as possible within the constraints of his or her talents and preparation. The highest possible performance of each athlete is relative to the athlete’s unique characteristics and abilities. It is also relative to the age or career status of the athlete or both. A novice athlete’s highest level of performance is considerably lower than the same athlete’s highest level of performance after 5 to 10 years of training.

Banister 1982, 1991; Banister and Calvert 1980; Calvert et al., 1976, Olbrecht 2000 expressed that the optimization of training seeks to achieve an ideal performance capability rather than simply increasing or decreasing some characteristic.

Training loads should be optimized. Increasing training loads does not always result in increased performance.

All other things being equal, an athlete who trains 30 hrs per week is likely to improve more than an athlete who trains 5 hrs per week. However, an athlete can also train too much, training more but benefiting less. Thus, there are limits to training loads. If an athlete trains too little, he or she may fail because an opponent worked
harder. If an athlete trains too much, he or she may fail because of over training, which is often expressed as injury or burnout. Therefore, training is a “Goldilocks” problem. The athlete must train neither too hard, nor too little, but to just the right extent. (Michael, H. Stone et al. 2007)

1.1.2. Objectives of Training

The objective of training includes the identification of talent and the training of junior athletes (Bloom 1985; Bomba 1985, 1990; B. Drabik 1996; Matsudo 1996, O’Brien 1993; Sands 1993). Talent identification and junior athlete training are usually linked by simple temporal order, but they are also linked by the fact that all athletes must develop from lower levels to higher and more defined levels. It is assumed that identifying talented athletes reduces the time, effort and cost of athlete development. Presumably an athlete’s ability will be better applied, with the result the athlete will be directed into sports that are more likely to match his or her particular gifts. (Bomba 1990; Drabik 1996; Sands 1993)

Many characteristics of athletes are highly heritable and thus can be detected with reasonable precision. Talent identification should be sensitive to the specific context of the athletes being assessed. Training demands and activities should be age appropriate in nature and developmental in focus (Greenspan 1983; Hoberman 1992; Hodge and Tod 1993; Preising 1989; Press 1992). When studying and working with junior athletes, scientists and practitioners must take care not to simply transplant ideas and process developed for adults. The objectives of training are wide and variable. Objectives vary relative to the goals of the athlete, coach, training program and sport system. Identification of objectives for each athlete should be undertaken prior to initiating training and periodically thereafter to ensure that the
training program remains focused on these objectives. (Michael, H. Stone et al. 2007)

1.2 Resistance Training

Resistance training is a general term that includes different modes and methods of regular exercise. The mode of training can include both machines and free weights. Resistance training comprises of training processes that can have the following goals such as injury prevention and rehabilitation, general fitness training, cosmetic training (body building), training for competitive sport.

Resistance training is multi faceted. Although several models of training have been proposed (Banister 1982, 1991; Banister et al. 1986; Bondarchuk 1988; Calvert et al. 1976; Hugh Morton 1991; Lutz 1990; Morton, Fitz-Clarke and Banister 1990; Ozolin 1970; Tabachnik and Mekhrikadze 1986; Taranov, Mironenko, and Sergejev 1995), many sports are currently searching for the ideal model of training. A model is a guide, a means of making the real world more manageable and easier to think about. Modeling is extremely important in science, including scientific approaches to training. (Michael, H. Stone et al. 2007)

1.3 Aqua Training

Water based exercise is predominantly for lower body exercise in a low impact, resistance based, environment. Although water-based exercise or training began with an emphasis on the elderly, that is no longer the case. The principles of water based training are similar to land-based training; however, the techniques are different. The body is uplifted in water by process called buoyancy and since the viscosity or thickness of the water is greater than air, movement of the body through the water provides an increased level of resistance (drag) over land-based exercise.
The buoyancy factor provides support for the body, thereby reducing the likelihood of muscle, bone and joint injuries. Buoyancy is defined as the ability of water to support a body's weight. Items float or buoyant in water because they displace an amount of water that weighs the same as the item itself. To simplify, an item floats when it displaces its own weight in water. This is why heavy iron ships float and small rocks sink and is subject to size, weight and shape or surface area in contact with the water. It was the ancient Greek Mathematician, Engineer, Physicist and not the least Astronomer Archimedes that first stated this principle and the same has been in use ever since.

Muscle is not as buoyant in water as fat. Therefore, both the chest and abdomen provide the greatest buoyancy since this is where air and most body fat is located. This becomes more significant in deep water versus shallow water immersion. (www.ifafitness.com, 1995-2010)

1.3.1. Importance of Aqua Training

Aqua training reduces impact on joints, reduces stress on joints by decreasing weight bearing, tones muscles, provides resistance in both eccentric (elongation) and concentric (contraction) muscle movements, improved balance and posture, increases flexibility, reducing capability for injury, allows special populations to exercise easily, equivalent calorie burn as land-based exercise. Because of the reduced influence of gravity, joints can easily be moved through the full range of motion without excess joint stress helping to improve flexibility. Deep Water-based running exercises can provide an augmented or alternate training regimen for runners who need to reduce the chronic effects of land-based running due to impact injuries.
Since the effects of gravity are reduced in water, impact is reduced while resistance to the movement is increased due to fluid dynamics. A water-based exercise or training programme can burn more calories than a comparable land-based class due to the increased resistance to movement while providing an increase in muscle strength and endurance.

Strength gains are not as good as weight bearing exercises on land since the buoyancy of the water reduces the weight. The speed of body movements through the water will subsequently be slower due to the increase in resistance. The equivalent level of physical fitness can be accomplished in water-based exercises as with land-based exercises.

Water based exercises reduces body weight by about 90% when immersed to the chest level, and 50% when at waist level which alleviates stress on joints and the supporting tissues. At the same time, resistance is increased by a multiple factor depending on the speed of movement due to water's higher density over air, which is about 800 times greater. Exercise in water has an added advantage that it can provide a user selectable resistance to movements. In addition, water pressure on the legs assists in circulation.

Water based exercises provide less joint stress not only for healthy individuals, but also for those special populations affected by medical conditions such as arthritis, neck and back problems, strokes and obesity. Special populations should acquire a medical clearance before beginning any exercise program including water-based-exercises. It is important to note that since gravity is not as much of a factor in water-based exercise; it will not be as effective as land-based exercise in preserving bone density. (www.ifafitness.com, 1995-2010)
1.3.2. Depth Aquatic Exercises

Water based exercises may be performed at one of three different levels: Shallow (waist deep), chest to shoulder depth, or deep water. Deep water exercises should only be reserved for accomplished swimmers. Water depth at the chest to shoulder level allows the body to be mostly supported by buoyancy and provides water resistance for the body to work against. Shallower water levels provide mostly body weight to work eliminating the added factor of water resistance. Chest to shoulder depth provides support of 80% to 90% of body weight and allows full suspension (feet off the bottom) for various exercises. (www.ifafitness.com, 1995-2010)

1.3.3. Contra Indications of Aqua Training

- Fever and infectious diseases
- Skin rashes and wounds that cannot be protected with waterproof dressing
- High or low blood pressure
- Vital capacity of <1L
- Seizure, or recent seizure activity
- Tracheotomy
- Bowel or bladder incontinence; unclamped drain tubes; unattached catheter bags
- Unprotected menstruation
- Inability to tolerate at least ½ hour of activity in the gym
- Unavailability of special handling needed for people with ostomies, cardiac involvement, orthostatic hypo tension, autonomic dysreflexia, hypothermia, and halo traction. (www.ifafitness.com 1995-2010)
1.4 The Effects of Physical Properties of Water

1.4.1 Gravity

During exercise in dry land the skeletal, muscular, cardiovascular, respiratory and other body systems are greatly affected by the forces of gravity. During exercise in water the effects created by the gravitational pull on the body are reduced. However, water possesses its own unique properties, which affect the body in a different way and provide with us with a totally new experience. The deeper the bodies submerged, our bodies, the greater will be the effects of water and the lesser will be the effects of the gravitational pull.

1.4.2 Buoyancy

It is generally accepted that the theory of buoyancy was discovered by the Greek philosopher and mathematician Archimedes (28-212 BC). His theory suggests that when a body is immersed in water it will displace an amount of water equal to the mass of the body submerged. The displacement causes the water to rise and surround the body and will push it upwards and out towards the water surface.

The reduction of gravitational pull and increased floatation provided by buoyancy will support the body frame. It will reduce the weight of the joints are normally required to carry when standing or moving on land. This allows the joints to lift and separate and will decrease the compression they normally experience during land based exercise programme.

Buoyancy will also naturally assist the floatation of our arms and legs (the body’ levers) to the water surface. This can reduce the amount of muscle work necessary to maintain certain positions during exercise. (Debbie Lawrence, 1998)
1.4.3. Factors Determining Level of Buoyancy

The degree to which a body will float is determined by three factors.

1. Body composition, the ratio of body fat to lean tissue (muscle and bone) carried by an individual.

2. The distribution of body fat, that is, where it is carried /deposited (example, lower or upper body).

3. The air in the lungs.

1.4.4 Less than (fatter) Body Types Affecting the Buoyancy

Rounder (endomorphic) and curvaceous body types are more buoyant. This is because they are composed of a higher proportion of body fat and a lower proportion of lean tissue. The float much more easily than their leaner colleague because body fat gas a lower density (is lighter) than water. Their increased flotation and buoyancy makes it harder for these body types to move quickly in the water. This is because they frequently have a larger surface area (width and breath) to drag through the water. This requires them to work harder and exert a greater force to create movement. (Debbie Lawrence, 1998)

1.4.5 Distribution of Body Fat Affecting Buoyancy and Floatation

An individual’s floatation is also determined by where they store and carry the majority of their body fat. Some individuals have greater proportion if their body fat distributed in the upper body giving them an apple shaped appearance. When the fat is stored in the lower body, the hips and legs tend to be more buoyant. They will therefore float in a more horizontal position. (Debbie Lawrence, 1998)
1.4.6 Air in Lungs Affecting Buoyancy

The greater the volume of lungs, for example during inhalation, the higher the body will float in the water; the less air there is in the lungs, for example during exhalation, the lower it will float. This is perhaps a less significant factor during water-based exercise. However, it is useful for determining a person's level of buoyancy and the floatation they are likely to experience. It is not an appropriate method for determining the floatation of non-swimmers or those less confident in water.

1.5 Resistance of Water Affecting the Body

There are three types of resistance created by the water. There are frontal resistance, eddy resistance or eddy drag, and viscous resistance. Each of these has different effect on the body, and will therefore be discussed individually. However, one should recognize that when moving in water they will each be acting on the body simultaneously.

1.5.1 Frontal Resistance

When the body is immersed in water it is surrounded by a medium, which exerts a constant and multi-dimensional resistance to it every movement. This resistance is approximately 12 times more resistant than air and requires the body to work three times harder than when exercising on dry land. Every movement potentially demands a greater muscular exertion and greater energy expenditure to overcome the resistance. Therefore, if this resistance is utilized effectively it can create the necessary overload for the muscular and cardio vascular systems that will induce the desired training effects, it can also be utilized to promote the burning of
calories which potentially assist with the control and management of body weight.  

(Debbie Lawrence, 1998)

1.6 Eddy Resistance (drag)

Eddy resistance or turbulence is created when a body or a body part moves through the water. When a greater number of body parts are required to move, the eddy resistance and turbulence is increased. Travelling movements, in particular, appear to increase the formation of eddy currents and create greater turbulence. In addition, the water will become more turbulent and more eddy currents will be formed when movements are performed at a greater speed, and when the force exerted by the body or body part is stronger.

1.7 Viscous Resistance

All fluids or liquids have a viscosity or thickness of flow. The greater the viscosity, the greater will be the resistance to movement. Oil is a liquid which naturally has a greater viscosity than water, therefore it exerts a greater resistance, making it harder to move an object through water. For example, stirring oil and water with a spoon will move more quickly and easily through the water. However, as the temperature of any liquid increases, so the viscosity decreases. Therefore, when a liquid is warmed, it will flow more freely and provide less resistance to movement. 

(Debbie Lawrence, 1998)

1.8 Propulsive Movements

The propulsive movements are the movements of our body levers (the arms and legs) which are necessary to overcome and manipulate the resistant properties of water.
These propulsive movements can be used to:

1. Initiate or create travel in a desired direction
2. Maintain a balanced and/ or stationary position during activity
3. Maintain floatation during deep water activities
4. Regain an upright position when balance is lost.

Swimmers move with relative ease and confidence in water, they therefore tend to perform the necessary propulsive movements fairly naturally. Alternatively, non swimmers and those less confident in water appear to move less comfortably in water. They tend to be less familiar and less killed at performing the propulsive movements that are necessary to manipulate the water in the appropriate way. It is therefore essential that they are coached and encouraged to develop these skills. Indeed, learning how to manipulate the water may increase their confidence in water and encourage them to learn to swim. This can provide them with yet another form of water activity to enjoy.

Sir Isaac Newton defined three laws of motion. Each contributes in some way to the movement of the body during water based activity. However, the third law is that which affects almost every water-based movement. This law states that for every action there is an equal and opposite reaction.

1.9 Hydro Static Pressure

Water exerts a pressure on the whole body as it immersed in water. The pressure exerted is proportional to the depth at which the body is immersed. Therefore, the deeper the body is submerged the greater will be the pressure applied by the water.
The pressure creates a feeling of tightness around the body, rather like the pressure of a bandage. It is the pressure which leaves our muscles feeling relaxed and our body lighter and refreshed after being immersed in water.

However, the pressure exerted on the thorax may create tightness in the chest area, making us more conscious of our breathing. This may create discomfort for some participants, particularly asthmatics. It is therefore advisable that they exercise in shallower water to avoid any discomfort created if they experience difficulties when breathing. (Debbie Lawrence, 1998)

1.9.1 Hydrostatic Pressure Affecting the Body

Hydrostatic pressure improves the circulation of blood around the body. Therefore, during water based exercising the blood is distributed more evenly. Alternatively, land-based exercise programmes require the blood to be redistributed to the working muscles. Specifically, the supply of blood to the kidneys is reduced and diverted to the muscles where it is most needed.

The pressure exerted on our body by the water will also promote the circulation of a greater volume of blood through the heart and vascular systems. This potentially increases the amount of blood pumped around the body in each contraction of heart (stroke volume), and the amount of blood that travels through the heart each minute (cardiac output). This improvement to the circulation of blood may contribute to the lower working heart rate frequently reported by participants during water based exercise. This infers that the heart is potentially placed under less stress during water-based activities, since it does not have to work hard to pump the blood around the body.
1.10 Water Temperature Affecting the Body

Immersion in water generally has a cooling effect on the body. This seen as an advantage by some participants since they will not be hot and sweaty throughout the workout. However, this may also create the misconception that they are exercising at a lower intensity. Additionally, the body will cool down approximately four times quicker than in air. This may therefore, potentially leave participants feeling cold, unless sufficient activities are included to maintain a comfortable body temperature. The rate at which the body will lose heat is determined by the actual temperature of the water, the air temperature of the surrounding environment, and the amount of natural insulation provided by body fat and muscle.

Initial immersion in to cooler water temperatures will cause the surface blood vessels to constrict. This is because the blood will temporarily be diverted away from the skin to the central organs to maintain their core temperature. This vaso-constriction may create an initial increase in heart rate and blood pressure. However, when the body becomes acclimatised to its new environment and warming activities start to occur, the blood vessels will once again dilate and the blood pressure and heart rate will normalize. Exercising in water that is too cool may maintain this vaso-constriction. This will increase the energy we expend via shivering to maintain a comfortable body temperature. It may also reduce the transportation and consumption of oxygen, which is essential for optimal training benefits to be received. Alternatively, exercising in a pool that is too hot may cause us to overheat and potentially dehydrate. A key disadvantage of not sweating is that we are unable to cool ourselves effectively when working in very hot pools.
Ultimately, the temperature of the water should not be below 84 degrees Fahrenheit and the surrounding air temperature should be slightly higher, although some may argue that this pool temperature is too low. In addition, it should not exceed 90 degrees Fahrenheit. The suitability of the pool temperature is dependent on the level of intensity of the activities being performed and the requirements of the group performing them. A less active or less energetic session may be safe to perform in a hotter pool. A more active session may well be comfortable to perform in a cooler pool by reasonably well-insulated body types. (Debbie Lawrence, 1998)

1.11 Importance of Physical Variables

Every individual must know the need of physical exercise. Physical fitness is the capacity of a person to function steadily and smoothly when a situation arises.

Physical exercise makes one mentally sharpen, physically comfortably and ease with his body and better able to cope with the demands that everyday life makes upon him. Increased physical fitness not only improves health but improves performance at work. Hundreds of American companies have back this idea financially by employing full time directors of fitness for their work. (Hardyal Singh, 1996)

Physical exercise helps an athlete to possess a high degree of physical conditions. The following physical variables which were considered for this study:

1. Speed
2. Agility
3. Explosive Power
4. Flexibility
1.11.1 Speed

Speed can be defined as “The ability on the basis of the mobility of the nervous system and the muscular apparatus, to perform movements at a certain velocity”. Physically velocity is expressed by the formula:

\[ V = \frac{D}{T} \]

Velocity = change in distance/change in time

A thorough analysis will show that results in most sports events are achieved by an acceleration of the body (or the body with an implement) which means that speed per unit of time is constantly increased. Acceleration is obtained by the coordinated strength and deployment of various groups of muscles, having imparted the highest possible speed to the body of the athlete or his implement in a given unit of time.

Speed comprises quick response, acceleration, maximum speed, and speed endurance. Since speed is generally considered as a collective term, it will not be further differentiated.

The speed of muscle contractions depends on the structure of muscle fibres and on the alteration of stimulus (“MAKE WAY”) and inhibition in the nervous system. The better the movements are coordinated, the faster excitations and inhibitions alternate in the nervous system, and the faster a movement can be performed. (Gerhardt Schmolinsky, 1978)

1.11.2 Explosive Power

It is refers to the ability to produce high peak rates of force development (PRDF) and is related to the ability to accelerate objects, including body mass. Explosive
power represents one of the most important features of track and field. Only the energetic aspect of substrate utilization represents the biological basis, as many investigators believe. Indeed, the most peculiar factors for explosive power development must be formed in neuro-muscular properties. (Stone, 1993)

1.11.3 Agility

Agility is the ability to change direction of the body and its parts rapidly. Agility is a combination of several athletic traits including strength, reaction time, and speed of movement, power and co-ordination. Agility is very important in all activities quick changes in direction are fundamentals to foot performance in practically all court games such as basket ball, tennis, badminton, volley ball and in many field games such as hand ball, soccer and basket ball. These games require running agility. Agility either general or specific can be improved by increasing the athletic components. (Phillip, 2001)

1.11.4 Flexibility

Flexibility is the range of motion through which joints are able to move. The natural joint range of motion of each joint depends on the design of the joint and the associated tendons, muscles, and ligaments. Furthermore, the flexibility of each joint is influenced by gender, habitual use, and stretching of the joint and associated structures.

Because many injuries occur when a limb or muscle is forced beyond its normal limits, flexibility training that gradually increases a joint’s range of motion can help to reduce the risk of injury. In addition to limiting range of motion and increasing the risk of injury, tight muscles may impede optimal performance. Well-stretched muscles that flow easily through the range of motion require less energy and
may facilitate better skill performance. Flexibility is sport specific, and a general rule is that athletes should be flexible through a slightly greater range of motion that necessary for the unhindered performance of their sport. (Brian J. Sharkey and Steven E. Gaskill, 2006)

1.12 Importance of Physiological Variables

Higher level of performance in sports and games might be dependent upon the physiological make up and it was recognized that physiological proficiency was needed for the high level performance. How much is determined by training and other adaptations made by the athlete.

Certain body types are well suited to particular types of athletic functions and movements. The Rift Valley of Africa, which includes countries such as Kenya and Ethiopia, has produced more World- and Olympic Champion distance runners than any other place on Earth, due to the slender, relatively long –striding people of that distinct, who live at altitudes in excess of 6,562 ft (2,000 m). These physical attributes have created a superlative human form for distance running. The people who live near the Baltic Sea in north east Europe, including Lithuanians and Russians, possess tall, lean, muscular frames, ideally suited to sports such as basket ball. These two examples are based on a broad range of experience and athletic success that these groups have enjoyed in the stated sports. (Shaver larry.G.1982)

The conflict between how much athletic ability is rooted in individual genetic as opposed to the influence of training and other factors are often expressed as “nature versus nurture”. Although precise attribution between athletic nature and nurture are impossible, it is a generally accepted sport science proposition that genes represent approximately 50% of athletic variation in performance, with 50%
attributable to both the individual athlete’s response to training, as well as social factors, such as the support provided to the athlete in pursuit of his or her goals.

There are a number of critical training factors constructed upon the inherent individual physical traits that will influence athletic success. The ability to increase one’s maximum oxygen uptake, expressed as VO$_2$ max, is one such factor. A greater VO$_2$ max represents a correspondingly enhanced ability to convert the bodily fuel sources into energy. VO$_2$ max is a genetic characteristic that may be typically increased through training between 10 % and 15 % exceptional athletes have experienced VO$_2$ max gains of 30%.

As a further example of the interrelationship between genetic and training determination, studies with elite endurance athletes such as Cyclist Lance Armstrong confirm that intense, long-term endurance training will modify the ratio of fast-twitch, explosive muscle fibers and slow-twitch, endurance fibers present in the musculoskeletal structure, producing more useful sport-specific muscles. (Shaver Larry.G. 1982)

1.12.1 Blood Pressure

Blood pressure reflects the force of the heartbeat and the resistance of the arteries to the pumping action of the heart. It is measured in millimeters of mercury (mmHg). The higher number, systolic blood pressure, represents the pressure created by the heart as it pumps blood (via ventricular contraction) to the body; this is the maximum pressure created by the heart during a complete cardiac cycle. The lower number, diastolic blood pressure, represents the pressure that remains in the arteries during the filling phase of the cardiac muscle, when the heart relaxes. It is the maximum pressure within the arteries during a complete cardiac cycle.
Normal blood pressure with respect to cardiovascular risk is below 120/80 mmhg. However, unusually low readings should be elevated for clinical significance. Based on the average of two or more readings taken at each of two or more visits after an initial screening. (Cedric X. Bryant and Daniel J. Green, 2003)

1.12.2 Cardio Respiratory Endurance

The ability of the heart, lungs, and circulatory system to deliver enough fuel and oxygen to the body’s cells. When levels of cardio respiratory fitness are low, the heart has to work very hard during daily activities and may not be able to work hard enough in an emergency. As, cardio respiratory fitness improves, the heart begins to function more efficiently. It doesn’t have to work as hard at rest or at low levels of exercise. The heart pumps more blood per heart beat, resting heart rate slows down, the number of red blood cells increases, blood supply to the tissues improves, and resting blood pressure decreases. A healthy heart can better withstand the strains of everyday life, the stress of occasional emergencies, and the wear and tear of time. Cardio respiratory endurance is considered the most important component of health related fitness because the function of the heart and lungs is so essential to overall good health. A person simply can’t live very long or very well without a healthy heart. (Thomas. D. Fahey et al. 1994)

1.12.3 Resting Heart Rate

Resting heart rate which is the number of beats felt exactly one minute. The average rate of the pulse in a healthy adult is 72 beats in each minute. There may be variation of up to five beats per minute within the normal range. The number of beats of a pulse per minute or the number of beats of the heart. The average rate is 72 beats
per minute but the rate can accelerate to 220 per minute. The lesser pulse rate given good performance for all the sports and games.

Heart rate determinations are not the same for land as for exercise in water. Studies have shown that water-based exercise heart rates are lower during water exercise, yet the same benefits are the same as land-based exercise.

When performing aquatic exercise, be aware that heart rate may not be the best indicator of the intensity of the workout. Studies have shown that persons who participate in both land- and water-based exercise often find their heart rates lower during water exercise, yet they receive the same benefits. Possible reasons for land-based and water-based heart rate differences are:

**Compression** - Hydrostatic pressure on the veins aids in the venous return of blood to the heart.

**Dive Reflex** - When the face is submerged in water, a natural process lowers the heart rate and blood pressure. This may even occur in chest high water.

**Gravity** - Blood requires less effort to flow back up to the heart.

**Partial Pressure** - A gas (oxygen) enters a liquid (blood) more readily under pressure.

**Temperature** - Since water has a greater cooling effect on the body, there is less effort required of the heart.

Due to the hydrostatic pressure of water which exerts external pressure on the chest, some prefers shallow breathe (top breathing). It is important to recognize that
this is occurring and encourage them to execute full breathing to avoid artificially and
dangerously increasing the heart rate and blood pressure. If the subjects raising arms
high overhead can artificially increase blood pressure and heart rate relative to VO2
requirements.

A user with too much buoyancy at the ankle level may find it difficult to
maintain an upright position. (Strukic, 1981)

1.12.4 Vital Capacity

Vital capacity is the maximum amount of air a person can expel from the
lungs after a maximum inspiration. It is equal to the inspiratory reserve volume plus
the tidal volume plus the expiratory reserve volume. A person's vital capacity can be
measured by a spirometer which can be a wet or regular spirometer. In combination
with other physiological measurements, the vital capacity can help make a diagnosis
of underlying lung disease. The unit that is used to determine this vital capacity is the
millilitre (ml). (www.wikipedia.org)

1.13 Reasons for Selection of Topic and Variables

Everyone is eager to know about the future well in advance. Hence, prediction
plays a key role in the day–to–day affairs. The prediction makes vast changes in the
life style of many individuals in the outcome of their engagements.

The investigator reviewed the number of scientific articles, journals, books,
self analyzed and found that selected physical and physiological variables would
influence the different depth of aquatic training. Hence the investigator selected the
research entitled “Effects of different depth of aqua training on selected physical and
physiological variables among college men”. For the purpose of this study, the
investigator selected the physical variables such as speed, agility, explosive power and flexibility. The physiological variables selected were blood pressure (systolic and diastolic), resting heart rate, cardio respiratory endurance and vital capacity.

1.14 STATEMENT OF THE PROBLEM

The purpose of the study was to find out the effects of different depth of aqua training on selected physical and physiological variables among college men.

1.15 HYPOTHESES

1. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on speed.

2. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on agility.

3. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on explosive power.

4. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on flexibility.

5. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on blood pressure (systolic and diastolic).

6. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on resting heart rate.
7. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on vital capacity.

8. There would be a significant difference between different training groups and control group due to different intensities (depths) of aqua training on cardio respiratory endurance.

9. There would be a significant difference occurred between the experimental groups on selected criterion variables after their respective training programme.

1.16 SIGNIFICANCE OF THE STUDY

1. This study is very much useful for the aqua trainers and experts.

2. This study is very much useful for the coaches and athletes.

3. This study gives authentic materials and methods of aqua training.

4. The same study may be conducted for females also on same variables.

5. This study would be the innovative tool to increase the sport performance.

6. The same study may be conducted with different variables.

7. The scholar recommends the comparison of aqua training and land-based training would be taken for research study.
1.17 DELIMITATIONS

1. The study was delimited on college men students, those who were studying in various classes of Lakshmibai National College of Physical Education, Kariavattom, Trivandrum, India.

2. The number of subjects was restricted to forty students.

3. The age of the subjects ranges from 19 to 25 yrs.

4. The subjects were divided into four groups, in which, Group - I underwent aqua training with water up to knee level, Group - II underwent aqua training with water up to hip level, Group - III underwent aqua training with water up to shoulder level and Group - IV acted as control group which was not participated any special training apart from their regular curricular activities.

5. Training period was limited to twelve weeks for three days per week.

6. The following physical variables, such as, speed, agility, explosive power and flexibility and physiological variables such as, systolic and diastolic blood pressure, resting heart rate, cardio-respiratory endurance and vital capacity were selected for the present study.

7. The physical variables such as speed, agility, explosive power and flexibility were assessed by administering 50 meters dash, shuttle run, standing broad jump and sit and reach test and the physiological variables such as blood pressure, resting heart rate, cardio-respiratory endurance and vital capacity were assessed by using sphygmomanometer, counting the pulse at resting condition, Cooper’s 12 minutes run/walk test and it was converted in VO₂ max and Spiro meter.
1.18 LIMITATIONS

The meteorological variations such as air, temperature, atmospheric pressure, relative humidity etc., during the testing periods could not be controlled and their possible influence on the result of the study was recognized as a limitation.

1. The study was limited to only a measurement of the selected physical and physiological variables.

2. Heredity and Environmental factors which contribute to performance have not been controlled.

3. No effect would be made either to control or to access the quality of the food ingested, life style, and effect of metabolic functions as these are recognised as a limitations for this study.

4. Though the subjects were motivated verbally, no special attempt was made to differentiate their motivational level during testing and training.

5. The previous experience of the subjects in the field of sports and games, which might be influencing during the training and data collection were not considered.

1.19 DEFINITION OF TERMS

1.19.1 Training

Any organized institution whose aim is to increase man’s physical, psychological, intellectual, mechanical performance rapidly. (Harre, 1982)

1.19.2 Speed

Speed is a measure of the ability to move all or part of the body as quickly as possible. (www.fitnessthroughexercise.com)
1.19.3 Explosive Power

It is refers to the ability to produce high peak rates of force development (PRDF) and is related to the ability to accelerate objects, including body mass. (Stone, 1993)

1.19.4 Agility

It is the ability to change speed and direction rapidly with precision and without loss of balance. (Brian J.Shakey and Steven E.Gaskill, 2006)

1.19.5 Flexibility

It is the range of motion thorough which joints are able to move. (Brian J.Shakey and Steven E.Gaskill, 2006)

1.19.6 Blood Pressure

Blood pressure reflects the force of the heartbeat and the resistance of the arteries to the pumping action of the heart. It is measured in millimeters of mercury (mmhg). The higher number, systolic blood pressure, represents the pressure created by the heart as it pumps blood (via ventricular contraction) to the body; this is the maximum pressure created by the heart during a complete cardiac cycle. The lower number, diastolic blood pressure, represents the pressure that remains in the arteries during the filling phase of the cardiac muscle, when the heart relaxes. It is the maximum pressure within the arteries during a complete cardiac cycle. (Cedric X. Bryant and Daniel J. Green, 2003)

1.19.7 Cardio respiratory endurance:

It is the ability of the heart, lungs and vascular system to function efficiently for an extended period of time. (Carl Gabbard et al, 1994)
1.19.8 VO₂ Max

It refers to the maximum amount of oxygen that an individual can utilize during intense or maximal exercise. It is measured as “millimeters of oxygen used in one minute per kilogram of body weight”. (McArdle WD et al. 2000)

1.19.9 Resting Heart Rate

The time from the end of one contraction to the end of the next contraction is a complete heart beat or pulse or cardiac cycle. The complete cardiac cycle takes less than one second (about 0.08 sec) in a normal adult at rest and it shortened by exercise. (Eva Lurie Weinerb, 1984)

1.19.10 Vital Capacity

The volume of air that can be moved out of the lungs after maximum inspiration is called vital capacity. (Strukic P.J, 1981)

The maximal volume of air that can be forcefully exhaled from the lungs following a maximal inspiration.