Nutrition and Physical Activity in the Arab Countries of the Near East

NUTRITION AND PHYSICAL ACTIVITY IN THE ARAB COUNTRIES OF THE NEAR EAST

Based on Workshop on Physical Activity in the Arab Countries of the Near East Cairo, Egypt 18-21 October, 1999

Edited by

ABDULRAHMAN O. MUSAIGER
Director, Environmental and Biological Programme
Head of Food and Nutrition Research
Coordinator, Arab Nutrition Society
Bahrain Center for Studies and research, Bahrain

SAMIR S. MILADI
Food and Nutrition Officer
Food and Agriculture Organization
Regional Office, Cairo, Egypt

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III. Abdulrahman O. Musaiger (editor)
IV. Samir S. Mildai (editor)

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Directorate of Information, Translation and Publication
Bahrain Center for Studies and Research
P.O. Box 496
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Preface

Regular physical activity can substantially reduce the risk of developing many chronic diseases. The prevalence of chronic diseases such as diabetes, cardiovascular disease, hypertension, obesity, osteoporosis and cancer has increased dramatically in the Arab countries, and become the main causes of morbidity and mortality in these countries.

Although, there are some programmes to improve the health and lifestyle of people in the Arab countries, physical activity is given little attention. In addition, there are many social and cultural barriers to practising physical activity in this region, especially among girls and women. Information on physical activity and its relationship with nutrition in Arab countries is at most scanty. This report provides useful information on nutrition and physical activity as well as current situation of physical activity in this part of the world.

Papers presented in this report were selected among papers presented in the workshop on "Nutrition and Physical Activity in the Arab Countries of the Near East", which was held in Cairo, Egypt, during 18-21 October, 1999. The meeting was organized by Food and Agriculture Organization (FAO), in collaboration with Arab Nutrition Society (ANSO), and Lebanese Association for Food Science and Nutrition (LAFSN).

The main recommendations of this workshop were summarized in so-called "Cairo Declaration", which includes the strategy to promote nutrition and physical activity in the Arab countries.

We would like to thank Bahrain Center for Studies and Research for providing secretarial work for organizing the workshop and facilities to review and typesetting of this report, and to MARS Incorporated for providing the fund to print it.

Abdulrahman O. Musaiger
Samir S. Miladi

CAIRO DECLARATION

PROMOTING PHYSICAL ACTIVITY AND PROPER NUTRITION FOR HEALTHY LIFESTYLE IN THE ARAB COUNTRIES

Changes in lifestyle and dietary pattern in the Arab countries during the past three decades have led to a dramatic increase in the prevalence of non-communicable chronic diseases. These diseases have become the main causes of morbidity and mortality in the Arab region. Physical activity is a key factor for physical and mental wellbeing. The interactions of nutrition and physical activity are essential for improving health, insuring dietary balance and maintaining active life.

The term "Physical Activity" is considered here in its broadest sense and refers to the entire spectrum of activity that any person undertakes, including normal activities of daily life at work, home, and in structured leisure time activities (sports and recreation). An increased awareness of the health benefits of physical activity must be translated into lifestyle changes, including in incorporation of a moderate level of activity.

Realisation of the health benefits of the physical activity and proper nutrition, requires the development of multi-agency policies and programmes that meet the needs and opportunities of the community, including specific population groups such as women, children, the elderly and those with disabilities. These programmes must be planned, implemented and evaluated taking into account existing socio-economic and cultural factors.

The following recommendations are proposed:

1. The establishment a National Coordinating Committee to promote physical activity in the community, including all involved parties in physical activity and nutrition such as Transportation, Ministries of Health, Environment, Education, Information, Youth, NGO's, Professional Associations and Private Sectors. The term of reference for this Committee is to formulate the relevant national strategies on physical activity considering the existing programs and institutions. The Committee will ensure the implementation of the approved strategies.

2. The initiation of research for data collection and its interpretation regarding the nutritional status, habitual activity patterns, and attitudes of communities towards physical activity, can serve a basis for the design of an appropriate national programmes and strategies.

3. The provision of services, opportunities and environmental inducements to encourage physical activity practices, including safe, accessible walking trials and sidewalks.

4. The dissemination of information on the importance of physical activity and proper nutrition including examples of suitable activities, via the mass media in a simple, relevant, and easily understood manner. In the process of developing these information guidance from experts on behavior changes should be sought.

5. Physical education classes, of best possible quality and appropriate frequency should be part of the curriculum in all schools, universities and other educational settings. The required physical and human resources should be made available.

6. Encouraging school children to develop a positive pattern and interest towards physical and proper dietary practice in order to ensure the foundation of a healthy lifestyle throughout life.

7. Necessary steps should be taken to increase the awareness of health care providers and educators as to the health benefits of physical activity, good nutrition and a healthy lifestyle, to make available appropriate resources.

8. National and International communities are urged to devote their knowledge, experience and resources for the promotion of physical activity and encourage its integration into everyday life of people.

The long-term goal of improved health and better quality of life will be achieved by a series of steps and actions directed towards the overall goal.

MACRONUTRIENTS, ENERGY BALANCE AND PHYSICAL ACTIVITY

Ayed F. Melhim
Department of Exercise Science
Faculty of Physical Education
Yarmouk University, Irbid, Jordan

INTRODUCTION

Nutrition plays an important role in the preparation and performance of athletes and has received considerable attention during the last two decades. Large amounts of research have been carried out in order to reveal the interactions of nutrition and physical performance.

Six major classes of nutrients are considered necessary in human nutrition. Carbohydrate, fat and protein, as well as water; these nutrients are referred to as macronutrients because the daily requirement is greater than a few grams. The human body requires substantial amounts of these macronutrients to provide energy, and support growth and development of the body tissues. On the other hand, most nutrients that help to regulate the metabolic process, particularly vitamins and minerals, are needed in much smaller amounts, usually measured in milligrams or micronutrients.

In order for a muscle to do work, it must contract by sliding its actin and myosin filaments. This process of muscle contraction, no matter whether it is strong or weak, requires energy; adenosine triphosphate (ATP) is the body's main source of energy for muscle contraction. Hydrolysis of ATP molecules makes available a considerable amount of energy to do work such as synthesis, transport and movement. Since the stored ATP in the muscle is limited and could be depleted within 1-3 seconds, immediate production and replacement of ATP is necessary as a backup system.

Table 1. The energy pathways and their time duration

Energy supplied by	Classification	Duration
ATP in Muscle	Anaerobic	1-3 seconds
ATP + PC	Anaerobic	4-15 seconds
ATP+ PC +Muscle Glycogen	Anaerobic	15-45 seconds
Muscle Glycogen +lactic acid	Aerobic +Anaerobic	45-140 seconds
Muscle Glycogen + fatty Acids	Aerobic	140sec and above

Energy balance involved in physical activity requires a sound nutrition to supply the necessary substrate fuels from the three energy-yielding macronutrients (carbohydrates, fats and proteins) for meeting widely varying levels of energy demands for different types of activities.

The purpose of this paper is to shed some light on the importance of each of these macronutrients to physical activity.

Carbohydrate

It has been well recognized for many years that dietary carbohydrate is the most important substrate from the standpoint of both health and physical activity. Besides being the only food that can be used for anaerobic energy production in the lactic acid system, it is also the most efficient fuel for the oxygen system. The metabolic pathways for carbohydrate are also more efficient than those of fat or protein.

Carbohydrates are usually ingested in three forms: (1) polysaccharides (starches) are generally formed when three or more glucose molecules combine, such as glycogen. (2) Disaccharide is the combination of two monosaccharides, such as lactose and sucrose. (3) Monosaccharides are the simple one-unit sugars such as glucose. In order to be useful in the body, these carbohydrates must be digested, absorbed, and transported to appropriate cells for metabolism.

Most of the dietary carbohydrate is digested to glucose for absorption into the blood and may be stored in the liver or muscles as glycogen, or be utilized as a source of energy by the nervous system. Excess glucose may be partially excreted by the kidneys, and major excesses are converted to fat and stored in the adipose tissue.

Carbohydrate and Physical Activity

According to Fox et al (1988) and Williams (1994) carbohydrate (glycogen and glucose) supplies about 40% of the body's energy needs during rest. This is true because the oxygen transport system (heart and lungs) is capable of supplying each cell with sufficient oxygen, and therefore with adequate ATP to satisfy all the energy needs of the resting state. As one participates in mild to moderate physical activity, carbohydrate use increases to 50% or more. When physical activity becomes more intense, carbohydrate is the preferred fuel. At maximal physical activity, carbohydrate is used almost exclusively. So, the most important factors determining which foodstuff will be used are the intensity and the duration of the physical activity.

Physical activities can be divided into two categories: (1) physical activity that can be performed for only short periods of time but which require maximal effort, and (2) physical activity that can be performed for relatively long periods of time but which require submaximal effort.

Saltin and Karlsson, 1971, have described the glycogen depletion patterns during physical activities requiring an intensity of 30 -120% of VO_2 max. It has been found that physical activities requiring 60-90% of VO_2 max significantly depleted glycogen stores in the muscle, and inactivities requiring less than 60% or more than 90% of VO_2 max, glycogen stores are not significantly depleted.

Physical Activities of Short Duration

Physical activities in this category include sprinting events such as 100, 200 and 400 meter dashes, the 800 meters run, and other events in which the required rate of work can be maintained between 2-3 minutes. These events require a high rate of energy expenditure and a more rapid production of ATP for muscle contraction.

Both the phosphagen (ATP-PC) and the glycolysis system are rapidly able to produce the ATP necessary to the high intensity of short duration physical activities (Table 1). Because both systems may function without oxygen, they are called anaerobic. Relative to physical activity, the ATP-PC system predominates in short powerful bursts of muscular activity such as the 100 and 200-meter dash, whereas the carbohydrate (glycolysis system) begins to predominate during longer physical activity such as the 400 and 800 meters. Spriet, 1995, stated that the glycolysis system provides approximately 80% of the total anaerobic ATP during an exhausting physical activity lasting 3 minutes. The predominant source of glucose in the glycolysis system is from muscle glycogen and this system is associated with the accumulation of lactic acid and hydrogen ions.

Although metabolic acidosis and ionic disturbances are thought to be the primary causes of muscular fatigue during such activities, carbohydrate availability may also play a role. It is suggested that the FT are depleted of glycogen during intense physical activity (Hargreaves, 1992). Furthermore, it has been demonstrated that increased dietary carbohydrate intake can improve high-intensity physical activity performance while inadequate carbohydrate intake impairs performance (Maughan, 1990).

Chemically speaking, anaerobic glycolysis is more complicated than the ATP-PC system. It requires 12 separate but sequential chemical reactions for completion. These reactions require the presence of a specific enzyme in order for the reactions to occur at a sufficient speed.

The net gain from this process is 3 moles of ATP formed for each mole of glycogen broken down. If glucose is used instead of glycogen, the gain is only 2 moles of ATP, because 1 mole of ATP is used for the conversion of glucose to glucose-6-phosphate.

There are two limiting factors to this system: (1) only a few moles of ATP can be resynthesized. Despite this limitation, the combined reaction of the ATP-PC and glycolytic system allows the muscle to generate power even when the oxygen supply is limited. (2) It causes an accumulation of lactic acid in the muscle and the blood. This accumulation can increase from a resting value of about 1 mmol./kg of muscle to more than 25 mmol. /kg. The formation of lactic acid in the body is related to fatigue.

Prolonged Physical Activities

Any activity that can be maintained for relatively long periods of time with an intensity of approximately 70-80 of the VO_2 max should be included under this category. The requirement of energy for this type of activity is dependent on the oxygen system. This system possesses a lower rate of ATP production than the phosphagen and the glycolysis system, but its capacity for total ATP production is much greater. So aerobic metabolism is the primary method of energy production during an endurance type of physical activity.

The oxidative system of energy production can generate up to 39 molecules of ATP from one mole of glycogen. If the process begins with glucose, the net gain is 38 ATP molecules. This system is the most complex of the three energy systems that have been mentioned. It involves 3 processes of reactions with the presence of oxygen to produce energy, carbon dioxide, and water. These reactions occur in the energy powerhouse of the cell, the mitochondrion.

Muscle glycogen is the predominant carbohydrate substrate utilized in the first 60-90 minutes of a prolonged type of activity that can supply approximately 700-800 kcal/h of aerobic energy. While in the next stages, when muscle glycogen has been decreased, the blood-borne glucose contribution to energy expenditure increases progressively (Costill, 1988), and may account for up to 90% of the carbohydrate metabolized by muscle in the final stages of the prolonged activity. It has been shown that skeletal muscle accounts for approximately 15-20% of the total peripheral glucose utilization during rest, while during cycling performance at 55-60% of VO_2 max, leg muscle glucose uptake can account for as much as 80-85% of the total body glucose utilization (Kjaer et al, 1991). The liver is known to be the major contributor of glucose to the blood via glycogenolysis and gluconeogenesis. Constantin-Teodosiu et al, 1992, stated that the importance of muscle glycogen and blood glucose availability during prolonged activity is demonstrated by the observation that fatigue is often associated with muscle glycogen depletion and / or hypoglycemia.

Because muscle glycogen depletion and hypoglycemia may cause fatigue during prolonged activity, carbohydrate feedings before, during and after prolonged physical activity result in delayed fatigue and improved performance and hasten recovery. Thousands of studies have been conducted on this topic since carbohydrate was identified as the most efficient energy source of physical activity 15 years ago.

According to the review by Hawley et al, 1997, it appears that there is little or no effect of glycogen loading before physical activity above normal resting values on a single exhaustive bout of high intensity ($\geq$100 VO_2 max) physical exercise lasting 3-5 minutes. Nor is there any benefit of elevating starting muscle glycogen content on moderate-intensity physical exercise lasting 60-90 minutes. In contrast, there is evidence to indicate that elevated starting muscle glycogen content will postpone fatigue by approximately 20% in physical activity lasting more than 90 minutes. In such activity, high carbohydrate diets have been reported to improve physical performance by 2-3% (Hawley et al, 1997).

Since carbohydrates are the major energy nutrient, they should contribute between 55-60% of the daily kcaloric intake, while during heavy physical activity the carbohydrate requirement may be increased to 8-10 g/kg bodyweight or 60-70% of total energy intake (Williams, 1994).

Fat

As indicated earlier, the two major energy source for the production of ATP during physical activity are carbohydrate in the form of muscle glycogen and fats in the form of fatty acids. Since carbohydrate stores in the body are limited and the fat stores are unlimited, the use of fat for energy production can delay exhaustion. According to Coyle (1991) carbohydrate stores within the body produce approximately 1200 kcal from muscle glycogen, 400 kcal from liver glycogen and 50 kcal from glucose in the blood. However, fat stores within the body are quite large, representing approximately 80,000 kcal even in a lean young man. Clearly any change that allows the body to use more fat would be an advantage, particularly for endurance physical activity performance.

Fat in our diet consists of several substances classified as lipids. The three major lipids of importance to humans are triglycerides, phospholipids, and cholesterol. Only triglycerides are major energy sources and are stored in adipose tissue within skeletal muscle fibers. To be used for energy, a triglyceride must be broken down to its basic unit: one molecule of glycerol and three molecules of three fatty acids (FFA). This process is called lipolysis, and enzymes called lipases carry it out. The glycerol molecule enters the bloodstream and is oxidized in the liver to form glucose by a process called gluconeogenesis, whereas the three FFA molecules are bound to the protein albumin as a carrier and transported to either the liver, heart or skeletal muscle, depending on where the demands for energy are greatest.

During rest, the Respiratory Exchange Ratio (RER) is usually around 0.80. This signifies that about 65% of the energy needs of the body are derived from the oxidation of plasma FFA. During prolonged physical activity, with an RER value of 0.85, 50% of the energy is met from lipid oxidation (Williams, 1994). The relative contribution that lipids can make to the physical activity metabolism depends upon the intensity and duration of the physical activity and the person's fitness.

During low-intensity exercise, between 25-40% VO_2 max, about 30-50% of the total energy cost is derived from carbohydrate while the other 50-70% comes from fat (Romijn et al, 1993). The plasma FFA accounts for most of the fat metabolized during this type of physical activity, although muscle triglycerides are also used. As the physical activity intensity increases toward 60-65% VO_2 max, there is a slight decrease in the amount of plasma FFA uptake. According to Romijn et al, 1993, the total fat oxidation is about 40% higher at 65% VO_2 max compared with physical activity at 25% VO_2 max. So, at higher work intensities the muscle triglycerides become increasingly important as the supplier of fatty acids. However, at higher work intensities such as 85% VO_2 max, total fat oxidation decreases as well as plasma FFA sources. It appears that there is a metabolic limit in the ability of FFA to generate ATP, and thus energy must be provided from other sources such as glycogen and plasma glucose (William, 1994).

Romijn et al, 1993, have shown that plasma FFAs account for only 50-60% of the total FFAs oxidized during the first 60 minutes of physical activity at 65 % VO_2 max. However, during prolonged physical activity (1-2 hours) of 65% VO_2 max, it has been shown that plasma FFAs become the predominant source of energy, and more so in the fasting state.

Lastly, at higher exercise intensity, 85% VO_2 max, which probably can not be maintained for a long duration (1-2 hours), most of the required energy is provided from carbohydrate sources. Romijn et al, 1993, demonstrated that the rate of plasma FFA turnover is about 25% lower at 85% VO_2 max than at 65%; therefore, a large portion of the fat oxidized during high-intensity physical activity is obtained from nonplasma FFA sources.

According to Williams (1994) there may be various factors that limit the role of FFA as the major source of energy during high intensity physical activity, including the following:

1. Inadequate rate of release from the adipose tissue.
2. Inadequate transport capacity by albumin.
3. Inadequate uptake by the muscle cell.
4. Inadequate use in the cell.

Endurance Training and Fat Metabolism

It is well established that fat is the fuel of choice during physical activity of long duration. In addition, a number of studies have shown that long term training for and regular participation in endurance physical activities causes an increase in fat metabolism and a sparing of glycogen (Turcotte et al, 1992; and Kiens et al, 1993). The magnitude of training Induced alterations in substrate used may be 30-50% based on the measurement of RER. Hurley et al, 1986, indicated that the cumulative proportion of energy derived from fat oxidation during the 120 minutes bout of cycle ergometer at 64% VO_2 max rose from approximately 40% before training to approximately 60% after training. Thus, there was a corresponding decrease in carbohydrate oxidation that was partially accounted for by a 40% decline in glycogen depletion. It was showed that endurance training reduced the plasma glucose oxidation by 30% during prolonged physical activity.

Thus, it can be concluded that one of the most important adaptations to endurance training is a reduced dependence on carbohydrate energy sources and an increase in total fat oxidation.

Although all the exact mechanisms have not been identified, several factors may be involved. Havel et al (1964) and Havel et al (1963) demonstrated that plasma FFA transported from remote adipose tissue stores are the source of additional fat oxidized by well trained individuals during submaximal physical activity. However, Winder et al, 1979, demonstrated that the plasma concentration of glycogen and catecholamines, the most potent stimulants of lipolysis, are reduced by 30-70% at the same absolute work intensity (approximately 60% VO_2 max) in the trained state. Thus, training reduces the release of catecholamines, and this seems to occur at the same time as an increase in fat oxidation during submaximal physical activity. The reason for this is that in highly trained individuals, muscle triglycerides provide a greater proportion of total fat oxidized.

In addition, several investigators have also reported high plasma Insulin concentration during prolonged physical activity in a trained state (Galbo 1983;

Winder et al 1979; Hartley et al 1972). This is likely to exacerbate the blunted sympathoadrenal responses to physical activity in a trained state. The antilypolytic action of a higher Insulin level is associated with lower levels of plasma FFA and glycerol because of an overall reduction in adipose tissue lypolisis under such physical activity.

Based on these observations, plasma FFA and glycerol do not appear to produce more energy during the trained state; muscle triglycerides are the most likely sources of energy. According to Martin (1996) oxidation of plasma FFA accounted for approximately 40% of energy derived from fat metabolism before training and approximately 23% afterward. Thus, in highly conditioned individuals more than 75% of fatty acids oxidized during moderate intensity physical activity may originate from a source other than plasma FFA.

Because physical training leads to an increased utilization of FFAs as an energy source and improved performance in prolonged exercise, a variety of nutritional and pharmacological supplements or techniques have been employed in attempts to facilitate this metabolic process during exercise. Dyck et al (1993), Vukovich et al (1993), Griffith et al (1994) and Griffith et al (1994) have demonstrated that both infusion and ingestion of fat were found to elevate plasma FFAs and spare muscle glycogen during physical activity. Based on these studies, high fat diets have been suggested to improve performance by elevating plasma FFA and increased rate of fat oxidation.

Several studies have examined the effects of short-term high fat diets on exercise performance, and the result has been equivocal (Sherman and Leenders, 1995). One of these studies was Johannessen et al, 1981, who examined endurance performance after the trained participants ingested either a high fat diet (76%) or a high carbohydrate (76%) diet for 4 days. The participants on the high fat diet demonstrated a shorter time to exhaustion when running on a treadmill. Another study by Phinney et al, 1983, also found that a high fat diet ingested by 5 trained cyclists did not improve endurance time.

In contrast, Muoio et al (1994) demonstrated that a diet of 38% fat ingested by 6 trained runners for 7 days resulted in a greater endurance time compared with a 24% fat diet. Sears, (1995), suggested a diet containing 40% carbohydrate 30% fat and 30% protein. Among the diet's performance promises are improvements in endurance, lean body mass and reduction in body fat. However, Sherman and Leenders (1995) in a more recent review, concluded that a high fat diet might not be effective in improving endurance. In addition the relationship of high blood fat levels and cardiovascular disease questions the practice of using a high fat diet to alter performance when it may negatively affect health. Accordingly, the recommended dietary fat intake for supporting physical activity is no more than 30% of total kcalories.

Protein

Protein, the final one of our three energy-yielding macronutrients, is quite different from its partners, carbohydrates and fats, in two main ways. First, although protein is also capable of providing energy, that is only a sideline, it's not a main function. Second, protein supplies the body's nitrogen, the essential element for all living creatures. Thus, the main function of protein is building and rebuilding all body tissues.

Protein is a complex chemical structure which contain carbon, hydrogen and oxygen just as carbohydrates and fats do. Protein has one other essential element nitrogen, which constitutes about 16% of most dietary protein. These four elements are combined into a number of different structures called amino acids. There are two groups of amino acids: (1) the essential or indispensable, amino acids. This group consists of nine amino acids that cannot be manufactured in the body and must be supplied in the diet. (2) The nonessential or the dispensable, amino acids which consist of eleven amino acids. This group can be formed in the body.

Protein is essential for all life. It comprises about 15% of the body weight of a human and is found primarily in muscle, which constitutes approximately 40% of the body weight and is the second largest store of potential energy in the body after fat. Despite this, protein and amino acids are often ignored in discussion of metabolism during physical activity, probably for two reasons: (1) amino acids contribute only a minor portion (5-15%) of the energy consumed during physical activity and (2) little is known about these complex aspects of metabolism (Graham et al, 1995).

Proteins and Physical Activity

Protein is usually discounted as a substrate fuel in energy production during physical activity. Although amino acids are capable of feeding into the Krebs cycle (citric acid cycle) at different points, the extent of this input during physical activity is minimal. Some amino acids breakdown during physical activity and nitrogen losses are evident, but researchers agree that under normal circumstances, protein makes a relatively insignificant contribution to energy during physical activity (Romijn et al, 1992). In endurance physical activity, however, somewhat more protein may be used, especially when carbohydrate resources are depleted. Lemon et al (1981) demonstrated that individuals who cycled at a similar intensity for 60min with low initial glycogen stores utilized more than twice the protein (10.4 Vs 4.4% of total energy expenditure) when compared with individuals with high initial stores. This emphasizes the important role of carbohydrate as a protein sparer and suggests that the demand on protein in physical activity is linked to carbohydrate availability. Certainly, this would become an important factor in endurance physical activity or in frequent heavy training in which glycogen stores are greatly reduced. In fact, when the process for gluconeogenesis is chemically blocked, hypoglycemia results and endurance performance is greatly impaired.

In addition, several investigators have reported that the available data appear to support an increased use of protein, or amino acids, as an energy source during exercise. Williams (1994) stated that in the majority of exercises, including strenuous weight training, protein appears to be a relatively minor source of energy and accounts for less than 5% of the total energy cost of the physical activity. Lemon et al (1991) demonstrated that in the later stage of prolonged endurance physical activity, protein could contribute up to 15% of the total energy cost.

Although the available evidence suggests that metabolism of protein and its use as an energy source are increased during exercise, the magnitude of its contribution may depend on several factors such as intensity and duration of the exercise, the availability of other fuels such as glycogen in the muscles, and environmental conditions.

Given the potential importance of protein to optimal performance, the protein supplementation has been used in attempts to enhance performance. Does this work? Slavin et al (1988) and others have concluded that average diet adequately meets the protein needs of the athletes. A diet containing 12-15% of kcalories from protein should be adequate for most athletes unless their total energy intake is deficient.

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MICRONUTRIENTS, FLUIDS AND ELECTROLYTES IN PHYSICAL ACTIVITY

Ron J. Maughan
University Medical School
Aberdeen , Scotland

INTRODUCTION

A physically active lifestyle imposes many demands on the human body, but can also provide great benefits in terms of health, fitness and enjoyment. To ensure that these benefits are realised, the exercise load – in terms of intensity, duration and frequency – must be suited to the aims and ambitions of the individual. It is also important to recognise the additional nutritional requirements that result from a physically active lifestyle and to ensure that these needs are met. Although there has been much research in this area, there is still much that we do not know. This paper will consider the evidence that an increased level of physical activity will increase the requirement for dietary intake of vitamins and minerals. It will also consider the physiological impact of exercise in a warm environment, and the need for replacement of water and electrolyte losses in sweat. Although the focus is on physical activity, rather than competitive sports activities, examples will be drawn from the latter when appropriate.

Micronutrients

For normal health to be maintained, a wide range of vitamins, minerals and trace elements must be present in adequate amounts in the body tissues, and the dietary intake must be sufficient to meet the requirement. Many vitamins and minerals play key roles in energy metabolism, and the adverse effect of deficiencies of these components is well recognised and easily demonstrated. Marginal deficiency states may have little effect on the sedentary individual, but small impairments of exercise capacity may have profound consequences for the person who exercises seriously. Regular intense exercise training may also increase micronutrient requirements, either by increasing degradation rates or by increasing losses from the body. Consequently, there is a great interest shown by athletes in some of these dietary components because of their role in maintaining or enhancing physical performance. There is often, however, a failure to appreciate that it is not inevitably, or indeed even generally, the case that increasing micronutrient intake to levels above those that are adequate for maintaining health will improve athletic performance.

Biological Functions of Vitamins

The use of vitamin supplementation to enhance performance is based on the known biological actions of these compounds, and some important biological functions related to physical activity are summarised in Table 1. Many vitamins, particularly the water-soluble vitamins, are involved in mitochondrial energy metabolism. It is therefore intuitively attractive to believe that supplying additional amounts may be beneficial, even though information on the influence of vitamin supplementation on mitochondrial metabolism is relatively scarce, and the information that is available does not support this. Nonetheless, athletes and physically active people - as with the sedentary population - often see dietary supplements as a form of "insurance policy": even when there is no evidence that a deficiency may exist or that intakes above the normal level may be beneficial, it may be as well to take supplements "just in case". This practice is generally harmless, except perhaps in the financial sense, but there are some concerns over the possible harmful effects of excessive intakes of the fat soluble vitamins (A,D, E and K) over long periods. The water-soluble vitamins are simply excreted if consumed in amounts in excess of the requirement. By definition, all vitamins must be supplied in the diet if health is to be maintained, but deficiency states are rare in the industrialised countries, and the classical symptoms of deficiency are unlikely to be observed in athletes.

Table 1. Major biological functions of the vitamins in exercise. Vitamin K is not included in this table, as no specific role for this vitamin in exercise has been identified

VITAMIN	METABOLIC ROLE
A	Antioxidant function
Thiamin (B1)	Carbohydrate metabolism
Riboflavin (B2)	Mitochondrial electron transport (as FAD)
Niacin (B3)	Multiple metabolic pathways (as NAD and NADP)
P yridoxine (B6)	Amino acid synthesis
Folate	Red blood cell synthesis
Pantothenic acid	Oxidative metabolism (as CoA)
Biotin	Biosynthetic reactions
B12 (Cyanocobalamin)	Red blood cell synthesis
Ascorbic acid (C)	Antioxidant, catecholamine synthesis, tissue repair
D	Calcium homeostasis
E	Antioxidant, prevention of free radical damage

Biological Functions of Minerals

At least 20 different minerals are required in adequate amounts to sustain normal function of tissues and cells. Many of these are required in only trace amounts, but others must be supplied in greater quantities. Deficiencies of all of these elements are theoretically possible, but in practice, deficiencies are generally uncommon, with the possible exceptions of iron, calcium and, in some parts of the world, iodine. A balanced diet consumed in amounts sufficient to meet energy requirements will normally supply all the vitamins in the required amounts, but not all active people have a high energy intake and many do not eat a varied diet.

There has been much interest in magnesium homeostasis in physically active people, including those who exercise regularly and those with physically demanding occupations. Magnesium plays a number of vital roles in the regulation of energy metabolism, acting as a cofactor and activator for a number of enzymes, and is also involved in calcium metabolism and in the maintenance of electrical gradients across nerve and muscle cell membranes. Magnesium is lost in sweat in concentrations that may be higher than those in the blood, leading to concern about magnesium deficiency in athletes losing large amounts of sweat. Magnesium deficiency is often proposed as a cause of exercise-induced muscle cramps, even though there is no experimental evidence to support this hypothesis (Maughan, 1986). In some countries, including Germany, this idea is so fixed that sports drinks intended to replace sweat losses invariably have added magnesium, even though the same products are sold in other countries without the addition of magnesium salts. Experimental magnesium deficiency results in a variety of symptoms, but these do not include muscle cramp.

Zinc is also involved as a cofactor in many enzyme reactions, and has many other roles, including promotion of tissue repair processes. Most of the body zinc content of about 2-g is present in muscle (60%) and bone (30%). Low concentrations are present in sweat, and exercise may stimulate urinary loss. A recent study shows that if dietary zinc intake is severely restricted for a period of 5-6 weeks, muscle strength and endurance are impaired (Van Loan et al, 1999), but this was only achieved by an extreme diet. This and other similar reports may account for the concern of many active individuals, but there is no evidence that the small increase in losses that accompanies exercise is sufficient to cause concern or that an inadequate intake is likely to occur naturally. Small amounts of zinc are present in many foods, including both animal and vegetable products. Copper is another divalent cation with important biological functions including modulation of enzyme activity and also a role in the synthesis of haemoglobin, catecholamines and of some peptide hormones. Once again, deficiencies are rare, as copper is found in a wide range of foods, including shellfish, liver, whole grain cereals, legumes and nuts.

Selenium has an antioxidant function by virtue of forming an integral part of the glutathione peroxidase enzyme, helping to protect cells against the damage that can result from free radicals. There is some evidence to suggest a role for selenium in protecting against some cancers. In regions of the world where the soil is low in selenium, vegetables will have a low selenium content and deficiencies are possible: these are, however, generally well recognised, and appropriate measures for fortification in place, so this should not affect most active individuals.

An adequate dietary iodine intake is essential for synthesis of the thyroid hormones thyroxine (T4) and triiodothyronine (T3), and thyroid deficiency was formerly common in parts of the world where the availability of iodine is low. Recognition of the role of iodine led to iodisation of salt in these regions. In most European countries, intakes are well in excess of requirements, and there is no evidence to suggest a greater requirement in physically active individuals.

A variety of other elements, including cobalt, molybdenum, manganese, chromium and phosphorus, play important metabolic roles and are required in the diet in small amounts. Deficiencies of all of these elements are sufficiently rare that the possibility of their being encountered in physically active people is negligible. Many of these elements, however, including cobalt, chromium and phosphate, are used as supplements by athletes, although there is evidence neither for an increased requirement nor for a beneficial effect of specific supplementation on performance.

A comprehensive review of the role of minerals in exercise performance and of the requirements of athletes and physically active individuals is presented by Clarkson (1991).

Dietary Micronutrient Intake in Physical Activity

With participation in regular strenuous exercise, there must be an increased total food intake to balance the increased energy expenditure: without this, hard exercise cannot be sustained for long. Provided that a reasonably varied diet is consumed, this will supply more than adequate amounts of protein, minerals, vitamins and other dietary requirements (Van Erp-Baart et al, 1989). There are of course always exceptions - as with the general population, not all physically active people (even those who are health conscious) eat a varied diet, and some will restrict energy intake to maintain low body weight and low levels of body fat. It must be remembered however, that the results of surveys which show intakes of vitamins and minerals below the RDA in some groups of active people (most especially female athletes in sports where a low body fat content is considered essential, including ballet dancers, gymnasts, and long distance runners) take no account of the very low body weight of most of these individuals. Indeed the RDA's are so imprecise that there is generally no attempt to relate the requirement to body weight. However, it is likely that the increased energy intake that is necessary to support participation in regular exercise will ensure an adequate intake of most essential dietary components.

There is no good evidence to suggest that specific supplementation with any of these dietary components is necessary or that it will improve performance. Deficiencies can only be established by biochemical investigation or by the identification of specific symptoms as mentioned above. Where the presence of a specific deficiency is established, this should be treated wherever possible by directing the individual towards a more appropriate choice of foods to include those with a high content of the deficient component. In almost every case, it is possible to meet requirements from a normal varied diet, and only where clinical signs of an established deficiency are identified should vitamin or mineral supplementation be considered. The only exceptions to the generalisation about the value of dietary supplements in meeting micronutrient needs may be iron and, in the case of very active women, calcium. There is also limited experimental support for antioxidant supplementation in some situations.

Iron, Haemoglobin and Oxygen Transport

Iron has a number of functions in the human body, but the principal one is its role - in the form of haemoglobin - in the transport of oxygen from the lungs to the tissues where it is required. A fall in the circulating haemoglobin concentration is associated with a reduction in oxygen carrying capacity and a decreased exercise performance (Maughan, 1992). The body stores some iron in the form of ferritin, and transport around the tissues is accomplished by another protein, transferrin. The first sign of iron deficiency is generally a fall in the circulating ferritin concentration. Anaemia - a low blood haemoglobin concentration - may result from an inadequate iron intake in the diet, but may also be due to inadequate absorption of dietary iron, or to a deficiency of Vitamins B12 or Folate, which are both involved in the formation of new red blood cells. The circulating transferrin level can rise sharply after exposure to any one of a number of stresses, and cannot be used as an index of iron status.

The observation that an individual's maximum oxygen uptake (VO_2 max) can be increased by artificial elevation of the circulating haemoglobin concentration, by use of red cell reinfusion procedures and also by administration of recombinant erythropoietin, to enhance performance has focused attention on the possible limitation to oxygen transport imposed by the oxygen carrying capacity of the blood (Ekblom et al, 1972). Although these procedures are, quite properly, banned in athletes, the search for legitimate means of achieving the same end goes on. This explains in part the popularity of altitude training among athletes, as well as the widespread use of iron supplementation. In a well-controlled study, well-trained subjects received either a sham saline infusion or an infusion of red cells in a double-blind crossover design (Buick et al, 1980). Blood volume was unchanged 24 hours after re-infusion, but haemoglobin concentration was increased by 9 % from 151 to 165 g/l. This was accompanied by a 5% increase in VO_{2max} and a 34% increase in treadmill running endurance time (from 7.2 to 9.7 min).

In view of the apparent importance of the oxygen carrying capacity of the blood for oxygen transport, it seems odd that one commonly observed adaptation to endurance exercise is a decrease in the circulating haemoglobin concentration, commonly referred to as sports anaemia. This is not a true anaemia, however, and the decrease in haemoglobin concentration is a consequence of the disproportionate increase in plasma volume. The total circulating haemoglobin mass is usually increased r t east aintained n he rained tate. his ay e onsidered o e an adaptation to the trained state, but hard training may result in an increased iron requirement and exercise tolerance is certainly impaired in the presence of anaemia. Low serum folate and serum ferritin levels are not associated with impaired performance, however, and correction of these deficiencies does not influence indices of fitness in trained athletes.

Stimulation of erythropoiesis - the formation of new red blood cells - is apparent within the first day or two of exercise training, and a similarly rapid response is observed on going to altitude. If the body's iron stores are inadequate at this time, there will certainly be some impairment of the process of adaptation. Special attention to dietary iron intake is therefore necessary for the sedentary individual who embarks on a strenuous exercise programme or for the individual, whether sedentary or physically active, who plans to spend some time at an altitude of more than about 1500-2000 metres.

Calcium

Osteoporosis is now widely recognised as a problem for both men and women, and an increased bone mineral content is one of the benefits of participation in an exercise program. Regular exercise results in increased mineralisation of those bones subjected to stress (Bailey et al, 1990) and an increased peak bone mass may delay the onset of osteoporotic fractures; exercise may also delay the rate of bone loss. The specificity of this effect is demonstrated by the unilateral increase in forearm bone density observed in tennis players(Pirnay et al, 1987).

When strenuous exercise is performed on a regular basis, there is likely to be a decrease in circulating levels of sex steroids in both men and women. Oestrogen plays an important role in the maintenance of bone mass in women, and low oestrogen levels cause bone loss (Drinkwater et al, 1984). Many of these women also have low body fat and, because of their low body mass, also have low energy (and calcium) intakes in spite of their high activity levels. All of these factors are a threat to bone health. The loss of bone in these women may result in an increased predisposition to stress fractures and other skeletal injury and must also raise concerns about bone health in later life (Martin and Bailey, 1987). It should be emphasised, however, that this condition appears to affect only relatively few athletes, and is unlikely to occur with the levels of exercise that are appropriate for those seeking health benefits. Hard sustained training is a relatively new phenomenon, particularly among female athletes, and it remains to be seen whether the long-term effects are clinically significant.

For these athletes, as for all individuals, and especially for women, an adequate calcium intake should be ensured, although calcium supplements themselves will not reverse bone loss while oestrogen levels remain low. It must be emphasised that, although there is little scope for harmful effects, calcium supplements should only be taken on the advice of a qualified practitioner after suitable investigative procedures have indicated an inadequate intake. The recommended dietary calcium intake varies between countries, but for men the recommended intake is normally about 800 mg/day, and for women about 1200 mg/day. Intakes of as much as 2000 mg/day are sometimes recommended. Even then, alternatives to supplementation, specifically alterations in the selection of foods to achieve a higher intake must also be considered, and should be sufficient to meet needs.

Antioxidant Nutrients

Athletes engaged in very hard physical training and sedentary individuals participating in unaccustomed exercise show signs of muscle damage in the post-exercise period, and there is evidence of free radical-induced damage to muscle membranes and subcellular structures. There is some evidence for an adaptive increase in antioxidant status in response to regular exercise (Clarkson, 1995), and this may help protect against further damage. Supplementation of the diet with antioxidant nutrients has been proposed as a possible way of further reducing the harmful effects of exercise. Some studies suggest that the severity of muscle damage – as assessed by circulating levels of muscle-specific proteins – can be reduced by supplementation with large doses of Vitamins A, C and E, but the evidence is not entirely convincing, and further information is required before any specific recommendations can be made.

Fluid and Electrolyte Loss and Replacement in Exercise: Introduction

If exercise is continued for long enough at sufficient intensity, fatigue occurs. Although fatigue is probably brought about by a series of factors, depletion of muscle glycogen and dehydration, with its concomitant effects on thermal and cardiovascular regulation, are two of the main causes. To some extent, the onset of fatigue can be delayed by training, which will increase fat utilisation, or by the consumption of a high carbohydrate diet to elevate pre-exercise muscle glycogen levels. The negative consequences of glycogen depletion are seldom more serious than a subjective sensation of discomfort and a transient reduction in performance capacity.

The effects of dehydration, however, are potentially more dangerous and can be reduced but not eliminated by appropriate preparation; in prolonged exercise in a warm environment, only an adequate fluid intake will reduce the likelihood of severe dehydration. As the quantity and type of fluid required will depend on the intensity and duration of the exercise, the environmental conditions and also on the physiology and biochemistry of the individual, recommendations regarding a universally suitable fluid replacement regimen are impossible. However, an understanding of the effects of exercise on fluid and electrolyte balance can be used to determine the fluid requirements of the athlete.

Fluid Loss During Exercise

Fluid loss during exercise is linked to the need to maintain body temperature within only a few degrees of the normal resting value of about 37°C. At rest the rates of energy turnover and heat production are low. During exercise, the rate of heat production can be increased to many times the resting level, and in a simple activity such as running, the rate of heat production is directly related to the running speed. When the ambient temperature is higher than skin temperature, heat will also be gained from the environment by physical transfer. In spite of this, marathon runners normally maintain body temperature within 2-3°C of the resting level, indicating that heat is being lost from the body almost as fast as it is being produced.

At high ambient temperatures, the only mechanism by which heat can be lost from the body is evaporation. For the faster runners in a marathon race, sweat rates in excess of 2 l/h may have to be sustained throughout the race in order to offset heat production (Maughan 1985). This is possible, but results in the loss of approximately 5l of body water, corresponding to a loss of more than 7% of body weight for a 70 kg runner. Water will also be lost by evaporation from the respiratory tract, but the loss by this route is small compared with sweat loss. The rate of water loss in running is approximately proportional to running speed, but there is a large inter-individual variability even under the same conditions.

Exercise performance is impaired when an individual is dehydrated by as little as 2% of body weight, and losses in excess of 5% of body weight can decrease the capacity for work by about 30% (Armstrong et al 1985; Saltin and Costill, 1988). The capacity to perform high intensity exercise which results in exhaustion within only a few minutes was shown to be reduced by as much as 45% by prior prolonged exercise which resulted in a loss of water corresponding to only 2.5% of body weight: smaller, but substantial, reductions in performance occurred after administration of diuretics or after sweat loss in a sauna (Nielsen et al 1981).

Fluid losses are distributed in varying proportions among the plasma, the extracellular water, and the intracellular water space. The decrease in plasma volume which accompanies dehydration may be of particular importance in influencing work capacity; blood flow to the muscles must be maintained at a high level to supply oxygen and substrates, but a high blood flow to the skin is also necessary to convert heat to the body surface where it can be dissipated. When the ambient temperature is high and blood volume has been decreased by sweat loss during prolonged exercise, there may be difficulty in meeting the requirement for a high blood flow to both these tissues. In this situation, skin blood flow is likely to be compromised, allowing central venous pressure and muscle blood flow to be maintained but reducing heat loss and causing body temperature to rise.

Electrolyte Losses with Sweating

Sweat is often described as an ultrafiltrate of plasma, but the ionic composition of sweat is not only different from that of plasma, it also varies considerably between individuals and over time in any one individual (Costill, 1977). In response to a standard heat stress, the sweat rate increases with training and acclimation and the electrolyte content decreases. These adaptations allow improved thermoregulation, at the expense of an increased water loss, while conserving electrolytes. The major electrolytes in sweat, as in the extracellular fluid, are sodium and chloride, although the sweat concentration of these ions is invariably lower than that in plasma. Sweat sodium concentration is normally in the range 20-80 mmol/l. Potassium content of sweat is high (4-8 mmol/l) relative to that of plasma (about 4-5 mmol/l) but is low relative to that of the intracellular fluid (about 150 mmol/l). Although the concentration of potassium and magnesium in sweat is high relative to that in the plasma, the plasma content of these ions represents only a small fraction of the whole body stores; Costill and Miller (1980) estimated that only about 1% of the body stores of these electrolytes was lost when individuals were dehydrated by 5.8% of body weight.

Fluid Replacement During Exercise

The rates at which substrate and water can be supplied during exercise are limited by the rates of gastric emptying and intestinal absorption; although it is not clear which of these processes is limiting, it is commonly assumed that the rate of gastric emptying will determine the maximum rates of fluid and substrate availability (Lamb and Brodowicz, 1986; Murray, 1987). In practice, however, the voluntary intake is usually much less than could be tolerated.

Increasing the carbohydrate content of drinks will increase the amount of fuel which can be supplied, but will tend to decrease the rate at which water can be made available. Even dilute glucose solutions (40g/l or more) will slow the rate of gastric emptying, and high concentrations (100 g/l or more) will stimulate intestinal water secretion. Volume has a stimulating effect on the rate of gastric emptying, and if the volume in the stomach can be kept high by repeated ingestion of fluid, the rate of gastric emptying can be maintained high, increasing the volume of fluid available in the intestine for absorption (Rehrer et al 1990). In the small intestine, active absorption of glucose, which is co-transported with sodium, stimulates water absorption by producing suitable trans-mucosal osmotic gradients. The highest rates of oral water replacement are thus achieved with dilute solutions of glucose and sodium salts (Maughan, 1991). There is no active transport mechanism for water in the gastro-intestinal tract: it simply follows osmotic gradients, and is free to move in either direction across the luminal wall. Moderately hypotonic solutions (200-250 mosmol/kg) potentiate the rate of water absorption produced by the active co-transport of glucose and sodium. Solutions containing high concentrations of glucose or any other solute will, because of their high osmolality, result in secretion of water into the gastro-intestinal tract; this will have the effect of accentuating dehydration and may also result in a subjective sensation of discomfort. Gastrointestinal distress appears to be relatively common among endurance athletes, and clearly indicates an accelerated rate of gastro-intestinal transit or a reduced absorptive capacity in those susceptible individuals (Brouns et al, 1987).

Where provision of water is the first priority, therefore, the carbohydrate content of drinks will be low, perhaps about 30-50 g/l, even though this restricts the rate at which substrate is provided. The substrate concentration is limited by the need to maintain the hypotonicity of the luminal contents: it has been argued that this can be achieved by the substitution of disaccharides or higher polymers for glucose, allowing greater carbohydrate provision, but the evidence is not convincing. The addition of sodium to drinks has been questioned on the grounds that secretion of sodium into the intestinal lumen will occur sufficiently rapidly to stimulate maximal rates of glucose-sodium co-transport. The evidence here is also questionable, but there are other good reasons for addition of sodium to rehydration fluids, as discussed below.

In situations where substrate depletion is likely to be the main cause of fatigue, the supply of exogenous carbohydrate will be the primary consideration. The ready availability of ingested carbohydrate as a fuel for the working muscles is demonstrated by the numerous studies which have followed the appearance in expired air of isotopes of carbon added as tracers. Oxidation of ingested glucose can account for about half of the total carbohydrate oxidation after 1-2 h of walking at 50% $VO_{2\,max}$; after 3-4 h, ingested glucose can supply as much as 90% of the total carbohydrate oxidised (Pallikarakis et al, 1988). In this situation, there is clearly some sparing of exogenous carbohydrate, but it is not clear if the results can be applied to exercise at higher intensities, where it appears that total carbohydrate turnover is increased when exogenous carbohydrates are given.

Effects of Fluid Ingestion on Performancel

The effects of ingesting different types and amounts of beverages during exercise have been extensively investigated, using a wide variety of experimental models. Not all of these studies have shown a positive effect of fluid ingestion on performance, but, with the exception of a few investigations where the composition of the drinks administered was such as to result in gastro-intestinal disturbances, there are no studies showing that fluid ingestion will have an adverse effect on performance. In prolonged exercise where substrate depletion is likely to occur, or during exercise in the heat which is sufficiently prolonged to result in dehydration, there can be no question that performance is improved by the regular ingestion of suitable glucose-electrolyte drinks (Lamb and Brodowicz, 1986; Maughan, 1991).

Post-Exercise Rehydration

Replacement of water and electrolyte losses in the post-exercise period may be of crucial importance for maintenance of exercise capacity when repeated bouts of exercise have to be performed. The need for replacement will obviously depend on the extent of the losses incurred during exercise, but will also be influenced by the time and nature of subsequent exercise bouts. Rapid rehydration may also be important in events where competitors undergo acute thermal and exercise-induced dehydration in order to make a weight category: the time interval between the weigh-in and competition is normally about 3 h, although it may be longer. Although the practice of acute dehydration should be discouraged, it will persist and there is a need to maximise rehydration in the time available.

Excessive intake of fluids with a low sodium content has been reported to induce hyponatraemia during exercise of long duration, and there is clearly a need for some electrolyte replacement where sweat losses are very large. Ingestion of plain water in the post-exercise period also results in a rapid fall in the plasma sodium concentration and in plasma osmolality (Nose et al, 1988). These changes have the effect of reducing the stimulus to drink (thirst) and of stimulating urine output, both of which will delay the rehydration process. In one study, subjects exercised at low intensity in the heat for 90-110 min, inducing a mean dehydration of 2.3% of body weight, and then rested for 1 h before beginning to drink (Nose et al, 1988). Plasma volume was not restored until after 60 min when plain water was ingested together with sucrose capsules. In contrast, when sodium chloride capsules were ingested with water to give a saline solution with an effective concentration of 0.45% (77 mmol/l), plasma volume was restored within 20 min. In the sodium chloride trial, voluntary fluid intake was higher and urine output was less; 71% of the water loss was retained within 3 h compared with 51% in the plain water trial. The delayed rehydration in the water trial appeared to be a result of a loss of sodium, accompanied by water, in the urine caused by enhanced plasma renin activity and aldosterone levels.

More recently, we have shown that the addition of either sodium or potassium to drinks consumed after sweat loss induced by intermittent low-intensity exercise in the heat will reduce fluid losses in the urine in the subsequent few hours (Maughan et al, 1994). If fluids are consumed after this type of exercise, urinary water losses in the period that follows will be inversely proportional to the sodium content of the ingested fluid, suggesting that replacement of electrolytes is necessary for the ingested fluid to be retained (Maughan and Leiper, 1995). When solid food is taken together with plain water, the food may supply sufficient electrolytes to allow full replacement of the sodium and potassium lost in sweat and in this case it is not necessary to add extra electrolytes to drinks (Maughan et al, 1996). Perhaps more importantly, we have also shown that it is not sufficient to consume an amount of fluid that is just equal to that lost during a bout of strenuous exercise: unless a greater amount of fluid is ingested, the ongoing urine losses will prevent a return to euhydration (Shirreffs et al, 1996).

It is clear from this and other studies that rehydration after exercise can only be achieved if the rehydration fluids contain electrolytes: replacement of sodium to expand the extracellular space and to maintain the circulating osmolality and sodium concentration is probably the most important consideration. The sodium content of sweat varies widely, and no single formulation will meet this requirement for all individuals in all situations. The upper end of the normal range for sodium concentration (80 mmol/l), however, is similar to the sodium concentration of many commercially produced oral rehydration solutions (ORS) intended for use in the treatment of diarrhoea-induced dehydration. By contrast, the sodium content of most sports drinks is in the range of 10-25 mmol/l; most commonly consumed soft drinks contain virtually no sodium and these drinks are therefore unsuitable when the need for rehydration is crucial. The problem with high sodium concentrations is that this may exert a negative effect on taste, resulting in a reduced consumption. In most situations, where there is an opportunity for solid food intake, the electrolyte content of the post-exercise meal will be sufficient to replace electrolyte losses.

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NUTRITIONAL ERGOGENIC AIDS AND EXERCISE PERFORMANCE

Ron J. Maughan
University Medical School
Aberdeen , Scotland

INTRODUCTION

Use of nutritional supplements is widespread in sport. A report of supplement use among national-level competitors from various sports revealed that 84% of those surveyed used some form of micronutrient supplement (Ronsen et al, 1999). Most athletes took multiple supplements, although many had nutritional habits that were described as "unsatisfactory", implying that attention to the normal diet might be a more beneficial approach for these athletes. Reviews of the published literature suggest that the use of supplements is more prevalent in athletes (46%) than in the general population (35-40%), while among elite athletes 59% report supplement use (Sobal and Marquart, 1994). In some surveys, 100% of weightlifters use some form of nutritional supplementation (Burke and Read, 1993).

It is not possible to review all of the nutritional supplements used by athletes, or to consider the evidence relating to more than a few. Some specific examples will illustrate the principles that determine usage, and the evaluation that ought to be applied to these supplements. This review will focus on three categories of supplements; those that affect energy production and metabolism, those that may influence muscle hypertrophy and lean body mass, and those that can influence general health.

SUPPLEMENTS THAT MAY INFLUENCE ENERGY METABOLISM

Creatine

Creatine has been used by many successful athletes, particularly in track and field athletics, but also now in many other sports. The extent of its use is apparent from the fact that the estimated sales of creatine to athletes in the United States alone in 1997 amounted to over 300,000 kg. What distinguishes creatine from other ergogenic aids is that it seems to be effective in improving performance. More significantly, perhaps, its use is not prohibited by the governing bodies of sport, and there appear to be no harmful side effects.

The highest tissue concentrations of creatine are found in skeletal muscle, and approximately two thirds of the total is in the form of creatine phosphate.

Creatine phosphate (CP) is present in resting muscle in a concentration approximately 3-4 times that of adenosine triphosphate (ATP), the immediate energy source for muscle contraction. Because muscle fatigue results if the intracellular ATP concentration falls, regeneration of ATP at a rate close to that of ATP hydrolysis is essential if fatigue is to be delayed. Transfer of the phosphate group from CP to ADP results in restoration of ATP and release of free creatine (C). Increasing the CP content of muscle ought to allow a greater amount of work to be done using this energy source. During recovery after exercise, creatine phosphate is resynthesised, using energy made available by oxidative metabolism which occurs within the mitochondria. This process may be accelerated if the muscle creatine content is increased. In high intensity exercise, hydrogen ions associated with anaerobic glycolysis cause muscle pH to fall, and this has been implicated in the fatigue process (Sahlin, 1986). Buffers within the cell resist changes in pH, and the breakdown of CP is such a mechanism, as a hydrogen ion is absorbed in the reaction. An increased availability of CP for breakdown may therefore increase the intramuscular buffering capacity, delaying the point at which pH reaches a critically low level.

Creatine is an amino acid (methylguanidine-acetic acid) which occurs naturally in the diet, being present in meat: 1 kg of fresh steak contains about 5 g of creatine. The normal daily intake is less than 1 gram, but the estimated daily requirement for the average individual is about 2 grams. The body has a limited capacity to synthesise creatine in the liver, kidney and pancreas and in other tissues. This is the only way in which vegetarians can meet their requirement. Synthesis occurs from amino acid precursors (arginine and glycine), but the synthetic pathway is suppressed when the dietary creatine intake is high.

The CP concentration of resting human muscle is about 75 mmol/kg dry weight and the free creatine concentration is about 50 mmol/kg (Harris et al, 1974). There is, however, quite a large inter-individual variability. Harris et al (1992) showed that ingestion of small amounts of creatine (1 g or less) had a negligible effect on the plasma creatine concentration, whereas feeding higher doses (5 g) resulted in an approximately 15-fold increase. Repeated feeding of 5 g doses every 2 h will maintain the plasma concentration at about 1 mmol/l over an 8 hour period. Repeated feeding of creatine (5 g four times per day) over a period of 4-5 days results in a marked increase in the total creatine content of skeletal muscle. An increase in muscle creatine content is apparent within two days of starting this regimen, and the increase is greatest in those with a low initial level: in some cases an increase of 50% is observed. Approximately 20% of the increase in total muscle creatine content is accounted for by creatine phosphate.

There is an upper limit to the creatine and CP levels that can be achieved in muscle, and there is some evidence that exercise can enhance the effect of creatine supplementation on the muscle creatine content. There is no effect of creatine supplementation on the ATP content of the muscle.

There is a limited number of scientific studies reporting the effects of creatine supplementation on muscle function and exercise performance. Many of the published studies appear to be well controlled, but cross-over designs are difficult because of the long washout period from the muscle. Where high doses are ingested over a period of 4-6 days, the muscle creatine content will remain elevated for several weeks.

A number of studies have shown improvements in power output in single exercise bouts involving running, cycling, dynamic knee extension exercise and sustained isometric repeated exercise bouts. Other studies, however, have used similar amounts of creatine and similar experimental models but have not shown a positive effect. There is no obvious explanation for these differences. The balance of the available evidence suggests that performance is improved in high intensity exercise tasks, especially where repeated exercise bouts are carried out. The published information has been reviewed in several papers (Greenhaff, 1995; Maughan, 1995; Mujika and Padilla, 1997).

There is little information on the effects of creatine supplementation on the performance of more prolonged exercise. In an incremental treadmill running test there was no effect of creatine supplementation on the cardiorespiratory or metabolic response to submaximal exercise, but exercise performance was not measured in this study (Stroud et al, 1994).

Few studies have looked for possible effects of creatine supplementation on muscle strength. This seems surprising in view of the importance of a high force generating capacity for the development of power. In an early study, Greenhaff et al (1993) required subjects to perform 5 sets of 30 maximal voluntary isokinetic contractions before and after supplementation with creatine or placebo. No effect was seen in the placebo group, and an increase in muscle peak torque production was seen in the creatine group only in the later stages of some of the sets.

More recently, Maganaris and Maughan (1998) showed that five days of creatine supplementation was effective in increasing maximum voluntary isometric strength of the knee extensor muscles in individuals engaged in a strength training program. This gain was maintained in a subsequent test after a period during which a placebo was administered. In a second group of subjects, the treatment order was reversed: no gain in strength was seen after the first period of placebo administration, but an increase was observed in the third test, after the creatine supplementation period. In previously untrained young women, the effects of a 10 week program of strength training were enhanced by daily supplementation with creatine relative to the effects observed with placebo treatment (Vandenberghe et al, 1997). Neither of these studies was able to provide a mechanism for the observed effects.

The mechanism by which creatine supplementation might improve performance is not entirely clear, although it seems clear that this effect is related to the increased muscle CP content. Recent results indicate that the rate of CP resynthesis after intense exercise is enhanced after high-dose creatine supplementation (Greenhaff et al, 1994). This allows faster recovery after sprints as well as allowing more work to be done during each subsequent high intensity effort. These effects will allow a greater amount of work to be done in training and should therefore result in a greater training response. This may be particularly important in view of the fact that the muscle creatine content remains high for weeks or even months after only a few days of high-dose dietary creatine supplementation.

Acute supplementation with creatine often results in a gain in body mass. This typically amounts to 1-2 kg over 4-5 days. Clarkson (1998) reported 11 studies where body mass increases occurred and 3 where no change in mass was reported. Because of the rapid increases in body mass, it must be assumed that this is mostly accounted for by water retention. Increasing the creatine content of muscle by 80-100 mmol/kg will increase intracellular osmolality, leading to water retention. Hultman et al (1996) found a reduction in urinary output during supplementation, tending to confirm this suggestion.

Many concerns have been raised that the effects of long term use of large doses of creatine are unknown and that its use may pose a health risk. Concerns focus on possible effects on renal function, in particular in individuals with impaired renal capacity. Studies on the response to long term creatine use are in progress at this time, but results are not yet available. There have, however, been no reports of adverse effects in any of the studies published in the literature. One study that specifically examined renal function in individuals supplementing with creatine found no reason to believe that renal complications were likely (Poortmans et al, 1997). Anecdotal reports of an increased prevalence of muscle cramps in athletes taking creatine supplements have been circulating for some time, but there is no substance to these stories. It seems likely that any injury suffered by an athlete will be ascribed to an easily identifiable change in habit, such as the introduction of a new supplement. Even with very large doses of creatine, however, the possibility of adverse effects seems remote. Creatine is a small water-soluble molecule easily cleared by the kidney, and the additional nitrogen load resulting from supplementation is small. Concerns over renal damage have also been raised in the context of protein supplementation among strength athletes and bodybuilders: these athletes may consume up to 3-4 grams of protein per kg body mass per day over very long periods, but there is no evidence that the theoretical problems of clearance of the extra solute load are real.

The use of any nutritional supplement which is effective in improving performance inevitably raises ethical issues. Ergogenic aids are banned by the governing bodies of sport for one of two reasons: on the grounds that they pose a threat to the health of the individual, or because they confer what is seen to be an "unfair" advantage. Although there is no reason to suppose that there are any risks to health associated with long term use of high doses of creatine, the studies quoted above which have used high doses, in the order of 20-30 g per day, have been of relatively short duration (5-14 days). Further studies are in progress and the results are awaited.

Carnitine

Depletion of the intramuscular glycogen stores is one of the primary factors involved in fatigue in prolonged exercise. The importance of carbohydrate as a fuel for the working muscles is confirmed by the close relationship between the pre-exercise glycogen concentration and the time for which exercise can be sustained. Further evidence comes from studies showing that increasing the combustion of fat during prolonged exercise, and thus sparing the limited carbohydrate stores, can improve endurance capacity. Increasing fatty acid mobilisation by heparin administration after ingestion of a high fat meal or by caffeine ingestion has been shown to be effective in improving performance.

Although the supply of plasma free fatty acids to the exercising muscle is an important factor in determining the relative contributions of fat and carbohydrate to oxidative metabolism, a number of other steps are involved in fat oxidation. Fatty acid uptake into the cell and translocation across the mitochondrial membrane are key steps. Carnitine combines with fatty acyl-Coenzyme A (acyl-CoA) in the cytoplasm and allows that fatty acid to enter the mitochondrion. The first step is catalysed by carnitine palmitoyl transferase 1 (CPT1), and the trans-membrane transport is facilitated by acylcarnitine transferase. Within the mitochondrion, the action of carnitine palmitoyl transferase 2 (CPT2) regenerates free carnitine and the fatty acyl-CoA is released for entry into the β-oxidation pathway. Within the mitochondrion, carnitine also functions to regulate the acetyl-CoA concentration and the concentration of free CoA. Free CoA is involved in the pyruvate dehydrogenase reaction as well as in the process of β-oxidation and thus plays a key role in the integration of fat and carbohydrate oxidation. An increased availability of carnitine within the mitochondrion might allow the cell to maintain a higher free CoA concentration, with a stimulatory effect on oxidative metabolism.

Because of the key role of carnitine in the oxidation of both fat and carbohydrate, it has been proposed that carnitine supplementation may improve exercise performance. and carnitine is widely sold as a supplement for athletes.

There is, however, no good evidence that carnitine deficiency occurs in the general population or in athletes. Vukovich et al (1994) reported that short term supplementation with carnitine (4-6 g/d for 7-14 d) had no effect on muscle carnitine levels or on the metabolic response to exercise. Even when fatty acid mobilisation was stimulated by high fat meals or heparin, there was no effect of carnitine supplementation on fat oxidation (Vukovich et al, 1994). In a comprehensive review of the literature, Spriet (1997) identified eight studies which examined the effects of supplementation on the metabolic response to endurance exercise, and found that three of those studies reported an increased rate of fat oxidation. He also reviewed the studies which have examined the effects of carnitine supplementation on exercise performance and concluded that the findings were not generally in support of an ergogenic effect of carnitine. It must be concluded that, although there is a theoretical basis for an ergogenic effect of carnitine on performance of both high intensity and prolonged exercise, this is not supported by the experimental evidence. Supplementation of the diet with carnitine is unlikely to be beneficial for athletes.

Bicarbonate

In exercise that causes fatigue within a few minutes, anaerobic glycolysis makes a major contribution to energy metabolism. Although glycolysis allows higher rates of ATP resynthesis than can be achieved by aerobic metabolism, the metabolic acidosis that accompanies glycolysis has been implicated in the fatigue process, either by inhibition of key glycolytic enzymes, by interfering with calcium transport and binding, or by a direct effect on the actin-myosin interaction. Because of these effects of acidosis on the muscle, induction of alkalosis prior to exercise, an increase in the muscle buffering capacity, or an increased rate of efflux of hydrogen ions from the active muscles all have the potential to delay fatigue and improve exercise performance.

Several investigators have reported a decrease in perceived exertion or an increase in performance during high intensity exercise after bicarbonate administration. Others, however, have shown no benefit of an induced metabolic alkalosis on perceived exertion or performance. In one study designed to simulate athletic competition, trained non-elite (best 800 m time about 2 min 5 s) middle distance runners were used as subjects and the exercise consisted of a simulated 800 m race: in the alkalotic condition, subjects ran almost 3 s faster than in the placebo or control trials (Wilkes et al, 1983). A more recent report indicates similar improvements (3-4 s) over a distance of 1500 m in runners who completed simulated races in about 4 min 15 s (Bird et al, 1995). Although these effects on performance might seem small, they are of considerable significance to the athlete: an improvement of even a fraction of a second in these events is considered to be a major achievement.

In most studies, a dose rate of 0.3 g of sodium bicarbonate or citrate per kg body weight has been employed to induce alkalosis, and this has usually been administered orally in solution or in capsule form. Such a dose rate has usually resulted in an increase of 4-5 mmol/l in the plasma buffer base 2-3 h after administration, although the time course of changes in acid-base status has not been carefully followed in most of these studies. There are potential problems associated with the use of large doses of bicarbonate. Vomiting and diarrhoea are not infrequently reported as a result of ingestion of even relatively small doses of bicarbonate, and this may limit any attempt to improve athletic performance by this method, certainly among those individuals susceptible to gastrointestinal problems. There have been reports of athletes using this intervention, which is not prohibited by the rules of sport, being unable to compete because of the severity of these symptoms. Although unpleasant and to some extent debilitating, these effects are not serious and there are no long term adverse consequences of occasional use. Sodium citrate administration, which also results in an alkaline shift in the extracellular fluid, has also been reported to improve peak power and total work output in a 60 s exercise test without any adverse gastrointestinal symptoms (McNaughton, 1990).

Where an increase in performance after bicarbonate ingestion has been observed, it has been ascribed to an increased rate of hydrogen ion efflux from the exercising muscles, reducing the rate of fall of intracellular pH, and relieving the pH-mediated inhibition of phosphofructokinase (Sutton et al, 1981). The higher blood lactate levels after exercise associated with metabolic alkalosis, even when the exercise duration is the same, may therefore be indicative not only of a higher rate of lactate efflux, but also of an increased contribution of anaerobic glycolysis to energy production. Whatever the mechanism, it seems reasonable to suggest that bicarbonate administration prior to high intensity exercise will only enhance performance when the intensity and duration of the exercise are sufficient to result in significant muscle acidosis.

Caffeine

Caffeine is a drug which, because of its longstanding and widespread use is considered socially acceptable. Caffeine and the related compounds theophylline and theobromine are naturally occurring food components, and for many people these substances are part of the normal daily diet and caffeine is probably the most widely used stimulant drug in the world. The use of caffeine is not prohibited in sport, but there is a limit to the amount that may be taken by athletes in competition: any individual whose urine contains caffeine at a level of more than 12 mg/l is guilty of a doping offence and is liable to be banned from competition.

Caffeine has effects on the central nervous system and on adipose tissue and skeletal muscle that give reason to believe that it may influence exercise performance. Early studies on the effects of caffeine on endurance performance focussed on its role in the mobilisation of free fatty acids from adipose tissue, increasing fat supply to the muscle, which in turn can increase fat oxidation, spare glycogen and thus extend exercise time. Caffeine ingestion prior to exercise to exhaustion at 80% of VO_2max increased exercise time from 75 min on the placebo trial to 96 min on the caffeine trial. A positive effect was also observed on the total amount of work achieved in a fixed 2-hour exercise test. In this and other studies, caffeine was shown to increase circulating free fatty acid levels, increase fat oxidation and spare muscle glycogen during prolonged exercise (See Spriet (1995) for a review of these studies). The consistency and clarity of these findings led to the widespread popularity of caffeine consumption prior to marathon running, although caffeine in much higher doses had long been used, particularly in professional cycling.

Growing evidence of a positive effect of caffeine on performance in the absence of any glycogen sparing effect, and of effects on high intensity exercise, where glycogen availability is not a limiting factor, has stimulated the search for alternative mechanisms of action. There is evidence for a number of effects of caffeine directly on skeletal muscle. It may affect the activity of the Na/K ATPase and the intracellular localisation and binding of calcium, it can cause an elevation of the intracellular cyclic AMP level as a result of inhibition of the action of phosphodiesterase, and it may have direct effects on a number of enzymes, including glycogen phosphorylase (Spriet, 1997). Effects on the central nervous system, either to modify the perception of effort or on the higher motor centres, have been proposed, but in the absence of evidence, this remains speculation.

There are several recent and comprehensive reviews of the effects of caffeine on exercise performance, and a detailed review of the literature will not be attempted here (Graham et al, 1994; Spriet, 1997). There are a number of studies showing beneficial effects of caffeine ingestion on a variety of laboratory tests of endurance performance. An increased time to exhaustion has been observed in a number of tests, but performance in simulated race situations, where a fixed amount of work has to be done in the shortest possible time, is also improved. More recent studies have focussed on exercise of shorter duration, and a number of studies have shown beneficial effects on performances lasting only a few (about 4-6 min) minutes. There is little information on performance in sprint tasks, and what is reported is conflicting.

It is clear from the published studies that positive effects of caffeine can be obtained in a variety of exercise situations with caffeine doses that are far below those necessary to produce a positive test. Doses of as little as 3 mg/kg body mass can produce ergogenic effects, but there appears to be a wide inter-individual variability in the sensitivity to caffeine. The reasons for this variability are not altogether clear, but, perhaps surprisingly, they do not appear to be related to the habitual level of caffeine consumption.

The diuretic action of caffeine is often stressed, particularly in situations where dehydration is a major issue. This affects particularly competitions held in hot, humid climates where the risk of dehydration is high, and is more important for endurance athletes where dehydration has a greater negative effect on performance. Athletes competing in these conditions are advised to increase their intake of fluid, but are usually also advised to avoid tea and coffee because of their diuretic effect. It seems likely, however, that this effect is small for those habituated to caffeine use (Wemple et al, 1997) and the negative effects caused by the symptoms of caffeine withdrawal may be more damaging.

An athlete found to have a urine caffeine concentration of more than 12 mg/l is deemed to be guilty of a doping offence and is liable to suspension from competition. It is clear from this that caffeine is considered by the International Olympic Committee to be a drug, but an outright ban on its use is impractical and manifestly unfair to those who normally drink tea and coffee. It is equally clear, however, that the amount of coffee that must be drunk to exceed the permitted limit (about 6 cups of strong coffee consumed within a period of about 1 h) is such that it is unlikely that this would normally be achieved. In addition, in endurance events, a urine sample taken after the end of the event would probably not register a positive test, even if large amounts had been consumed before the start.

SUPPLEMENTS THAT MAY INCREASE MUSCLE MASS

In sports that require strength and power a high lean body mass, and especially a high muscle mass, confers a definite advantage. Supplement use is widespread among athletes in strength sports, and a wide variety of supplements are used. A few of the supplements that are more commonly used by athletes are described briefly below, but this list is by no means comprehensive.

Protein and amino acids

The idea that athletes need a high protein diet is intuitively attractive, and indeed there is evidence that the requirement for protein is increased by physical activity. (Lemon, 1995). Muscles consist largely of protein, and their involvement is fundamental to performance in all sports. It is also readily apparent that regular exercise has a number of highly specific effects on the body's protein metabolism. Strength training results in increases in muscle mass, indicating an increased formation of actin and myosin, and it is tempting to assume that this process is dependent on protein availability. Endurance training has little effect on muscle mass, but does increase the muscle content of mitochondrial proteins, especially those involved in oxidative metabolism. Hard exercise also results in an increased level of muscle damage, usually at the microscopic level, and there is clearly a role for protein in the repair and recovery processes.

The changes that comprise that adaptive response are selective, and are specific to the training stimulus: they are also dependent on the availability of an adequate intake of protein in the diet. The case for a high protein diet for athletes thus seems to be well founded and is widely believed to be true. In a survey of American college athletes, 98% believed that a high protein diet would improve performance. There is, however, compelling evidence that protein supplementation is not necessary for the athlete. The dietary protein requirements of the general population have been the subject of extensive investigation. It is now generally accepted that a daily requirement of about 0.6 grams of protein per kilogram of body weight per day will meet the needs of most of the population, provided that a variety of different protein sources make up the diet, and provided also that the energy intake of the diet is adequate to meet the energy expenditure (Lemon, 1991). To allow for individual variability and variations in the quality of ingested proteins, the Recommended Daily Allowance for protein is set at about 0.8 g/kg in most countries.

The contribution of protein oxidation to energy production during exercise decreases to about 5% of the total energy requirement, compared with about 10-15% (ie the normal fraction of protein in the diet) at rest, but the absolute rate of protein degradation is increased during exercise because of the high energy turnover (Dohm, 1986). This leads to an increase in the minimum daily protein requirement, but this will be met if a normal mixed diet adequate to meet the increased energy expenditure is consumed. Deficiencies in protein intake are more likely in the sedentary individual, especially when energy intake is restricted in order to control body weight than in the athlete training hard who consumes sufficient energy to meet the demand. In spite of this clear relationship between total energy intake and the adequacy of dietary protein intake, however, many athletes ingest large quantities of protein-containing foods and expensive protein supplements. Daily protein intakes of up to 400 grams are not unknown in some sports, and in the diet of body builders, protein typically accounts for more than 20% of total energy intake, and occasionally as much as 40%. Disposal of the excess nitrogen is theoretically a problem if renal function is compromised, but there does not appear to be any evidence that excessive protein intake among athletes is in any way damaging to health (Lemon, 1991).

Although the recommended protein intake for athletes has been set at about 1.2-1.7 g/kg/d (Lemon, 1991), protein may account for a lower than normal percentage of total energy intake on account of the increased total energy intake. In endurance athletes, and especially in marathon runners, it is not uncommon to find that protein accounts for less that 10%, and sometimes even less than 8%, of total energy intake. Even lower values - perhaps even less than 5% of total energy intake - may be able to provide sufficient protein when the total intake is very high. It seems clear, therefore, that supplementation with protein is not necessary for athletes, except perhaps in the rare situations where energy intake is restricted. Even then, restriction of energy intake will severely limit the duration and intensity of exercise that can be performed and there is unlikely to be a need for a higher intake of protein than will be supplied by the diet.

Sales of whole protein powders account for a major part of the nutritional supplement sales to athletes, but a number of individual amino acids are also popular. Arginine and ornithine are reported to stimulate growth hormone release and to promote growth of lean tissue when taken during a period of strength training (see Clarkson , 1998, for a review of these studies). There is some published evidence to support this, but any increase in growth hormone secretion is small compared with that which results from a bout of high intensity exercise. A number of other amino acids (including histidine, lysine, methionine and phenyalanine, are sold as "anabolic agents", but Clarkson (1998) concluded after a review of the literature that "there is little reason to believe that amino-acid supplements will promote gains in muscle mass".

Notwithstanding the lack of experimental data to support their beliefs, most strength trained athletes believe that a high protein diet can improve the rate of gain of muscle mass. Science ignores the accumulated wisdom at its peril, and it is possible that there may be effects that remain to be identified.

Chromium picolinate

Chromium is an essential trace element which has a number of functions in the body, and has been reported to potentiate the effects of insulin (Mertz, 1992). Because of the anabolic effects of insulin, it might be expected that amino acid incorporation into muscle protein would be stimulated, enhancing the adaptive response to training. There is also some evidence to suggest an increased urinary chromium loss after exercise, further supporting the idea that athletes in training may have higher requirements than sedentary individuals. Chromium is widely used as a supplement by strength athletes, and is usually sold as a conjugate of picolinic acid: this form is reported to enhance chromium uptake (Evans, 1989).

Supplementation of the diet with chromium picolinate was reported to enhance the adaptive response to a strength training program, with an increase in lean body mass (Evans, 1989). No direct measures of muscle mass were made, however, and the results of this study must be viewed with caution. A number of subsequent studies, mostly using more appropriate methodology, have failed to reproduce these results, with no effect on lean tissue accretion or on muscle performance being seen (Clarkson, 1998; Walker et al, 1998). Nonetheless, chromium supplementation remains popular.

Beta-hydroxy beta-methylbutyrate (HMB)

β-hydroxy β-methyl butyrate is a metabolite of leucine, and is also present in small amounts in some foods. There appears to be only one study published in a peer-reviewed journal in which the effects of HMB administration to humans has been investigated (Nissen et al, 1996). This paper presented the results of two supplementation studies which showed that subjects ingesting 1.5 or 3 g of HMB per day for 3-7 weeks experienced greater gains in strength and in lean body mass compared with control groups. Although it is not easy to find any fault with this study, it would be premature to conclude on the basis of this report that there is an advantage to be gained from HMB supplementation. Nonetheless, it is sold in large amounts in sports nutrition stores.

No mention has been made of supplements such as iron or calcium or of the varied vitamin preparations which are widely used by the general public. The evidence suggests that the use of these supplements is perhaps more prevalent in athletes than in the general population, but the perceived benefits are similar. Iron, of course, is important to the athlete because of the importance of haemoglobin in oxygen transport, and while anaemia is not more prevalent in athletes than in the general population the consequences may be more apparent. Nonetheless, the same principles apply, and supplementation is not warranted unless a specific deficiency is known to exist.

SUPPLEMENTS THAT MAY IMPROVE GENERAL HEALTH

Glutamine

Modest levels of regular exercise are associated with an increased sensation of physical wellbeing and a decreased risk of upper respiratory tract infections (URTI) (Nieman, 1997). The consequences of minor URTI symptoms are usually minimal, but for the athlete in hard training or preparing for a major competition, any injury or illness can have a devastating effect. Although there is good evidence that an active lifestyle is associated with improved health, a number of recent epidemiological surveys have suggested that the athlete in intensive training or completing an extreme endurance event is more susceptible to minor opportunistic infections than is the sedentary individual.

It has been suggested that severe exercise results in a temporary reduction in the body's ability to respond to a challenge to its immune system. It is not clear, however, that the various changes in parameters of the immune system that have been reported will result in a reduced ability to deal with opportunistic infective agents. Several studies have shown a reduced circulating glutamine level in the hours after hard exercise (see Rowbottom et al (1996) for a review of these studies). In view of the role of glutamine as a fuel for the cells of the immune system, this has been proposed as a mechanism that would compromise the ability to respond to infection (Newsholme, 1994). Other studies have shown that athletes suffering from chronic fatigue symptoms attributed to overtraining also have low circulating glutamine concentrations. At present, the limited information on the influence of glutamine supplementation that is available provides no clear pattern of results. Studies by Newsholme and colleagues suggest a beneficial effect of glutamine supplementation on resistance to infection after endurance exercise, although a positive effect was not always seen (Castell et al, 1997).

In spite of the attractiveness of this hypothesis, it has not yet been established that there is a clear link between hard exercise, compromised immune function and susceptibility to infection. Nonetheless, glutamine supplementation for athletes is being promoted and supplements are on widespread sale in sports nutrition outlets. The evidence that glutamine supplementation is beneficial is far from clear, but this is an active area of research, and the picture will undoubtedly be clarified in the near future.

Antioxidant nutrients

Athletes often take vitamin supplements, usually without any thought as to the vitamin status of the individual concerned. There has been much interest recently among athletes in vitamins C and E which have been shown to have antioxidant properties, and which may be involved in protecting cells, especially muscle cells, from the harmful effects of the highly reactive free radicals that are produced when the rate of oxygen consumption is increased during exercise (Kanter, 1995). Unaccustomed exercise, particularly if it involves eccentric exercise in which the muscle is forcibly lengthened as it is activated, results in damage to the muscle structure and post-exercise soreness. Because it normally peaks 1-3 days after exercise, this is often referred to as delayed-onset muscle soreness. It is believed that free radicals, highly reactive chemical species, may be involved in the damage that occurs to muscle membranes. Alleviating or avoiding these symptoms would allow a greater training load to be sustained. An increased generation of free radicals is also associated with damage to cellular DNA, and to a variety of lipids and proteins. If the post-exercise damage can be reduced by an increased intake of anti-oxidants, then recovery after training and competition may be more rapid and more complete. The evidence for this at present suggests a possible role but is not conclusive. Even the suggestion, however, is enough to convince many athletes to take supplements of these vitamins "just in case".

Free radical generation during exercise is primarily related to the increased oxygen use within the mitochondria, suggesting that free radical generation will be directly proportional to the intensity and duration of exercise. Infiltration of damaged muscle by leucocytes may also account for some of the elevation in free radicals that is observed after exercise as these cells generate free radicals as part of their cytotoxic defence mechanisms. A variety of other mechanisms that may promote free radical generation have been described (Kanter, 1995).

Free radicals have been implicated in a number of disease processes, including cardiovascular disease, diabetes and some forms of cancer, as well as in the ageing process. The body has a number of endogenous defence mechanisms which effectively neutralise free radicals before they cause tissue damage: important enzymes are superoxide dismutase, glutathione peroxidase and catalase. Several nutritional antioxidants also play important roles. Nutritional antioxidants include vitamins A, C and E. Other dietary components, including selenium which has a structural role in glutathione peroxidase), and ubiquinone (or Coenzyme Q_{10}) may also play important roles but are less well researched. Copper, zinc and manganese are structural components of superoxide dismutase, and iron is a co-factor for catalase.

There is some evidence of a protective effect of antioxidant supplementation against exercise-induced muscle damage. For a review of these studies, see Kanter (1995) and Packer (1997). The evidence suggests that there may be a reduction in signs of muscle damage after supplementation, but there is no evidence for any beneficial effect on performance. Toxic effects of megadose supplementation are unlikely, but there are concerns about the possible consequences of long term use of megadoses of single antioxidants. A recent study has reported increased levels of muscle damage in exercise after supplementation with ubiquinone (Malm et al, 1996).

Regular training increases the effectiveness of the endogenous antioxidant mechanisms so that even extreme exercise (long distance triathlon) may not cause any indications of oxidative damage in well trained athletes (Margaritis et al, 1997). It is not clear therefore whether individuals engaged in regular exercise have an increased requirement for exogenous antioxidants.

In conclusion, there is little evidence to support the suggestion that supplementation with antioxidant nutrients can improve exercise performance, but there is a growing body of evidence to suggest that supplementation may reduce the extent of exercise-induced oxidative damage to tissues. If this is indeed the case, it may be that the athlete undertaking a strenuous training program may benefit in the long term by being able to sustain a higher training load. There is also evidence, however, that prolonged exposure to training increases the effectiveness of the endogenous antioxidant mechanisms, and it may be that supplementation is unnecessary.

Other compounds

Athletes use a wide range of nutritional supplements in their quest for improved performance. Even a cursory inspection of sports shops and magazines reveals the scale and diversity of supplement use. Most of the exotic supplements make extravagant claims and are sold at inflated prices. The market, however, is largely unregulated and few of the claims made for these products are supported by any evidence: instead they rely on endorsement by top athletes (who are paid handsomely for doing so) and on the gullibility of the consumer.

Sales figures for exotic supplements such as ginseng, bee pollen, royal jelly and pangamic acid, together with a wide range of vitamins and minerals (including boron, vanadium, zinc, magnesium, manganese), demonstrate that many athletes remain convinced of their effectiveness. In spite of the limited and conflicting evidence, however, the balance of the available information suggests that there is no benefit of these substances for healthy individuals consuming a normal diet. Examination of the information in the bodybuilding world gives an idea of the range of products used and of the claims made for them (Phillips, 1996). Some supplements are potentially harmful in large doses and their use should be actively discouraged. Many studies that purport to show beneficial effects are poorly designed, often with inadequate subject numbers and no control group, and few are published in reputable journals. The power of the placebo effect is well recognised, and athletes seem to be particularly susceptible. Where a beneficial effect is obtained, this is often due to the presence of illegal substances: for example, ephedrine and related compounds are common ingredients of many herbal remedies, and the use of these products renders the athlete liable to disqualification. Similarly, many products described as giving a feeling of "increased energy" contain levels of caffeine that would cause the athlete to fail a drugs test.

CONCLUSIONS

Athletes are forever searching for nutritional supplements that will give them a significant advantage over their competitors, and are prepared to go to enormous lengths to find effective nutritional aids. This accounts in part for the reports of widespread use of illegal drugs in sport, but the difficulty lies in finding something that is effective in improving performance, but is not against the rules. It is also important that any chemical substance to be used in this way should not have harmful side effects.

There are many effective dietary ergogenic aids: the most obvious examples are carbohydrate supplements and sports drinks. All essential dietary components, including protein, essential fatty acids, vitamins and minerals, might be considered to come into this category. These components, however, are essential for the maintenance of health and normal physiological function health, and supplementation above the level required for maintenance of health is not likely to improve exercise performance. The ergogenic aids discussed here are only a few of those used by athletes, but represent those for which there is evidence of efficacy, or where there is much topical interest.

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EXERCISE AND MENTAL WELL-BEING

Stuart Biddle
Department of Physical Education, Sports Science, & Recreation Management, Loughborough University
Loughborough, UK

INTRODUCTION

The promotion of health through physical activity and exercise now incorporates the recognition of the importance of well-being and quality of life. This chapter, therefore, reviews the evidence for a link between physical activity, and specifically exercise, and emotional well-being.

Emotion and Mood

The mood states and emotions associated with exercise have a potentially important role in health promotion. If we believe that physical activity is a positive health behaviour to be encouraged and promoted, how people feel during and after activity may be critical in determining whether they maintain their involvement. Hence, emotion and mood may have motivational properties for an important health-related behaviour. In addition, positive mood and affect are important health outcomes in their own right.

There are a very large number of studies investigating the relationship between exercise and affective states. As such, I will draw my conclusions from three types of studies: reviews (both meta-analytic and narrative), experimental trials, and large population surveys conducted in Britain.

Narrative and Meta-Analytic Reviews

Of 20 reviews located, there is cautious support for the proposition that exercise is associated with enhanced affect and mood. The caution comes from the relatively weak research designs utilized. For example, the comprehensive review by Leith (1994) showed that experimental evidence was less convincing than the percentage of studies finding positive mood effects drops from pre-experimental studies (100%) to quasi-experimental (79.2%) to true experimental studies (62.5%).

Nevertheless, the reviews span several countries and populations, such as those in the workplace, women, and people with disabilities. Also, diverse methods and measuring instruments are used, yet yield similar findings. In addition, hardly any studies report negative mood effects.

McDonald and Hodgdon (1991) report a meta-analysis on exercise and mood and they delimited their review to aerobic fitness training studies. Results suggest a clear relationship between exercise and vigour and a lack of negative mood, with effect sizes being small-to-moderate. McDonald and Hodgdon (1991) concluded that 'aerobic fitness training produces some positive change in mood at least on a short-term basis.

Population Surveys

Population surveys, while often suffering from methodological shortcomings, have the advantage over some other studies insofar as they usually have large samples, are representative of the population, and hence allow good generalisability of findings. Three such studies from Britain show clear positive relationships between physical activity (PA) and psychological well-being (PWB). Confidence in these results is enhanced by noting that the surveys cover both adolescents and adults, use clinical and non-clinical assessment tools, and cover a total sample of 15,577. However, not all groups seemed to benefit from PA. In addition, one cannot conclude that these are exercise-induced effects. Although the Allied Dunbar National Fitness Survey (ADNFS; Sports Council & Health Education Authority, 1992) demonstrated that the same trend was evident for those in poor as well as good health, large-scale surveys offer few clues on the cause of PWB.

Nevertheless, the British studies are comparable to Stephens' (1988) secondary analysis of four North American surveys. Across several measures, and with over 55,000 adults, there was a clear association between PA and psychological well-being. For example, positive affect was associated with PA for both men and women in the two age groups under and over 40 years. Stephens (1988) provided the following clear conclusions: "the inescapable conclusion of this study is that the level of physical activity is positively associated with good mental health in the household populations of the United States and Canada, when mental health is defined as positive mood, general well-being, and relatively infrequent symptoms of anxiety and depression. This relationship is independent of the effects of education and physical health status, and is stronger for women and those age 40 years and over than for men and those age under 40. The robustness of this conclusion derives from the varied sources of evidence: four population samples in two countries over a 10-year period, four different methods of operationalizing physical activity and six different mental health scales."

Evidence from population surveys, therefore, supports a relationship between exercise (or PA), and mood and affect. The nature of such surveys means that we can only conclude that participation in exercise, or the quantity of PA taken, is associated with PWB over time. Acute effects of exercise cannot be studied in this way. Similarly, whether this relationship can be said to be causal remains to be seen. In this regard, evidence from experimental trials is required.

Evidence from Experimental Trials

Few studies have investigated the effects of exercise on the affect and mood through controlled experimental trials. British studies show that the intensity of exercise is important in determining the effects of exercise on mood, something not suggested in other types such as large-scale surveys. Three of the studies by Steptoe and his colleagues (Steptoe and Bolton, 1988; Steptoe and Cox, 1988; Moses et al, 1989) show that moderate, but not high intensity exercise, has mood enhancing effects. Similarly, Parfitt et al (1994) show that feeling states in exercise are significantly worse at a higher intensity for less active individuals. Such findings led Leith (1994) to recommend that 'moderate-intensity exercise appears to have the best potential to impact on participant mood states'.

Ralin (1997) has suggested that high-intensity activity may delay rather than eliminate post-exercise anxiety reductions. The increases in negative mood after high intensity exercise reported in Steptoe's research may be due to the higher exertion required, but studies have shown that positive mood is still enhanced some time later. The temporal nature of changes in mood after different intensities of exercise requires further investigation. However, even if the post-exercise negative mood effect is transitory, it may be enough to affect adherence and reduce physical activity participation.

Mood: Summary

Based on the evidence reviewed, the following summary statements can be made:

- participation in exercise and physical activity is consistently associated with positive affect and mood
- where quantified trends have been identified, aerobics exercise has a small-to-moderate effect on vigour (+), fatigue (-), and confusion (-), and a small effect on anger (-)

- the relationship between physical activity and psychological well-being has been confirmed in several large population surveys, in the UK and elsewhere, using different measures of activity and well-being
- experimental trials support an effect for moderate intensity exercise on psychological well-being
- the effect of high intensity exercise on affect and mood is less clear, although may occur after a period of post-exercise recovery.

EXERCISE AND ANXIETY

The study of the proposed anxiety-reducing effects of exercise has a long history in sport and exercise psychology and has remained an area of considerable interest to researchers up to the present. Typically, anxiety is defined in both state and trait terms, and sometimes with reference to both cognitive and somatic elements. In addition, exercise researchers have been interested in the psychophysiological stress reactions of participants differing in fitness levels.

Given the volume of research on anxiety, I have separated it from the effects of exercise on mood. Although many mood studies include measures of tension and anxiety (such as those using the POMS), it is clearer conceptually to deal with anxiety as a separate construct.

Meta-Analytic Findings

In reviewing the effects of exercise on anxiety-related emotions I will draw extensively on results from several meta-analyses with, to date, four such published reviews (Long and van Stavel, 1995; McDonald and Hodgdon, 1991; Petruzzello et al., 1991; see Table 1).

Petruzzello et al. (1991) have conducted the most comprehensive meta-analysis of the field to date. I will review their findings alongside the more focused meta-analyses of McDonald and Hodgdon (1991) and Long and van Stavel (1995). While caution should always be exercised in interpreting the results of any review, whether quantitative or narrative, it is my belief that appropriate use of meta-analysis will result in greater understand of the effect of exercise on anxiety.

Petruzzello et al. (1991) analyzed data from 124 studies that examined the effect of exercise on anxiety. They included studies published between 1960 and 1989 that investigated state anxiety, trait anxiety, and psychophysiological indicators of anxiety. McDonland and Hodgdon (1991) restricted their meta-analysis to studies investigating the effects of aerobic fitness training on psychological outcomes, one of which was anxiety. This yielded 36 effect sizes from 22 studies. Long and van Stavel (1995) restricted their meta-analysis to adults involved in quasi-experimental training studies using standardized anxiety measures. Clinical studies (psychiatric and Type A) were omitted leaving 40 studies and 76 effect sizes for analysis.

The main findings from these meta-analyses are summarized in Table 1 and show that exercise has a significant small-to-moderate effect on anxiety. Petruzello et al. (1991) found that for state anxiety studies using no-treatment control groups and motivational control groups both showed a significant ES, but the ES was larger for pre-post within-subjects design. However, McDonald and Hodgdon (1991) found that survey studies produced a lower ES than experimental studies. These findings suggest that the internal validity of the study may not necessarily influence effect sizes (ES) but anxiety change can occur when motivational factors are controlled. In addition, Petruzzello et al. found that exercise was equally effective as other anxiety reducing treatments. This last finding may be particularly important given the lost cost of exercise.

When reviewing exercise and affect, it was suggested that higher intensity exercise may not produce such positive effects as more moderate exercise. However, for state anxiety, Petruzzello et al. (1991) found that effect sizes for the intensity of exercise were homogeneous. For psychophysiological indices of anxiety, though, the meta-analysis showed the highest effect size for 40-59% of HR_{max} or VO_{2max} ES=1.06; n=13) and this was significantly different from 70-79% intensity (ES=41; n=24). However, all four intensity categories, including 80% and above, showed effect sizes significantly different from zero. These results suggest that moderate intensity exercise may be particularly beneficial for anxiety reduction, but other higher intensities can also be beneficial.

Population Surveys

The extensive secondary data analysis of physical activity and mental health reported by Stephens (1988) includes evidence on anxiety. Data on over 10,000 adults in Canada showed that reporting symptoms of anxiety was less likely in more active individuals. This held for men under and over 40 years of age and for women over 40 years, but not for younger women. Other large-scale epidemiological data sets, such as the ADNFS, provide only general well-being measures, making it impossible to detect changes in anxiety. This is also true for Steptoe and Butler's (1996) data with 5061 adolescents. However, they do report that 'greater participation in vigorous sports and activities was associated with lower risk of emotional distress, independently of sex, social class, illness during the previous year, and use of hospital services' (p.1791).

Experimental Trials

In a qualitative review of exercise and anxiety, Leith (1994) identified 20 experimental studies. Of these, 14 (70%) showed reduced anxiety from exercise, with the rest showing no change. None showed increased anxiety from exercise. A series of experimental trials in the UK by Steptoe and his colleagues provides a useful framework for drawing conclusions concerning experimental work on exercise and anxiety.

Steptoe and Cox (1988) studied the psychological responses of 32 female medical students to both high (cycle ergometry exercise of 50rpm against 2kg/100W) and low (0.5kg/25W) intensities. For the anxiety-tension subscale scores from the POMS, they found a significant level x time interaction. This showed a significant increase in anxiety from pre-to-post-test for the high intensity condition and a non-significant decrease for low intensity exercise. Similar results were reported by Steptoe and Bolton (1988), with anxiety increasing during high intensity exercise, then showing a decline post-exercise. Anxiety levels for those in the lower intensity condition showed a clear decline from pre-test to post-test, including anxiety reported during the activity.

Moses et al. (1989), testing sedentary adults across high intensity, moderate intensity attention-placebo, and waiting list conditions, also found evidence for anxiety reduction in the moderate group but not the high intensity group. In fact, those exercising at a higher intensity reported increases in anxiety from pre- to post-test. Moderate intensity exercise undertaken by low-active anxious adults in the study by Steptoe et al, (1993) was also associated with anxiety reduction whereas an attention-placebo condition showed no change.

These studies illustrate that exercise is associated with anxiety reduction under experimental conditions. However, Steptoe's data are particularly striking as they suggest that it is moderate rather than high intensity exercise that produces anxiety reduction during exercise, although anxiety has also been shown to reduce in the post-exercise recovery period.

Anxiety: Summary

Based on the evidence reviewed, the following summary statements can be made concerning exercise and anxiety:

- meta-analytic findings suggest that exercise is associated with a significant small-to-moderate reduction in anxiety

- this holds for acute and chronic exercise, state and trait anxiety, psychophysiological indices of anxiety, and groups differing by gender and age

- evidence concerning the different effects for aerobics and non-aerobic exercise is unclear

- experimental studies support an anxiety-reducing effect for exercise, mainly for moderate exercise during activity, but for both moderate and high intensity exercise post-activity

- large-scale epidemiological surveys support an anxiety-reducing effect for exercise.

EXERCISE AND DEPRESSION

Estimates suggest that 20% of those who seek consultation in primary health care settings in the UK have some degree of depressive symptomology. Moreover, it has been estimated that 5-10% of the population of developed countries is affected by clinical depression at some time. If exercise can reduce depression it will constitute an important area of mental and public health. Consequently, much research has been conducted in this area, although many studies are cross-sectional, have poor internal validity, or other methodological problems.

One problem with the field of research on exercise and depression is that many studies do not define depression clearly, use inappropriate measures, or investigate participants who have not reached clinically defined levels of depression, hence may be suffering transitory negative mood, not depression (Mutrie, in press). For example, many studies report 'depression' scores from POMS rather than clinical assessment tools that allow clinical criteria to be identified, such as the Beck Depression Inventory.

Meta-Analytic Findings

Two meta-analyses have been conducted on exercise and depression McDonald and Hodgdon (1991), already reported in the sections on mood and anxiety in this chapter, have also meta-analyzed depression as an outcome variable for their study of aerobics fitness training. In addition, North et al. (1990) reported a meta-analysis of 80 studies yielding 290 effect sizes on exercise and depression. The main results from these two meta-analyses are summarized in Table 2 and show a moderate-to-large effect.

Population Surveys

The large-scale survey analysis reported by Stephens (1988), and discussed previously in this review, can again provide evidence at the level of epidemiological data. Results for over 3000 North American adults from the first National Health and Nutrition Examination Survey (NHANES-I) showed that depression was highest for those reporting 'little/no exercise' in comparison to those classified in the 'moderate' and 'much' exercise categories. Interestingly, this difference suggests that only moderate exercise may be sufficient for anti-depressant affects and that additional activity yields no additional benefit. Further support was provided in follow-up data in NHANES-II.

These data can be persuasive for reasons of generalisability and large sample sizes. However, many individuals included in these surveys are not depressed in the first place and so measurement may be capturing simply transient mood or general well-being. In addition, measures of physical activity are weak, often using single item self-report measures assessed in a cross-sectional rather than prospective design.

Experimental Trials

Leith (1994) reports 42 studies investigating exercise and depression and 81% show anti-depressant effects. Of the 13 Leith classifies as experimental, 9 (69%) report changes in depression, although not all of these investigated clinically depressed individuals. A more recent review by Mutrie (in press) reports 10 randomised controlled trials on exercise and depression for those defined at clinical levels of depression. From these studies she concludes that exercise does produce a decrease in depression, both for aerobic and anaerobic exercise, and that this decrease is similar to that found for other treatments. Evidence is also provided that exercise can produce long-term effects, at least up to one year. These trials all last between 8-12 weeks but include only adults. Clearly more work is required with young people.

The work of Martinsen and colleagues in Norway has been particularly influential is demonstrating experimentally the anti-depressant effects of exercise. For example, Martinsen, Medhus and Sandvik (1985) randomly allocated patients in a psychiatric hospital to either an aerobic exercise group or a control group. The exercise group underwent a 9-week intervention comprising three 1-hour aerobic training sessions at 50-70% of aerobic capacity. The control group spent an equivalent time in occupational therapy. Results showed that the exercise group increased their aerobic fitness and decreased their depression to a larger extent that the control group. Changes in depression, however, were not related to changes in fitness. While recognizing the difficulties of such experimentation in hospital settings, Martinsen et al. concluded "a training programme had a substantial antidepressant effect in psychiatric patients up to 60 years old in hospital" (p.109).

Exercise and Clinical Depression: Is the Relationship Causal?

Much of the evidence in exercise and mental well being is cross-sectional and correlational. To this end, to what extent can we conclude that exercise or physical activity causes a reduction in depression? Some researchers have suggested that w adopt criteria used in epidemiological research for this purpose (see Mutrie, in press). The main criteria involve demonstrating consistency, strength of association, an appropriate temporal sequence, a dose-response effect, biological plausibility, specificity, and experimental support.

Consistency

The association between exercise and depression has been demonstrated over several decades and countries, with different populations (e.g. psychiatric inpatients, mildly depressed), ages, in both genders, and in studies using different designs. This led Mutrie (in press) to be satisfied that the literature meets the criterion of consistency.

Strength

There is evidence for a moderate relationship between exercise and depression. This is not disputed and has been shown across many studies, including meta-analysis. The strength is shown by an effect size of approximately 0.5.

Temporal Sequence

To strengthen the case that exercise causes a reduction in depression it is necessary to show that exercise precedes depression change rather than depressed individuals being less active. The plethora of cross-sectional studies cannot help us in this regard. However, Mutrie (in press) suggests that prospective population studies strengthen our confidence concerning the temporal sequence. In addition, the ADNFS in England (Sports Council & Health Education Authority, 1992) found that the relationships between physical activity and well-being (not just depression) were the same for those in poor health and those in better health. In short, there is some evidence for temporal sequence, but this area does need additional work to increase our confidence.

Dose-Response

Evidence showing that greater amounts of exercise produce less depression is mixed. A dose-response curve is suggested by the data from North et al.'s (1990) meta-analysis. The effect for exercise training of less than 16 weeks (ES=0.30) was less than for 17-20 weeks (ES=0.97) which, in turn, was less than for 21 weeks or more (ES=2.25). However, experimental evidence for dose-response relationship is weak due to the paucity of studies that directly test such an issue. In addition, the large-scale population data reported by Stephens (1988) shows a 'threshold' effect (active or inactive) rather than a dose-response relationship.

Biological Plausibility

Identifying the mechanism explaining why exercise reduces depression is an important step in demonstrating cause and effect. For depression, there are many 'plausible' mechanisms, both biological and non-biological. However, we are not at the stage in research knowledge of identifying what mechanisms are at work in exercise and depression. This leads us to conclude that locating the mechanisms is a major priority for research.

Specificity

Depression is not only affected by exercise, therefore the condition of specificity cannot be supported. However, this does not preclude a real effect for exercise.

Experimental Support

As already discussed, there is supportive experimental evidence for exercise reducing depression.

In summary, using the criteria adopted for testing cause-effect in epidemiological research, evidence points favourably in the direction of exercise causing depression change.

Depression: Summary

Based on the evidence reviewed, the following summary statements can be made concerning exercise and depression:

- meta-analytic findings suggest that exercise is associated with a significant moderate reduction in depression

- this holds for acute and chronic exercise, different exercise modalities, and groups differing by gender and age
- experimental studies support an anti-depressant effect for exercise large-scale epidemiological surveys support the claim that a physically active lifestyle is associated with lower depression
- using criteria adopted in epidemiological research for establishing cause and effect, evidence supports a relationship between exercise and depression in respect of consistency, strength of association, and experimental support
- although some evidence does exist, it is less easy to support an appropriate temporal sequence, a dose-response effect, or biological plausibility
- on balance, there is some support for the view that exercise is causally related to depression

The relationship between exercise/physical activity and mental well-being is not new. Much has been said about this topic at an anecdotal level by exercisers and in the media. However, an evidence base is building and although more high quality research is required, we can conclude that a clear relationship does exist for exercise and mood, anxiety and depression. In the case of clinical depression, this relationship is likely to be causal.

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Table 1. Summary results from three meta-analyses on exercise and anxiety

Study	Outcome variables	Activity/Fitness Measure	N of effect Sizes	Mean Effect Size
McDonald & Hodgdon (1991)	State anxiety	Aerobics fitness training	13	0.28
	Trait anxiety	Aerobics fitness training	20	0.25
Petruzzello et al. (1991)	State anxiety	Exercise	207	0.24
	Trait anxiety	Exercise	62	0.34
	Psyco-physiological indicators	Exercise	138	0.56
Long & van Stavel (1995)	Within-group pre-post studies	Exercise training	26	0.45
	Contrast group studies	Exercise training	50	0.36

1. **All effect sizes are significantly different from zero.**

Table 2. Summary results from two meta-analyses on exercise and depression

Study	Outcome variables	Activity/Fitness Measure	N of Effect Sizes	Mean Effect Size
North et al. (1990)	Depression	Exercise	290	0.53
	Depression	Exercise programmes	226	0.59
	Depression	Follow-up	38	0.50
	Depression	Single exercise sessions	26	0.31
	Depression	Exercise for initially non-depressed	143	0.59
	Depression	Exercise for initially depressed	120	0.53
	Depression	Weight training	7	1.78
	Depression	Various aerobic	54	0.67
	Depression	Walk and/or jog	89	0.55
	Depression	Aerobic class	13	0.56
	Depression	Jogging	66	0.48
McDonald & Hodgdon (1991)	Depression	Aerobic fitness training	17	0.97
	Depression 'cluster'[2]	Aerobic fitness training	Mean of 7 combined Ess	0.55
	SDS	Aerobic fitness training	7	0.66[3]
	BDI[4]	Aerobic fitness training	5	1.22[3]
	DACL[4]	Aerobic fitness training	3	1,54[3]
	CES-D	Aerobics fitness training	2	0 73[3]
	SCL-90	Aerobic fitness training	1	1.02

1. All effect sizes are significantly different from zero unless stated (or with ES n=1); signs disregarded (all ES scores reflects a decrease in depression with exercise.
2. Cluster comprised: depression scores from the MAACL, POMS, MMPI and other 'mixed tests'; POMS confusion scale; POMS vigour scale (reversed); POMS fatigue scale.
3. No significance levels reported.
4. Both BDI and DACL were used in one study together.

THE ROLE OF REGULAR PHYSICAL ACTIVITY IN SUCCESSFUL AGEING

Wojtek J. Chodzko-Zajko
Kent State University, USA

INTRODUCTION

Recently, the United States Surgeon General's Report (US Surgeon General, 1996) concluded that regular physical activity has important positive effects on the muscloskeletal, cardiovascular, respiratory, and endocrine systems. Furthermore, the effect of exercise on these systems is associated with a number of health benefits including a decreased risk of premature mortality and reduced risks of coronary heart disease, hypertension, colon cancer, and diabetes mellitus. Participation in physical activity also appears to reduce depression and anxiety, improve mood, and enhance our ability to perform daily tasks throughout the life span (US Surgeon General, 1996). Despite this growing awareness of the health benefits of physical activity for older adults, exercise participation and adherence decreases with age. In comparison to younger adults, older adults exercise less frequently and choose activities that are lower in their absolute energy demands. In the first section of this address a brief overview of what is currently known about the physiological, psychological, and social benefits of regular activity is presented. Because physical activity has been defined in many different ways, in this paper, the World Health Organization's broad and inclusive definition of physical activity is adopted which includes all movements in everyday life, including work, recreation, exercise, and sporting activities (WHO, 1997).

Physiological Benefits of Physical Activity

The physiological benefits of participation in regular physical activity are now well established. Among the short-term benefits attributed to regular exercise are improved sleep (Brassinton and Hicks, 1995), improved glucose regulation (Giacca et al., 1994) and increases in catecholamine activity (Richter and Sutton, 1994). Long term adaptations to extended exercise participation include improved cardiovascular performance, increased muscular strength and endurance, enhanced flexibility and range of motion, decreased adiposity and improved lipid status (Spirduso, 1995). Goldberg and Hagberg (1990) have suggested that the physiological responses of elderly adults to exercise training are essentially similar to those experienced by younger individuals. The WHO (1997) has summarized the known physiological benefits of regular physical activity as follows.

Table 1. A SUMMARY OF THE PHYSIOLOGICAL BENEFITS OF PHYSICAL ACTIVITY FOR OLDER PERSONS
World Health Organization, 1997

Immediate benefits:	
	Glucose levels: Physical activity helps regulate blood glucose levels
	Catecholamine activity: Both adrenalin and noradrelnalin levels are stimulated by physical activity.
	Improved sleep: Physical activity has been shown` to enhance sleep quality and quantity in individuals of all ages.
Long term effects:	
	Aerobic/cardiovascular endurance: Substantial improvements in almost all aspects of cardiovascular functioning have been observed following appropriate physical training.
	Resistive training/muscle strengthening: Individuals of all ages can benefit from muscle strengthening exercises. Resistance training can have a significant impact on the maintenance of independence in old age.
	Flexibility: Exercise which stimulates movement throughout the range of motion assists in the preservation and restoration of flexibility.
	Balance/coordination: Regular activity helps prevent and /or postpone the age-associated declines in balance and coordination that are a major risk factor for falls.
	Velocity of movement: Behavioral slowing is a characteristic of advancing age. Individuals who are regularly active can often postpone these age-related declines.

Psychological Benefits of Physical Activity

Physical activity can also have significant psychological consequences. There is now compelling evidence that regular exercise enhances psychological health and well being. Among the short-term psychological benefits attributed to regular exercise are improved relaxation (Landers and Petruzzello. 1994), reduced stress and anxiety (Petruzzello et al., 1991) and improved mood state (Nieman et al., 1993). More long term benefits include improved life satisfaction (Berger and Hecht, 1990), enhanced self-esteem and heightened self-efficacy (McAulley and Rudolph, 1995), and fewer mood state disturbances (O'Connor, et al 1993). The WHO (1997) has summarized the known psychological benefits of regular physical activity as follows (Table 2).

Table 2. A SUMMARY OF THE PSYCHOLOGICAL BENEFITS OF PHYSICAL ACTIVITY FOR OLDER PERSONS
World Health Organization, 1997

Immediate benefits:	
	Relaxation: Appropriate physical activity enhances relaxation. Reduces Stress and Anxiety: There is evidence that regular physical activity can reduce stress and anxiety. Enhanced Mood State: Numerous people report elevations in mood state following appropriate physical activity.
Long term effects:	
	General Well-Being: Improvements in almost all aspects of psychological functioning have been observed following periods of extended physical activity. Improved Mental Health: Regular exercise can make an important contribution in the treatment of several mental illnesses, including depression and anxiety neuroses. Cognitive Improvements: Regular physical activity may help postpone age related declines in Central Nervous System processing speed and improve reaction time. Motor Control Performance: Regular activity helps prevent and /or postpone the age-associated declines in both finer and gross motor performance. Skill acquisition: New skills can be learned and existing skills refined by all individuals regardless of age.

The importance of physical activity for the social functioning of older persons

In the recent World Health Organization Guidelines for Promoting Physical Activity in Older Persons (WHO, 1997) a number of significant short and long-term effects of physical activity on socio-cultural variables are discussed. Ageing is associated with a need to adjust to changing roles and role losses. Due to factors such as death of friends and loved ones, retirement, financial hardships, ill-health, and isolation, many older people are forced to systematically relinquish more and more of the roles which they consider to be a meaningful part of their identity (McPherson, 1990). Physical activity can be helpful in assisting older people to adjust better to these role losses. Activity Programmes can provide seniors with the opportunity to widen their social networks, to stimulate new friendships, and to acquire positive new roles in their retirement (McPherson, 1990; 1994). The WHO (1997) summarizes the known socio-cultural consequences of regular physical activity as follows (Table 3).

Special Need for Research into Physical Activity Among Older Adults

Exercise participation and adherence decreases with age. In comparison to younger adults, older adults exercise less frequently and choose activities that are lower in their absolute energy demands. Over two-thirds of older adults living in the United States report having no regular exercise routine. Among older adults who begin a formal program of physical activity, compliance and adherence are major impediments to success. With the growing awareness of the benefits of regular exercise, it is sometimes difficult to understand why exercise professionals have been so unsuccessful in motivating older adults to engage in regular physical activity. Various demographic, social and psychological variables have been proposed as determinants of physical activity in older adults. For example, lack of access to facilities and Programmes, lack of meaningful role models, institutionalism, and retirement have all been cited by older adults as reasons why they are physically inactive. In addition, social or cultural expectations, such as stereotypes concerning the appropriateness of physical activity for older adults, or misconceptions about physical abilities have also been cited as reasons for lack of involvement.

Planning for the Future – The Need to Develop Intergenerational Physical Activity Programmes

In 1992, the United Nations General Assembly designated that the year 1991 will be celebrated as the International Year of Older Persons (IYOP). Towards a society for all ages) was selected as the overall theme for the IYOP. The United Nations has identified four dimensions which are considered to be critical components necessary for the development of a society for all ages; (1) Improving the situation of older persons; (2) Fostering life-long individual development; (3) Acknowledging multi-generational relationships; and (4) Addressing socio-economic needs. Alexandre Sidorenko, Officer-in-Charge of the United Nations Programme on Aging states that the aging of society has resulted in a demographic, socio-economic, and cultural revolution which has greatly affected the relationships between the generations. Sidorenko stresses that, in order to achieve a society for all ages it will be necessary to establish an age-integrated society, one that fosters reciprocity and equity between the generations even as it encourages lifelong development and self-reliance on the part of individuals (Sidorenko,1999).

Table 3. A SUMMARY OF THE SOCIAL BENEFITS OF PHYSICAL ACTIVITY FOR OLDER PERSONS
World Health Organization, 1997

Immediate benefits:	
	Empowering Older Individuals: A large proportion of the older population voluntarily adopts a sedentary lifestyle which eventually threatens to reduce independence and self-sufficiency. Participation in appropriate physical activity can help empower older individuals and assist them in playing a more active role in society.
	Enhanced Social and Cultural Integration: Physical activity Programmes, particularly when carried out in small groups and/or in social environments enhance social and inter-cultural interactions for many older adults.
Long term effects:	
	Enhanced Integration: Regularly active individuals are less likely to withdraw from society and more likely to join the social milieu.
	Formation of new friendships: Participation in physical activity, particularly is small groups and other social environments stimulates new friendships and acquaintances..
	Widened Social and Cultural Networks: Physical activity frequently provides individuals with an opportunity to widen available social networks.
	Role maintenance and new role acquisition: A physically active lifestyle helps foster the stimulating environments necessary for maintaining an active role in society, as well as for acquiring positive new roles.
	Enhanced Integrational Activity: In many societies, physical activity is a shared activity which provides opportunities for intergenerational contact thereby diminishing stereotypic perceptions about ageing and the elderly.

In recent years, within gerontolgy there has been an increasing emphasis on the need to develop intergenerational Programmes which are able to bring together senior citizens with young children and adults in mutually supportive and stimulating environments. For example, in the United States, government sponsored intergenerational Programmes were implemented as early as 1963 with the establishment of the Foster Grandparent Program. This program was followed by other initiatives, including the Retired Senior Volunteer Program (RSVP) in 1969 and the National Council on Ageing Intergenerational Programmes in 1980. A common feature of each of these Programmes was the pairing together of older adults with individuals many years their junior. Among social science researchers there is a growing consensus that such Programmes often result in significant benefits for both young and old participants. For example, researchers have demonstrated that intergenerational Programmes which bring together nursery school children with senior citizens living in nursing homes significantly improve social interaction levels among both groups (Storm and Storm, 1995; Short-DeGraff and Diamond, 1996). Similarly, others have shown that when college students are encouraged to interact with older adults, they are significantly less likely to develop negative stereotypes about the ageing process and more likely to formulate meaningful relationships with older adults. (Dellmann-Jenkins et al.; 1994; McGowan and Blankenship, 1994). Despite the presence of promising research findings within the social sciences, there has been very little systematic research to examine the impact of intergenerational programming in the area of physical activity and ageing. This lack of research into intergenerational programming in the exercise sciences is unfortunate because intergenerational Programmes have the potential to increase physical activity participation levels in individuals of all ages.

Although it is now well established that significant physiological, psychological, social, and societal benefits accrue from participation in physical activity (WHO, 1997), the proportion of older individuals who participate regularly in physical activities is generally low. For example, the United States Surgeon General's Report on Physical Activity and Health (1996) estimates that only about 17 percent of older people exercises at or above recommended levels of physical activity. A significant problem is motivating individuals of all ages to begin and to continue to participate in regular exercise (Lee, 1993). The development of intergenerational Programmes has the potential to increase the proportion of individuals of all ages who participate regularly in physical activity.

Quality of life is dependent upon the successful integrating of physical health, psychological well being, social satisfaction, and spiritual contentment. By bringing together senior citizens and younger people in the gymnasium, on the playing fields, in the classrooms, and on the stage, intergenerational programmes have the potential to broaden the horizons and sensitivities of all involved, as well as positively impacting on their physical and psychological well-being. The extent to which we are able to take advantage of the impetus provided by IYOP and truly "build a society for all ages" may depend on our ability to develop intergenerational initiatives which bring together people of all ages in mutually supportive physical, social, and educational environments.

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PATTERNS OF FOOD CONSUMPTION IN THE ARAB COUNTRIES

Samir S. Miladi
Food and Agriculture Organization
Regional Office, Cairo, Egypt

INTRODUCTION

The Arab countries lie astride the lines of communication with Europe, Africa and West Asia, and have been subjected to influences, in terms of the dietary patterns, from the West as well as the East. The Mediterranean dietary habits are however, predominant in most of these countries.

The total land area of the Near East region is about 13.6 million km² out of which 75% is desert and about 20% pastures and forests; the remaining 5% is under permanent crops. It should be noticed that only 20% of this limited arable land is irrigated and 80% relies on rainfall. The fluctuation and uneven distribution of rainfall affects food production, and in turn the diet and health, especially of the rural population.

Thus, the two major constraints affecting the expansion of food production in the Arab countries are the lack of arable land and of water resources. In addition, some countries of the region such as Somalia, Sudan and Mauritania, are affected from time to time by severe droughts, while certain geographic areas in Tunisia, Morocco and Jordan etc., may also suffer occasionally from droughts, which lead to acute food shortages.

The total population of the Region in 1997-1998 was 280 million, with an annual average growth rate of 2.8%, which is considered to be among the highest growth rates in the world. This means that the population of the region will double within approximately the next 28 years, whereas the population of Europe, in contrast, is expected to double in about 235 years. Consequently, food production and consumption are being affected by high population pressures on the limited arable land. This problem is aggravated by a high increase in urbanization, which ranges from 4 to 6% per year. As a result, more and more food producers are becoming food consumers, and the expansion of the cities is mostly at the expense of the limited agricultural land. Moreover, during the last three decades, the region has experienced massive population movements both within as well as from outside the region. These changes were coupled with large food imports to meet the increasing demands. This contributes to the new dietary patterns and with their consequent implication on nutrition status and health.

History of Dietary Patterns and Human Evolution in the Arab Countries

In ancient times great civilizations flourished along the valley of the two great river systems, Euphrates and Tigris, in the East, and the Nile in the West.

The first man who inhabited this region might be traced back to over 50.000 years B.C. The sources of the food in this early stage of history were leaves, fruits, berries, roots, seeds, insects and eggs, which the first man used to spend long hours collecting from his environment. He was also able to hunt certain animals to use their skin and flesh. His main occupation at that time was to search for food by transferring his chemical energy into kinetic energy, which was necessary for his body movement. His long and hard physical activity was associated with the production of endorphin and serotonin which played a role in the reduction of stress, depression and fatigue to enable him to continue his search for food and the essential requirements of his living.

During the early life of mankind, he was exposed to sudden dangers from savage animals, flood and earthquakes. Which put him under severe stress and obliged him to move very fast to escape. His body had to excrete adrenaline which is used to make the glucose available from the glycogen, so he could be able to run and escape from the danger, he was facing. This can teach us the benefit of physical activity in the management and reduction of stress, anxiety and depression.

In the years 8000-9000 B.C., man discovered food grains, especially wheat in Egypt and barley in Iraq, and started to settle and practice agriculture. Since food grains could be conserved for longer periods, his basic food was available all year round. He therefore felt more food secure and learnt later how to make bread from wheat. Through the years, he developed agriculture practices and invented tools such as the hoe, hydromel, and plough, which paved the way for him to increase his food production. During the same period, rice was discovered in China, (see Table 1) whereas animals were domesticated later (Table 2).

During the same period, he discovered different techniques for food preservation, such as drying, pickling and fermentation. The history of food production (crops and animal) demonstrates the strong relationship between the struggle of mankind for his food need and the intense physical activity which was required for his active living.

The ancient civilization was determined by the progress that mankind accomplished in securing his food and later he was able to develop writing, in Egypt and Iraq and recognition of God.

Looking at the Pharaonic civilization which started 10,000 years B.C., the status and sculptures of ancient Egyptians represented males and females who were not underweight (slim) or over weight (obese) It was a disgrace in the ancient Egyptian culture for an individual to be obese or slim.

The abundance of a wide variety of foodstuffs of plants as well as animals in relation to the relatively limited number of people, prove that nutritional disorders were unknown. The diet consisted of cereals, wheat and barley, legumes, especially broad beans, lentils, and chickpeas while olives and sesame were used as sources of fat. Large amounts of vegetables, especially onions, garlic and green beans were consumed in the ancient diet. Fruit, especially grapes and dates. Were dried or used for fermentation.

Breast feeding for 2 years and exposure of young children to sunlight were well known to Ancient Egyptians and widely practised. In addition to their active living, they practised more than 40 different sports. Every year, one week was dedicated for sports celebration and competition which involved all the society members, men, women and children.

The Arab countries were well-known by the inland and sea trade. Caravans from the Arabian Peninsula to the North of Syria and Palestine and South of Yemen were on the move all year round. Through the trade, newly discovered foods were spread all over the region. Similarly, in addition to trade, wars between countries played an important role in the expansion of food and new dietary habits. Walking long distances was practised in caravans, which required high-energy food such as dates and camel milk, the latter as a source of water, energy and nutrient.

During the Pharaonic time, life expectancy of Kings was between 70 and 80 years or more. This proved that they had a good knowledge of food, medicine and healthy lifestyles. The diet of the builders of pyramids and temples mainly consisted of wheat, broad beans and vegetable oils, onions and green leaves. This diet was not only used to provide energy and different nutrients but it required a long time to be digested, so the labourers would not feel hungry after a short time.

The two biggest enemies of the Arab population in these old times were famine and plague, which killed large numbers of people. Very limited information was reported on malnutrition among the farmers or the pastured communities during this period.

Over the years during which Persians, Greeks, Romans and Mongols invaded the region, farmers had to pay heavy taxes and were sometimes obliged to leave the land. This was the period when malnutrition and undernutrition were widely spread in the region. The farmers were consuming unbalanced food and accordingly they had to work and produce less food due to their negative energy balance.

However, the dietary patterns deteriorated mainly at the time of wars, invasions and famines. It is only 400 years ago when the Othmanic Empire dominated the region, and introduced 2 classes of population, the nobles (Pacha) and the mass poor. During this period the deterioration of nutrition status was associated with low access to food, increase in poverty and spread of diseases.

The above shows that dietary patterns are important elements of the history and culture of society at all times and in all locations. The proper dietary patterns are necessary for a healthy and productive population and it is an integral part of its development and civilization.

Table 1. Major Crops or the Ancient World

Crop	Date B.C.	Place
Wheat, barley, beans, olives	8500	Fertile Crescent & Egypt
Rice, millet	7500	China
Sesame, rice	7000	India
Sugar, Cane, bananas	7000	New Guinea
Oats, poppy seeds	6000	West Europe
Sorghum	5000	Sahel
Yams and Palm oil	3000	West Africa
Sunflower, corn, beans	3000	America

Table 2. History of Domestication of Large Mammal Species in the World

Species	Date B.C.	Place
Sheep/Goat	8000	Ferlite Crescent & N. Africa
Pig	8000	China
Cow	6000	India
Donkey	4000	Egypt
Horse	4000	Ukraine
Water Buffalo	4000	China
Arabian Camel	2500	Arabia
Bactrian Camel	2500	Central Asia

Factors Affecting Changes in Dietary Patterns in Arab Countries

There are vast differences in socio-economic, ecological and cultural conditions among the Arab countries. This region includes the poorest countries (Somalia, Yemen, Sudan) and the richest countries (United Arab Emirates, Qatar) in the world; the overpopulated (Egypt) and the least populated (Qatar) and those countries of highest illiteracy rates (Somalia, Mauritania) and of the lowest rates (Jordan, Tunisia). These factors, along with the differences of government policies and programmes, significantly affect dietary patterns, nutrition and health of the population.
It is recognized that food carries, in the context of the Arab population, special social and cultural meanings in various communities and also carries psychological significance well beyond consideration of nutritional value or physiological needs.

It is necessary to highlight the major factors that have recently influenced food consumption patterns in the Arab countries. These are disaster, economic, social and cultural, technological, and physiological factors. (Figure 1).

Economic Factors

- The food consumption patterns in a given society are a function of food prices and consumer income. Dietary patterns change as income grows or declines. In fact, there is a positive relation between GNP/capita and food energy derived from animal sources, fats and sugar. The low-income groups tend to be conservative in their food choices and often resist changes. They are generally in a negative energy balance, which mean they spend more energy than the quantity received from their food, while high-income groups show increased demand for a selection of food varieties, and prefer convenience foods and outside-home meals. They normally live inactive lives and suffer from a positive energy balance which generally leads to obesity.

- Food prices are affected by several factors. Locally produced food costs are initially influenced by prices of agricultural input, such as fertilizers, insecticides and high yielding varieties. as well as by rainfall and the cost of irrigation. They are also affected by the marketing and distributing systems, seasonal variations, food taxation or subsidies and by price control or free market. Some countries used to, or still do ration basic food commodities such as vegetable oil, sugar and rice, e.g. Iraq, Egypt and Syria. Others subsidize certain foods, such as bread and wheat flour, e.g. Tunisia, Morocco and Jordan. The prices of imported foods are affected by the international market (supply and demand) and by agreements between the exporting and importing government.

- Recently, several countries have adopted structural adjustment programmes for both the producers and consumers. These programmes have affected supply and demand for several food commodities. In addition, economic factors such as devaluation of local currency, inflation, and exchange rates, affect prices of basic food commodities and accordingly, dietary patterns.

- Consumer income plays a fundamental role in determining food choices. It is influenced by the degree of economic development of the country, distribution of income, family size, cost of non-food items, employment policies and income-generating activities, as well as the geographic location of the consumer in rural or urban areas.

Therefore the dietary patterns, nutrition status and health of the Arab population are necessarily affected by food prices and consumer income.

Environmental Factors

- The amount of rainfall and its distribution affect food production and, in turns, food prices and farm income.

- In Sudan during periods of drought, the price of sorghum increases whereas, the price of livestock decreases, due to the shortage in animal feed and to its high price. Floods also affect food production.

- Poor sanitation and the absence of a clean a water supply affect the nutrition and health status of the population, in addition to food contamination and unhygienic practices. The hot climate in certain Arab countries prevents out-door physical exercise and this contributes to a positive energy balance and the prevalence of cases of obesity.

- People who live in rural areas, and nomads generally, consume traditional foods and they are more physically active than those living in towns.

Figure 1. Factors Affecting Food Consumption Patterns

Disaster Factors

- Natural (Food, Drought)
- Man-made (War & Internet Conflict)

Environmental Factors

- Ecology, Rain Fall
- Season Variation
- Environment
- Food Safety

Economic Factors

- Food Prices
- Income

Social and Cultural Factors

- Education awareness
- Religion
- Traditions
- Geographical Location

Technological Factors

- Food Industries
- Processing
- Advertisements

Physiological & Psychological Factors

- Age
- Sex
- Consumer Behaviour

Social and Cultural Factors

The level of education, family size, age of marriage, frequency of pregnancy, employment of women, health and nutrition awareness are important determinants of the diet and health of a community.

- The cultural factors, including religion, beliefs, taboos and local traditions are also significant to the health of children and to mothers in certain societies. For example the spread of bottle-feeding replacing breast-feeding in many parts of the region affects the growth of children because of lack of hygiene.

- The widespread adoption of street foods for low-income groups and of fast and convenience foods (especially those rich in fat and low in fiber) for high-income groups, affect the diet and health of these groups.

- New food habits have emerged in certain countries as a result of labour import. This is especially noticeable in the Arab Gulf countries which employ large numbers of Asian workers.

- Lack of physical activity and nutrition awareness among certain population groups have led to obesity and consequent health related problems such as diabetes and heart diseases.

- The spread of smoking among a considerable portion of the societies also contributed to the increase in diet-related non-communicable diseases.

- Stress and anxiety about new lifestyles have had an effect on diet-related non-communicable diseases.

- Certain medicines encourage or discourage appetite. This is seen among adult and the elderly. Certain drugs can promote weight gain.

Technological Factors

- The expansion of food industries and advertisements for certain foods play a vital role in changing the dietary patterns in many Arab countries. This is exemplified in the widespread consumption of soft drinks and 'empty calorie' foods, as well as dense calorie foods.

- The canning and freezing industries make it possible for the consumer to have access to several foods all the year round. Similarly the development of the dairy industries has also contributed to the increased consumption of dairy products for certain income groups.

- The food industries also change consumption patterns by improving food appearance such as colour, texture, odour and flavour, and accordingly the food demand increases. In most countries of the Region, food industries are expanding at a very fast rate. As a result of this expansion, more urban as well as rural consumers are becoming users of processed foods, such as biscuits, sweets, soft drinks, snack foods, ice-cream, cakes and pies.

- Food advertisements sometimes concentrate on selling one particular product and promoting negative dietary habits towards another nutritive product, such as the replacement of milk by soft drinks. In other instances, false or misleading claims are introduced, in the absence of adequate food control and active Consumer Protection Societies.

- On the other hand certain industries e.g. the dairy, meat and fish industries are also contributing to the improvement of the diet and promoting positive dietary habits.

- Legislation and food standards regarding nutrition labelling are lacking in many countries. They can be effective when the consumers have a knowledge of good dietary habits.

Disaster Factors

- Some countries of the region face both man-made disasters, especially wars and international conflicts such as in Iraq, Sudan and Somalia, and natural disasters such as drought in Mauritania and Somalia, and floods in Sudan. These disasters have short and long-term implications on the dietary patterns and the nutritional and health status of the population.

- Food aid has also contributed to changes in dietary habits. For example, in Sudan, wheat, which was not previously consumed by the nomadic population, has replaced sorghum. Sorghum used to be the traditional stable, which was cultivated in the country.

The above mentioned factors which influence dietary patterns and lifestyles have direct implications on the nutrition and health of the population.

Implications of the Patterns of Food Consumption on Nutrition and Health

During the last three decades the region has experienced various nutritional problems: under-nutrition, micronutrient deficiencies and over-nutrition. The degree of these problems varies among and within the countries. This section will deal with the changes in food groups and sources of energy which have influenced over-nutrition and have been occurring in the in the same countries which have witnessed a decrease in physical activity and rapid changes in lifestyles.

During the last 30 years the average per caput energy intake in the region has increased by 30% and fat intake by 45%. However there are big variations among countries in terms of the increase of energy intake: in Libya it has increased by 90%, in Saudi Arabia and Algeria by over 80% and in Egypt and Tunisia by 40%, whereas there have been no significant changes in Somalia and Sudan.

The largest increases in food consumption have been seen in sugar, fat and vegetable oil, and meat, especially poultry, none of which are sources of fiber. Sugar consumption has doubled in Egypt, Algeria, Libya and Saudi Arabia, and increased by more than 50% in Jordan and Lebanon. The consumption of vegetable oils has tripled in Algeria and Libya. There has been a slight increase in the consumption of milk, fruit and vegetables. As to the grain legumes (pulses), there have been no increases in consumption and there have even been some decreases in consumption in some countries during the same period.

These new food habits are characterized by a low intake of food rich in fiber and a high intake of energy derived from fat, sugar and refined wheat flour, in addition to saturated fatty acids and cholesterol. Table 3 shows the average per capita intake of dietary energy, protein and fat. With the exception of Yemen, the average intakes of energy are higher than the Recommended Daily Allowance.

Table 3. Average Food Consumption (1989)

	Energy (kcal/day/capita)	Protein (g/day/capita)	Fat (g/day/capita)
Low income			
Yemen	2,142	60.0	33.5
Lower-middle income			
Egypt	3,336	83.5	78.4
Iraq	2,887	71.8	75.3
Morocco	3,020	81.3	55.6
Syria	3,003	78.6	82.7
Jordan	2,634	71.4	62.0
Algeria	2,866	76.6	61.2
Iran	3,181	84.1	62.2
Tunisia	3,119	83.3	85.7
Lebanon	3,274	86.2	97.1
Upper-middle income			
Libya	3,324	80.5	108.3
Saudi Arabia	2,874	86.5	82.5
High income			
Kuwait	3,195	95.3	104.9
United Arab Emirates	3,309	101.6	111.5

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PHYSICAL ACTIVITY RECOMMENDATIONS AND EXERCISE PRESCRIPTIONS GUIDELINES FOR THE ARAB NATIONS

Khalid S. Almuzaini

Exercise Physiology Laboratory, Dept. of PE & Movement Sciences
College of Education, King Saud University, Riydh, Saudi Arabia

INTRODUCTION

Over the last century, tremendous advancements in technology have been made. Advancement in mechanization and automation has radically reduced human physical activity (World Health Organization [WHO] & Federation Internationale de Medecine Sportive [FIMS], 1995). This, along with advancement in information and entertainment technology (such as the Internet and Satellite Television) has led to a sedentary lifestyle that has raised much concern about human health, especially from industrialized countries. However, with the world becoming a small village, lowering of physical activity level is becoming a worldwide phenomenon. Therefore, efforts have been made by governments and health organizations to promote a physically active lifestyle. This trend over the past 50 years toward more physically active lifestyles is supported by scientific evidence that has linked the level of daily physical activity to human health and well being.

In fact, scientific evidence suggests that higher levels of regular physical activity are associated with lower mortality rates for both older and younger adults, decreased risk of cardiovascular disease mortality in general and of coronary heart disease mortality in particular, lower blood pressure, decreased risk of colon cancer, lower risk of developing non-insulin-dependent diabetes mellitus and maintaining normal muscle strength, joint structure, and joint function. Furthermore, weight-bearing physical activity is essential for normal skeletal development during childhood and adolescence and for achieving and maintaining peak bone mass in young adults. Also, strength training and other forms of exercise in older adults preserve the ability to maintain independent living status and reduce the risk of falling. Moreover, regular physical activity might favorably affect body fat distribution. More benefits of regular physical activity include relief of symptoms of depression and anxiety and improvement of mood and improve health-related quality of life by enhancing psychological well-being and by improving physical functioning in people suffering from poor health (US Dept. of Health and Human Services [USDHHS], 1996). On the other hand, physical inactivity is recognized as a risk factor for coronary artery disease (Fletcher et al., 1996). In fact, epidemiologic studies have indicated that low levels of habitual physical activity and low levels of physical fitness are associated with markedly increased all-case mortality rates (Blair, 1989; Paffenbarger, 1986; Pate et al., 1995).

Thus, various national and international organizations and committees concerned with the health of populations have issued general guidelines and recommendations for physical activity (USDHHS, 1991; American College of Sports Medicine [ACSM], 1995a; Fletcher et al., 1995; Pate et al., 1995; Fletcher et al., 1996; USDHHS, 1996; ACSM 1998a; ACSM, 1998b; Feigenbaum and Pollock, 1999). Usually some physical activity recommendations target specific populations. For example, there are some existing guidelines specific for healthy children (ACSM, 1988; American Medical Association [AMA], 1992; Sallis and Patrick, 1994, Health Education Authority (HEA), 1997) and the elderly (Pollock et al., 1994; ACSM, 1998c; Cotton et al., 1998; Heikkinen, 1998; Evans, 1999). Other recommendations target various chronic diseases, such as coronary heart disease (ACSM, 1994), hypertension (ACSM, 1993; Fagard, 1995; World Hypertension League Consensus Statement [WHLCS], 1991), osteoporosis (ACSM, 1995b), and obesity and weight control (ACSM, 1983; ACSM, 1999). Also, some review articles that introduce new recommendations to professionals or to the public exist (Jones and Eaton, 1995; Burns, 1996; King and Senn, 1996; Phillips et al., 1996; Feigenbaum and Pollock, 1997; Lee and Meyers, 1997; Cote, 1998).

Most of the physical activity recommendations and guidelines are issued in response to local needs and from local governments or organizations, such as the USDHHS in the United States of America. These organizations usually direct their position stands and consensus statements to the local citizens. Indeed, efforts by some international and national organizations such as WHO, ACSM, and CDC to increase the worldwide awareness regarding the benefits of regular physical activity and the quantity and quality of it needed to improve health and well-being, are acknowledged. However, the need to develop local consensus documents, recommendations, and guidelines for physical activity still exists. This is because of the variations in culture and lifestyles among the nations of the world. A relevant example of this scenario is the lifestyle physical activity interventions. In fact, this has led most of the developed nations to issue their own physical activity guidelines. A very recent example of this is the Japanese national physical activity and health promotion guidelines (Ohta, 1999). Unfortunately, to the best of the author's knowledge, physical activity guidelines directed to the need of the Arab nations do not exist. Therefore, the purpose of the present paper is to summarize existing recommendations and guidelines for physical activity and exercise prescription for apparently healthy persons of all ages. Notice that the rationale and scientific background of guidelines and recommendations is out of the scope of this article. Also, the present paper focuses on disease prevention and health promotion. Thus, it does not include issues of physical activity and exercise prescription for treatment or rehabilitation after disease.

The present paper summarizes the most current physical activity guidelines and recommendations, for all ages, in a tabular format for easy reference. This besides the fact that physical activity guidelines and recommendations directed for the Arab nations do not exist, adds to the significance of the present paper. To fit the need of the Arab nations at all ages, recommendations and guidelines are summarized for three age classifications, children and adolescents (5-18 years of age), adults (19-64 years of age), and the elderly and the frail and very old (65 years of age and above). Special needs of females are considered and relative recommendations are provided for all ages if available. The underlying principle throughout the present paper is based on current beliefs summarized in the following points:

- The scientific evidence clearly demonstrates that regular, moderate-intensity physical activity provides substantial health benefits (CDC and ACSM, 1995).

- Recently, an important distinction has been made between physical activity as it relates to health versus fitness. Thus, the quantity and quality of exercise needed to attain health-related benefits might differ from what is recommended for fitness benefits (ACSM, 1998a).

- Lower levels of physical activity (particularly intensity) may reduce the risk for certain chronic degenerative diseases and improve metabolic fitness and yet may not be of sufficient quantity or quality to improve health indices, such as maximal oxygen consumption (VO_2max) (ACSM, 1998a).

- Many significant health benefits can be achieved by going from a sedentary state to a minimal level of physical activity while programmes involving higher intensities and/or greater frequency/durations provide additional benefits (ACSM, 1998a).

- All people over the age of 2 years should accumulate at least 30 minutes of endurance-type physical activity, of at least moderate intensity, on most preferably all days of the week (USDHHS, 1996).

- Adolescents who develop a habit of participating in activities that can be carried over into adulthood will be more likely to remain active at an older age (Sallis and Patrick, 1994).

- Physical activity must be incorporated into everyday life along with appropriate nutrition, adequate rest, and other positive lifestyle habits (Ohta, 1999).

Definitions

- *Duration*- Distance or length of time (or calories burned, in the case of the exercise prescription) (Sharkey, 1997).

- *Exercise* - A subset of physical activity defined as planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness (Caspersen et al., 1985).

- *Exercise prescription*-Individualization of the exercise duration, frequency, intensity, and mode of an exercise program (Wilmore and Costill, 1999).

- *Frequency*- The number of times per week.

- *Intensity*- The relative rate, speed, or level of exertion (Sharkey, 1997). See Table 1 for classification of physical activity intensity.

- *Maximal oxygen uptake (VO_2 max)*- The maximal capacity for oxygen consumption by the body during maximal exertion. It is also known as aerobic power, maximal oxygen intake, maximal oxygen consumption, and cardiorespiratory endurance capacity (Wilmore and Costill, 1999). It is the best single measure of aerobic fitness with implications for health (Sharkey, 1997) (Table 1).

- *Physical activity*- Any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen et al., 1985).

- *Physical fitness*- A set of attributes that people have or achieve that relates to the ability to perform physical activity (Caspersen et al., 1985).

- *Rating of perceived exertion (RPE)*- A person's subjective assessment of how hard he or she is working (Wilmore and Costill, 1999).

Table 1. Classification of physical activity intensity, based on physical activity lasting up to 60 minutes

	Relative endurance-type activity intensity			Relative strength-type exercise intensity*
Intensity	VO_2max (%) Heart rate reserve (%)	Maximal heart rate (%)	RPE[+]	Maximal voluntary contraction (%)
Very light	< 25	< 30	< 9	< 30
Light	25-44	30-49	9-10	30-49
Moderate	45-59	50-69	11-12	50-69
Hard	60-84	70-89	13-16	70-84
Very hard	≥ 85	≥ 90	> 16	> 85
Maximal	100	100	20	100

* Based on 8-12 repetitions for persons under age 50 years and 10-15 repetitions for persons aged 50 years and older.

+ Borg rating of perceived exertion 6-20 scale (Borg, 1998).

Table 1. was modified from one in the Surgeon General's Report on Physical Activity and Health (USDHH, 1996).

Recommendations for cardiovascular screening before participation in physical activity/exercise

The ACSM and the AHA have recently issued a joint position statement (ACSM and AHA, 1998) which provides recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. In this position statement, it was emphasized that pre-participation screening should identify people at high risk and should be simple and easy to perform. Furthermore, the statement asserts that recommendations that would inhibit large numbers of people from participating in exercise programmes are not justified. This is because most of the health benefits of exercise accrue at moderate levels of intensity (Pate et al., 1995), in which the risks are probably low (ACSM and AHA, 1998). Therefore, a practical tool for pre-participation screening is likely to have an effect on identifying high-risk individuals without inhibiting their participation in exercise programmes. The Physical Activity Readiness Questionnaire (PAR-Q) is one of such tools (see Table 2). It has been recommended as a minimal standard for entry into low-to-moderate intensity exercise programme and was designed to identify adults for whom physical activity might be inappropriate or those who should have medical advice concerning the most suitable type of activity (Shephard et al., 1991; Thomas et al., 1992). Although physical activities and exercise prescriptions provided in the present paper are intended for apparently healthy people, at least a minimal pre-participation screening tool, such as the PAR-Q, is encouraged before the person plans to become much more physically active than he/she is now. Notice that most sedentary individuals can begin a moderate exercise program safely (ACSM, 1995a). However, previously inactive men over age 40, women over age 50, and people at high risk for cardiovascular diseases (CVD) should first consult a physician before involvement in a vigorous physical activity program (USDHHS, 1996).

Table 2. Physical activity readiness questionnaire (PAR-Q)

Yes	No	
___	___	1. Has a doctor ever said that you have a heart condition and recommended only medically supervised activity?
___	___	2. Do you have chest pain brought on by physical activity?
___	___	3. Have you developed chest pain in the past month?
___	___	4. Have you on one or more occasions lost consciousness or fallen over as a result of dizziness?
___	___	5. Do you have a bone or joint problem that could be aggravated by the proposed physical activity?
___	___	6. Has a doctor ever recommended medication for your blood pressure or a heart condition?
___	___	7. Are you aware, through your own experience or a doctor's advice, of any other physical reason that would prohibit you from exercising without medical supervision?

If you answer "yes" to any of these questions, contact your personal physician or healthcare provider before increasing your physical activity.
Source: ACSM & AHA (1998).

Children and Adolescents (5-18 years of age)

Few guidelines and recommendations specific for physical activity for children and adolescents exist (ACSM, 1988; Riople et al., 1986; AMA, 1992; Sallis and Patrick, 1994; ACSM, 1995a; Riddoch and Boreham, 1995; HEA, 1997; Ohta et al., 1999; Story and Neumark-Sztainer, 1999). Also, benefits of regular physical activity at this age have been documented (Harsha, 1995; Goran et al., 1999; Sothern et al., 1999). Indeed, more definitive recommendations must await the advancement of knowledge about the benefits of physical activity as it relates to youth health and well-being. For example, because long-term studies are lacking, controversy remains regarding the effects of physical activity in youth on chronic disease in adulthood. Sallis and Patrick (1994) suggested two health-related rationales for adolescent physical activity. The first one was to promote physical and psychological health and well-being during adolescence. This was based on available evidence indicating that regular physical activity produces multiple beneficial physiological and psychological outcomes during this age. The second was to enhance future health by increasing the chance of remaining active as an adult. The latter rationale was based on a belief that adolescents who develop a habit of participating in activities that can be carried over into adulthood will be more likely to remain active at an older age. These benefits of physical activity have encouraged many health organizations to concentrate more on the younger population in the hope that efforts of early intervention would result in prevention of future health catastrophes. And because one of the developing world's broadest and deepest channels for putting information at the disposal of its citizens is the formal education system (WHO, 1997), the last decade has witnessed an increased interest in school programme, such as physical education, as a means of promoting healthy lifestyles (Haywood, 1991; McGinnis et al., 1991; Morris, 1991; Morrow, 1991; Nelson, 1991; Center for Disease Control and Prevention [CDC], 1997; National Center for Chronic Disease Prevention and Health Promotion and CDC, 1997; WHO, 1997; Rogers et al., 1998; Denman, 1999).

Physical activity guidelines for early childhood (< 11 years of age) are in the form of general statements. The National Institute of Health (NIH) consensus development conference statement on physical activity and cardiovascular health (NIH consensus conference, 1996) suggested that children and adults alike should accumulate at least 30 minutes of moderate-intensity physical activity on most, and preferably all, days of the week. The Surgeon General's report (USDHHS, 1996) recommends that "All people over the age of 2 years should accumulate at least 30 minutes of endurance-type physical activity, of at least moderate intensity, on most preferably all days of the week" (p. 28). Also, the Healthy People 2000 objectives (as reported in the USDHHS, 1996) include children in recommendations. These objectives indicate that people aged 6 and older should engage regularly, preferably daily, in light to moderate physical activity for at least 30 minutes per day. They also indicate that vigorous physical activity, which promotes the development and maintenance of cardiorespiratory fitness, should be practiced 3 or more days per week for 20 or more minutes per occasion. Further, these objectives assert that at least 40% of people at this age should regularly perform physical activities that enhance and maintain muscular strength, muscular endurance, and flexibility. Other physical activity recommendations for young children are provided by the HEA, where young age is defined as all people aged 5-18 years (HEA, 1997; Biddle et al., 1998). The HEA recommends the following:

1. All young people should participate in physical activity of at least moderate intensity for one hour per day.

2. Young people who currently do little activity should participate in physical activity of at least moderate intensity for at least half an hour per day.

3. At least twice a week, some of these activities should help to enhance and maintain muscular strength and flexibility, and bone health.

Other physical activity guidelines for early childhood are provided by the recent Japanese national physical activity and health promotion guidelines (Ohta et al., 1999). The Japanese guidelines define young age as early childhood (3-6 years of age) and late childhood (7-18 years of age). The main goal of physical activity from these guidelines is to stimulate play in early childhood. This, in turn, helps build the foundation on which future physical activity participation is built. For the late childhood, the goal is to promote appropriate muscular and skeletal development, as well as psychological well-being (Ohta et al., 1999).

For children aged > 11 years, the consensus statement from the 1993 international consensus conference on physical activity guidelines for adolescents (Sallis and Patrick, 1994) provides recommendations for adolescents aged 11-21 years. These guidelines are as follows:

1. "All adolescents should be physically active daily, or nearly every day, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities" (p. 307)

2. "Adolescents should engage in three or more sessions per week of activities that last 20 min or more at a time and that require moderate to vigorous levels of exertion" (p. 308).

Table 3 provides a summary of current physical activity recommendations for children and adolescents (age 5-18 years). Because of the need for maintaining muscular strength and endurance, and flexibility, prescriptions for these are provided. Notice that recommendations and guidelines are summarized under two objectives, promotion of general health and development and maintenance of health related physical fitness.

Adults (18-64 years of age)

For adults (age 18-64 years) exercise is prescribed for different purposes. These include enhancing physical fitness and promoting health by reducing risk factors for chronic disease. There are five important components of a systematic, individualized exercise prescription. These are appropriate mode, intensity, duration, frequency, and progression of physical activity. Indeed, regardless of the presence or absence of risk factors and disease, these five components have an important application when developing exercise

Table 3. Physical activity recommendations and exercise prescription guidelines for children and adolescents (5-18 years of age)

Physical Activity:	Objective: Promotion of general health (5-18 years of age)	Objective: Developing and maintaining health related physical fitness (11-18 years of age) — Cardiorespiratory	Objective: Developing and maintaining health related physical fitness (11-18 years of age) — Muscular strength and flexibility
Type	Walking up stairs, walking or riding a bicycle, and doing household chores. Weight-bearing activities that promote bone health include gymnastics, dance, aerobics, skipping and sports such as basketball.	Brisk walking, jogging, stair climbing, soccer, basketball, racquet sports, swimming laps, skating, cross country skiing, cycling, and strenuous housework.	Strength (resistance) training and stretching exercises.
Frequency	Daily or nearly every day	3 or more sessions per week	2-3 times per week for each major muscle group.
Intensity*	Moderate	Moderate to hard	Moderate to hard: 6-15 repetitions of each exercise (resistance is increased in 0.5-1.4 kg increments after doing 15 repetitions in good form).
Duration	Accumulation of at least 30 minutes, preferably, one hour per day.	20-60 minutes of continuous or intermittent (minimum of 10-min bouts accumulated throughout the day).	20-30 min per session
Special considerations	Physical activity should be part of play, games sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities. Physical activity should be enjoyable, involve a variety of muscle groups, and include some weight bearing activities. Activities for younger children that enhance strength include play, such as climbing, skipping or jumping, whereas for adolescents they might include structured exercise, such as resistance programme. Intensity or duration is less important as long as energy is expended and a habit of daily activity is established.	Young children may achieve the recommendation during play, by alternating short bouts of moderate to vigorous physical activity with rest periods or bouts of lower intensity activity. A diversity of activities that use large muscle groups are recommended as part of sports, recreation, chores, transportation, work, school physical education, or planned exercise.	A preparticipation physical exam and adequate supervision are mandatory. Strength training should be a part of a comprehensive program structured to improve motor skills and level of fitness. It should be preceded by a warm-up period and followed by a cool-down. No resistance should be applied until proper form is demonstrated. Trunk strength and muscular flexibility may be associated with reduced risk of injury and back pain in later life. Flexibility program (stretching exercises) is part of the warm-up and cool-down periods.

* For classification of intensity, refer to Table 1.
Sources: Mostly, from Sallis and Patrick (1994), HAE (1997), and ACSM (1995a).

prescriptions to improve and maintain physical fitness for persons of all ages and functional capacities (ACSM, 1995a). However, there have been efforts to extend the traditional exercise-fitness model to a broader physical activity-health paradigm (CDC and ACSM, 1995). This initiative regarding physical activity was brought to the US public as a health message. The CDC and ACSM recommendation (CDC and ACSM, 1995) was distinct in two important ways. First, it emphasized the health benefits of moderate-intensity physical activity. Second, it considered accumulation of physical activity in intermittent, short bouts, an appropriate approach to achieving the activity goal. Furthermore, this recommendation indicated, based on scientific evidence, that the amount of physical activity is more important than mode, intensity, or duration of the activity bouts. In other words, the health benefits of physical activity appear to accrue in approximate proportion to the total amount of activity performed, measured as either caloric expenditure or minutes of physical activity (CDC and ACSM, 1995). The expert panel from the CDC and ACSM (1995), based on the most reasonable data, believed that "(1) caloric expenditure and total time of physical activity are associated with reduced cardiovascular disease incidence and mortality; (2) there is a dose-response relationship for this association; (3) regular moderate physical activity provides substantial health benefits; and (4) intermittent bouts of physical activity, as short as 8 to 10 minutes, totaling 30 minutes or more on most days provide beneficial health and fitness effects" (p. 405). Also, this recommendation emphasizes the important role of other components of fitness, such as muscular strength and flexibility. This is because people who maintain or improve their strength and flexibility may be better able to perform daily activities, may be less likely to develop back pain, and may be better able to avoid disability, especially as they advance into older age (CDC and ACSM, 1995).

Therefore, a concept of lifestyle physical activity interventions has emerged over the last few years and its history is closely linked with the history of public health physical activity recommendations (Dunn et al., 1998), such as those discussed in the present paper. Dunn et al. (1998) define lifestyle physical activity as "the daily accumulation of at least 30 minutes of self-selected activities, which includes all leisure, occupational, or household activities that are at least moderate to vigorous in their intensity and could be planned or unplanned activities that are part of everyday life" (p. 399). Dunn et al. added that this definition emphasizes that the activities are selected individually and are not prescribed. These activities can be consciously planned by the individual or they can be unplanned by manipulation of the environment, such as signs suggesting that individuals climb stairs instead of using escalators. Also, the lifestyle physical activity model introduces the concept of accumulating physical activities in short bouts throughout the day, rather than performing them in one long bout of continuous activity. Indeed, some recent studies have promoted a re-evaluation of the minimum thresholds of exercise duration to confer health benefits (DeBusk et al., 1990; Jakicic, 1995; Snyder et al., 1997; Almuzaini et al., 1998; Murphy and Hardman, 1998). These studies have investigated the effects, on health related indices, of splitting exercise bouts into several shorter sessions compared with one long continuous bout. The results of such studies further support the concept of lifestyle physical activity interventions (Dunn et al., 1998).

Although the ACSM and other groups have promoted the use of the exercise prescription model, which specifies the recommended amount of exercise in terms of frequency, intensity, and duration, recent public health recommendations for physical activity include options to this model that emphasize lifestyle activity. As mentioned above, this approach can perhaps be integrated more readily than structured exercise into busy schedules and provides flexibility to sedentary individuals who desire to become more active (Blair and Morrow, 1998). Table 4 considers both models and presents current physical activity recommendations and exercise prescription guidelines for adults (age 19-64 years).

The elderly and the frail and very old (65 years of age and above)

Indeed, the general guidelines described in the previous section apply to individuals of all ages (see Table 4). However, because physiological ageing does not occur uniformly across the population, it is not wise to define "elderly" by any specific chronological age or set of ages. In fact, the wide range of health and fitness levels found among the elderly warrant special considerations and make generic exercise prescription more difficult (ACSM, 1995a). Pollock et al. (1994) stated that, in general, most of the basic guidelines of exercise prescription that have been developed for the younger and middle-aged population are appropriate for elderly. They further emphasized that the application of the exercise prescription is one important difference in programme specific for the elderly. This is because the elderly participant is more susceptible to fatigue, orthopedic injury, and possible cardiovascular problems. Therefore, the exercise prescription for the elderly should include activities of low impact and the intensity should be moderate and applied more gradually (Pollock et al., 1994).

The most recent position stand on exercise and physical activity for older adults (ACSM, 1998c) suggests that adding large muscle rhythmic aerobic forms of exercise such as walking, running, swimming, and cycling to an individual's habitual lifestyle maximize both the quality and quantity of life in older adults. Recommendations on cardiovascular (CV) function indicated that moderate or high-intensity exercise may be required to elicit adaptations in the CV system and in CV disease risk factors. However, light-to-moderate-intensity exercise

Table 4. Physical activity recommendations and exercise prescription guidelines for adults (19-64 years of age)

Physical Activity:	Objective: Promotion of health	Developing and maintaining health related physical fitness: Cardiorespiratory	Muscular strength and endurance	Flexibility
Type	Brisk walking, cycling for pleasure or transportation, swimming, aquatic exercises, calisthenics, racket sports, or simply working around the house or yard.	Any activity that uses large muscle groups, which can be maintained continuously, and is rhythmical and aerobic in nature. This includes, walking-hiking, running-jogging, stair climbing, swimming, cycling, and various endurance game activities or some combination thereof.	Strength (resistance) training, such as dynamic resistance exercises are recommended.	Stretching exercises sufficient to develop and maintain rage of motion, stretch the major muscle groups, and include appropriate static and dynamic techniques.
Frequency	Most, preferably all, days of the week.	3-5 days per week	2-3 days per week	A minimum of 2-3 days per week
Intensity	Moderate	Moderate to hard: 55/65-90% of maximum heart rate (HRmax) or 40/50%-85% of maximum oxygen uptake reserve (VO_2R) or maximum heart rate reserve (HRR).*	8-12 repetitions of each exercise (progress every 1-2 weeks).	Stretch muscle/tendon groups and hold for 10-30 s at the point of mild discomfort
Duration	About ≥ 30 min of physical activity that can be accumulated in relatively short bouts during the course of the day.	20-60 minutes of continuous or intermittent (minimum of 10-min bouts accumulated throughout the day).	One set of 8-10 exercises that conditions the major muscle groups.	Stretch the major muscle/tendon groups for at least 4 repetitions for each exercise.
Special consider-ations	If you perform lower-intensity activities, you should do them more often, for longer periods of time, or both. If you prefer more formal exercise, you may choose to walk or participate in more vigorous activities, such as jogging, swimming, or cycling for 30 minutes daily. If you do not engage in regular physical activity, you should begin by incorporating a few minutes of increased activity into your day, building up gradually to 30 minutes per day of physical activity. If you already meet the recommendation, you are also likely to derive some additional health and fitness benefits from becoming more physically active.	Duration is dependent on the intensity of the activity. Thus, lower-intensity activity should be conducted over a longer period of time (30 min or more). On the other hand, individuals training at higher levels of intensity should train at least 20 min or longer. Moderate-intensity activity of longer duration is recommended for adults not training for athletic competition. The lower intensity values, i.e., 40-49% of VO_2R or HRR and 55-64% of HRmax, are most applicable to individuals who are quite unfit.	Multiple-set regimens may provide grater benefits if time allows. For older and more frail persons (about 50-60 yr of age and above) 10-15 repetitions may be more appropriate. Strength training should be rhythmical, performed at a moderate-to-slow controlled speed, through a full range of motion, and with a normal breathing pattern during the lifting movements.	A general stretching program that exercises the major muscle/tendon groups should be developed using static, ballistic, or modified proprioceptive neuromuscular facilitation (contract/relax, hold/relax, active/assisted).

*Maximal heart rate can be estimated using the following: 220 - age. Maximum heart rate reserve (HRR) and maximum oxygen consumption reserve are calculated from the difference between resting and maximum heart rate and resting and maximum oxygen consumption, respectively. A percentage of this value is added to the resting heart rate and/or resting oxygen consumption to estimate training intensity (ACSM, 1998a). Sources: Different sources were used, but the following references were utilized heavily: CDC and ACSM (1995) and ACSM (1998a).

training in older adults has a consistent beneficial CV response, that is, a reduction in blood pressure in older hypertensive adults. Furthermore, the initiation and maintenance of long-term light-to-moderate-intensity physical activity programme in older adults may reduce the rate of age-associated deterioration in numerous physiological functions, even if they do not result in absolute increases in these functions. In the long run, this should benefit both quantity and quality of life (ACSM, 1998c).

The ACSM is currently recommending strength or resistance training as an important component of an overall fitness program. Evans (1999) in his recent guidelines indicated that strength training is particularly important in the elderly, in whom loss of muscle mass and weakness are prominent deficits. Strength training is also an important way to increase levels of physical activity in the elderly in addition to its positive effects on insulin action, bone density, energy metabolism, and functional status (ACSM, 1998c). Postural stability and flexibility is another concern in the elderly population. The recent recommendation on postural stability (ACSM, 1998c) indicated that a broad-based exercise program that includes balance training, resistive exercise, walking, and weight transfer should be part of a multifaceted intervention to reduce the risk of falling. Exercises, which have been shown to increase joint range of motion such as walking, aerobic dance, and stretching, are recommended and should be included in a general exercise program for the older adult (ACSM, 1998c).

Recent recommendations for the frail and very old participants (ACSM, 1998c) indicated that exercise programmes for this population should include progressive resistance training of the major muscle groups of the upper and lower extremities and trunk. These recommendations suggest the incorporation of balance training, either as part of strength training or as a separate modality. It is also recommended that aerobic conditioning follows strength and balance. This is based on evidence suggesting that improving muscle strength, joint stability, and balance may significantly improve the tolerance to weight-bearing activity, such as walking.

For reasons such as increased muscle stiffness and reduced elasticity of connective tissue which result from advancing age, Evans (1999) emphasized that proper warm-up and stretching can have a greater effect in reducing the risk of an orthopedic injury in the elderly. He recommended a 5-minute warm-up (exercise at a reduced intensity) followed by 5-10 minutes of slow stretching. Evans added that a cool- down (slow walk and more stretching) after exercise is important in older individuals. Also, Evans recommended exercising with a friend. He stated that the more people the older individual exercises with, the more likely he/she will adhere to exercise programmes.

Table 5. Exercise prescription guidelines for the elderly and the frail and very old (65 years of age and above)

Physical Activity:	Objective		
	Cardiovascular function	Muscular strength and endurance and postural stability	Flexibility
Type	Walking, stationary cycling, water exercise, swimming, machine-based stair climbing, or seated stepping machines.	Strength training, resistive exercise, balance training, and weight transfer.	Walking, aerobic dance, and stretching exercises.
Frequency	3-5 days per week	2 days per week	3 times per week (preferably daily)
Intensity	Moderate to hard	10-15 repetitions of each exercise (begin at a lower intensity level and progress slowly every 2-4 weeks).	Slow movement followed by a static stretch sustained for 10-30 seconds. The degree of stretch achieved should not cause pain, but rather mild discomfort.
Duration	20-60 min of continuous or intermittent (minimum of 10-min bouts accumulated throughout the day).	1 set of 8-10 exercises that conditions the major muscle groups	Approximately 15-30 minutes per exercise session.
Special considerations	For the frail elderly, it is recommended that moderate intensity aerobic training begin after tolerance to weight-bearing activity, such as walking, has been significantly improved. This is done by improving muscle strength, joint stability, and balance. Then, moderate intensity training can begin, first by reaching a target frequency (at least 3 days per week), then duration (at least 20 min), and finally, appropriate intensity (40-60% of HRR). However, walking intensity should be increased by adding hills, inclines, steps and stairs, pushing a weighted or occupied wheelchair rather than increasing velocity or changing to jogging.	For the frail elderly, some standing postures with free weights should be used to simultaneously enhance balance and muscle coordination.	Stretching exercises should be prescribed for every major joint in the body (hip, back, shoulder, knee, upper trunk, and neck regions). Stretching exercises should be included as an integral part of warm-up and cool-down exercises. For deconditioned older adults beginning an exercise program, it may be particularly appropriate to devote an entire exercise session to flexibility. Each stretching exercise should be performed 3-5 repetitions.

*HRR = Heart rate reserve (see Table 4 for definition).

Sources: Mostly, from ACSM (1998c) and ACSM (1995a).

Table 5 provides current exercise prescription guidelines and special considerations for the old and the frail and the very old. Notice that Table 4 presents physical activity recommendations for promotion of health which apply to the elderly.

Special needs of women

Physical activity recommendations for the female are generally similar to those for the male. However, women are unique because they experience menstruation, pregnancy, childbirth, child nursing, and menopause. Each of these is associated with specific health and physical activity considerations (Ohta et al., 1999). Furthermore, older women have specific physical activity objectives, such as the prevention and management of diseases like osteoporosis. Therefore, physical activity goals unique to women are preservation and improvement of health, reduction of the symptoms of menopause and prevention and treatment of osteoporosis (Ohta et al, 1999). In general, physical activities for the promotion of health for women are similar to those for men (see Tables 3, 4, and 5). The following are specific physical activity considerations relating to pregnancy, menopause, and osteoporosis.

According to the ACSM guidelines (ACSM, 1995a), benefits of exercising during pregnancy include positive effects on back pain, stress, anxiety, digestion, constipation, body weight, and postpartum belly. However, exercise may not be appropriate for every pregnant woman. Therefore, it is important that pregnant women get a physician's authorization before beginning an exercise program. This can contribute to better maternal health and reduce the risk to the developing fetus. The American College of Obstetrics and Gynaecology (ACOG) has issued guidelines (ACOG, 1994) for the safe prescription of exercise for expectant and nursing mothers. These guidelines differentiate between women who exercise and become pregnant and women who start exercising during pregnancy (ACSM, 1995a). The ACOG guidelines suggest that pregnant women can continue to exercise and derive health benefits even from mild to moderate exercise routines. Moreover, regular exercise, performed at least 3 times per week, is preferable to intermittent activity. Because pregnancy requires an additional 300 kcal/day in order to maintain metabolic homeostasis, pregnant women should be particularly careful to ensure an adequate diet. Among the recommended physical activities for pregnant women are regular walking and supplementary stretching and light calisthenics. Also, non-weight-bearing exercises, such as cycling or swimming, will minimize the risk of injury (ACOG, 1994).

The recent Japanese national physical activity and health promotion guidelines (Ohta, 1999) suggested that daily activities such as housework or a job outside the home have little effect on improving the symptoms of menopause. Thus, hobbies, leisure activities, sports, and exercise might have a more positive influence on reducing or dissipating symptoms of menopause. The Japanese guidelines suggest that exercises and sports that can be performed easily and that lead to feelings of exhilaration and enjoyment are examples of appropriate physical activities to alleviate symptoms of menopause. For the prevention of osteoporosis, the Japanese guidelines suggest activities such as exercises and sports that include jumping or stepping movements, resistance training, walking, and running. After reviewing the role of physical activity in maximizing bone mass, the ACSM position stand on osteoporosis and exercise (ACSM, 1995b) emphasized that physical activity cannot be recommended as a substitute for hormone replacement therapy at the time of menopause. This position stand indicates that weight-bearing activity is essential for the normal development and maintenance of a healthy skeleton. And a general activity program emphasizing strength, flexibility, coordination, and cardiovascular fitness is important, because it may indirectly reduce the risk for osteoporotic fractures by decreasing the risk of falling and by enabling older women to remain active, thus avoiding loss of bone through inactivity (ACSM, 1995b).

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BARRIERS TO PRACTISING PHYSICAL ACTIVITY IN THE ARAB COUNTRIES

Abdulrahman O. Musaiger[1] and Mona S. Al-Ansari[2]
[1] Bahrain Center for Studies and Research, [2] University of Bahrain, Bahrain

INTRODUCTION

Regular physical activity can substantially reduce the risk of developing many chronic illnesses (USDHHS, 1996). The prevalence of chronic diseases such as cardiovascular disease, diabetes mellitus, hypertension, and cancer have increased dramatically during the last two decades in the Arab Region, and have become one of the main causes of death in most Arab countries. Promoting physical activity is one of the main components of programmes to prevent and control chronic diseases and promote healthy lifestyles. However, there are many barriers to practising physical activity in the Region. The aim of this paper, therefore, is to elaborate on the factors and barriers associated with practising physical activity in some Arab countries.

Patterns of Physical Activity in the Arab Countries

Data on patterns of physical activity or exercise among the public in the Arab region are scarce. In Bahrain, 12.7% of men and 8.3% of women aged 30-79 years practised exercise regularly (Musaiger and Al-Roomi, 1997). In Egypt, it was found that practising exercise is the activity least done during the leisure time of a typical day. Only 2% of adults (20-70 years) were reported as practising exercise in a typical day, 8.5% practising during the weekend and 2.5% during the annual leave (Yasin et al, 1998). Of male school children (6-18 years) in the United Arab Emirates, 42% performed light exercise or didn't practise any physical activity, 48% were moderately active, and only 10% were heavily active (Moussa et al, 1994).

Some Factors Associated with Practising Physical Activity in the Arab Region

Several factors have been found to determine the practice of physical activity among children and adults in Western countries (Allison et al, 1999; Chinn et al, 1999 and Jaffee et al, 1999). Many studies suggested that watching television is associated with inactivity and obesity (Tucker and Friedman 1989 Gortmaker et al, 1990). In the United Arab Emirates, Al-Neyadi et al (1995) found that the relative risk to be obese was 1.3 for male university students who watched television for more than 4 hours a day compared to those who watched television for less than 4 hours a day. However, Robinson et al (1999) found that among adolescent girls, television viewing time appears to have only weak, if any, meaningful associations with adiposity and physical activity

In Saudi Arabia, about 18% of school children (6-18 years) spend more than 2 hours/day watching television, and as the age of children increases the proportion of children who watch television rises. The percentage was 15% for children aged less than 9 years and increased to 26% for children aged over 17 years (Al-Sumai et al, 1997). In Bahrain, 77% of men and 79% of women aged 30-79 years watched television daily (Musaiger and Al-Roomi 1997). In Egypt, 23% of adults (20-70 years) watched television in the leisure time of a typical day. The proportion is higher among women (48%) than men (15%). However, during the weekend, the percentage of Egyptians who watched television increased dramatically to 68% and 82% for men and women respectively (Yasin et al, 1998). In Qatar, it was found that 19% of men aged more than 19 years watched television for more than 5 hours a day compared to 41% of women (Musaiger and Al-Mulla, 1998).

The type and quantity of foods eaten while watching television may be a confounding factor for the occurrence of obesity. The habit of eating food while watching television is widespread in the Arab countries. For example, 31% of men and 54% of women in Egypt watched television while having lunch, and the corresponding proportions for supper were even higher, 72% and 85% for men and women, respectively. (Yasin et al, 1998). In the United Arab Emirates, Musaiger (2000) showed that 53% of secondary school girls frequently eat food while watching television, 41% sometimes and only 6% did not eat any food. The main types of food eaten while watching television were chocolates and sweets (21%), potato chips and puffs (19%), nuts (12%) and carbonated beverages (10%). These foods contain a high amount of calories and may contribute to the extra calorie intake by the schoolgirls.

Obesity itself may be a factor to reduce physical activity. Many studies in the Arab region demonstrated that obese subjects were less active than non-obese. In Bahrain, Zaghloul et al (1985) found that 65% of obese girls were categorized as less active compared to 29% of non-obese, and only 4% of obese were active compared to 18% of non-obese, respectively. About 60% of obese school children in the United Arab Emirates were considered light exercises or non-active compared to 24% of non-obese (Moussa et al, 1994).

In Saudi Arabia, Khalid (1995) reported that strenuous physical activity was significantly and inversely associated with obesity in men, but there was no clear trend for women. The lack of association between strenuous physical activity and obesity in women was attributed to the low and homo-genous level of strenuous physical activity.

Smoking is another factor that maybe associated with inactivity. We found only one study in the region that correlated smoking with practising exercise. Hamadeh and Musaiger (2000) found that smokers were less likely to practise exercise than non-smokers. Of men smokers, 8% were practising exercise compared to 13% in ex-smokers and 16% in non-smokers.

Age is an important factor that determines the practising of physical activity. As people get older, the practise of exercise and physical activity is diminished. In Bahrain, Musaiger et al (1999) found that 20% of men aged 30-49 years practise exercise regularly, and the percentage decreased to 7.5% among men aged 50-79 years. In another study, it was found that 9% of elderly Bahraini people (≥65 years) were unable to move outdoors and 8% need help to do this. About 37% of the elderly were unable to do light housework and 29% need help to do this housework (Musaiger, 2000).

Beliefs and attitudes toward obesity and physical activity should also be considered when studying factors associated with physical activity in the Arab communities. In Qatar, Musaiger et al (1991) found that there were several wrong attitudes toward obesity and reducing weight among women, and these attitudes were more prevalent in obese than non-obese women. For instance, 40% of obese and 35% of non-obese women believe that sauna baths help in reducing the fatness, and that therefore there is no need to practise exercise. In Bahrain, Al-Amer (1996) found that 53% of women avoid practising exercise because they believe that exercise causes extra muscle and negatively affects their figures.

Pregnancy and multiparity have been widely reported as factors preventing women from practising exercise in this region. In general, the fertility rate of Arab women is very high (ranges from 4 to 6), and therefore it is not surprising that many women perceive that pregnancy and lactation are barriers to practising exercise. Investigations in this part of the world indicate that multiparity is associated with the prevalence of obesity among women. A study among women attending health centers in Qatar showed that the prevalence of overweight and obesity (BMI >25) was already high among women who have one child (65%), but increased to 85% in women who have 6 children and more (Musaiger et al, 1991). Al-Shammari et al (1994) reported that the mean BMI increased significantly with parity in Saudi women, as the mean BMI was 25.1 in women with no parity, increased to 27.1, 29.8 and 31.7 in women with 1-2, 3-4 and more than 4 parities.

Socio-Cultural and Economic Barriers to Practising Physical Activity

Most studies in the Arab countries focused on barriers to practising physical activity in women. This maybe due to difficulties faced by females in practising exercise in the Arab culture, as males in general have more freedom and places to practise sport and other recreational activities. We reviewed 10 studies investigating barriers to practising physical activity and sport in six Arab countries (Egypt, Jordan, Bahrain, Qatar, Sudan and Iraq). The main findings are summarized in Table 1. The barriers can be divided into five categories: economic, social, psychological, cultural and environmental. Women's commitments to work/home, physiological conditions (pregnancy and lactation) and lack of places and facilities for women to practise exercise were the main barriers perceived by the studied women.

A detailed study on the main barriers to practising exercise and other recreational activities among 310 women in Bahrain was carried out by Al-Amer (1996). The main social barriers perceived by women were: work/home commitments (49%) and care of children (36%). However, 24% of women perceived that the negative attitude by family members toward women practising exercise/sport is also considered to be a barrier for them. It is true that in some Arab cultures, girls and women are not allowed by family members to practise sport or exercise out-doors, or in the same place with boys and men. Therefore, 79% of women perceived that the unavailability of women's clubs is the main factor for not practising exercise. They believe that there is a sex discrimination, as sport and other recreational facilities are always provided for males (67%), and they found difficulty in practising any physical activity in the presence of men (66%). Transportation difficulties (57%) and expensive fees (44%) were the main economic barriers to Bahraini women practising exercise.

Table 1. Main barriers to practising physical activity among women in the Arab countries (review of 10 studies)

1. Economic barriers	Lack of facilities, lack of training places, lack of women's clubs, transportation difficulty, expensive fees
2. Social barriers	Women's duties (studying, work, household, husband and children), lack of time
3. Psychological barriers	Lack of motivation, lack of encouragement by family/husband etc
4. Cultural barriers	Beliefs and attitudes, discrimination against women
5. Environmental barriers	Unsuitable weather, health and physiological conditions (pregnancy)

No. of studies reviewed: 3 in Egypt, 2 in Iraq, 2 in Bahrain and one each in Jordan, Qatar and Sudan

Many of the above barriers were mentioned in studies in developed (EC, 1999) countries. The European Commission Survey on physical activity in 15 countries showed that work/study commitments, not being the sporty type, looking after children, expense, illness, lack of facilities and old age are the main barriers to practising physical activity by both men and women (EC, 1999).

In a small scale study in women, Hasanane et al (1992) asked the women to suggest solutions to promote physical activity among females. "Establish a women's club" was the main suggestion (45%), followed by "provide suitable places for women to practise exercise" (31%), "encourage and train the women trainers" (27%), "establish women's sport team's" (26%), increase the awareness of the public through the mass media (24%) and organize course and give lectures on women's sport" (18%).

CONCLUSION

There are several factors associated with inactivity in the Arab region. However, these factors vary from country to country based on the economic and cultural situation. In general, females are facing more barriers to practising physical activity than males. In addition females were less likely to practise exercise than males. Sports and physical activity receive little attention in schools, especially in girls' schools. There is insufficient information in the mass media to promote physical activity among the public. Nevertheless, the lack of sport and other recreational facilities is an important factor for the high prevalence of inactivity, particularly among women. Therefore, there is an urgent need to promote physical activity through the mass media and school/university curricula. Training courses for trainers and organizing workshops and seminars on the benefits of physical activity are highly recommended. Finally, places for practising exercise for females should be provided to give them the same chance as males.

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PATTERNS OF PHYSICAL ACTIVITY AMONG SAUDI CHILDREN, ADOLESCENTS, AND ADULTS WITH SPECIAL REFERENCE TO HEALTH

Hazzaa M. Al-Hazzaa
Exercise Physiology laboratory
King Saud University
Riyadh, Saudi Arabia

INTRODUCTION

For a considerably long time, our ancestors lived simple yet satisfying lives. They appeared to have plenty of exercise by just doing their physically demanding daily work tasks. This enforced exercise was apparently of sufficient duration and intensity to maintain lean body mass and appropriate levels of physical fitness.

During recent years, however, the Kingdom of Saudi Arabia has witnessed a tremendous development at an astounding rate. The rise the standard of living and mechanization has been apparent in all aspects of people's life, and as industrialization and modernization progress, a number of changes in physical activity and eating patterns are likely to occur. Indeed, the changes in life style for the society at large have been very dramatic. Physical inactivity and sedentary living with associated low levels of physical fitness are becoming increasingly prevalent in Saudi society. Moreover, with satellite TV and increased reliance on computer and telecommunication technology, further reduction in physical activity is projected in the coming years.

The impact of these life style changes on societal health is very considerable. In fact, these changes are thought to be responsible for the epidemic of non-communicable diseases, along with their complications (Alwan, 1993). National epidemiological surveys in Saudi Arabia indicate a high prevalence of overweight and obesity among Saudi adult population (Al-Nuaim, 1997; Al-Nuaim et al., 1996; Elhazmi & Warsy, 1997). Furthermore, the assessments of body fats in school children reveal that obesity is on the rise, along with other coronary artery disease (CAD) risk factors, among Saudi children and adolescents (Al-Hazzaa, 1997; Al-Hazzaa et al., 1994; Al-Hazzaa et al., 1994a; Al-Hazzaa et al., 1993).

It is now well recognized that physical inactivity and increased sedentary living habits represent a serious threat to the body, and that a regular physical activity habit reduces an individual's risk of both cardiovascular disease and all-cause mortality (Blair et al., 1989; Bouchard et al., 1990; Haskell, 1994; Oja, 1995; Shephard, 1999; Shephard, 1997). Recently, a number of consensus statements and governmental documents, including the US Surgeon General's Report, have further emphasized the importance of regular physical activity to the health and well-being of people of all ages (ACSM, 1995, 1988; Fletcher et al., 1995; Leon, 1997; Pate et al., 1995; Pollock et al., 1998; Sallis & Patrick, 1994; US Department of Health, 1999,1996).

This paper, therefore, examines the status and patterns of physical activity among Saudi children, adolescents, and adults, and describes the health implications of physical inactivity on children and adolescents where data are most available. Additionally, it is the intent of this paper to briefly discuss the determinants of physical activity and factors influencing it in Saudi society.

Patterns of physical activity among Saudi people

It is important that we understand the definition of physical activity before examining its pattern among Saudi people. Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure above the basal level (Caspersen et al., 1985; US Department of Health, 1996). Physical activity is considered to be a complex set of behaviors. Our ability to relate physical activity to health indicators depends on accurate, precise and dependable measures. Physical activity is commonly measured by either self-report or direct monitoring through mechanical/electronic or physiological measurements.

The published data regarding physical activity levels and patterns of Saudi people mainly come from two major sources of data collection; self-reported questionnaires and continuous monitoring of day long heart rate. Heart rate (HR) telemetry was exclusively applied in studies involving children and adolescents. However, before discussing these physical activity data, three important notes must be mentioned. First, nationally representative population studies describing the patterns of physical activity and energy expenditure in the Saudi society are relatively nonexistent. Second, all the published studies that are presented in this paper, whether coming from our laboratory at King Saud University or from a doctoral thesis by Alshehri (1998), had samples which were drawn from Riyadh, the capital of Saudi Arabia, with a population of over three million inhabitants. Nevertheless, since the changes in life style and eating habits for the Saudi people have occurred across the country and are not limited to the capital, there is no real reason not to generalize our results on other Saudi people living in urbanized areas of Saudi Arabia (according to the 1992 national population census, over 60% of the Saudi population live in urbanized areas). Third, there exists no published data, at all, on physical activity patterns of Saudi females.

Physical activity patterns of children and adolescents

It is widely recognized that children and addescents need regular physical activity for normal growth and development, and maintenance of good health and fitness (Al-Hazzaa, 1997; ACSM, 1988; Sallis & Patrick, 1994; Pate & Trost, 1998; US Department of Health, 1996). Table 1 presents two major consensus statements concerning physical activity recommendations for children and adolescents. The first one was from the International Consensus Conference on Physical Activity Guidelines for Adolescents, published in 1994 (Sallis & Patrick, 1994), and the second statement was the result of the NIH Consensus Conference held in 1995 (NIH, 1996). Both statements call for regularly sustained physical activity of moderate to vigorous intensity on most days of the week. The question we can ask then is whether Saudi children and adolescents satisfy these requirements of almost daily physical activity.

Table 1. Major consensus statements on physical activity recommendation for children and adolescents.

International Consensus Conference of Physical Activity Guidelines for Adolescents *(Sallis & Patrick, 1994, PP.307, 308).*

Guideline 1:

" All adolescents should be physically active daily, or nearly every day, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities."

Guideline 2:

" Adolescents should engage in three or more sessions per week of activities that last 20 min or more at a time and that require moderate to vigorous level of exertion."

National Institute of Health Consensus Conference (NIH, 1996, P.241).

"Children and adults alike should set a goal of accumulating at least 30 minutes of moderate-intensity physical activity on most, and preferably all, days of the week."

In the early 90s, we started a series of research studies aimed to assess the pattern of physical activity among Saudi children and adolescents, with special reference to cardiovascular health and fitness (Al-Hazzaa, 1995; Al-Hazzaa, 1995a; Al-Hazzaa, 1994; Al-Hazzaa & Sulaiman, 1993; Al-Hazzaa et al., 1994; Al-Hazzaa, 1994a; Al-Hazzaa et al., 1993). For physical activity assessment we used all-day heart rate telemetry measurement. The data was stored and then retrieved at a later time.

The boys spent a limited time on activities that raised the heart rate above a level corresponding to ventilatory anaerobic threshold (HR-VAT), and even less time on activities that raised the heart rate to or above 160 bpm, which is equivalent to 60% of a child's maximal heart rate reserve. Out of 8 hours of continuous monitoring, the boys spent an average of 14.6 and 9.6 minutes on activities that raised the heart rate above HR-VAT or above 159 bpm, respectively. In fact, about 16% of the children never exceeded a heart rate of 159 bpm during the whole day period. Analysis of the physical activity patterns according to age showed no significant differences in mean physical activity levels between boys of different ages (7-12 years), though children at age 11-12 years tend to have more time spent in vigorous activity, compared to the other age categories. In contrast to the above mentioned findings of low daily activity profile for average Saudi boys, trained young soccer players, between the age of 11&15 years, were able to spend 63.7% of a soccer match with a heart rate above 159 bpm(Al-Hazzaa et al., 1995). This amounts to 38.2 minutes in a 60-min soccer match. In another study, which was based on a self- reported questionnaire sent to a sample of 220 young Saudi boys, 24% of the sample reported that they were being active in sports for 5 hours or more weekly, while 28% of the boys were physically active for less than two hours a week (Al-Hazzaa, 1995). Self-reported activities by the children/or their parents, however, are not as valid and reliable as heart rate monitoring when assessing physical activity levels. As for the activity most commonly reported by the Saudi boys (as shown in Table 2), soccer was ranked first, followed by swimming, bicycling, and walking/jogging (Al-Hazzaa, 1995). The latter three sports are considered to be lifelong physical activities.

There is a dearth of information regarding physical activity patterns of young Saudi girls. However, in a doctoral thesis, aimed at assessing coronary artery disease (CAD) risk factors among Saudi school children (Alshehri, 1998), hypoactivity, hypercholesterolaemia, and obesity were found to be the main prevalent risk factors among children. Girls were shown to have a 17% lower physical activity score than boys.

Although very little information is available on physical activity patterns among specific populations in Saudi Arabia, one very recent study did monitor daily heart rates for 12 hours continuously in a group of mentally-retarded children including those with Down syndrome (Al-Harby et al, 1999). Table 3 presents the results of such a study. Mean daily heart rate was significantly lower in mentally-retarded boys compared with healthy controls. In addition, the percentage of time spent on activities raising the heart rate to 60% of heart rate reserve or above was significantly higher in the healthy normal subjects. There was also a trend that the percentage of time spent on activities raising the heart rate above 50% of an individual's resting heart rate was higher among the control group.

Table 3. Physical activity levels of mentally-retarded Saudi children relative to healthy controls

Variable	Mentally-retarded		Normal
	Down syndrome	Non-Down	
Age(yr.)	11.1 ±1.1	11.3±0.97	11.0±1.0
Heart rate max (bpm)	172.7±3.2	192.9±6.4	196.5±3.8
Mean daily HR(bpm)	97.3±9.9	99.3±8.9	107.3±7.2 ¶
TimeHR>40% HRR(%)	2.5±2.7	1.47±1.4	3.6±2.2 *
Time HR>50%HR rest (%)	32.8±18.7	29.4±19.8	41.7±19.1

HR= heart rate measured by heart rate telemetry; HRR= heart rate reserved;
HR rest = resting heart rate.
* different from non-Down (P<.05)
¶ different from non-Down & Down syndrome (P<.05)
Data from Al-Harby et al, 1999.

To summarize the patterns of physical activity among Saudi children and adolescents, we can say that from the available evidence it seems that most Saudi children and adolescents (and more so for girls) do not meet the minimal weekly requirement of moderate to vigorous physical activity necessary for an effectively functioning cardiorespiratory system. These findings become really alarming when considering the fact that nearly 50% of the Saudi population is under 15 years of age (or 6 million children, according to the national population census held in 1992).

Physical activity patterns of saudi adults

When scanning the published literature on the physical activity of Saudi adults, one can really be surprised at how little research has been done in this important area of study. Only two major studies were located that dealt with the patterns of physical activity of Saudi adults. Both deal with males, and are written in Arabic. Table 4 presents the findings of these two studies. Physical inactivity varied somewhat between the two reports, averaging from about 46% in college males (Al-Hazzaa, 1990) to over 53% in adult males (Al-Refaee and Al-Hazzaa, 1997). The proportion of Saudi adults aged 18 years and older who are classified as physically active on a regular basis also varied from about 22% in college males to about 19% in adult males. Despite minor differences, these two reports were consistent. In the college-male study (Al-Hazzaa, 1990), when the proportion of subjects who met or exceeded a frequency of 3 times a week was considered, the percentage of young adults who were active dropped from 22% to 15%. With this considerably low rate of activity, especially in young adults, it comes as no surprise that the percentage of young adults who utilized sports clubs facilities was shown to be very low. In a research survey, conducted about 15 years ago on a sample of young adults from the GCC countries (Educational Research Center, 1986), responses from the Saudi sample indicated that only 7.1% of young males in this country uses the services and/or are involved in sports activities offered by youth institutions.

To draw a brief comparative picture on the physical activity profile of people from other countries, the following suffices. The US Surgeon General's Report (US Department of Health, 1996) indicated that according to three recent surveys the proportion of inactive adults in the USA varied from 21.7% to 28.7%. Healthy people 2000 Objectives of the USA calls for reducing to no more than 15% the proportion of people aged 6 year and older who are inactive (US Department of Health, 1999). In a review paper, Oja (1995) presented the health- related physical activity profiles from several European and North American countries. The proportion of moderately and/or vigorously active males in this review varied from 21% in Sweden to nearly 50% in Canada and England.

Table 4. Physical activity profile of Saudi males, drawn from two distinct adult studies in Riyadh*

Variable	Study 1	Study 2
Reference	Al-Hazzaa, 1990	Al-Refaee & Al-Hazzaa, 1997
Original sample	362	1333
Characteristics	College males	Adult
	(mean age = 22yr)	(mean age = 41yr)
Physically Inactive	45.8%	53.4%
Physically Active		
Irregular	32.3%	27.7%
Regular	21.9%	18.9%

* Both studies used stratified random samples.

As to the physical activity most commonly reported by Saudi males, Table 5 presents findings from two studies (Al-Hazzaa, 1990; Al-Hazzaa,1995). The second study (Al-Hazzaa, 1995) was primarily focusing on children, but included some questions for parents (adults). Nevertheless, both studies were consistent in that walking and/or jogging ranked the number one activity for young and middle aged adults. It is also obvious that lifelong activities account for most leisure time physical activities of Saudi adults.

Studies on the physical activity patterns of Saudi women are, unfortunately, yet to be published. This is in spite of the fact that obesity, for example, is more prevalent in Saudi females than in males (Al-Nuaim et al., 1996; El-Hazmi & Warsy, 1997). However, casual observation suggests that women, in general, are less active than men. This trend is supported by findings from Western societies that women are less active than men (US Department of Health, 1996), though the opportunities for women to be active are much greater than in the Middle-Eastern culture.

Associations between physical activity and health indicators

Regular physical activity has long been regarded as an important part of a healthy lifestyle, and recent evidence has strongly reconfirmed the relationship between physical activity and a wide range of physical and mental health benefits (ACSM, 1988, 1995; Bouchard et al., 1990; Leon, 1997; NIH, 1996; Pollock et al., 1998; Sallis and Patrick, 1994; US Department of Health, 1996). Physical inactivity and sedentary living habits, on the other hand, have been linked to a number of chronic diseases, including CAD, hypertension, diabetes mellitus, osteoporosis, colon cancer, and anxiety and depression (Bouchard et al., 1990; Leon, 1997; NIH, 1996; Pate et al., 1995; US Department of Health, 1996).

Table 5. Physical activity most commonly reported by Saudi adults, based on two different studies*

College Males (Al-Hazzaa, 1990)	Adult Males (Al-Hazzaa, 1995)
Walking/Jogging (32.2%)	Walking/Jogging (79%)
Soccer (27.7%)	Swimming (31.9%)
Swimming (8.2%)	Ball Games (26.7%)
Weight Training (5.7%)	Racket Sports (22.9%)
Racket Sports (5.6%)	

* Percentages were inclusive (subjects reported all sports they participated in), while in the other study (Al-Hazzaa, 1990), subjects reported the activity that they most often take part in

Studies relating physical activity (or inactivity) to health indicators in Saudi adults are undoubtedly lacking. However, data concerning the physical activity patterns of Saudi children and adolescents, relative to cardiovascular health and fitness, do exist (Al-Hazzaa, 1997; Al-Hazzaa, 1995; Al-Hazzaa, 1995a; Al-Hazzaa, 1994; Al-Hazzaa & Sulaiman, 1993; Al-Hazzaa et al., 1994; Al-Hazzaa et al, 1994a; Al-Hazzaa et al., 1993). The interest in studying children's physical activity relative to cardiovascular health stem from the fact that diseases such as CHD and obesity, for which inactivity is a likely risk factor, have their origin in childhood (Sallis et al, 1992). Indeed, a number of CAD risk factors were shown to exist in Saudi children of 7-13 years of age (Al-Hazzaa et al., 1993). In the above mentioned study, it was found that out of 220 Saudi boys who were studied 22.9% exceeded a total cholesterol level of 5.2 mmol/l; 26.4% had a triglycerides level above 1.4 mmol/l; 15.4% had a LDL-C level above 3.4 mmol/l; 4% had a HDL-C level below 0.96 mmol/l; about 16% were obese (fat % was above 25% of body mass); and 4.2% had high systolic and diastolic blood pressures. Another important consideration in studying the physical activity of children is that physical activity habits are established early in life and they have to some extent an influence on adult physical activity (Taylor et al., 1999).

In one of our studies (Al-Hazzaa, 1997) coronary artery disease (CAD) risk factors were more present in the least active boys compared to their most active counter parts, as seen in Table 6. With the exception of total serum cholesterol, mean values for all other CAD risk factors are much higher in the least active boys compared to the most active group. Physical activity, in this respect, was assessed by the percentage of time that boys spent in activity which raised the heart rate to above 159 bpm (60% of maximal heart rate reserve). When the percentages of children who exceeded certain recommended levels of blood lipids were considered relative to activity levels, as seen in Table 7, there was a clear reduction in risk with increased activity level (Al-Hazzaa et al., 1994).

Table 6. Coronary artery disease (CAD) risk factors by activity level in Saudi children (n = 92) *

Risk Factor	Most Active (9.7 yr.)	Least Active (9.6 yr.)
Total cholesterol (mg/dl)	180.0	176.0
Triglycerides (mg/dl)	99.8	122.5**
HDL-Cholesterol (mg/dl)	54.8	47.7**
HDL-C/TC (%)	31.2	27.8**
SBP (mm/Hg)	98.6	101.6
DBP (mm/Hg)	85.1	60.6

TC = Total cholesterol, SBP and DBP = Systolic and diastolic blood pressure.
* *Significant differences at P<0.05
* Subjects were matched for body mass and fat %.
Data from AL-Hazzaa, (1997).

Table 7. The percentages of children who exceeded recommended levels of blood lipids based on physical activity levels.

Risk Factor	Activity level	
	Most Active	Least Active
TC(≥5.2 mmol/L)	22.7%	26.0%
TG(≥1.4 mmol/L)	9.1%	48.0%
HDL-C(≥0.96 mmol/L)	0.0%	4.3%
LDL-C(≥1.4 mmol/L)	8.7%	21.7%

Data from Al-Hazzaa et al., 1994.

Factors influencing physical activity of Saudi people

Accumulating evidence indicates that physical activity is influenced by several factors. Although there are some differences between children and adults determinants of physical activity, they can be broadly classified into demographic, physiological, psychological, and environmental factors (King et al., 1992; Taylor et al., 1999; US Department of Health, 1999). In the next paragraphs, the most pertinent factors that influence the physical activity of Saudi children and adults, and on which we have some research data, will be examined.

Obesity

Cross-sectional studies (Al-Hazzaa et al., 1994; Al-Hazzaa et al., 1994a; Al-Hazzaa et al, 1993) indicate that about 16% of Saudi school boys are considered obese (body fat content is above 25% of body mass). What is more, mean fat percent seems to have increased considerably over the past decade (Al-Hazzaa, 1997). Moreover, longitudinal analysis of data for a small group of Saudi boys living in Riyadh showed that body fat percent had increased from 15% at the age of 8.0 years to about 21% at 13 years of age (Al-Hazzaa et al., 1997). Research on CAD risk factors in Saudi children (Al-Hazzaa et al., 1993) showed that obesity correlated positively with triglycerides level ($r = 0.28$; $p < .01$) and HDL-C/TC ratio ($r = 0.22$; $p < .01$).

Furthermore, obesity has long been considered as a negative determinant of physical activity behavior (US Department of Health, 1996). In Saudi children and adolescents, obesity had a low correlation with physical activity, but a higher correlation with cardiovascular fitness. This fairly low correlation between obesity and physical activity can be explained by two reasons. First is that a large proportion of obese children who are inactive will not have any time spent above a heart rate of 159 bpm, and are therefore excluded from the analysis. Second, there are many confounding factors that can influence the relationship between obesity and physical activity. Despite the above-mentioned statements, when physical activity levels of obese versus lean subjects were examined (Table 8), we can see that lean boys were more active than obese boys (Al-Hazzaa et al., 1993a). The differences between the two groups were evident in both vigorous as well as moderate-activity levels, ranging from about 50% at intensity above 159 bpm to about 30% at intensity above139 bpm.

Table 8. Physical activity levels in obese versus lean Saudi boys (means ± SEM)*

Variable	Lean (N=52)	Obese (N=52)
Age (yr.)	9.2 ±0.19	10.0 ± 0.19
Body mass(kg)	24.6 ± 0.60	42.3 ± 1.5
Body fat(%)	9.7 ±0.13	29.0 ± 1.1
(%) of Time spent at activity raising HR:		
Above 159 bpm	2.30 ±0.33	1.56 ±0.24
Above 139 bpm	7.13 ±0.90	5.5 ± 0.57

* Significant difference at 0.05 level
Data from Al-Hazzaa et al., 1993a.

Cardiorespiratory Fitness

Data on cardiorespiratory fitness, as measured by maximal oxygen uptake (VO_2 max) in the laboratory, indicate that untrained Saudi boys between the age of 7 and 15 years have on average about 48 ml/kg. min (Al-Hazzaa & Sulaiman, 1993; Al-Hazzaa, 1997). This value increases to about 56 ml/kg.min in a group of trained young soccer players (Al-Hazzaa et al., 1995). The relationship between cardiorespiratory fitness and physical activity was shown to be significant in a group of Saudi children, with a correlation coefficient of 0.29 (Al-Hazzaa & Sulaiman, 1993). As seen in Table 9, physically fit boys tend to be physically active compared to less fit counterparts. Furthermore, physically active Saudi boys tend to run 1000 meters faster than less active boys (Al-Hazzaa et al., 1994a).

Table 9. Physical activity levels (based on HR telemetry) of Saudi children by cardiorespiratory fitness (VO_2max)

VO_2 max (ml/kg. min)	% of Daily Time	
	HR > 159 bpm	HR > 139 bpm
53.6	2.6 (.66)	7.6 (1.38)
43.5	1.29 (.33)	3.9 (.73)

Data of % of daily time were means (SEM).
Data from Al-Hazzaa & Sulaiman,1993

School physical education programme

The school physical education (PE) programme is viewed as an important factor in establishing a life long physical activity habit for young people (US Department of Health, 1996, 1999). Unfortunately, the school (PE) programme in Saudi Arabia suffers from a major deficiency in both the quantity of weekly allocated PE time as well as the quality of the programme offered. In the primary schools, students get two 45 minutes of PE weekly, while in the secondary and intermediate levels, it is only one 45 minutes of PE a week. Studies have demonstrated that the actual time of a PE lesson was not more than 32 minutes (Al-Hazzaa, 1992; Al-Hazzaa, 1995a; Al-Hazzaa & Almuzaini, 1999). The school: PE programme emphasized the traditional competitive sports such as soccer and track & field, at the expense of lifetime fitness activities, weight training, and recreational and outdoor pursuits. Females, however, do not have PE at all.

Studies that monitor heart rate during PE lessons in Saudi schools have given us valuable information on the intensity of these PE lessons (as shown in Table 10). The percentage of time students were engaged in moderately intense activity (above 60% of individual's maximal heart rate reserve) varied from about 30% in primary school (Al-Hazzaa, 1992; Al-Hazzaa, 1995a) to 39% in intermediate schools (Al-Hazzaa and Almuzaini, 1999). These figures translate to about 13 minutes, at most, of activity that is high enough to promote cardiorespiratory fitness.

Correlational analyses of children's activity levels during PE lessons with their activity levels outside school reveals a significantly moderate correlation coefficient ($r = 0.48$; $p<0.05$) (Al-Hazzaa, 1995a; Al-Hazzaa and Sulaiman, 1993). This means that students who were active in PE lessons were likely to be active outside school time, too, and vice versa. This finding has some implications on how PE teachers conduct their classes. They should, therefore, give great attention and care to those students who are inactive in PE lessons.

Other determinants of physical activity in Saudi people

Physical activity is influenced by both genetic and environmental factors (Perusse et al., 1989). It is estimated that the genetic effects of habitual physical activity are at 20% of the total variation (Perusse et al., 1989). In one of our studies on 40 pairs of Saudi prepubescent brothers (Al-Hazzaa, 1994). We found a heritability coefficient of 0.52 ($P<0.01$) in the percentage of time spent at heart rate above 159 bpm. However, the heritability coefficient was much lower when physical activity of moderate intensity was considered.

Table 10. Results of heart rate telemetry of school children and adolescents during physical education lessons

Variable	Study 1	Study 2	Study 3
School level	Primary	Primary	Intermediate
Subject Age(yr)	9.9 ±1.3	10.4± .96	14.4 ± 1.7
Body fat %	14.6 ±5.8	19.5 ± 10.4	17.9 ± 8.9
Distance covered during P.E (km)	1.93 ±.17	1.76 ± . 93	1.81 ± 1.2
Time HR>159 bpm (%)	28.4	32.6 ±2.4	39.4 ± 19.4
Time HR>159 bpm (min)	11.4	13.0	12.6

Study 1 = Al-Hazzaa, 1992.
Study 2 = Al-Hazzaa, 1995a.
Study 3 = Al-Hazzaa and Almuzaini, 1999.

Television viewing is another environmental factor that influences physical activity. In Saudi children, television watching showed an inverse relationship with the amount of time spent in physical activity (Al-Hazzaa, 1995). Television viewing was shown, else-where, to be a strong predictor of obesity in children and adolescents (Dietz, and Gortmaker 1985).

Normative beliefs of parents regarding the physical activity of their children were also shown to be predictors of physical activity behavior in children and adolescents (Sallis et al., 1992). In one of our studies (Al-Hazzaa, 1995), the correlation between children's physical activity and how parents valued the importance of physical activity for their children was shown to be significant ($r = 0.29$; $p = 0.0001$). Also the activity level of the parents could influence their children's physical activity. Saudi parent-child physical activity correlation coefficient was found to be 0.20 ($p = 0.002$).

Tables 11 and 12 present the most important reasons for Saudi adults to be active or inactive, respectively, according to two different studies with samples from Riyadh (Al-Hazzaa, 1990; Al-Refaee and A-Hazzaa, 1997). Maintaining health (including losing weight) was the number one reason for both young and middle-aged Saudi adults. Recreation and socializing came second and third, respectively. The major barriers to physical activity of Saudi adults are shown in table 12. Time constraints seems to be the major factor for not being physically active. In one of the physical activity studies (Al-Refaee and Al-Hazzaa, 1997), the physical activity level was lower for those who were married, working in the private sector, working two shifts, or who had only one day off during the week.

Table 11. Most important reasons for being physically active among Saudi males (results were from two adult studies in Riyadh)

Variable	Study 1 (College males)	Study 2 (Adults)
Reference	Al-Hazzaa,1990	Al-Refaee & Al-Hazzaa,1997
Age (yr.)	21.9 ± 2.1	41.5 ± 10.2
Reason (%)		
Maintaining health	50.6%	42.9 %
Losing weight	*	21.0%
Recreation	35.5%	18.6 %
Socializing	7.3%	5.9%
Medical Advice	____	5.8%
Miscellaneous	6.6 %	5.8%

* Included with maintaining health in this study

Promoting physical activity in Saudi Arabia

Obviously getting people to change their life style in relation to exercise habits requires a tremendous effort from those involved in governmental policy, community health, school education, municipalities, etc. However, the following suggestions for promoting physical activity may be implicated:

1. National policy initiatives are needed for promoting physical activity. The Saudi Sports Medicine Association, the Saudi Physical Education Federation, and the Saudi Federation for Sports For All should play a leading role in developing such initiatives for the promotion of physical activity among Saudi children, adolescents, and adults.

2. Implementing physical education curricula and instruction that emphasizes daily PE lessons with enjoyable participation in lifelong physical activities.

Table 12. Most important reasons for being physically inactive among Saudi males (results from two adult studies in Riyadh).

Variable	Study 1	Study 2
Reference	Al-Hazzaa,1990	Al-Refaee & Al-Hazzaa,1997
Reason (%)		
Do not have time	62.7%	47.3%
Lack of place or space	17.3%	23.5 %
Medical reason	7.3%	9.9%
Fear of embarrassment	4.3%	9.2 %
Not convinced of benefits	----	4.1%
Miscellaneous	8.4 %	6.1%

3. Providing physical education instruction and extracurricular activities that meet the needs and interest of all students, including the disabled, the obese, the unfit, and those with chronic health problems.

4. Parents and health care providers should advocate quality physical activity instruction in schools.

5. Provision for more physical activity facilities and programmes, as well as making school sports facilities available for community use after school hours and at the weekend.

6. Medical communities and associations must be involved in a public education effort aimed at encouraging active life styles and healthy eating habits among Saudi people.

7. Primary care providers have an important role to play in physical activity promotions. by providing routine assessment and counselling on physical activity and fitness for their patients.

8. Active approaches requiring individual initiative (such as enrolling in exercise programmemes), though they are partially successful in promoting physical activity, are not enough. Passive approaches should be incorporated, too. Such strategies include providing walking trails, time allowance for exercise at work, and having school facilities opened for community use after school hours.

9. Opportunities for physical activity should be made available for a wide range of people including the elderly, children, and women. For municipalities, this means establishing safe and convenient walking, jogging, and bicycling paths, and playgrounds and fitness areas for children and adults. Schools could also hold a health, fitness and physical activity fair and invite parents as well. Summer camps for obese or disabled children and adolescents should be fully considered, where they can learn about fitness and physical activity.

10. Business organizations can support healthy life style by establishing fitness and wellness programmemes and providing exercise facilities with trained leaders in physical activity, fitness and health promotion.

11. Innovative ideas for planning fitness facilities should be fully explored. This may include such places as shopping malls.

12. Colleges and universities should consider establishing programmes in exercise sciences and fitness, which can provide trained graduates in such areas as fitness, wellness, and physical activity promotion.

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HABITUAL PHYSICAL ACTIVITY IN KUWAIT

Jasem Ramadan
Department of Physiology, Faculty of Medicine,
Kuwait University, Kuwait

INTRODUCTION

A link between physical activity and health has been suspected for more than 2000 years. Formal scientific documentation in this matter was initiated in the mid-20th century (Morris, et.al., 1953; and Morris, et.al., 1966). Since that time, the positive health benefits of physical activity (Morris, et.al., 1990; Paffenbarger, et.al., 1986; Powell, et.al., 1987; King, et.al., 1989; Drinkwater, 1994) and, conversely, the negative effects of physical inactivity (McGinnis and Foege, 1993; Hahn, et.al., 1986) have consistently been documented by epidemiological controlled experimental and clinical studies. In parallel with the growth of scientific information on the subject, the media in developed countries of the West continually promote the desirability of exercise for health, fitness, and fashion. In the 1970s and 80s, there was a 'boom' in the growth of aerobics, running, jogging, and walking in the United States. In the Gulf region this trend obviously started later, only in the 1990s. In the Gulf, public awareness of physical activity and fitness is still a goal to be achieved. However, public awareness of fitness has done little to change the fact that the majority of the population of the US (Centers for Disease Control and Prevention, 1991) and other developed countries remain essentially sedentary (Stephens and Thomas, 1994). Physical activity surveys conducted at national level In several countries (Risk Factor Prevalence Study, 1990, Stephens and Craig, 1990; and Allied Dunbar National Fitness Survey, 1992) indicate that only 15% of adults engage in vigorous physical exercise and that 15 to 40% are totally sedentary. The aims of our study in Kuwait were: (a) to show the relationship between physical activity, the physique and the cardiovascular fitness of Kuwait adult males, and (b) to survey the possible avenues available for physical activities in Kuwait.

METHODS

Subjects

The subjects were healthy adult males 18-37 years of age. All subjects were nondiabetic, had no evidence of cardiorespiratory diseases and were not currently taking any medication. One inactive group and two active groups were studied. Subjects that had not participated in any regular physical activity during the week were considered inactive (group 0). Subjects that were regularly active once a week (group 1) or repeated regular physical activity two or more times a week (group 2) were assigned to the two additional activity groups.

Design

All subjects underwent a maximal graded treadmill exercise test and body composition assessment. Activity levels were obtained from a questionnaire that included information on the type, frequency, duration, and intensity of the physical activities performed during the week.

Maximal graded exercise test

The Bruce treadmill exercise protocol was used. Both the speed and inclination of the treadmill were increased every three min. Oxygen consumption (VO_2) and carbon dioxide (VCO_2) production were continuously monitored using an automated system (Quinton model Q.plex 1, Seattle, Washington, USA). VO_2 max was defined as the highest VO_2 observed during any one minute of the exercise test. The criteria used for attaining VO_2 max included a plateau of VO_2 with increasing work rate, a respiratory exchange ratio >1.05, and a maximum heart rate within 5 beats/min of the age-predicted maximum.

Height, weight, and skin-fold thickness were measured on all subjects. Body fat was determined using skin folds measured at seven sites according to the equations of Baumgartner and Jackson (1982). Body weight was measured to an accuracy of 0.1 kg, using a Detecto scale (Detecto Inc., Webb City, MO, USA).

Sports and Fitness Facilities

We surveyed the avenues available for sports and fitness performance throughout the country and took pictures of some of those facilities.

RESULTS

A variety of sports and fitness facilities are available in Kuwait. Some places are used by special population groups and others are used by the general public. Such facilities consist of (a) standard sports clubs, used by athletes of different competitive sports and activities; (b) schools, university, and other educational institutions sports facilities, which are used for the educational programmes as well as leisure time activity places; (c) private sports centers, health clubs, where people pay fees for the usage of such facilities and become members; (d) hotel fitness centers, which provide sports and fitness facilities to local residents as a marketing and promotional tool for their hotels, and provide a membership advantage to be used by selected community individuals; (e) youth centers, scattered throughout the country to be used by the youth in the various cities and communities, sponsored by the state and supervised by the Public Authority for Youth and Sports (PAYS), in which proper and qualified supervisors are available; (f) community sports playgrounds and walk-jog tracks to be used by the public and supervised by PAYS; (g) the beach front, extending from north to south of Kuwait along the sea side. It is used by both the private sector and the general public; and (h) home exercise equipment and pools, which individuals use at their own pace in specially allocated areas of their homes.

Comparison of body composition and maximal exercise performance in the three groups are presented in Table 1. Subjects that reported no routine physical exertion during the week weighed nearly 12 kg more than those reporting routine exercise once a week and 14 kg more than those reporting two and more exercise sessions per week (Figure 1). This occurred in spite of similar average body height in all groups. The body mass index (kg/m2) was significantly higher in the totally sedentary group (30.5) than in the groups reporting one (26.4) and two or more (25.2) exercise sessions per week. This suggests that the weight differences between the groups were mostly due to differences in body fat contents. This was confirmed by the significantly larger skin folds present in the sedentary group than those present in the exercising groups, at the sub-scapular, mid-axilla, chest (Figure 2), triceps, thigh, calf (Figure 3), abdominal and supra-iliac regions (Figure 4). The sedentary group had 10-12% more body fat calculated from the skinfolds, (Baumgarther and Jackson 1982) than the more active groups (Figure 5). The body fat was more than 13 kg higher in the totally sedentary group than in the more physically active ones. Body fat thus accounted for most of the excess body weight present in the inactive group. The larger body fat was also reflected in the larger biceps and calf circumferences present in the inactive than in the active groups (Figure 6). The large differences in body composition observed between the sedentary group and the active ones occurred without major differences in fitness levels between the groups. Thus, the resting heart rates did not differ significantly between the sedentary group and that reporting one exercise session per week, in spite of nearly 13 kg excess body fat in the former compared to the latter (Figure 7). Resting heart rate was 6 beats/min lower ($P<0.2$) in the group reporting 2 or more exercise sessions per week compared with that reporting one session per week in spite of similar body fat content (11 kg) in the two groups (Figure 7). Thus, the differences in intensity and frequency of routine physical exercise between these groups of subjects were not sufficient to result in significant differences in resting heart rates, i.e. were not enough to produce cardiovascular conditioning. However they were associated with large differences in body weight, skin folds and fat weights. The absolute rates of maximal exercise oxygen consumption (VO_2 max) did

Table 1. Physical characteristics and exercise performance of subjects

Test	Group(0) (n=10)	Group(1) (n=19)	Group(≥2) (n=16)
Age (year)	29.20±2.43	27.21±1.55	28.56±1.50
Height (cm)	170.10±2.11	169.4±1.41	170.6±1.91
Weight (kg)	87.40±5.01	75.85±2.97*	73.31±3.15*
BMI	30.47±2.21	26.41±0.99*	25.21±1.11*
Fat (%)	25.75±3.41	18.99±1.85**	17.17±2.12**
Fat weight (kg)	23.72±4.41	15.02±1.92^{+}	13.20±1.91^{+}
VO2 max(ml.min-1.kg-1)	39.38±2.50	40.97±1.71	42.43±2.30
HR.max (bpm)	185±3.62	188±2.84	181±2.80
RQ	1.80±0.40	1.09±0.30	1.05±0.33

Values are mean + SE.
Significant at* p<0.05, **p<0.01, + p<0.001.

not differ between groups (Figure 8). When the VO_2 max data were normalized per body weight (Figure 9, VO_2 max in ml/min per kg body weight), the sedentary group had slightly lower aerobic capacity (39.3) than the once a week active (40.9) or than the two or more times per week (42.4) active group, a reflection of the lower proportion of oxygen consuming tissues present in the less physically active subjects. The differences in VO_2 max/kg however did not reach statistical significance (P<0.6). When the maximal exercise oxygen consumption was expressed per unit of lean (or fat free) body mass (in ml/min. per kg fat free mass, Figure 10), the group active two or more times per week had a slightly higher aerobic power per unit lean than the others, but the difference did not achieve statistical significance (P<0.6). Thus, the differences in physical activity reported by these groups were not sufficient to result in different levels of aerobic conditioning. In summary, in spite of minimal differences in aerobic fitness, the sedentary group had a much higher body weight, higher skin folds and a higher body fat content than the more physically active groups.

DISCUSSION

The availability of sports playgrounds and fitness facilities in Kuwait appears to be adequate for both the Kuwaiti citizens and for some of the private sectors. There are more than 18 public sports clubs and more than 30 private and hotel fitness centers in different parts of the country. Facilities are available to the young population either at schools, university, educational institutions and in the youth centers present in most parts of the country. Properly supervised places are available for those who need special attention, and unsupervised facilities are available to those who want to be on their own. Most of these places have both indoor and outdoor facilities. This is an important factor in Kuwait for participation in any form of physical activity particularly because of the harsh summer climate. Participation in physical activity seems to be very low in Kuwait. This is not because of lack of sports places and fitness facilities, but due to lack of education and media promotion of physical activity, as well as inadequate preventive and health maintenance campaigns for preventing diseases such as diabetes and hypertension and other cardiovascular diseases (Pate, et al., 1995). There are also strong cultural traditions that consider physical activity lowly or degrading and ennoble the sedentary way of life.

The data indicate that large differences in body weight, BMI, skinfolds, body fat content and fat percentage exist between sedentary and minimally physically active groups. The reported differences in routine physical activity may reflect the fact that overweight and obese subjects are physically inactive. By contrast non obese subjects that maintain 14 kg less body weight and 13 kg less body fat, tend to be more physically active, exercising at least once per week. The exercise levels reported by the subjects in these groups were insufficient to result in aerobic conditioning. Only in the group reporting two or more exercise sessions per week was the resting heart rate slightly but not significantly lower. The aerobic capacity and the maximal oxygen consumption per unit lean body mass were slightly but not significantly larger in the active than in the sedentary group. Blair and his colleagues (1995) observed a reduction in mortality risk in men who maintained or improved physical fitness. However, in our groups, minimal exercise levels insufficient to result in aerobic training were associated with significantly lower body weight and body fat contents in those groups reporting some routine physical activity. This finding may reflect the presence of higher levels of energy expenditure for daily physical activities in the groups reporting some routine physical exercise sessions per week than in those reporting no routine exercise sessions at all. The findings also indicate the presence of very low rates of daily energy expenditure in the group that reports no routine physical exercise sessions. Measurements of daily energy expenditure and a prospective study of the effects of minimal levels of routine physical activity on body composition should shed light on the nature of the possible cause and effect relationship that exists between the low levels of physical activity and the large difference in body composition present in the groups of Kuwaiti subjects observed. In conclusion, physical activity should continue to be encouraged (Blair and Connelly, 1996) to avoid the sedentary habits in Kuwait, the Gulf and the Arab countries. We quote: "A little exercise is better than none, while more is better than a little" (Lee and Paffenbarger 1996).

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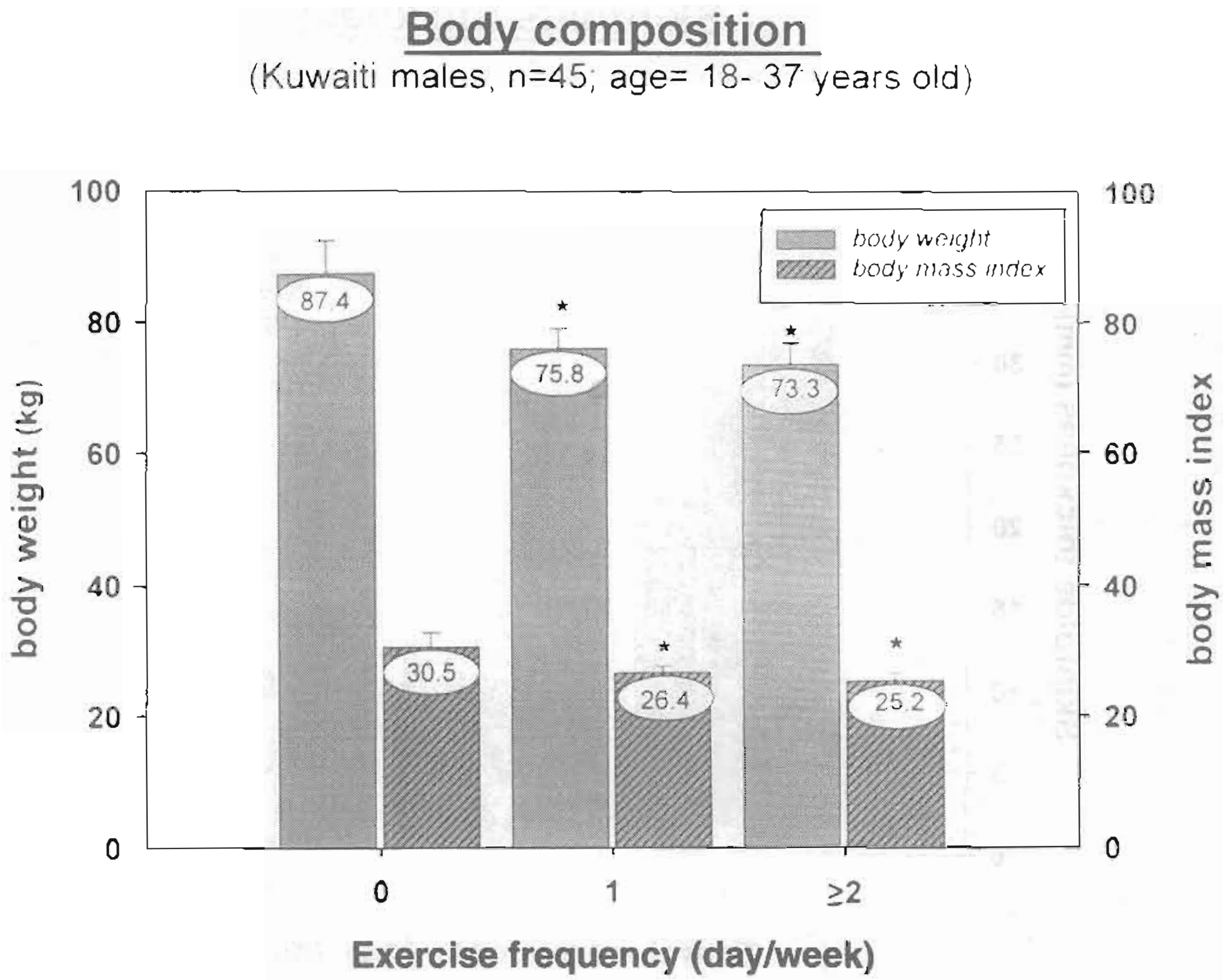

Figure 1 . Body composition for exercising and non-exercising groups. Significantly lower than in non-exercising group (0) at * $p<0.05$.

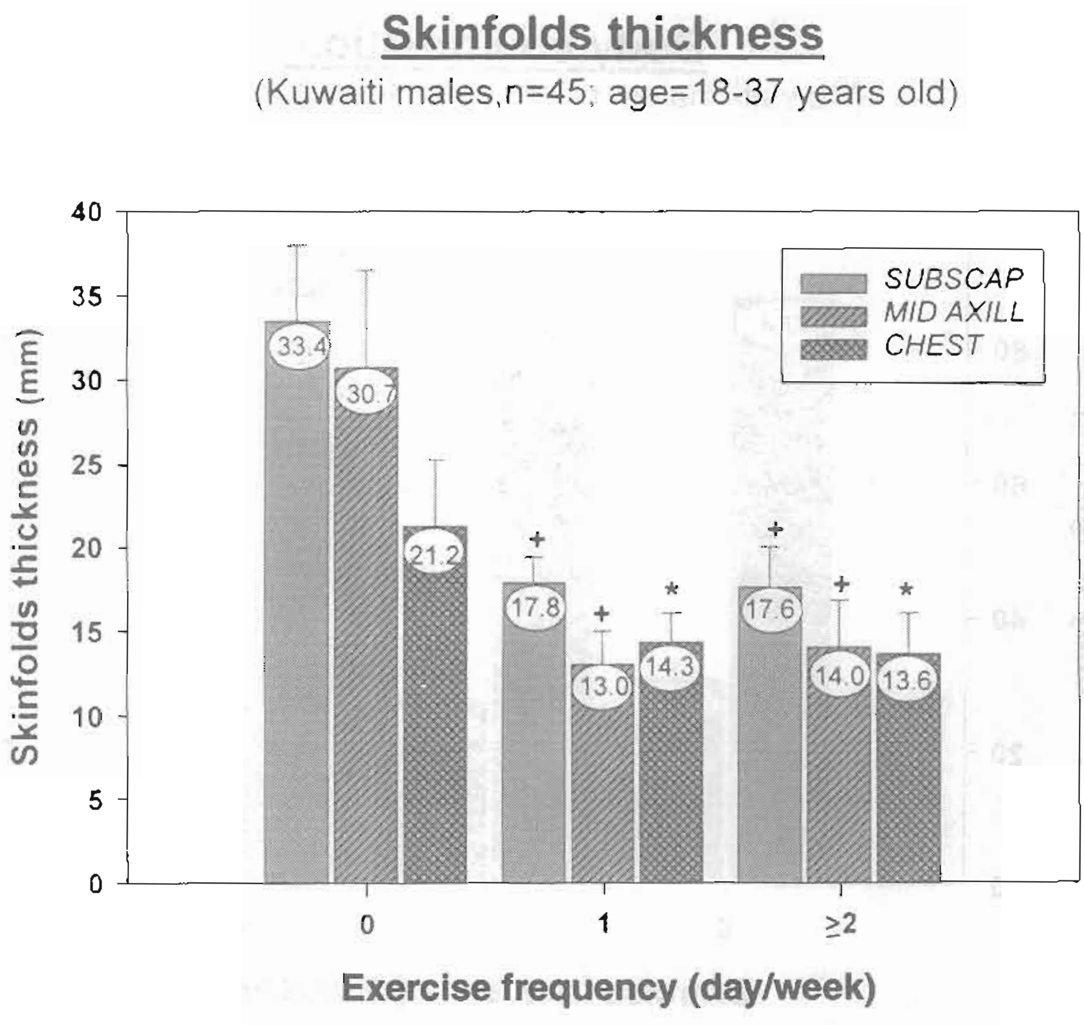

Figure 2.Skinfolds thickness for exercising and non-exercising groups. Significantly lower than in non- exercising group(0) at * $p<0.05$,+ $p<0.001$.

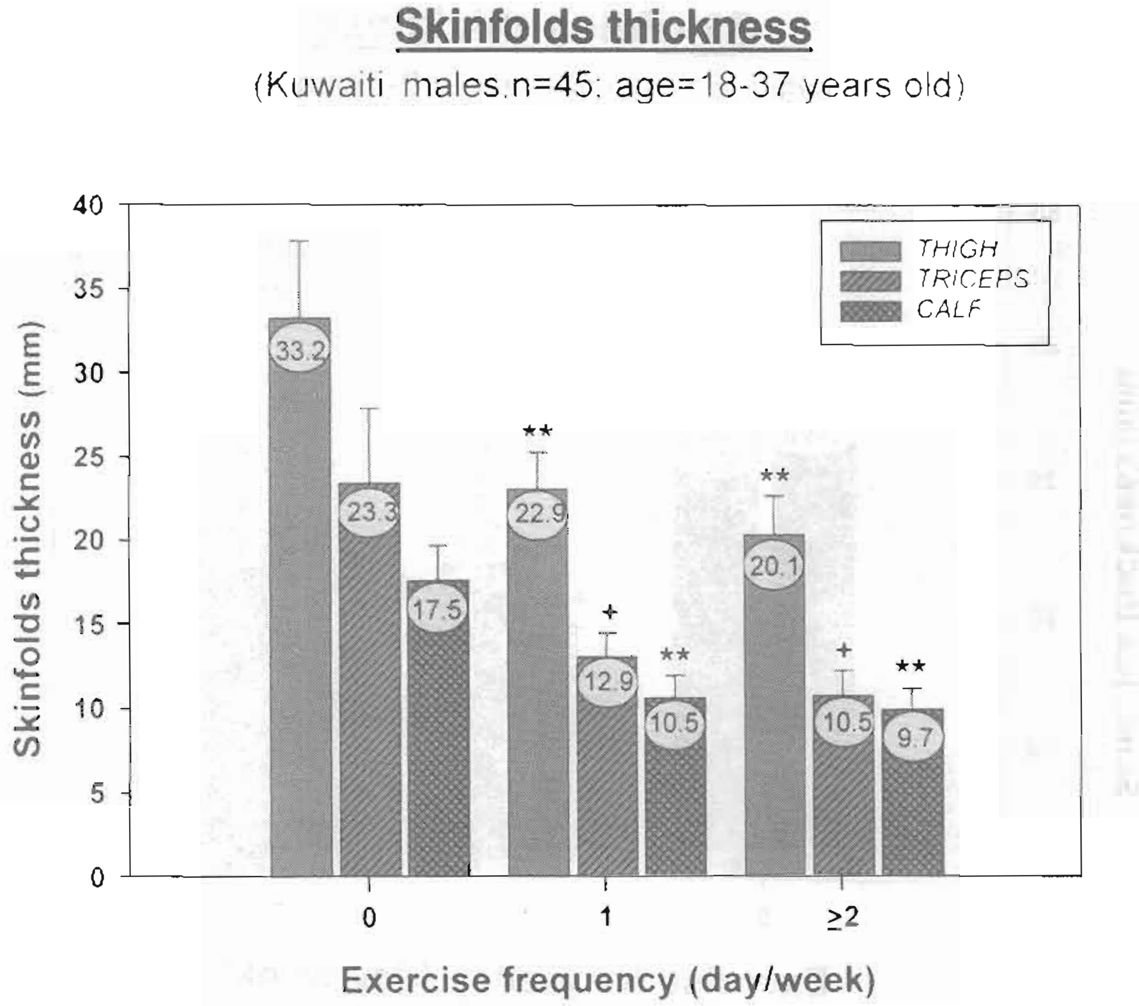

Figure 3.Skinfolds thickness for exercising and non- exercising groups. Significantly lower than in non-exercising group (0) at ** p<0.01, + p<0.001.

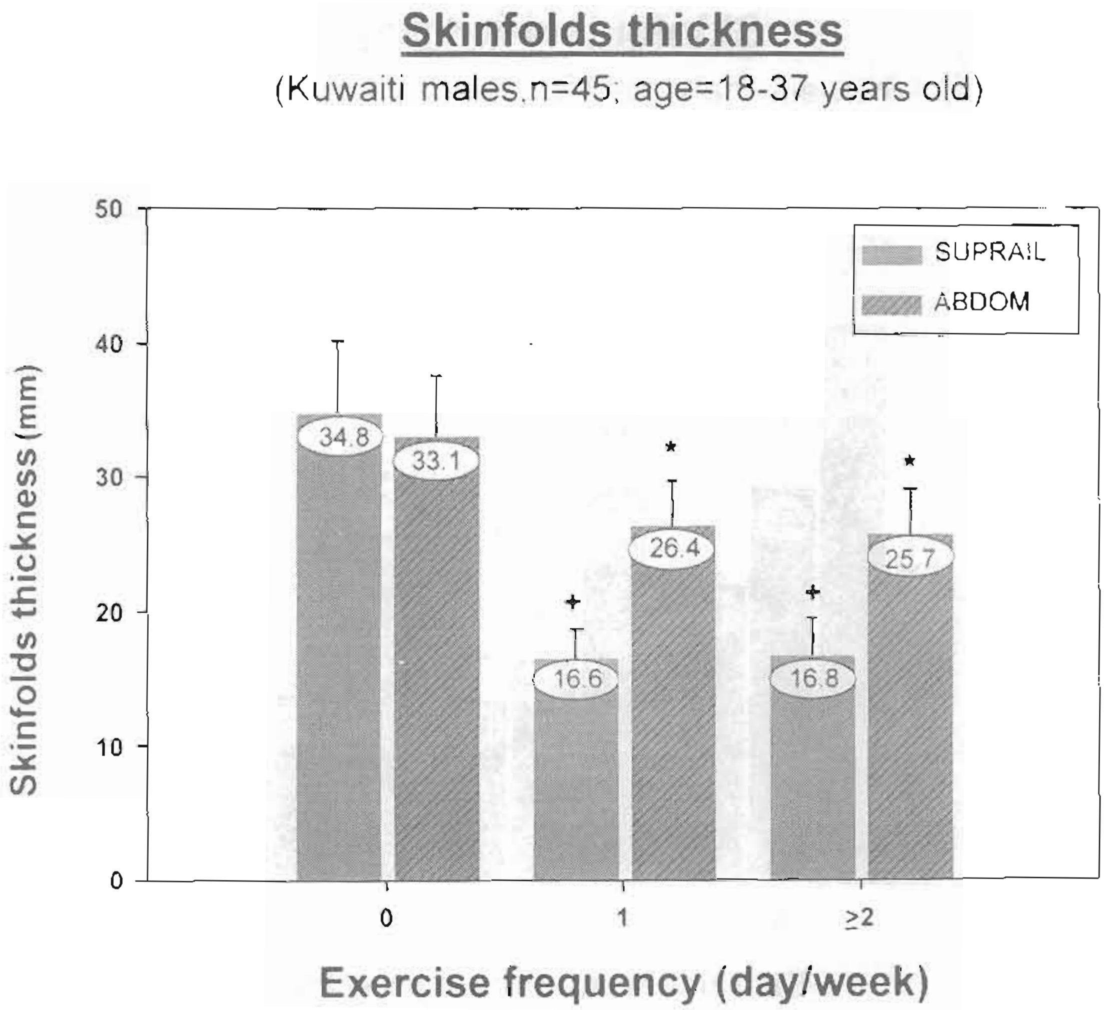

Figure 4.Skinfolds thickness for exercising and non-exercising groups. Significantly lower than in non-exercising group(0) at *p<0.05,+P<0.001.

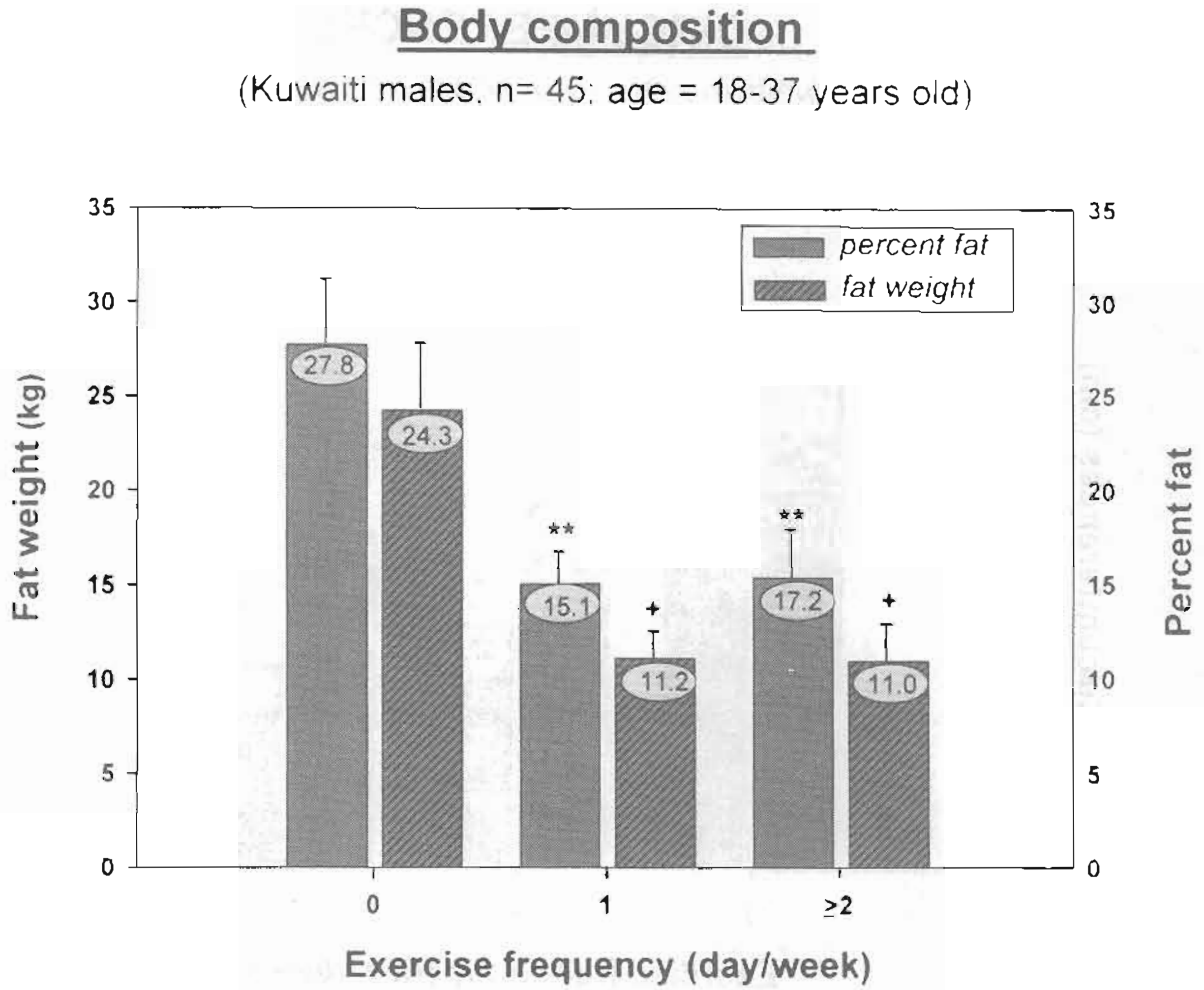

Figure 5.Body fat for exercising and non-exercising groups. Significantly lower than in non-exercising group(0) at **p<0.01,+p<0.001

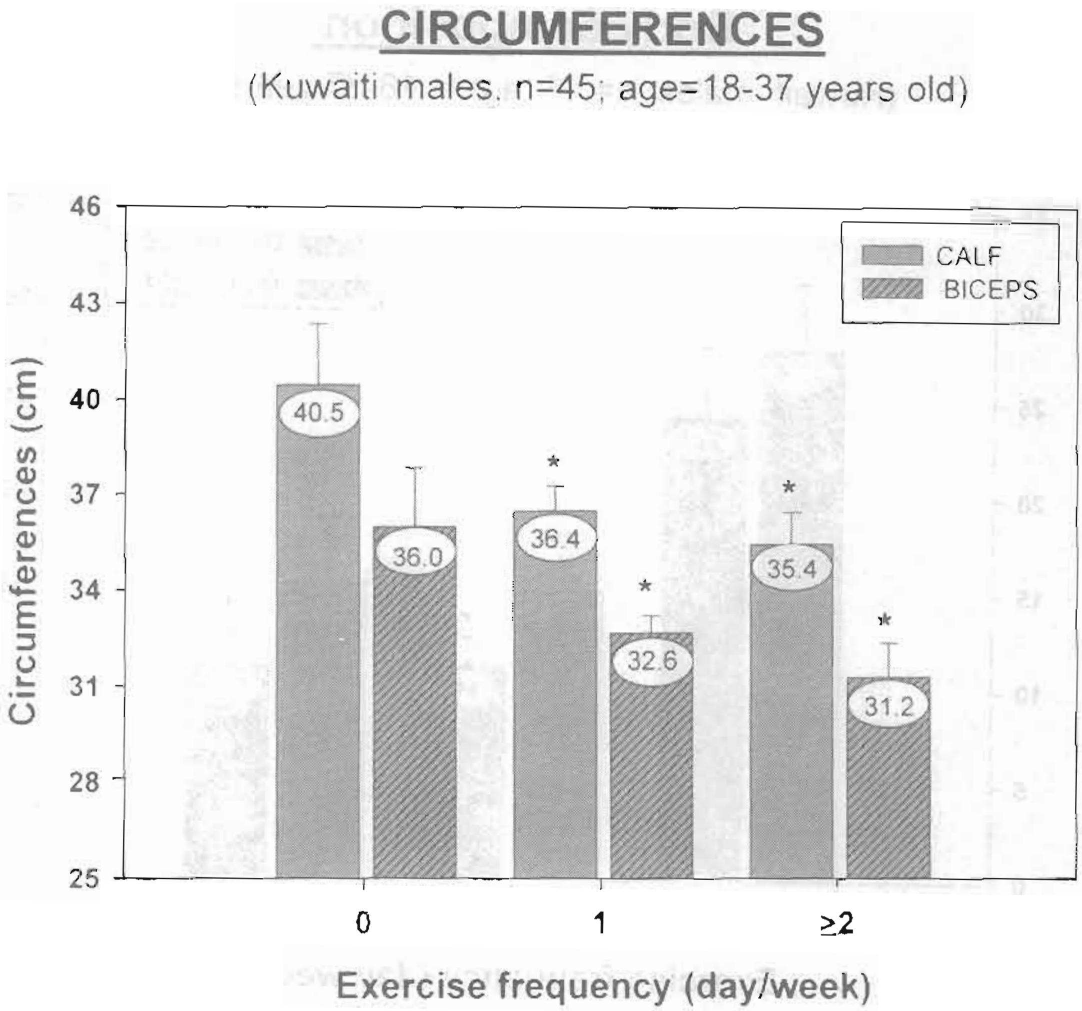

Figure 6.Circumferences for exercising and non-exercising groups. Significantly lower than in non-exercising group (0) at * p<0.05.

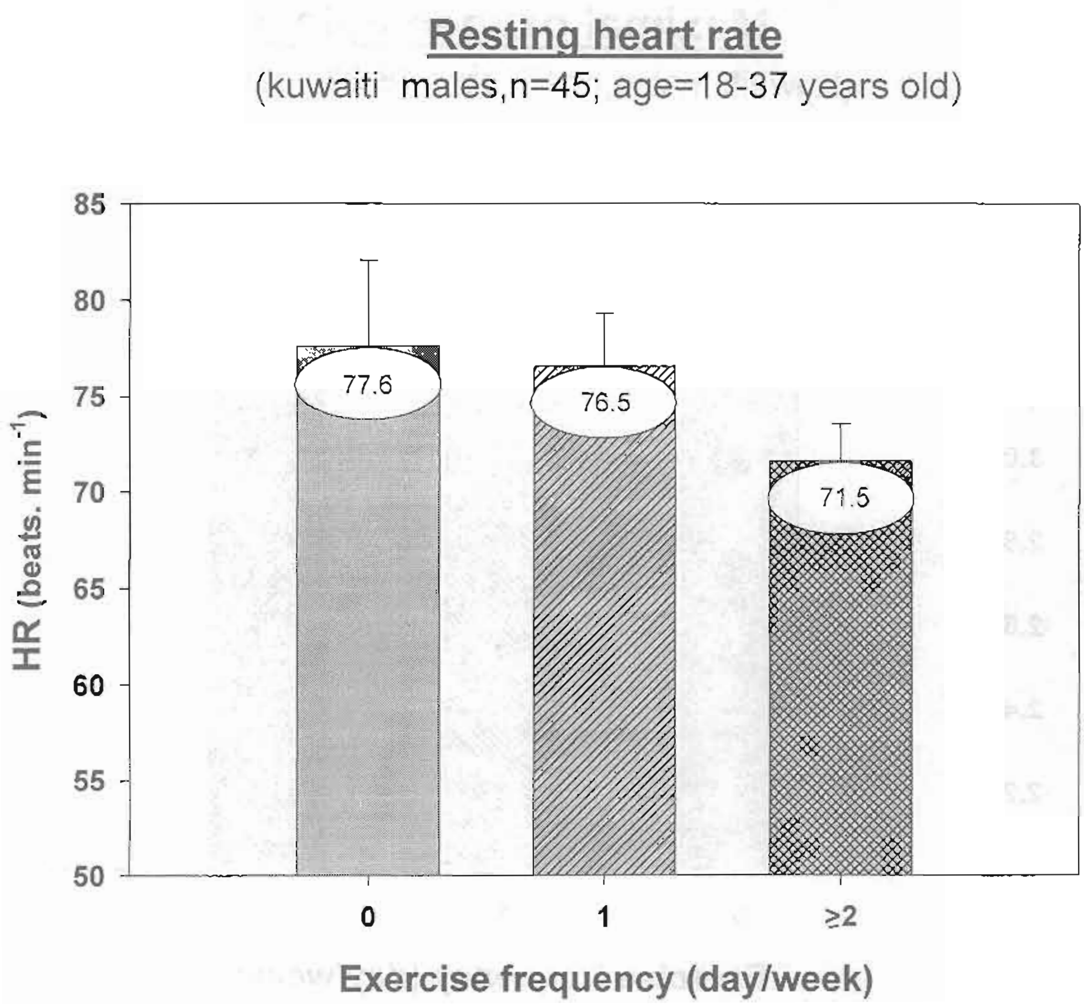

Figure 7.Resting heart rate for exercising and the non-exercising groups.

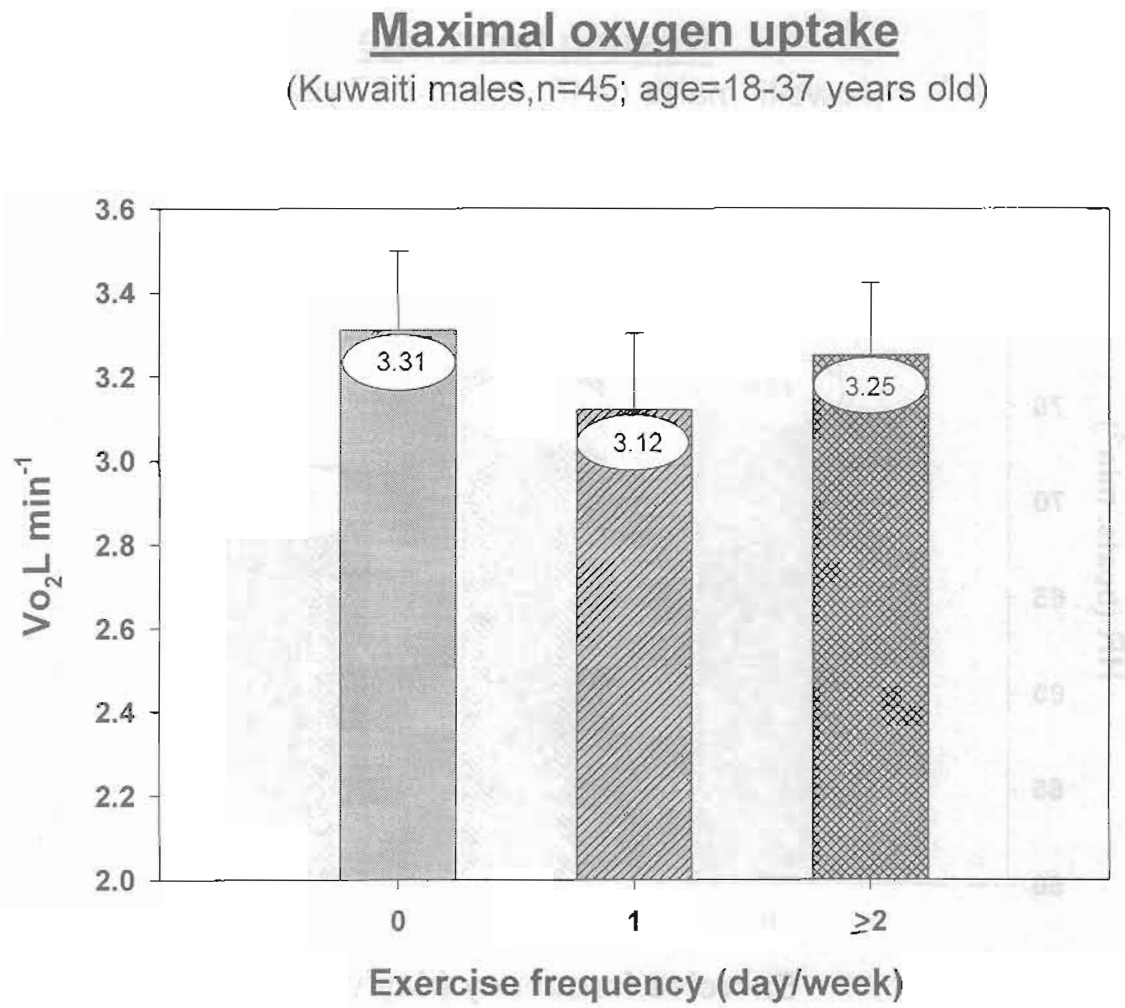

Figure 8.Maximal oxygen uptake for the exercising and non-exercising groups.

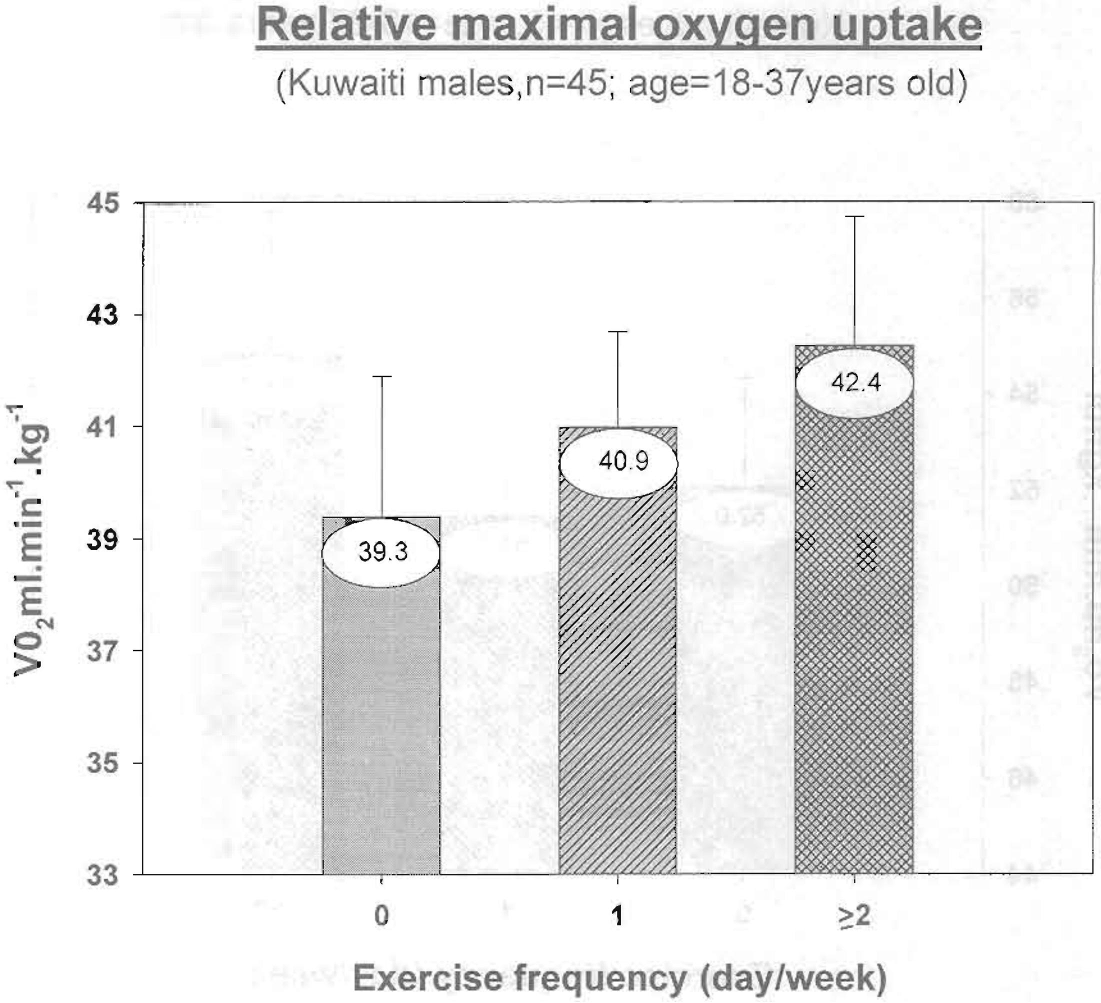

Figure 9.Maximal oxygen uptake relative to total body weight in exercising and non-exercising groups.

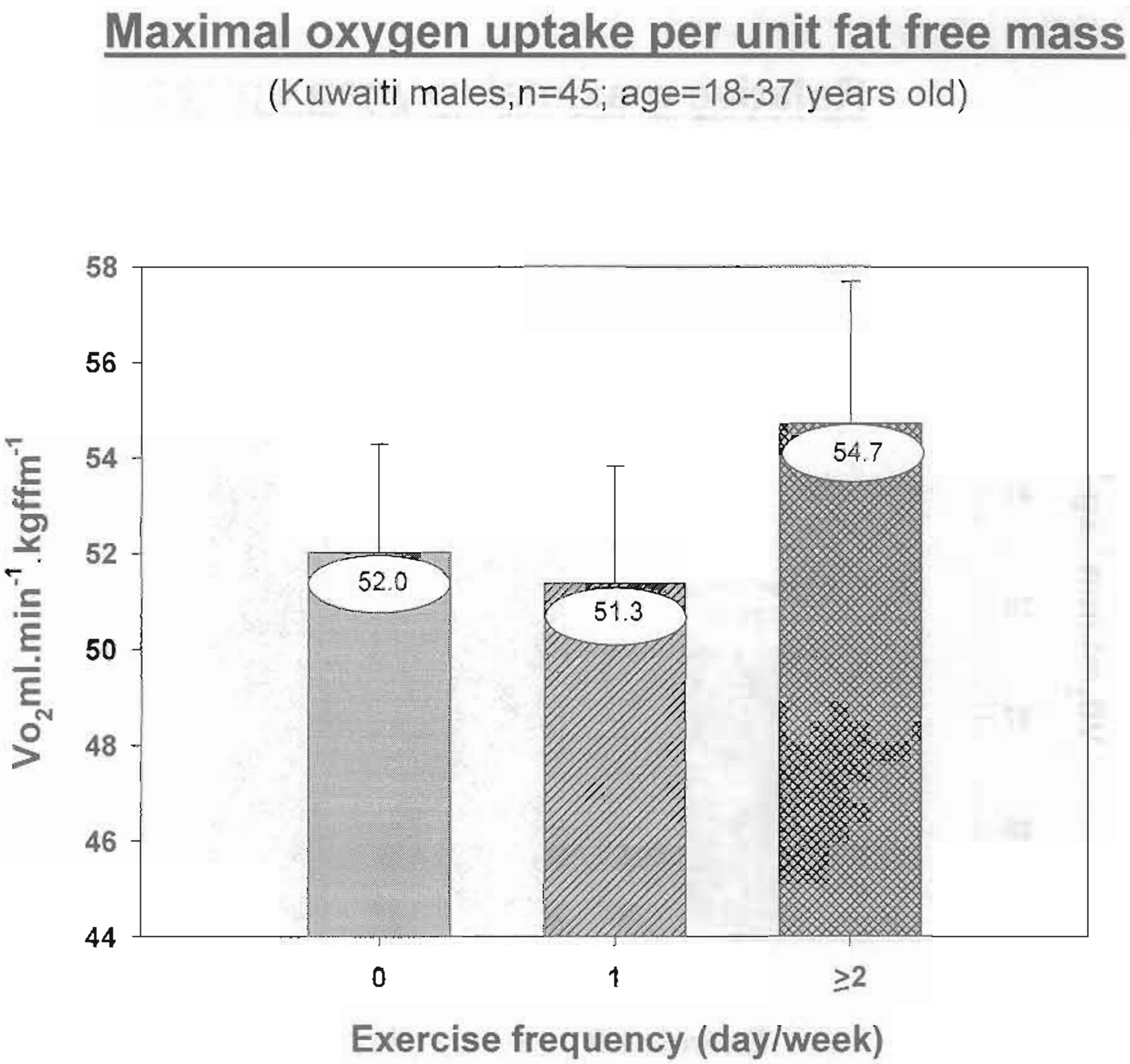

Figure 10.Maximal oxygen uptake relative to fat free mass in exercising and non-exercising groups.

AN OVERVIEW OF THE PHYSICAL ACTIVITY STATUS IN JORDAN

HAMED R. TAKRURI[1] *and AYDE F. MELHIM*[2]
[1] *Faculty of Agriculture, Jordan University,* [2]*Faculty of Physical Education, Yarmouk University, Jordan.*

INTRODUCTION

Physical activity is an important element in maintaining body fitness, preventing modern affluence diseases and increasing productivity (Williams, 1997;). The prevalence of chronic diseases related to malnutrition such as cardiovascular diseases (CVD), diabetes mellitus and renal diseases has increased in Jordan in the last three decades (Takruri, 1994; MOH/HKJ, 1997); CVD are the leading cause of death and diabetes mellitus was proved to be highly prevalent (Ajlouni et al 1997).

Physical activity has developed gradually and slowly in Jordan since the early twenties of this century (The Physical Activity Committee/ Ministry of Youth and Sports (PAC/ MYS), 1993).

Recently, and since the nineties, promotion in physical activities has entered a new era. Different elements including manpower, sports establishments, legislations, scientific material and supporting services have been considered through what is called an Integrated System Approach of Promotion (PAC/MYS, 1993).

The development achievements have been made possible by proposals to build up essential pillars for athletic activity, training of players, providing suitable curricula of physical activities, data collection and research encouragement, improving the athletic media and provision of medical services and social security for players and club members (PAC/MYS, 1993).

The Ministry of Youth and Sports have adopted such development plans through holding **The National Conference for Development of Physical Activity in Jordan** on December 19, 1991. Many proposals were discussed and were then implemented through projects during the last few years.

A committee (The Physical Activity Promotion Committee) was assigned to follow up such development. It held 51 sessions to put forward plans, practices and fields for such promotion programmes and the way they are to be implemented. The committee suggested 9 programmes, which were classified into 5 main fields, namely: manpower, material establishments, organization and legislation, data base formation and finally, supporting services.

Thus planning was inaugurated to achieve a boost in "Sport for All", a slogan initiated years ago, and to create a spirit of competition in sports at the local, national, regional and international levels.

A brief discussion of these planning programs is given in the following paragraphs. It is then followed by highlights in the contribution of different sectors of the community in the physical activity practices, with recommendations for promoting the physical activity status in Jordan.

Plans for the Promotion of Physical Activity in Jordan
1920-1929:

Historical Background

Physical activity started and was gradually developed by the establishment of the Emirate of Trans-Jordan in 1921. The physical activity session at school was considered an important session. It included football, some track and field games and Swedish gymnastics. Football was introduced to the country in 1992. Other games such as cycling, hockey and polo were also introduced and mainly played by the armed forces. The first sports federation was started in Amman in 1929.

1930-1939

More school physical activities were practiced. Basketball and volleyball were introduced in 1937/1938. Other sports teams and more sport federations were also established and competition matches with the Arab teams were organized.

1940-1949

The number of clubs increased and included famous clubs such as Amman Club, Shabab Club, Jazira Club, Sarih Club (in Irbid). In 1944 the general federation for sports was formed as a legislative authority which coordinates and supervise all sport activities. During this era more and more matches and competitions took place.

1950-1959

More attention was paid to the physical activity in schools. A number of graduates in Egyptian institutes started to join clubs and schools to teach and train physical activity and guide athletics. The General Federation for Sports formulated many committees for sports; participation in many sports in Alexandria, Beirut and Damascus was organized.

Woman started to participate in physical activity and sports and the preparative Olympic committee was formed (in 1957).

1960-1969

The Jordanian Olympic Committee was formed in 1961. It was responsible for the participation of Jordan in the 3rd and 4th Arab Games Championships (Morocco, 1961 and Cairo, 1965 respectively).

The Youth Care Institution was formulated in 1966 to replace the Olympic committee and be in charge of coordination and supervision of sports in Jordan. This was an era for reformulation of clubs and federations. Further arrangements for a number of Pan-Arab Championships took place. More sports federations were formed (e.g. Chess Federation, Water Skiing Federation). The number of sport clubs increased (from 19 to 43). A famous sports event was the participation in the World Cup Championship in Munich, Germany.

1970 to date

Many events and activities of development have taken place since the early seventies, which include:

- The Army Sports Federation was formed in 1971.
- Participation in many championships at international levels.
- The Ministry of Youth and Sports was established in 1984.
- The number of athletic clubs jumped to 239 with more participation at regional and international levels. Many prizes were gained.
- The establishment of Prince Hassan Sports City in 1990 and many sport complex centers were established in different governorates.

The present sports status at this stage can be summarized as follows

1. The increase in physical activity establishments and sports facilities.
2. The increase in the number of sports clubs and athletic training centers.
3. The increased number of physical activity federations.
4. The increased number of trainers and referees.
5. Organization of many sports championships at the Pan-Arab and continental levels.

6. Hosting many clubs and federations from many Arab and other countries, and mutual planning for athletic and sports events.
7. Establishing directorates for youth care in all of the governorates.
8. The participation in sports and physical activity events at regional and international levels.
9. The rise in the quality of care available to sports teams, including health care and nutritional counselling.

Promotion Programmes

Basic Input Needed for Development: The following are the main input needed for development and promotion of physical activity in Jordan (PAC / MYS, 1993):

a) Manpower represented by players, teachers, trainers, referees, administrative bodies.

b) Courts and physical establishments.

c) Regulations and legislations

d) Scientific information needed for making decisions and policies.

e) Supportive services such as sports security, athletic media and social security.

Output: Objectives and Expected Results

The following were considered to be the eventual outcomes of the promotion plan:

a) The development of a modern and civilized understanding of athletics in the community through building a feeling of cooperation and honorable competition.

b) Building of new athletic values by the Jordanian people which concentrate on the importance of athletics for the individual, the community and humanity as a whole.

c) Achievement of practising athletics by all sectors and members of the community: Sports for All.

d) Promotion of physical fitness as a means to better health and joy and more productivity.

Construction of low-cost physical activity establishments

Main objectives included the provision of low-cost establishments in different districts of the country to facilitate achieving "Sports for All" through helping clubs to improve their performance; verbalizing the role of municipalities to contribute in providing facilities.

Construction of fields and public squares

The aims of this project include facilitating public participation in sports; making use of fields and public squares for celebrations and leisure time.

Sport information and education

The aim include educating the public on athletics and sports; provision of information media; archiving information material.

A center for sports research and studies

The aims of this project include provision of recent advances on sports and physical activity; putting forward criteria for selection of suitable players for different types of sports; criteria for physical fitness for different age groups; providing trainers and referees with recent advances in their profession and on the right diet and nutrition of athletes.

Establishing a national center for sports medicine

This is concerned with preventive and curative medical care for athletes through provision of first aid, medical examination, physical therapy, counselling on the appropriate diet during training, and before and after the sports event, etc....

Jordanian Sports: Legislative and Administrative Responsibilities

The physical activities and sports did not follow any legislative authority till the beginning of the sixties. As mentioned earlier, a law for the Olympic Committee and Sports Federations was issued. This committee became responsible for care of physical activities till 1966.

In 1966, the Youth Care Institution temporary act was issued, and in 1968 a permanent act was issued for youth care. It recognized the sports federation present at that time. Nine federations were reformulated for: basketball, skating, handball, table tennis, track & field, weight-lifting, boxing, volleyball and chess, (Table1).

Development Projects

Initiation of Sports Schools: The aim of these schools was to build primary-secondary schools which, besides other curricula, would concentrate on physical activity training and physical fitness including sound and adequate nutrition for students.

Such projects aimed at the realization of:

a) Early discovery of students who are extremely fit and naturally prepared for athletics.
b) Founding types of schools, which provide both academic and athletic education.
c) Providing capabilities for graduating students who are superior in physical activity as well as academic performance.
d) Supplying clubs and national teams with talented athletes.
e) Giving opportunity for staff members in physical education to carry out research.
f) Helping students of the Faculties of Physical Education to carry out their training and practical applications.

A center of training athletic teams

The aim of this center was to facilitate ideal training for team members and enable them to get in contact with international teams. Furthermore, the center aimed at realizing a source of income from the facilities it provides.

Preparation and training of physical activity leaders

This includes preparing trainers through courses and workshops, preparing referees, administrators, and hosting regional and international conferences.

Center for the Olympic Committee and physical activity federations

The objectives of this project were:

- Organizing contacts and administrative and technical relations between the Olympic Committee and federations.
- Coordination of the work of federations and the Olympic committee.
- Promotion of the performance of different members of athletic federations.

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In 1976, The responsibility of sports and youth care was transferred to the newly formed Ministry of Culture and Youth, 13 Additional federations were licensed from 1975-1984. These are federations for: Swimming, squash,

shooting, taekwando, cycling, Javelin, tennis, handicapped, wrestling, horse-riding, judo, gymnastics and fencing.

Table 1. Athletic federations in Jordan.

Period	Number	Type of Federations
Youth Care Institution (1966-1975)	9	Basketball, skating, handball, table tennis, track & field, weight lifting, boxing, volleyball, chess.
Ministry of Culture and Youth (1976-1984)	13	Swimming, squash, shooting, taekwando, cycling, javelin, tennis, handicapped, wrestling, horse-riding, Judo, gymnastics, fencing.
Ministry of Youth and Sports (1985-)	3	Physical activity medicine, physical activity information, companies federation

Ref. PAC/MYS, (1993).

Since 1985, the Ministry of Youth and Sports has been in charge of sports and youth care. Three additional federations came into existence: the sports medicine, sports information and companies federation.

Thus it is worth noting that the popular efforts in developing sports preceded the official efforts. However, at present Jordanian sports and physical activity are under the patronage of a ministry with qualified personnel (Table 2). There is a large number of clubs distributed in all of the districts (33% of which are in Amman and 28% in Irbid).

The ministry supervises sports through the ministry headquarters in Amman, directorates of youth care in the governorates, sport clubs and federations and the Olympic Committee.

Contribution to Sports and Physical Activity by Different Sectors in Jordan

Physical Activities and Physical Education in the Schools

The Ministry of Education devotes one or two regular sessions for athletics and physical education per week. Additionally students might participate in extra physical activities outside the classes. All types of physical activities and sports are practised. Qualified teachers train the students; in 1994, 416 B. Sc. graduates, 1285 community college graduates and 8 M. Sc. graduates were employed in the Ministry of Education excluding private schools teachers. Training of teachers is done through the Education Training Center which is responsible for qualifying teachers and providing them with refresher courses.

However there are many limitations and obstacles which face physical education and limit physical activities (PA) at schools, which include:

1. The number of physical education teachers is not enough; some schools do not have qualified teachers.
2. The numbers of sessions is not enough (2 for the first seven primary classes and one for the rest); the time dedicated for PA and sports is not more than 20 minutes.
3. Limited facilities; i.e. play fields, gymnasiums.
4. Limited budget for physical education and activities.

Table 2. Percentage of school students participating in physical activities in 1998-1999.

Students	Primary		Secondary	
	Male	Female	Male	Female
1. Total Number of students	578,935	556,211	83,242	82,233
2. Participants in sports	23,057	12,011	23,256	16,743
3. % Participants	4.0%	2.2%	27.9%	20.4%
- % of (2) participating in :				
- Football	22.3%	-	19.8%	%
- Track & Field	16%	20.3%	18.0%	22.6%
- Cross country race	12%	17.2%	14.0%	17.8%
- Basketball	9%	14%	11.1%	14.3%
- Volleyball	14%	22%	12.2%	19.0%
- Handball	9%	13%	12.1%	15.2%
- Badminton	3.4%	7.3%	4.3%	5.5%
- Table tennis	4.1%	6.4%	4.9%	5.3%
- Gymnastics	0.10%	0.13%	0.76%	-%

Table (2) shows the number and % of primary students participating in different physical activities matches in 1998/1999. It is noticed that the % participation is much lower for primary than secondary school students. Highest participation by males is in football, followed by track & field and cross-country races, whereas in females the highest participation is in track and field and volleyball (Nuweiran and Dhumor, 1999).

Physical Activities in Community Colleges

Until recently the Ministry of Higher Education was supervising the intermediate community colleges. There are no statistics about the participation and involvement of students of these colleges in physical activities. It seems that the short period of stay (2 years) of the students in these colleges is mainly responsible for the limited care of athletics and physical activities in these colleges.

However, there are fields and facilities in many of these colleges: in 1993 there were 15 play fields for football, 35 for basketball, 36 for volleyball, 30 for handball and 36 for tennis.

Physical Activity in Jordanian Universities

The practice of physical activities in Jordanian universities aims at building the physical and psychological make up of students and helping them to have social relationships. Physical activities also aim at organizing competitions and championships with teams in the local community and Arab and non-Arab universities.

The deanship of student affairs guides and organizes the physical activities in each university. Each university has many teams which have competitions in matches and games among different faculties and departments. Furthermore there are championships at the university level and participation in matches with clubs and sport federations.

The most important contribution to physical activities came through establishing faculties of physical education in the University of Jordan and Yarmuk University. More than 2500 B.Sc. students have been graduated from these 2 Universities. Also postgraduate programs (M. Sc.) have been started. Recently 2 other universities, Mu'otah and Hashemiyah have developed faculties for physical education.

Thus the Jordanian Universities provide graduates to work at schools and clubs and participate in the training and supervision of sports and physical activities throughout the country. Research in physical education is also conducted in the universities.

These universities and other official and private universities have many facilities and sports establishments which serve students, staff employees and the local community.

Theoretically there are no real obstacles which face physical activities in Jordanian universities, since facilities are available. However, the increasing number of students require more extension of the sports establishments and services. Also, participation in sports by students is not satisfactory due to a number of barriers, including lack of motivation, lack of interests and social and cultural attitudes, especially among female students. Therefore, more efforts and better facilities, including indoor sport facilities, should be considered in order to increase participation in physical activities.

Physical Activity in the Armed Forces

The first military sports federation was established in 1971 aiming at encouraging armed forces members to better participate in athletics and sports and for strengthening social relationships among them. There are military teams for many types of games (Table 10). These teams have participated in many championships within and outside the country. Naturally, there is a big interest in physical activities and sports among army people. Many matches in army clubs have been performed annually since the 1920s.

Police Sports Federation

There is participation in physical activities among soldiers of the police force at local and regional levels. However, there is need for better facilities, fields and other establishments. The 1993 statistics show that there are 26 referees and 33 trainers attached to the Police and Security Department, with a number of fields for football, basketball, and volleyball, all of which are not legally equipped.

Clubs

As mentioned earlier there are many clubs and federations which are all under the supervision and administration of the Ministry of Youth and Sports. Hundreds of clubs are situated throughout all areas and governorates of the country.

Woman's Participation in Sports and Physical Activities

Participation of Jordanian women in physical activities came late. The first sports team for women in Jordan was established in 1964 at the University of

Jordan. This was followed in 1968 by founding women's athletic teams in Ahli, Orthodoxi and Al-Jeel Al-Jadeed clubs, (PAC/MYS, 1993).

In 1969, the first female national teams of basketball and volleyball were formed. In 1970, four handball teams were formed in Amman, Irbid, Madaba and Zarka.

However, social and cultural factors resulted in a limited level of woman's participation in sports throughout the 1970s. The only individual sport which was encouraged was table tennis. In the 1980s, woman's participation in sports was encouraged by the government and teams were formed in a few of the famous clubs such as Ahli, Orthodoxi and Homentmin. National teams in volleyball, basketball, swimming, gymnastics and track and field athletics came into existence and participated in many local, regional and international games competition.

The Physical Activity of the Aged and Handicapped

In 1982, the Jordanian Federation for the Handicapped was established. It is responsible for the care of disabled and handicapped people through organizing competitions and championships on local and regional levels. The handicapped, depending on the extent of their disability, are guided to participate in hobbies and athletics they can practise,. There is financial support dedicated by the Ministry of Youth and Sports for this purpose.

So far, there is no satisfactory legislation to deal with sports for the aged. The practice of athletics and sports by the aged is not common. There is a need for encouraging athletics for such a group of people, as obesity and malnutrition are common in this age group. Motivation for sports in this group is usually hindered by social barriers. Research is needed in this regard as a means for weight control, increasing vitality and promoting health status.

Physical Activity Medicine

PA medicine is concerned with sports physiology. It guides talented athletes for distribution in the types of sports they are fit for and guides the education of players in the prevention of accidents. Furthermore, it takes care of casualties. Recently, there has been an initiative to educate athletes and team members on their health and the right diet before, during and after athletic events.

A center for sports medicine was established in 1983. Since then it has treated around 5000 cases annually. In addition, the Ministry of Youth and Sports established the first federation for sports medicine in 1988. However, sports medicine faces many obstacles which include:

1. There is an insufficiency in curative care and in the number of physicians.
2. There are no medical records and files for players.
3. There is not enough education and counselling for athletes.

Problems and Obstacles

These have been dealt with under different paragraphs of this report. It is worth mentioning that Jordanian sports and physical activities have developed slowly but satisfactorily. There is a good degree of attention to sports and physical activity from the responsible authorities, mainly the schools, colleges, universities and the Ministry of Youth and Sports. However, much can be done to achieve the slogan of "Sports for All" and increase the participation level of different sectors and strata of the community.

RECOMMENDATIONS

The following recommendations are put forward for promoting the status of sports and physical activity in the country.

At School Level

1. Employment of sufficient numbers of physical education teachers, particularly at the primary stage.
2. Gymnastics needs further care and encouragement; its training should start from an early age (first four grades).
3. To encourage better performance, there should be matches between schools and clubs.
4. In schools with limited athletic facilities and in those with no fields, individual games should be encouraged.
5. School athletics should cover all students and not only the top ones.
6. Increasing the number of physical training sessions.

At the University Level

Although facilities are available, a lot of educational and counselling efforts are needed to encourage students, employees and staff members to participate in sports and types of physical activities available. In addition, there is a need for more facilities, especially as the number of students is increasing in many of the universities.

At the Club and Federation Level

Much can be done by the Ministry of Youth and Sports to upgrade and promote sports:

1. More facilities are needed to encourage women's sports such as indoor-sports facilities and taking care of sports which fit the cultural practices of the people.
2. More education and counselling in different media. TV watching has a negative effect on the fitness and health of our children and even adults. If we cannot ban it, we should use it as a source of education.
3. More care and effort is needed for sports medicine through better medical services, better recording, filing, education and cure.
4. Increasing and improvement of fields and squares and provision of facilities for children to play in and practice physical activities that they enjoy and make them happy.
5. Continuous maintenance of fields and other sports establishments.
6. Use of international standards in furnishing sports establishments.
7. Dedication of a sufficient number of trainers, and continuous refreshing of their knowledge through training courses.

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